SC-CAMLR-XIX

SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

REPORT OF THE NINETEENTH MEETING OF THE SCIENTIFIC COMMITTEE

HOBART, AUSTRALIA
23 – 27 OCTOBER 2000

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Abstract

This document presents the adopted report of the Nineteenth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 23 to 27 October 2000. 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.

CONTENTS

Page

OPENING OF THE MEETING 1
Adoption of Agenda 1
Report of the Chairman 2
Intersessional Activities 2
Intersessional Activities of CCAMLR Members 2

FISHERY STATUS AND TRENDS 2
Krill 2
Harvest Levels for the 1999/2000 Season and Intentions for the 2000/01 Season ... 2
Compliance with Data Reporting Requirements 3
Krill Economics 3
Conversion Factors 3
Fish Catches (All Species from Licensed Fisheries) 4
Reported Catches for *Dissostichus* spp. 4
Estimates of Catch and Effort from IUU Fishing 4
Crabs 5
Squid 6

CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION 6
Advice to the Commission 8

DEPENDENT SPECIES 9
Species Monitored under the CCAMLR
Ecosystem Monitoring Program (CEMP) 9
Assessment of Incidental Mortality 10
Research into the Status of Seabirds at Risk 10
Incidental Mortality of Seabirds during Regulated
Longline Fishing in the Convention Area in 2000 11
Compliance with Conservation Measure 29/XVI 12
Fishing Seasons 12
Assessment of Incidental Mortality of Seabirds during
Unregulated Longline Fishing in the Convention Area 13
Incidental Mortality of Seabirds in relation
to New and Exploratory Fisheries 13
Incidental Mortality of Seabirds during
Longline Fishing outside the Convention Area 14
Research into and Experience with Mitigating Measures 15
Policy Considerations in relation to Mitigating Measures
and Conservation Measure 29/XVI 15
International and National Initiatives relating to Incidental
Mortality of Seabirds in relation to Longline Fishing 17
Incidental Mortality of Marine Mammals in Longline Fisheries 18
Incidental Mortality in Trawl Fisheries 18
Marine Debris 18
Loss or Discard of Fishing Gear 20
Marine Debris collected by Vessels at Sea 20
Surveys of Marine Debris on Beaches 20
Entanglement of Marine Mammals in Marine Debris 21
Marine Debris associated with Seabird Colonies 21
Oil Contamination 21
Report to CEP 21

Fourth International Marine Debris Conference on Derelict Fishing Gear and the Marine Environment 22
Marine Mammal and Bird Populations 22

HARVESTED SPECIES 24
Krill 24
CCAMLR-2000 Survey 24
Krill Length-frequency Data, Biomass and Distribution from Area 48 25
Krill Length-frequency Data, Biomass and Distribution from Area 88 25
Estimates of B_0, Potential Yields and Precautionary Catch Limits 25
Subdivision of Precautionary Catch Limits 26
Development of the GYM 27
Future Analysis of the CCAMLR-2000 Survey 27
Advice to the Commission 27
Fish Resources 28
Fish and Squid Biology/Demography/Ecology 28
Developments in Assessment Methods 29
Assessments and Management Advice 29
Assessed Fisheries 29
Dissostichus spp. 29
D. eleginoides at South Georgia (Subarea 48.3) 29
Standardisation of CPUE 29
Size at Capture 29
Determination of Long-term Annual Yield using the GYM 30
Management Advice for *D. eleginoides* (Subarea 48.3) 30
D. eleginoides at South Sandwich Islands (Subarea 48.4) 31
Management Advice for *D. eleginoides* (Subarea 48.4) 31
D. eleginoides at Ob and Lena Banks (Division 58.4.4) 31
D. eleginoides at Kerguelen Islands (Division 58.5.1) 31
Management Advice for *D. eleginoides* (Division 58.5.1) 32
D. eleginoides at Heard and McDonald Islands (Division 58.5.2) 32
Management Advice for *D. eleginoides* (Division 58.5.2) 32
General Advice on *D. eleginoides* Assessments 33
C. gunnari at South Georgia (Subarea 48.3) 33
Management Advice for *C. gunnari* (Subarea 48.3) 34
C. gunnari at Kerguelen Islands (Division 58.5.1) 34
Management Advice for *C. gunnari* (Division 58.5.1) 35
C. gunnari at Heard and McDonald Islands (Division 58.5.2) 35
Management Advice for *C. gunnari* (Division 58.5.2) 35
Workshop on Assessment Methods for Icefish (WAMI) 36
Other Finfish Fisheries 36
Antarctic Peninsula and South Orkney Islands (Subareas 48.1 and 48.2) 36
Management Advice 36
Divisions 58.4.1 and 58.4.2 36
Management Advice 37
Pacific Ocean Sector (Subareas 88.2 and 88.3) 37
Management Advice 37
Electrona carlsbergi (Subarea 48.3) 37
Management Advice 37
General By-catch Provisions 37
Management Advice 38
Future Work of WG-FSA 38
Crab Resources 38
Management Advice 38
Squid Resources 39
Management Advice 39

ECOSYSTEM MONITORING AND MANAGEMENT 39
  Environmental Variables 39
  Ecosystem Analysis 39
  Ecosystem Assessment 40
    Krill-centred Interactions 40
    Fish and Squid-centred Interactions 41
    Status of the Krill-centred Ecosystem 41
    Further Approaches to Ecosystem Assessment 41
  Future Work 42
  Survey of Land-based Marine Predators 43

MANAGEMENT UNDER UNCERTAINTY 43
  IUU Fishing 43
  Regulatory Framework 43
  Trigger Levels in the Management of the Krill Fishery 47
  Advice to the Commission 47

SCIENTIFIC RESEARCH EXEMPTIONS 47

NEW AND EXPLORATORY FISHERIES 48
  New and Exploratory Fisheries in 1999/2000 48
  New and Exploratory Fisheries Notified for 2000/01 52
    General Issues 52
    Review of Individual Notifications 55

DATA MANAGEMENT 56
  Management of CCAMLR Data 57
  Fishery Monitoring 57
  Data Analysis 58
  Projections for the Intersessional Period 2000/01 58

COOPERATION WITH OTHER ORGANISATIONS 58
  Cooperation with the Antarctic Treaty System 59
    CEP 59
    SAER 59
    Balleny Islands Proposal 59
    Terra Nova Bay Proposal 60
    Management Plans forwarded by the ATCM 60
  Reports of SC-CAMLR Representatives at Meetings
   of Other International Organisations 62
    IWC 62
    SCAR 62
    SCOR 63
  Future Cooperation 63

PUBLICATIONS 64

SCIENTIFIC COMMITTEE ACTIVITIES DURING
THE 2000/01 INTERSESSIONAL PERIOD 65

BUDGET FOR 2001 AND FORECAST BUDGET FOR 2002 66

ADVICE TO SCOI AND SCAF 67

ELECTION OF CHAIRMAN 67

NEXT MEETING 67

OTHER BUSINESS ... 67
Commemoration of CCAMLR-XX ... 67
Species Identification Sheets ... 68
Rapporteur Support ... 68

ADOPTION OF THE REPORT ... 68

CLOSE OF THE MEETING ... 68

REFERENCES ... 69

TABLES ... 70

FIGURES ... 78

ANNEX 1: List of Participants ... 81

ANNEX 2: List of Documents ... 95

ANNEX 3: Agenda for the Nineteenth Meeting of the Scientific Committee ... 107

ANNEX 4: Report of the Working Group on Ecosystem Monitoring and Management ... 111

ANNEX 5: Report of the Working Group on Fish Stock Assessment ... 275

ANNEX 6: Instructions and Example Form for Reporting Sightings of Vessels ... 499

ANNEX 7: Secretariat Tasks in Support of the Scientific Committee for the 2000/01 Intersessional Period ... 503

ANNEX 8: Glossary of Acronyms and Abbreviations used in CCAMLR Reports ... 509

REPORT OF THE NINETEENTH MEETING OF THE SCIENTIFIC COMMITTEE

(Hobart, Australia, 23 to 27 October 2000)

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 23 to 27 October 2000 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, 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 ASOC, CEP, FAO, IUCN, IWC, SCAR and SCOR, and encouraged them to participate in the meeting as appropriate.

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

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

- Dr R. Holt (USA) – Fishery Status and Trends;
- Dr P. Penhale (USA) – Species Monitored in the CCAMLR Ecosystem Monitoring Program;
- Prof. J.P. Croxall (UK) – Assessment of Incidental Mortality;
- Dr K.-H. Kock (Germany) – Marine Mammal and Bird Populations;
- Dr S. Nicol (Australia) – Krill Resources;
- Dr G. Parkes (UK) and Mr C. Jones (USA) – Fish Resources;
- Dr E. Marschoff – Crab Resources;
- Mr B. Watkins (South Africa) – Squid Resources;
- Dr A. Constable (Australia) – Ecosystem Monitoring and Management;
- Drs R. Hewitt (USA) and G. Parkes (UK) – Management under Conditions of Uncertainty about Stock Size and Sustainable Yield;
- Dr I. Everson – New and Exploratory Fisheries;
- Prof. B. Fernholm (Sweden) – Cooperation with Other Organisations; and
- Dr D. Ramm (Secretariat) – all other matters.

Adoption of Agenda

1.6 The Provisional Agenda had been circulated prior to the meeting, and was adopted with the addition, time permitting, of discussion regarding commemorative arrangements for CCAMLR-XX under Item 18 ‘Other Business’ (Annex 3).

Report of the Chairman

Intersessional Activities

1.7 The CCAMLR 2000 Krill Synoptic Survey of Area 48 (CCAMLR-2000 Survey) was undertaken in January–February 2000 by the *Atlantida* (Russia), *James Clark Ross* (UK), *Kaiyo Maru* (Japan) and *Yuzhmorgeologiya* (USA). The survey was the successful culmination of plans set in motion during the 1996 WG-EMM meeting.

1.8 Three CCAMLR meetings were held during the 1999/2000 intersessional period:

(i) the B_0 Workshop to analyse data from CCAMLR-2000 Survey (La Jolla, USA, 30 May to 9 June 2000);

(ii) the meeting of WG-EMM (Taormina, Italy, 17 to 28 July 2000); and,

(iii) the meeting of WG-FSA, including ad hoc WG-IMALF (Hobart, Australia, 9 to 19 October 2000).

1.9 On behalf of the Scientific Committee, the Chair thanked the Conveners for their significant contributions to the meetings and the host countries for providing the necessary facilities. The report of WG-EMM is attached as Annex 4 and that of WG-FSA as Annex 5.

Intersessional Activities of CCAMLR Members

1.10 Catch and effort reports indicated that fisheries conducted in the Convention Area under the conservation measures in force in 1999/2000 targeted *Champsocephalus gunnari* (4 149 tonnes), *Dissostichus* spp. (9 076 tonnes), and *Euphausiasuperba* (101 742 tonnes, based on monthly catch and effort reports), and included new and exploratory fisheries (CCAMLR-XIX/BG/5 Rev. 1). Details are reported in Sections 2 and 9.

1.11 Scientific observers conducted 44 trips on board fishing vessels, and provided complete coverage of fishing for finfish (SC-CAMLR-XIX/BG/18). The Scientific Committee thanked all observers for their great efforts during the past season, and for continuing to develop and improve the amount and quality of data collected (see Section 3).

1.12 Amongst other highlights of 1999/2000, representatives of the Scientific Committee had attended 14 international meetings (see SC-CAMLR-XVIII, paragraph 11.36).

FISHERY STATUS AND TRENDS

Krill

Harvest Levels for the 1999/2000 Season and Intentions for the 2000/01 Season

2.1 Reported catches of krill (*E. superba*) from STATLANT data are shown in Tables 1 and 2. A total of 101 286 tonnes was caught during the 1999/2000 split-year. The catch was taken by Japan, Republic of Korea, Poland, Ukraine and Uruguay.

2.2 The following plans for krill fishing during the 2000/01 season were reported: Japan expects to reduce the number of its vessels from four to three but will maintain its current harvest level; Argentina, the Republic of Korea, South Africa and Uruguay each expect to have one vessel fishing for krill. Both Russia and Ukraine indicated that they would deploy two vessels each. The USA reported it will have one or two vessels fishing and the UK indicated it may have one vessel fishing for krill. No information was received from Poland, which has fished in recent years, nor from Canada, a non-Member nation that has previously stated its intention to fish for krill.

Compliance with Data Reporting Requirements

2.3 The Scientific Committee noted that not all monthly catch and effort reports from the krill fishery were submitted by Members on time subject to the requirements of Conservation Measures 32/X and 40/X (CCAMLR-XIX/BG/5 Rev. 1, Figure 2).

Krill Economics

2.4 The last two meetings of the Scientific Committee have requested information from the krill fishery on past and current market prices for krill products (SC-CAMLR-XVII, paragraphs 2.5 and 2.6; SC-CAMLR-XVIII, paragraph 2.7). This information is needed for economic analysis of the fishery aimed at assessing the economic trends affecting the fishery and developing management strategies which are compatible with the fishery's stage of development (SC-CAMLR-XVII, Annex 4, paragraph 2.9).

2.5 In response to this request, it was reported that the average wholesale price of krill from the Sydney Fish Market ranged between A$2.65 and A$6.91 per kg in the period between 1992 and 1999 (WG-EMM-00/25, Table 4). However, the Scientific Committee noted that information on krill prices from markets where larger quantities of krill were frequently traded was still not available.

2.6 Japan indicated that economic information relative to its krill fishery was complicated and was considered confidential by its fishery. The Scientific Committee acknowledged the need to protect trade information; however, much of the information it needed to manage the fishery was public information. The Scientific Committee reiterated the need for economic information from all Members associated with the krill fishery.

Conversion Factors

2.7 At last year's meeting the Scientific Committee noted WG-EMM's discussion of conversion factors (CFs) used to estimate the total catch of krill and that the Japanese had provided descriptive information (SC-CAMLR-XVIII, paragraph 2.5). However, there is still little quantitative information on the exact conversion rates relating krill green weight to different products from the various fishing fleets, fishing areas or seasons.

2.8 The Scientific Committee agreed that confidentiality of fisheries on CF data may be an issue, however, some data were available in the literature and these might allow a more rigorous approach to estimating CFs. For example, Yoshida (1995) which provides economic information and CFs for *Euphausia pacifica* may provide valuable information relevant to *E. superba*.

2.9 Dr Everson also indicated that biochemical composition in krill compared to krill products may yield information relevant to CFs (e.g. there is a narrow tolerance of water associated to krill meal which can be examined to determine CFs). Consequently, the Scientific Committee supported WG-EMM's approach to task a small subgroup, convened by Dr Everson (Annex 4, paragraph 2.9) to take the matter of CFs further during the intersessional period.

Fish Catches (All Species from Licensed Fisheries)

2.10 Catches reported from the Convention Area during the 1999/2000 split-year are presented in Tables 3 and 4. The total reported catch of all finfish in the Convention Area was 19 283 tonnes. This was slightly greater than the 18 094 tonnes caught during the 1998/99 split-year. The major catches of finfish in 1999/2000 include: 8 892 tonnes in Subarea 48.3, 5 214 tonnes in Division 58.5.1, 2 665 tonnes in Division 58.5.2, 854 tonnes in Subarea 58.6, and 869 tonnes in Subarea 88.1.

2.11 The Scientific Committee also drew the attention of the Commission to the catch information for individual species given in SC-CAMLR-XIX/BG/1 Rev. 1 and CCAMLR-XIX/BG/5 Rev. 1. The Scientific Committee recognised that distillation of these papers into summary paragraphs in its report is a difficult task and requested that the Commission consider how it would wish catches be reported to the Commission through the Scientific Committee report. It also requested that WG-FSA consider at its next meeting how best to present catch information in line with the advice of the Commission.

2.12 It was noted that the fishery for *C. gunnari* in Subarea 48.3 had exceeded the catch limit of 4 036 tonnes by 74 tonnes (Annex 5, Table 1). This was attributable to late reporting of catch data to the Secretariat and a consequential late closure of the season. It was agreed that better adherence to the reporting requirements should occur so that catch limits are not routinely exceeded.

2.13 Although the Scientific Committee does not normally elicit responses from Members concerning their intention to participate in established finfish fisheries, it was encouraged to hear that Brazil had informed the Commission of its intention to enter the *Dissostichus eleginoides* fishery in Subarea 48.3 for the first time. Likewise, the UK also expressed the expectation that it will have three to four vessels participating in the same fishery and, in addition, one in the experimental pot fishery for *D. eleginoides*.

Reported Catches for *Dissostichus* spp.

2.14 The total green-weight landings of *Dissostichus* spp. for the 1999/2000 split-year from the licensed fishery was estimated as 14 441 tonnes. This was a decrease compared to the previous split-year (17 558 tonnes). Reported catches from waters outside the Convention Area are given in Table 5 and totalled 11 553 tonnes. This gave a reported total of 25 994 tonnes (Annex 5, paragraph 3.19).

Estimates of Catch and Effort from IUU Fishing

2.15 WG-FSA used the approach adopted at its 1998 meeting to estimate the magnitude of IUU fishing effort and catches of *Dissostichus* spp. in various subareas and divisions during the 1999/2000 split-year. The results of this analysis indicate that the estimated unreported catch for all subareas and divisions in the Convention Area was 6 546 tonnes (Annex 5, Table 5). This compares to an estimated IUU catch of 4 913 tonnes in the 1998/99 split-year and 22 415 tonnes in 1997/98.

2.16 The Scientific Committee recognised that estimating IUU catches has become increasingly more difficult, primarily due to transhipments on the high seas which are difficult to track through the sources available to its working group. Consequently, estimates of IUU catches are likely to be underestimates of the true catches to an unknown extent.

2.17 The Scientific Committee noted that the IUU fishery appears to be concentrated in Area 58. However, up to four Argentinian vessels were known to have fished illegally in Subarea 48.3. In Area 58, the IUU fishery targets known plateaux or topographic features, in particular the Kerguelen Plateau (Kerguelen and Heard Islands) or the area around Crozet Islands. The oceanic banks (Ob and Lena, Division 58.4.4) and Africana/Del Cano Rise (Subarea 58.6) are also subject to IUU fishing.

2.18 Mauritius remains the primary site for the landing of IUU-caught fish, in particular after May 2000 when the Catch Documentation Scheme for *Dissostichus* spp. (CDS) came into force. The implementation of the CDS appears to be having other impacts on IUU fishing, with indications that fish without CDS papers are sold at a discounted price.

2.19 With the advent of CDS data as an additional information source, the Secretariat was tasked with reconciling estimated IUU catches with reported catches intersessionally. This will serve as a preliminary assessment in developing further data with which to track IUU fishing.

2.20 The Ukraine alerted the Scientific Committee to the fact that there were reports that a substantial trawl fleet currently operating in the Indian Ocean may relocate to the Southern Ocean once they deplete fish stocks now being fished.

2.21 France reported IUU fishing vessels which fish on the Kerguelen and Crozet plateaux are very aggressive and endanger legal fishing vessels.

2.22 The Scientific Committee concluded that IUU fishing compromises the ability of CCAMLR to manage its fisheries. However, it noted that to date estimates of IUU catches had been factored into assessments of *Dissostichus* spp. potential yield (especially *D. eleginoides* in Subarea 48.3 and Division 58.5.2).

2.23 Chile indicated its registered vessels are required to carry an automatic vessel positioning device which prevents them from participating in IUU fishing. Further expansion of this requirement by other countries, as is required by Conservation Measure 148/XVII, would greatly reduce the IUU fishing effort.

2.24 With regard to IUU fishing, the Scientific Committee agreed that it was important for observers to record and report sightings of vessels fishing in the Convention Area. However, observer sightings must be factual and not accusatory. Therefore, it was agreed to develop a standard form of recording this information. An example is attached as Annex 6 and will be provided to observers (via technical coordinators) to test in the field during the forthcoming season. The matter will be reviewed by the Scientific Committee at its next meeting.

Crabs

2.25 No fishing for crab species occurred in the Convention Area during the 1999/2000 season.

2.26 The USA and Uruguay had notified their intention to fish for crabs in Subarea 48.3 during the 2000/01 season. The US vessel has already fulfilled the requirement of an experimental harvest regime set out in Conservation Measure 150/XVIII, whereas the Uruguayan vessel has not.

2.27 At the meeting, the UK also indicated their intention to participate in the crab fishery in Subarea 48.3 during the 2000/01 season.

Squid

2.28 No fishing for squid occurred in the Convention Area during the 1999/2000 season.

2.29 The UK and the Republic of Korea have resubmitted a joint proposal to conduct an exploratory fishery on *Martialia hyadesi* in Subarea 48.3 during the 2000/01 season.

CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

3.1 In the 1999/2000 season, 44 fishing trips in the Convention Area were observed by CCAMLR-designated scientific observers, or national observers, from Argentina, Australia (national observers), Chile, France (national observers), South Africa, Ukraine, UK, Uruguay and the USA (SC-CAMLR-XIX/BG/18). The fisheries targeted *C. gunnari*, *Dissostichus* spp. or *E. superba*.

3.2 The Scientific Committee noted further substantial improvement in the quality and timing of the submission of the observer reports and logbooks. In addition, the Secretariat had completed all the tasks set last year to improve scientific observations (SC-CAMLR-XVIII, paragraphs 3.14, 3.17 and 3.18). The Scientific Committee thanked all scientific observers for their work during the 1999/2000 fishing season and for the quality and quantity of information collected.

3.3 The Scientific Committee noted the discussion of WG-EMM in relation to scientific observations on board vessels targeting *E. superba* (Annex 4, paragraphs 2.15 to 2.31), and in particular:

(i) the placement of a CCAMLR-designated scientific observer from the USA on board the *Chiyo Maru No. 5* from Japan which was fishing for krill in Subarea 48.1 at the time of the CCAMLR-2000 Survey (Annex 4, paragraph 2.16);

(ii) the placement of a national scientific observer on board a Ukrainian krill vessel operating in Subarea 48.2 during May–June 1999 (Annex 4, paragraph 2.30); and

(iii) the drafting and distribution by the Secretariat of a questionnaire seeking information on krill fishing strategies (Annex 4, paragraph 2.21).

3.4 The Scientific Committee noted that the captain of the *Chiyo Maru No. 5* had not allowed the CCAMLR observer on the fishing deck or in the factory area because of safety concerns. This restriction had resulted in problems observing catches of krill and by-catch, describing time budgets and collecting data on product weight to catch weight CFs (Annex 4, paragraphs 2.18 and 2.19). Dr Holt appreciated the concern, but confirmed that the CCAMLR observer did have extensive experience and training in conducting observations on board fishing vessels, and was accredited for work on deck and in the processing areas.

3.5 The Scientific Committee noted that the by-catch of juvenile fish recorded by the observers on the Japanese and Ukrainian krill trawlers did not appear to be large, although it was recalled that the observer on the Japanese vessel did not have direct access to the catches (Annex 4, paragraphs 2.29 to 2.31).

3.6 The Scientific Committee also noted that there had been no feedback or responses to the draft questionnaire seeking information on krill fishing strategies. The Scientific Committee recommended that the Secretariat reissue the draft questionnaire. Members were urged to provide comments on, and if possible complete, this questionnaire as this information is urgently needed by WG-EMM. The Scientific Committee reminded Members that the purpose of the questionnaire was to develop an understanding of the fishing operation, and possible ways to use data on CPUE. Proprietary/confidential information was not required.

3.7 Dr E. Goubanov (Ukraine) advised that the collection of biological data on krill required highly qualified scientific observers. A number of Ukrainian observers had such qualifications, as well as extensive experience in krill fisheries, and were available for deployment within the Convention Area.

3.8 The Scientific Committee noted the discussion of WG-FSA in relation to scientific observations on board vessels targeting finfish (Annex 5, paragraphs 3.35 to 3.54), and in particular:

(i) the quality of the reports has been good, with all logbooks presented in CCAMLR format, and 14 logbooks (35%) received were submitted using the CCAMLR electronic forms in Microsoft Excel format (Annex 5, paragraph 3.37);

(ii) there were no significant problems reported by observers on the use of the S*cientific Observers Manual* (Annex 5, paragraph 3.46); and

(iii) the revised waste disposal form used this year had improved the quality of data on the disposal of fishing gear, oil, organic and inorganic galley waste and plastic packaging bands (Annex 5, paragraph 3.40).

3.9 Prof. G. Duhamel (France) confirmed that two observers on board the French-flagged longliners operating in the exploratory fishery for *D. eleginoides* in Subarea 58.6 were of French nationality (see also Annex 5, paragraph 3.36). These vessels had operated for a short period of time in that fishery, and technical problems had prevented the deployment of CCAMLR-designated scientific observers. This problem would be resolved before conducting further fishing trips to those grounds.

3.10 Dr Goubanov made a number of recommendations for changes to the observer logbook forms, including removing the requirement to measure sea-surface temperature, recording the vertical opening of trawls and replacing the recorded bottom depths at the start and end of a tow with the maximum and minimum bottom depth during the tow. The Scientific Committee noted these recommendations.

3.11 The Scientific Committee also noted the limited number of sightings of fishing vessels reported by scientific observers (Annex 5, paragraph 3.52). A subgroup was formed to develop a form with the aim of improving the quality and frequency of this type of reporting (see paragraph 2.24).

3.12 The Scientific Committee noted that WG-FSA had revised the sampling requirements for exploratory fisheries (Annex 5, paragraph 3.49). The Scientific Committee agreed that while length-frequency and sex data should continue to be recorded for at least 100 individuals of *Dissostichus* spp., samples for biological studies (e.g. ageing) should be taken and gonad stages recorded for at least 30 fish.

Advice to the Commission

3.13 The Scientific Committee drew the Commission's attention to the continued, high quality of data collected by both CCAMLR-designated scientific observers and national scientific observers. These data had greatly contributed to the work of WG-EMM and WG-FSA.

3.14 The Scientific Committee advised that further wider deployment of scientific observers on board krill trawlers, and the reporting of their data to the Secretariat, should be encouraged. The Scientific Committee stressed the need to deploy scientific observers on board vessels entering a fishery, or participating in the development of a fishery, at times when quality data were essential for successful long-term management of the fishery. To improve the collection of this scientific information, the Scientific Committee recommended the placement of national and, or, international scientific observers, following the protocols outlined in the *Scientific Observers Manual,* in krill fisheries, consistent with other CCAMLR fisheries.

3.15 The Scientific Committee wished to bring to the attention of the Commission that some Members require specific reference to CCAMLR-designated scientific observers in conservation measures dealing with krill fisheries before this requirement can be passed in national legislation.

3.16 The Scientific Committee advised that national observers should follow the guidelines given in the *Scientific Observers Manual*. Proposals for improving the manual with specific reference to the krill fishery should also be solicited.

3.17 The Scientific Committee advised that factual information provided by scientific observers on the sighting of fishing vessels was useful in evaluating the level of fishing vessel activity in the Convention Area. A new data form and guidelines (Annex 6) were developed for inclusion in the *Scientific Observer Manual*. This form aims to improve the quality and frequency of this type of reporting.

3.18 The Scientific Committee advised that, particularly for vessels with only one scientific observer, the number of currently specified tasks is such that urgent attention is needed to the prioritisation of duties and to reassessment of sampling requirements (Annex 5, paragraph 3.51).

3.19 Finally, the Scientific Committee advised that, where possible:

(i) two scientific observers should be deployed on board each vessel operating in fisheries where requirements for observer data are high;

(ii) scientific observers should record and submit data using the CCAMLR electronic forms in Microsoft Excel format; and

(iii) scientific observers should record data on CFs on a fish-by-fish basis.

3.20 The Scientific Committee recalled the requirement for CCAMLR-designated scientific observers in the exploratory fishery for *M. hyadesi* in Subarea 48.3 (Conservation Measure 183/XVIII, paragraph 3). In that regard, it was noted that the joint notification by the UK and the Republic of Korea indicated that the Korean-flagged vessel which will participate in that fishery in 2000/01 will carry at least one CCAMLR scientific observer designated by the UK (CCAMLR-XIX/8).

DEPENDENT SPECIES

Species Monitored under the CCAMLR Ecosystem Monitoring Program (CEMP)

4.1 Dr Hewitt began the presentation of the WG-EMM report by noting that the Working Group had reviewed the summary report on CEMP indices (WG-EMM-00/26) and thanked the Secretariat for the significant progress made in organising and summarising the CEMP data.

4.2 In particular, the introduction of electronic data forms facilitated the rapid submission of data, reduced errors and improved the quality and utility of the data.

4.3 The Scientific Committee reiterated its wish to have updated CEMP data available at WG-EMM each year. It also endorsed the value of the summaries and pointed out that work was under way to develop new methods (e.g. composite indices) for examining the data and focusing on specific questions of interest to CCAMLR.

4.4 A number of papers reported on the reproductive performance of seabird and pinniped populations (Annex 4, paragraphs 3.11 to 3.15), and these were noted by the Scientific Committee, in particular:

(i) a report on chick provisioning and survival among Adélie penguins at Béchervaise Island (Division 58.4.2) summarised data from nine seasons and indicated the importance of distance of the sea-ice edge from the colony and the availability of food during the guard stage of the breeding cycle. It was suggested that competition with fisheries for food, if it occurs during the early chick-rearing period, is likely to have the greatest impact on the penguin population at Béchervaise Island (Annex 4, paragraph 3.11);

(ii) macaroni penguin populations at Bouvet Island (Subarea 48.6) increased and chinstrap populations decreased relative to counts in the 1996/97 season. The decrease in chinstrap population was attributed to a habitat change (Annex 4, paragraph 3.14); and

(iii) an overview of pinniped research at Cape Shirreff in the 1999/2000 season indicated that reproductive performance for adult females and for the growth of pups were above average. Additionally, dive data suggested that foraging fur seals were working well within their physiological limits for diving (Annex 4, paragraph 3.15(ii) and (iii)).

4.5 The Scientific Committee noted that the Subgroup on Designation and Protection of CEMP Sites, chaired by Dr P. Penhale (USA) and coordinated by Dr E. Sabourenkov (Secretariat), had undertaken ground work during the 1999/2000 intersessional period. Membership of this group included Drs A. Constable (Australia), E. Fanta (Brazil), K. Kerry (Australia) and M. Naganobu (Japan), Prof. D. Torres (Chile), Drs K. Shust (Russia) and P. Wilson (New Zealand), with Drs S. Kawaguchi (Japan) and Y. Lee (Republic of Korea) being added.

4.6 The Scientific Committee endorsed the Working Group recommendation to approve the revision of the Seal Islands Management Plan and the revision of the Cape Shirreff Management Plan.

4.7 The Scientific Committee also endorsed the Working Group recommendation that the conservation measures related to the CEMP sites (Conservation Measures 18/XIII, 62/XI and 82/XIII) be reorganised (Annex 4, paragraphs 5.21 to 5.24).

4.8 The intent of the reorganisation of these conservation measures was to separate the procedures for according protection of CEMP sites (including guidance to writing management plans and the Code of Conduct which apply to all plans) from the designation of individual sites with associated management plans.

4.9 The Working Group reviewed the CEMP site maps provided in response to a request by the Secretariat for improved site maps. Maps were requested from 11 Member countries and were received from five. The maps from New Zealand were viewed as meeting the criteria and should provide an excellent example for others to follow. The maps from Norway and the UK were also considered as meeting the criteria. The maps provided by Australia, which gave excellent information when viewed as the colour originals on the CCAMLR website, were difficult to assess when printed in black and white. The maps from Japan would benefit from minor technical improvements.

4.10 The Working Group recommended that the subgroup review the criteria provided in the Antarctic Treaty System for the production of maps of protected areas and in Conservation Measure 18/XIII, Part A, as a background to developing guidance for CCAMLR Members who plan to produce maps of CEMP sites.

4.11 The Working Group recommended that ancillary information, possibly in GIS format, that Member countries wished to provide could be posted on an individual country website with a direct linkage from the CEMP map section of the CCAMLR website.

Assessment of Incidental Mortality

4.12 The Scientific Committee reviewed the report of ad hoc WG-IMALF. It endorsed the report and its conclusions, subject to the comments set out below, and drew these to the attention of the Commission.

Research into the Status of Seabirds at Risk

4.13 The Scientific Committee encouraged the review and further acquisition of data on:

(i) size and trends of populations of albatross species and of *Macronectes* and *Procellaria* petrel species vulnerable to interactions with longline fisheries (Annex 5, paragraph 7.9);

(ii) the foraging ranges of populations of these species adequate to assess overlap with areas used by longline fisheries (Annex 5, paragraph 7.9); and

(iii) genetic research relevant to determining the provenance of birds killed in longline fisheries (Annex 5, paragraph 7.12).

4.14 The Scientific Committee noted that it would also be useful to collate and summarise available demographic data on relevant species and populations; it encouraged WG-IMALF to consider how this might be achieved. It is suggested that some preliminary summary (e.g. of relevant published literature) could be prepared in time for the next meeting of WG-EMM.

Incidental Mortality of Seabirds during Regulated
Longline Fishing in the Convention Area in 2000

4.15 The Scientific Committee noted the results and conclusions of the comprehensive analysis of this year's data (Annex 5, paragraphs 7.24 to 7.50 and Tables 48 to 52):

(i) For Subarea 48.3 the total estimated seabird by-catch was 21 birds, at a rate of 0.0004 birds/thousand hooks (Annex 5, paragraphs 7.32 and 7.33) (compared with 210 birds at a rate of 0.01 birds/thousand hooks last year). Fishing season restrictions and improved compliance with Conservation Measure 29/XVI have reduced by-catch in the regulated fishery in this subarea to negligible levels (Annex 5, paragraph 7.49).

(ii) For Subareas 58.6 and 58.7 the total estimated seabird by-catch was 516 birds (a three-fold increase over last year) at a rate of 0.02 birds/thousand hooks (compared with 0.03 birds/thousand hooks last year) (Annex 5, paragraphs 7.34 and 7.35). Increased by-catch this year was mainly due to greater fishing effort, but poorer compliance with Conservation Measure 29/XVI also contributed (Annex 5, paragraph 7.50).

(iii) Differences in by-catch rates between Subarea 48.3 and Subareas 58.6 and 58.7 were clearly attributable to:

(a) vessels in the latter subareas fishing in close proximity to major breeding sites of albatrosses and petrels during their breeding season; and

(b) poor compliance with night-time setting requirements (Annex 5, paragraph 7.43).

The Scientific Committee endorsed the recommendation of the Working Group that fishing within 200 n miles of the Prince Edward Islands should be prohibited from January to March inclusive (Annex 5, paragraph 7.44).

(iv) For Subarea 88.1 there had been no seabird by-catch for the third successive year, due to strict compliance with Conservation Measure 29/XVI (including the exemption from night setting) and Conservation Measure 190/XVIII (Annex 5, paragraph 7.47). In addition to continuing to use streamer lines that met all specifications in Conservation Measure 29/XVI, no offal discharge was made at any time during the cruise, in full compliance with Conservation Measure 190/XVIII. No seabird by-catch was reported for fishing in Division 58.4.4 (Annex 5, paragraph 7.31).

4.16 The Scientific Committee commended the achievement of the progressive reduction of seabird by-catch in Subarea 48.3 to a level now regarded as negligible (Annex 5, paragraph 7.49 and Table 52). It noted that some improvement was still possible for Subareas 58.6 and 58.7.

4.17 Mr Watkins commented that 68% of the seabird by-catch in Subareas 58.6 and 58.7 had been taken on just 49 (2.8%) of 1 748 sets, indicating that the problem was, in fact, a very restricted one.

4.18 The Scientific Committee noted concerns over issues relating to the proportion of hooks being observed to derive estimates of seabird by-catch. It encouraged intersessional work to estimate the proportions of hooks which needed to be observed in order to derive reliable estimates of seabird by-catch. It recognised, however, that complementary to this work was a reinvestigation of the appropriate regime for sampling of the fish catch by the scientific observer. Both sampling strategies also need to be reviewed in the light of the subdivision and prioritisation of the tasks of observers, particularly on vessels where it is only possible to accommodate one observer (see also paragraph 3.18).

4.19 Mr I. West (New Zealand) expressed concern that some observers incorrectly report the proportions of hooks observed. He noted that it is a simple operational task to get this right. The Scientific Committee requested technical coordinators to take particular care in briefing scientific observers on this matter.

4.20 The Scientific Committee endorsed the desirability of obtaining data on incidental mortality of seabirds in the French EEZs in Subarea 58.6 and Division 58.5.1 so that a fully comprehensive evaluation, covering the whole of the Convention Area, could be conducted.

4.21 Prof. Duhamel indicated that full data were collected by observers on each vessel fishing in the French EEZs but that the time required to process these data had delayed submitting reports to CCAMLR; he indicated that appropriate reports would be submitted to CCAMLR next year.

4.22 The Scientific Committee welcomed this and noted that, in addition to reports, it was important to receive the data themselves in a form comparable to those reported for all other parts of the Convention Area.

Compliance with Conservation Measure 29/XVI

4.23 The Scientific Committee noted the detailed review of this topic (Annex 5, paragraphs 7.51 to 7.60 and Tables 53 to 55) and the conclusions that overall compliance with this conservation measure this year, compared to last year, was slightly improved in Subarea 48.3, slightly poorer in Subareas 58.6 and 58.7, poor in Division 58.4.4 and complete in Subarea 88.1 (Annex 5, paragraph 7.192(i)). It recognised that, apart from the continuing failure of all vessels to comply with the line-weighting regime, the problems seemed mainly to relate to the inability or unwillingness of particular vessels to comply with the provisions relating to streamer lines, offal discharge and night setting. The Scientific Committee was additionally concerned at the compliance failure of vessels entering the longline fishery in the Convention Area for the first time (Annex 5, paragraph 7.60).

4.24 The Scientific Committee welcomed the analysis of vessel performance by region and year (Annex 5, Table 55), recognising that this highlighted those vessels most in need of action and assistance to rectify their continuing failure to comply with this conservation measure.

4.25 Prof. C. Moreno (Chile) observed that he had some initial reservations concerning highlighting vessels in this way but recognised that not only would it help improve their performance in CCAMLR waters but that such improvement – particularly where involving structural reconfiguration – would also ensure improved performance when they operated outside the Convention Area. The Scientific Committee endorsed these views.

Fishing Seasons

4.26 The Scientific Committee noted a brief retrospective analysis (Annex 4, paragraph 7.63) indicating that the Commission decision last year to delay the start of longline fishing probably contributed significantly to the reduction in seabird by-catch in Subarea 48.3.

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

4.27 The Scientific Committee noted that:

(i) Estimates of potential seabird by-catch have been made using two alternative catch rates; the average catch rate for all cruises in the regulated fishery (lower level) and the highest catch rate for any cruise in the regulated fishery for that period (higher level) (Annex 5, paragraph 7.64).

The estimates for 2000 (Annex 5, paragraphs 7.70 to 7.74, Tables 56 and 57) were:

Subarea 48.3:	1 800–2 400 to 6 500–8 800 seabirds;
Subareas 58.6 and 58.7:	15 400–20 600 to 27 900–37 800 seabirds;
Divisions 58.5.1 and 58.5.2:	7 000–10 300 to 14 100–18 900 seabirds; and
Division 58.4.4:	1 700–3 000 to 2 200–4 100 seabirds.

(ii) The overall estimated totals for the whole Convention Area (Annex 5, paragraph 7.75 and Table 57) indicated a potential seabird by-catch in the unregulated fishery of 26 400–35 300 (lower level) to 50 900–68 300 birds (higher level) in 1999/2000. At the higher level, this compares with totals of 66 000–107 000 in 1996/97, 76 000–101 000 in 1997/98 and 44 000–59 000 in 1998/99.

(iii) The species composition of the estimated potential higher level seabird by-catch (Annex 5, Table 58) indicates a potential by-catch of 21 900–68 000 albatrosses, 5 000–11 000 giant petrels and 79 000–178 000 white-chinned petrels in the unregulated fishery in Convention Area over the last four years (Annex 5, paragraph 7.81).

4.28 The Scientific Committee, while noting the large, and possibly increasing, uncertainties pertaining to these estimates, endorsed its conclusion of last year that such levels of mortality are entirely unsustainable for the populations of albatrosses, giant petrels and white-chinned petrels breeding in the Convention Area (Annex 5, paragraph 7.80).

4.29 The Scientific Committee requested WG-IMALF to consider the extent to which the potential levels of seabird by-catch in IUU fisheries in the Convention Area can be related to the population levels (and population trends if possible) of the principal target species and species groups and what additional monitoring of local populations may be required to ensure that these populations are not threatened.

4.30 The Scientific Committee recommended that the Commission continue to take the most stringent measures possible to combat unregulated fishing in the Convention Area (Annex 5, paragraph 7.82).

Incidental Mortality of Seabirds in relation
to New and Exploratory Fisheries

4.31 The Scientific Committee noted that:

(i) of the 22 new and exploratory fisheries approved for 1999, only four were operational in 1999/2000; no seabird by-catch was reported for any of these fisheries (in Subareas 58.6 and 88.1, and Division 58.4.4) (Annex 5, paragraphs 7.90 and 7.91);

(ii) the assessment of potential risk of interactions between seabirds and longline fisheries for all statistical areas in the Convention Area was reviewed, revised for Subareas 88.1 and 88.2, and provided as advice to the Scientific Committee and Commission in SC-CAMLR-XVIII/BG/23 and Annex 5, paragraph 7.88, noting particularly the correction in Annex 5, paragraph 7.89. The codes for potential risk of interaction with seabirds for Subareas 48.1 and 48.4 should be 1 and 3 respectively (not 2 as depicted);

(iii) the 33 proposals by six Members for new and exploratory longline fisheries in 14 subareas/divisions of the Convention Area in 2000/01 were addressed, in relation to advice in SC-CAMLR-XVIII/BG/23 and Annex 5, Table 59; and

(iv) the potential problems identified, from the perspective of WG-IMALF, were:

(a) in proposals by Argentina for Subareas 48.1 and 48.2 and Divisions 58.4.2, 58.5.1 and 58.5.2. The desired year-round fishing season has substantial overlap with the recommended season closures to protect seabirds (Annex 5, paragraph 7.195(a));

(b) in proposals by France (for Divisions 58.4.3, 58.4.4, 58.5.1, 58.5.2 and Subareas 58.6 and 58.7), which do not specify a fishing season so cannot be assessed in this important regard (Annex 5, paragraph 7.195(iv)(b); and

(c) in Subarea 88.1, where there are important issues relating to exemptions from the night-setting requirements of Conservation Measure 29/XVI (Annex 5, paragraphs 7.94 to 7.103).

4.32 The Scientific Committee supported the New Zealand proposal to continue the line-weighting experiment in Subarea 88.1, and endorsed the Working Group recommendations as set out in Annex 5, paragraphs 7.95 to 7.103.

4.33 In summary, these recommendations were that all vessels in Subarea 88.1 and requiring the exemption from the night-setting requirements of Conservation Measure 29/XVI must undergo sink rate line certification (Annex 5, paragraph 7.98) prior to entering the subarea and comply with all the experimental protocols of the existing sink-rate experiment. Any vessel catching a total of three (3) seabirds must immediately revert to night setting as required in Conservation Measure 29/XVI.

4.34 However, it recognised that potential difficulties might exist (depending on the number and nature of vessels operating in the fishery in Subarea 88.1) in implementing this advice in respect of:

(i) a specified level of seabird by-catch triggering in real time the potential closure of the fishery (by reversion to the night-setting provisions of Conservation Measure 29/XVI); and

(ii) the ability of vessels other than autoliners to undertake line-weighting experiments of the kind specified in Annex 5, paragraph 7.96.

Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area

4.35 The Scientific Committee noted that the only formal report received related to by-catch of black-browed albatrosses (probably from South Georgia) in the Japanese autoliner longline fishery around Tristan da Cunha and Gough Islands (Annex 5, paragraphs 7.104 and 7.105). It sought clarification as to the current obligations of Japanese longline fishing vessels relating to use of mitigating measures in respect of seabird by-catch.

4.36 The Scientific Committee endorsed the Working Group request to Members for reports from regions adjacent to the Convention Area, on longline fishing effort, on incidental mortality of seabirds and on implementation of mitigating measures (Annex 5, paragraphs 7.111 and 7.112). It also regretted the absence of any feedback to the WG-IMALF meeting from CCAMLR observers at meetings of the various tuna commissions (Annex 5, paragraphs 7.182 and 7.183).

Research into and Experience with Mitigating Measures

4.37 The Scientific Committee noted the promising results obtained from trials, in waters within or adjacent to the Convention Area, of underwater setting devices:

(i) by South Africa, of the Mustad funnel in Subareas 58.6 and 58.7 where, on night-time and daytime sets in summer, seabird by-catch was reduced from 0.013–0.009 and 0.03–0.02 birds/thousand hooks respectively; and

(ii) by Australia, using a funnel setting at 6 m depth, in its domestic tuna longline fishery, eventually resulting in zero seabird by-catch (Annex 5, paragraph 7.119).

It strongly encouraged further trials of these and similar devices, as they are likely to represent an effective solution to the seabird by-catch problem in the medium to long term.

4.38 Similarly, the Scientific Committee strongly encouraged trials with and reports on the use of streamer-line configurations and line-weighting regimes that might permit improvements to these elements of Conservation Measure 29/XVI to be achieved (Annex 5, paragraphs 7.123 to 7.125 and 7.150).

4.39 The Scientific Committee noted that:

(i) New Zealand vessels operating in Subarea 88.1 successfully achieved the required line-sink rates in their line-weighting experiments (Annex 5, paragraph 7.128);

(ii) the advice that some further trials are required before a weighting regime for autoliners could be incorporated into Conservation Measure 29/XVI (Annex 5, paragraph 7.148); and

(iii) no seabird by-catch had been reported in association with the experimental use of pots to catch *D. eleginoides* in Subarea 48.3 (Annex 5, paragraph 7.129).

Policy Considerations in relation to Mitigating Measures and Conservation Measure 29/XVI

4.40 The Scientific Committee noted and endorsed the advice that:

(i) Conservation Measure 29/XVI is the key element in minimisation of incidental mortality of seabirds during longlining in the Convention Area. Compliance is still substantially deficient, particularly in some key elements. Improving the current situation requires:

(a) further development of underwater setting, which offers the most likely medium- to long-term solution to the problem;

(b) work to develop line-weighting regimes to ensure sink rates that will preclude seabirds accessing bait. This offers the best short-term solution, as well as the likelihood of permitting exemption from several other mitigating measures currently in use in the Convention Area; and

(c) in the meantime, better compliance with the existing suite of mitigation measures in Conservation Measure 29/XVI is essential (Annex 5, paragraphs 7.134 and 7.135);

(ii) the main issues relating to compliance with Conservation Measure 29/XVI are:

(a) how to get fishers to comply with the straightforward elements of the conservation measure, in respect of offal discharge, streamer lines and night setting;

(b) how to tackle the consistent inability of vessels to comply with the element of the conservation measure that specifies the line-weighting regime for Spanish system longliners; and

(c) how to develop the requirements for an appropriate line-weighting regime for autoliners (Annex 5, paragraph 7.136).

4.41 The Scientific Committee endorsed the suggested means of addressing these problems (Annex 5, paragraphs 7.138 to 7.150), and drew the particular attention of the Commission to the advice that:

(i) given the simplicity of complying with the elements of Conservation Measure 29/XVI relating to offal discharge, night setting and streamer lines, vessels unable, or failing, to comply with these elements should be prohibited from fishing in the Convention Area. This should be emphasised to technical coordinators, fishing companies and national authorities at the earliest opportunity (Annex 5, paragraphs 7.151 to 7.153);

(ii) in circumstances where all other elements of Conservation Measure 29/XVI apply (e.g. in respect of night setting, streamer lines and offal discharge) and with appropriate closed seasons, the line-weighting regime for the Spanish system of longlining should be set at weights of a minimum of 8.5 kg spaced at no more than 40 m intervals (Annex 5, paragraph 7.146);

(iii) once experimental trials of autoline weighting are completed in Subarea 88.1 and similar trials have been carried out in areas of higher risk to seabirds, it should be possible to recommend a line weighting for autoline vessels that will have utility for all subareas of the Convention Area (Annex 5, paragraph 7.148); and

(iv) that the ultimate aim in managing seabird by-catch in the Convention Area will be to allow fishing at any time of day without seasonal closure of fishing grounds. However, current indications are that allowing fishing in summer, at night, using streamer lines, proper offal discharge practices and c. 40 m between weights on longlines (existing practice for Spanish system vessels), will still result in unacceptably high mortality of seabirds. Clearly, more time is required to allow experimentation into the effectiveness of line-weighting concepts and underwater setting devices with the Spanish system that will reduce seabird by-catch and be more acceptable to the fishing industry. In the meantime, seabird by-catch in the Convention Area should be managed in accordance with practices adopted in

Subarea 48.3, where a combination of a closed season in summer, night setting, the use of streamer lines and proper offal discharge practices has effectively solved the seabird by-catch problem (Annex 5, paragraphs 7.149 and 7.150).

4.42 The Scientific Committee further advised that, once full compliance with Conservation Measure 29/XVI was achieved, together with negligible levels of seabird by-catch, any relaxation of closed seasons should proceed in a step-wise fashion (e.g. similar to the process by which the closed season was extended) and the results of this carefully monitored and reported.

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

4.43 The Scientific Committee recollected the Commission requests (CCAMLR-XVII, paragraph 6.27; CCAMLR-XVIII, paragraph 6.15) that Members implement by 2001 their National Plans of Action (NPOAs) in support of the FAO International Plan of Action on the Reduction of Incidental Catch of Seabirds in Longline Fisheries (IPOA–Seabirds). In this connection it welcomed the reports (Annex 5, paragraphs 7.160 to 7.169) that:

(i) New Zealand and the USA already had draft plans available for consultation and that Australia’s Threat Abatement Plan contained the essence of its NPOA (which would be prepared in due course); and

(ii) Brazil and Chile were commencing to prepare plans.

It encouraged other Members, particularly the European Community, which it was understood had only just embarked on the assessment process, to develop and implement their plans as soon as possible.

4.44 Dr Kawaguchi stated that Japanese fishers also wished to conserve seabirds at appropriate levels because they respect seabirds as friends in isolated oceans. Japan is now working to finalise its NPOA through dialogue with fishers and industries and intends to submit it to the FAO COFI meeting next year. Japan will formulate its national plan in accordance with the FAO IPOA–Seabirds, taking into account the discussions, resolutions and recommendations by the regional fisheries organisations.

4.45 The Scientific Committee also noted:

(i) the very encouraging progress in respect of the development of a Regional Agreement for the Conservation of Albatross under the CMS (Annex 5, paragraph 7.201(ii)); and

(ii) meetings in New Zealand (November 2000) and Uruguay (2001) seeking to promote discussion with fishers and fishery managers in seeking solutions to the by-catch of seabirds in longline fisheries (Annex 5, paragraph 7.201(iii) and (iv)).

It encouraged Members to participate actively in these initiatives.

4.46 The Scientific Committee noted with appreciation the efforts by ASOC member BirdLife International to provide fishers and fishery managers in Taiwan with information on how to reduce seabird by-catch in longline fisheries (SC-CAMLR-XIX/BG/21 Rev. 1), based on information contained in CCAMLR publications on this topic.

Incidental Mortality of Marine Mammals in Longline Fisheries

4.47 The Scientific Committee noted that only one marine mammal was reported killed in the longline fishery in the Convention Area this year (Annex 5, paragraph 8.1); interactions with killer whales and sperm whales, resulting in potential loss of fish were, as usual, widely reported (Annex 5, paragraph 8.2).

Incidental Mortality in Trawl Fisheries

4.48 With one exception, reported incidental mortality of seabirds and marine mammals associated with trawl fisheries in the Convention Area was at a very low level indeed, involving two Antarctic fur seals and three seabirds (Annex 5, paragraphs 8.4 and 8.5).

4.49 In Subarea 48.3, however, a trawler (*Betanzos*) targeting icefish killed 19 black-browed albatrosses in a single haul using pelagic trawl gear. This total is similar to the overall estimated by-catch (21 birds) for all vessels in the longline fishery in Subarea 48.3 this year (Annex 5, paragraphs 8.6). The Scientific Committee endorsed the request to observers to report in detail on such occurrences, including advice as to how they could be avoided in future (Annex 5, paragraph 8.8).

4.50 No reports were received indicating any contravention of Conservation Measure 173/XVIII in respect of incidental mortality of seabirds or marine mammals.

Marine Debris

4.51 The Chairman noted that under this agenda item the Scientific Committee reviewed:

(i) reports from Members on impacts of marine debris on marine living resources; and

(ii) data and reports from Members on surveys of marine debris.

4.52 He also drew attention to the fact that CEP had requested CCAMLR to table a report on marine debris, especially in relation to compliance with Protocol Annex IV, at the next CEP meeting (SC-CAMLR-XIX/BG/17; St Petersburg, Russia, May 2001). It was important for the Scientific Committee to provide advice on what might be contained in this report.

4.53 It was noted that at the request of SCOI (CCAMLR-XVIII, Annex 5, paragraphs 5.10(iii) and (xx)), the Commission decided at last year's meeting to:

(i) discontinue the Members' Reports on Assessment and Avoidance of Incidental Mortality once the Secretariat, in consultation with the Scientific Committee, has designed a standard form for submission of the data generally included in the report. Once the standard form is developed and approved, it will be used to submit data directly to the CCAMLR database; and

(ii) direct the Secretariat to provide information submitted by Members on assessment and avoidance of incidental mortality in summary form to Members for review during annual meetings of SCOI, the Commission and the Scientific Committee.

4.54 However, Comm Circ 00/37:

(i) directed Members to report on research activities on the assessment and avoidance of incidental mortality of Antarctic marine living resources as part of their report of Member's Activities in the Convention Area – currently posted on the CCAMLR website in language of submission;

(ii) indicated that reports of beached debris surveys undertaken according to the CCAMLR standard method would continue to be submitted directly to the CCAMLR database in the normal fashion;

(iii) enacted the decision in CCAMLR-XVIII, Annex 5, paragraph 5.10(iii), in the absence of prior consultation with the Scientific Committee. The circular contained an appendix of forms for reporting, direct to the CCAMLR database, information on:

(a) loss or discards of fishing gear;
(b) collection of marine debris by vessels at sea; and
(c) interactions of marine mammals and seabirds with fishing gear.

4.55 It was noted that the form in paragraph 4.54(iii)(c) had potential overlap with data submitted by scientific observers on longline vessels fishing in the Convention Area. Furthermore, no provision had been made for reporting, in standard format, data from surveys (or observations) of:

(i) entanglement of mammals (and birds) in marine debris;
(ii) marine debris associated with seabird colonies; and
(iii) animals externally contaminated (i.e. soiled) by hydrocarbons or other substances.

All these categories relate to data currently submitted in reports by Members, in some cases for the last decade.

4.56 The Scientific Committee summarised its understanding that information on six topics relating to marine debris were (or should be) reported to CCAMLR in standard fashion on an annual basis, viz:

(i) loss or discards of fishing gear;
(ii) collection of marine debris by vessels at sea;
(iii) surveys of marine debris on beaches;
(iv) entanglement of mammals in marine debris;
(v) marine debris associated with seabird colonies; and
(vi) animals externally contaminated (i.e. soiled) by hydrocarbons or other substances.

4.57 In response to a question as to whether data on pollutants such as pesticides should be provided to CCAMLR, the Scientific Committee indicated that the coordination of programs of research and monitoring into such topics were under active consideration by CEP, which would probably be the appropriate recipient for such information.

4.58 In respect of information relating to the six topics set out in paragraph 4.56, the Scientific Committee requested the Secretariat to ensure, in consultation with Members as appropriate, that standard reporting forms were available for submission to the CCAMLR database of all categories of information.

4.59 It also requested the Secretariat to prepare annual summaries of these data in a manner that would enable the Scientific Committee to view trends across time for data from each site or source for which information was (or had been) reported. It should consult intersessionally with Members as necessary in order to ensure that an appropriate consolidated report was available for consideration at next year's meeting of the Scientific Committee.

Loss or Discard of Fishing Gear

4.60 SC-CAMLR-XIX/BG/28 indicated that only Australia had reported lost or discarded fishing gear, involving 28 fishing floats, 3 plastic safety helmets and 4 pieces of netting, the largest 220 m^2, in Division 58.5.2.

Marine Debris collected by Vessels at Sea

4.61 SC-CAMLR-XIX/BG/28 indicated that only Australia had reported the observation and/or collection of marine debris by vessels at sea, involving two fishing buoys (one each in Divisions 58.4.1 and 58.5.2) and 500 m of longline fishing gear (in Division 58.5.2).

Surveys of Marine Debris on Beaches

4.62 SC-CAMLR-XIX/BG/28 indicated that in 1999 beach debris surveys had been conducted by Brazil, Chile, UK, Uruguay and the USA and that data had been reported to the CCAMLR database by the UK.

4.63 The Scientific Committee encouraged Brazil, Chile, Uruguay and the USA to submit their data to the CCAMLR database, especially Brazil (which had been carrying out surveys at Admiralty Bay each summer since 1984) and Chile (whose surveys at Cape Shirreff had been reported to the database for the period 1993 to 1997).

4.64 The UK reported (SC-CAMLR-XIX/BG/5) that the ninth year of beach debris surveys at Bird Island, South Georgia, revealed a total of 213 items of debris, half the total in 1997/98 and the second lowest ever. Longline fishing materials made up the majority of items collected; several packaging bands were reported.

4.65 At Signy Island, South Orkney Islands, the tenth UK survey (SC-CAMLR-XIX/BG/6) recorded a total of 55 items, 35% lower than in 1998/99 and the second lowest total ever. Plastic waste was predominant, including 10 packaging bands. Of additional concern was the quantity of polystyrene foam which accounted for 31% of all items and 46% of items small enough to be ingested by seals and seabirds. The Scientific Committee endorsed the recommendation in the report that Members should be advised to use alternative packaging materials wherever possible.

4.66 Beach debris surveys by Uruguay (SC-CAMLR-XIX/BG/26) at King George Island, South Shetland Islands, reported a small number of items, mainly fishing line material but also a packaging band.

4.67 Prof. Torres informed the meeting that Chilean surveys at Cape Shirreff in 1999 had collected some 265 kg of beach debris, 93% of which was plastic.

Entanglement of Marine Mammals in Marine Debris

4.68 UK surveys at Bird Island, South Georgia, for the tenth consecutive winter and the twelfth consecutive summer (SC-CAMLR-XIX/BG/2), indicated continuing low levels of entanglement of Antarctic fur seals. Nevertheless, four of the six winter observations and seven of the 14 summer ones involved entanglement in packaging bands.

4.69 The fourth annual survey at Signy Island, South Orkney Islands (SC-CAMLR-XIX/BG/3), reported only five entangled fur seals, the lowest total yet. One seal was entangled in a packaging band.

4.70 Prof. Torres updated the meeting on the results of Chilean surveys at Cape Shirreff. Between 1988 and 1997 the average annual number of entangled fur seals recorded was two. No entangled seals were recorded during 1998/99. However, five Antarctic fur seals (two adult females and three adult males) were observed with neck wounds and/or scars indicating the likelihood of having been entangled. During the 1999/2000 summer, one juvenile female fur seal was released from entanglement with plastic debris. Five individuals with signs or marks of entanglement were observed.

Marine Debris associated with Seabird Colonies

4.71 The seventh year of surveys at Bird Island, South Georgia (SC-CAMLR-XIX/BG/4), revealed an unprecedented quantity of fishing hooks (54% higher than the previous year) and monofilament longline originating from fishing vessels, in association with wandering albatrosses. Analysis of regurgitated material from wandering albatross chicks indicated that 79% received food containing line and/or hooks. Quantities of fishing gear remained close to levels of previous years for all other species (grey-headed albatross, northern giant petrel and southern giant petrel) but had increased for black-browed albatross.

Oil Contamination

4.72 At Bird Island, South Georgia, one wandering albatross was recorded with a small patch of oil on its flank (SC-CAMLR-XIX/BG/4). No other reports were received of animals contaminated by oil, but Prof. Torres noted that Chilean scientists had recorded oil stains on rocks at Cape Shirreff.

Report to CEP

4.73 The Scientific Committee advised that for the CCAMLR response to the CEP request (paragraph 4.53), the Secretariat should compile a report to include:

(i) relevant text taken from the review of interactions between marine life in the Convention Area and fishing and fishing-related activities (SC-CAMLR-XIX/BG/11);

(ii) Tables 1 and 2 (summarising marine debris surveys) from SC-CAMLR-XIX/BG/28;

(iii) similar tables relating to the other categories of information reported to CCAMLR as listed in paragraph 4.57; and

(iv) a list of all papers on these topics submitted to the Scientific Committee and Commission.

4.74 In this connection, Members were requested to inform the Secretariat as soon as possible of any errors or omissions concerning the data in Tables 1 and 2 of SC-CAMLR-XIX/BG/28.

4.75 The report to CEP should also seek to clarify, based on the data summarised by and available to CCAMLR, what information CEP might wish CCAMLR to report to it in the future.

Fourth International Marine Debris Conference on Derelict Fishing Gear and the Marine Environment

4.76 Prof. Torres reported on his attendance at this meeting (SC-CAMLR-XIX/BG/29), where he had also participated in a working group on monitoring and removal of materials and had drawn attention to the work being undertaken by CCAMLR. He had provided the Secretariat with copies of relevant information and leaflets relating to marine debris. For more information on the conference, Members should access the website at www.hihwnms.nos.noaa.gov.

4.77 Prof. Torres noted that the conference had proposed the establishment of a Pacific Rim Debris Commission, the first meeting of which was scheduled for Hawaii, USA, in March 2002. He suggested that CCAMLR should be represented at this meeting. The Scientific Committee agreed to consider this at its next meeting.

Marine Mammal and Bird Populations

4.78 Following decisions made at the Sixth Meeting to consider every three to five years the status of Antarctic bird and mammal populations, WG-EMM reviewed their status at its 2000 meeting, based on an extensive report provided by SCAR-BBS and a summary report from SCAR-GSS.

4.79 The SCAR-BBS report focused on bird populations for which datasets of 10 years and longer existed. A total of 61 datasets from 21 species (7 penguins, 7 albatrosses, 4 petrels, 1 skua, 2 shags) satisfied these criteria. These probably represent almost all the available long-term data on Antarctic bird populations. All these data were analysed using appropriate statistical models and techniques to identify statistically significant trends.

4.80 The Scientific Committee noted the endorsement of the report by WG-EMM (Annex 4, section 3) together with its summary of some of the principal conclusions, relating both to CEMP and non-CEMP species (Annex 4, paragraphs 3.7, 3.21 to 3.23).

4.81 In respect of the CEMP species, the Scientific Committee noted, from the report itself (WG-EMM-00/16) and from Annex 4, paragraph 3.7(i) that:

(i) whereas Adélie penguins in east Antarctica had increased since the 1980s, most populations of Adélie and chinstrap penguins in the Antarctic Peninsula region had decreased over the same period;

(ii) gentoo penguin populations in the Antarctic Peninsula area had increased since the 1980s, whereas populations at sub-Antarctic islands were stable or decreasing over similar, though more recent, periods; and

(iii) macaroni penguin populations at South Georgia had decreased significantly since the late 1970s, whereas populations in the Indian Ocean were probably stable.

4.82 The Scientific Committee noted the comments (Annex 4, paragraph 3.9) concerning potential sources of bias which might confound some interpretations and suggestions to SCAR-BBS to assist in future undertakings of this kind.

4.83 Prof. Croxall indicated that:

(i) concerns that shifts in species or population distributions could confound, or complicate, interpretations of declines (Annex 4, paragraph 3.9(i)) were, given the time spans involved and the philopatry and site fidelity of the species concerned, unfounded in most, if not all, cases;

(ii) great care had been exercised by SCAR-BBS with any interpretations involving potentially anomalous or outlier values, such that weighting each abundance estimate by some reliability function (Annex 4, paragraph 3.9(iii)) would be unnecessary, if not inappropriate – especially given the standardised protocols used to collect the data for most of the species involved; and

(iii) there were few, if any, rapid changes in abundance which were inconsistent with the demographies of the species concerned (Annex 4, paragraph 3.9(iv)), except in certain well-documented cases where deferred breeding (e.g. in gentoo penguins and black-browed albatrosses) was largely responsible for the magnitude of certain interannual changes in abundance.

4.84 The Scientific Committee noted these comments and requested that information on these three points be provided to WG-EMM to help interpret the report of SCAR-BBS when it next considers the status and trends of these species.

4.85 In addition, the Scientific Committee endorsed the view of WG-EMM that summarised information on the demographies (e.g. generation time, productivity) would be useful in the short term for understanding how populations may be changing at this time, particularly in relation to the trends identified by SCAR-BBS.

4.86 The Scientific Committee also noted the potentially valuable data on population trends in non-CEMP species. WG-EMM was asked to consider the utility of such data for its work on ecosystem assessment and to identify which species would be most appropriate as long-term indicators of changes in the ecosystem.

4.87 The Scientific Committee noted the absence of population data from any species of burrowing petrel, particularly white-chinned petrel, the species most commonly killed in longline fisheries in the Convention Area.

4.88 Prof. Croxall commented that population trends for such species were particularly difficult to establish and very few baseline data existed. However, a statistically significant decrease had recently been detected in the breeding population of white-chinned petrels at Bird Island, South Georgia, the only site for this species where adequate baseline data exist (Annex 5, paragraph 7.8).

4.89 The Scientific Committee thanked SCAR-BBS for its considerable work in assembling such comprehensive data and undertaking such careful and extensive analyses. It agreed to ask SCAR again in five years time to provide a report on the status of bird populations taking into account the consideration by WG-EMM at its next meeting on those species considered to be of greatest interest.

4.90 The summary report from SCAR-GSS indicated that fur seals (two species) were increasing over their whole range of distribution. Elephant seals seemed to be stable in the Atlantic Ocean sector whilst declining in the Indian Ocean. Less was known about the current trends in populations of the four ice seal species. Further information on ice seals and a cross-species review were likely to be produced from workshops in 2001 to analyse data from the SCAR-GSS APIS Program.

4.91 The Scientific Committee had only received the report on seals immediately prior to its meeting. It was unable to consider it in detail. It asked Prof. I. Boyd (UK) to provide an assessment of the relevant aspects of this report for the 2001 meeting of WG-EMM.

4.92 Concerning interactions with IUCN (Annex 4, paragraphs 3.17 and 4.26) Prof. Croxall noted that the latest edition of the IUCN Red List had just been published. This used the criteria to assess threatened species status which had been developed following extensive international collaboration by a variety of biological and statistical experts. These criteria included explicit use of rates of population decrease in relation to the generation time of the species involved. They were thus of considerable potential relevance to CCAMLR's approaches and interests. No species of Antarctic seal was currently classified as threatened using these criteria, although several species of Cetacea occurring in the Convention Area were classified as globally threatened. For birds, several penguin, albatross and petrel species breeding or occurring in the Convention Area had been classified as globally threatened. Full details of the assessments of the bird species had been published in BirdLife (2000).

4.93 The Scientific Committee recommended that the Secretariat contact BirdLife International to obtain copies of the relevant accounts for tabling at the next meeting of the Scientific Committee.

4.94 The Scientific Committee was encouraged by the close cooperation it had with the IWC at its CCAMLR-2000 Survey in January–February 2000 in the western part of the Atlantic Ocean and other national whale research programs in the Southern Ocean. Whale observers were present on three of the four vessels participating in the survey. A workshop is envisaged for 2001 to jointly analyse data on krill distribution and oceanographic features in relation to whale distribution. The IWC Observer provided a brief report on the status of their comprehensive assessment of whale stocks. The only whale species for which the assessment is nearly completed is humpback whales and some stocks of minke and Bryde's whales. Assessments of other ecologically important species, such as fin whales, have not been started. The Scientific Committee will continue its close collaboration with the IWC (paragraphs 11.27 and 11.28).

HARVESTED SPECIES

Krill

CCAMLR-2000 Survey

5.1 The Scientific Committee noted with pleasure WG-EMM's report of the success of the CCAMLR-2000 Survey of Subareas 48.1, 48.2, 48.3 and 48.4 which had been carried out in January–February 2000. The survey involved ships from Japan, Russia, UK and the USA. This survey had been the largest operation ever mounted in support of CCAMLR activities and was a significant milestone in the work of the Scientific Committee. The Scientific Committee congratulated the organisers of the survey and of the subsequent workshop which had achieved a considerable task of surveying such a large area and of estimating B_0 in such a timely fashion.

Krill Length-frequency Data, Biomass and Distribution from Area 48

5.2 A considerable amount of information on krill length frequencies, biomass and distribution had been collected by the CCAMLR-2000 Survey and by complementary later surveys in Area 48, as well as through the analysis of predator diets and from fisheries data during the austral summer of 1999/2000 (Annex 4, paragraphs 2.36 to 2.63). The Scientific Committee noted the complexity of this information which reflected variability at a number of time and space scales and endorsed WG-EMM's suggestion that these and other datasets be analysed at workshops during 2001.

Krill Length-frequency Data, Biomass and Distribution from Area 88

5.3 WG-EMM had examined data on krill biomass and demography from the Ross Sea (Annex 4, paragraphs 2.74 to 2.78). The Scientific Committee endorsed the Working Group's encouragement of the conduct of a standardised krill acoustic biomass survey in the Ross Sea, an area for which there was currently no precautionary catch limit. The designs and protocols of this survey should be submitted to WG-EMM for prior approval as had been done for the Australian survey of Division 58.4.1 and for the CCAMLR-2000 Survey.

Estimates of B_0, Potential Yields and Precautionary Catch Limits

5.4 The Scientific Committee reviewed the deliberations of WG-EMM on the derivation of a new krill biomass estimate and associated CV for Area 48 based on the results of the CCAMLR-2000 Survey (Annex 4, paragraphs 2.84 to 2.111). The biomass estimate of 44.29 million tonnes and the CV of 11.38% were endorsed as the best available for Area 48.

5.5 The potential yield of krill in Area 48, had been calculated by WG-EMM using the revised biomass and CV and no other new input parameters. The GYM had produced a γ of 0.091 resulting in a potential yield of 4.0 million tonnes which was endorsed by the Scientific Committee as the best available advice on a precautionary catch level for Area 48.

5.6 The Scientific Committee noted the revised biomass estimate for krill in Division 58.4.1 (Annex 4, paragraphs 2.36 to 2.63). The revised biomass of 4.83 million tonnes (CV 17%) differs from the earlier estimate (6.67 million tonnes, CV 27%) largely because of a recalculation of the effect of sound absorption during the survey. The Scientific Committee endorsed this new biomass estimate.

5.7 The potential yield of krill in Division 58.4.1, had been calculated by WG-EMM using the revised biomass and CV and no other new input parameters (Annex 4, paragraphs 2.112, 2.113 and 6.6). The GYM had produced a γ of 0.091 resulting in a potential yield of 0.44 million tonnes which was endorsed by the Scientific Committee as the best available advice on a precautionary catch limit for Division 58.4.1.

Subdivision of Precautionary Catch Limits

5.8 The Scientific Committee endorsed WG-EMM's assessment of the requirement for subdivision of potential yields as a precautionary measure in order to distribute fishing effort and thereby reduce the potential impact of fishing on land-based predators (Annex 4, paragraph 2.114).

5.9 Accordingly, the Scientific Committee endorsed the subdivision of the potential yield in Area 48 based on the proportion of survey transects in each subarea.

Subarea	Potential Yield (million tonnes)
48.1	1.008
48.2	1.104
48.3	1.056
48.4	0.832

5.10 The Scientific Committee noted WG-EMM's deliberation on subdivision of the potential yield of krill in Division 58.4.1 (Annex 4, paragraphs 2.120, 2.121 and 6.7 to 6.10). Evidence from the 1996 Australian survey had indicated that the biomass of krill in the east of Division 58.4.1 (115–150°E) was only half of that found in the west of the division (80–115°E) and that these two areas were oceanographically distinct.

5.11 The calculated potential yields for Division 58.4.1 west was 0.277 million tonnes and that for Division 58.4.1 east was 0.163 million tonnes. Dr Naganobu indicated, however, that while he was not opposed in principle to a subdivision of Division 58.4.1 the use of oceanographic data to subdivide areas required further consideration. Consequently he could not agree to the proposed subdivision of the potential yield in Division 58.4.1 at this time.

5.12 Some Members suggested that in the absence of a mechanism for subdividing the potential yield in this division, the Commission should adopt a procedure such as that which had been agreed for the precautionary limit for krill in Area 48 in 1991 and which is contained in Conservation Measure 32/X. This would involve a 'trigger level' of catch above which the overall yield would have to be subdivided into smaller management areas. It was suggested that an appropriate level for this 'trigger' might be 0.163 million tonnes (the calculated potential yield for Division 58.4.1 east) which is the level at which the Commission could be assured that krill in the east of the division would not be in danger of being overfished. For further discussion on trigger levels see section 7.

5.13 The Scientific Committee noted that the concept of a 'trigger level', above which further subdivision of the Area 48 catch limit would occur, is reflected in Conservation Measure 32/X which has stood since 1991.

5.14 The Scientific Committee noted that precautionary catch limits are levels that the catch should not exceed in relatively large statistical areas or divisions. The further division of statistical areas into smaller management units is a separate requirement to take into account the localised demands of land-based predators. Both approaches will be necessary as part of a precautionary management strategy.

5.15 WG-EMM had indicated that it may take five to 10 years before a full management procedure for krill was in place (Annex 4, paragraph 4.117). Consequently, the Scientific Committee recommended as a matter of priority that WG-EMM provide guidelines for methods to subdivide the krill potential yield in all areas as a precautionary measure to avoid concentrating fishing effort in small but critical areas, and to consider the level at which appropriate 'trigger levels' might be set.

5.16 There is evidence of significant changes in populations of a number of vertebrate species and of krill throughout the South Atlantic region. The spatial and temporal scales of these changes will have to be taken into account when deciding on the suite of management measures adopted.

Development of the GYM

5.17 The Scientific Committee endorsed the recommendation of WG-EMM that the documentation of the KYM and GYM should be completed and that this process should include a description of the input parameters and their characterisation (Annex 4, paragraph 2.110). This process should be coordinated in the Secretariat by the CCAMLR Data Manager.

5.18 Because of the mutual interest of WG-EMM and WG-FSA in the assessment work and particularly in the development of the GYM, it was suggested that the Convener of the WG-FSA subgroup on methods (Dr Constable) circulate a letter to participants in WG-EMM inviting their input to the work of this subgroup (Annex 5, paragraph 10.9(iv)).

Future Analysis of the CCAMLR-2000 Survey

5.19 The Scientific Committee endorsed the terms of reference and membership of the CCAMLR-2000 Survey Analysis Steering Group (Annex 4, Appendix F). A proposal to hold a workshop to further the analyses in May–June 2001 at the British Antarctic Survey, Cambridge, UK, was welcomed (SC-CAMLR-XIX-BG/30). Involvement of the IWC in this workshop was encouraged and CCAMLR involvement in a proposed IWC workshop in late 2001 was also recommended. The Scientific Committee noted that, because of the volume of data collected by the CCAMLR-2000 Survey, there would probably be requirements for further workshops to coordinate the publication of results.

5.20 The Scientific Committee endorsed the holding of the proposed third International Coordination Workshop to further collaborative analysis of ancillary data collected by vessels from Japan, Republic of Korea, Peru and the USA in Area 48 during 1999/2000 (Annex 4, paragraph 2.124).

5.21 A proposal by Dr B. Bergström (Sweden) to coordinate an ad hoc subgroup on population genetics was endorsed (Annex 4, paragraph 2.131).

5.22 The Scientific Committee recognised the need for further studies into improving the precision and accuracy of acoustic surveys to assess the abundance and dispersion of krill (Annex 4, paragraphs 2.127 and 2.128).

5.23 Efforts should be made to analyse acoustic data with the objectives of estimating the abundance and dispersion of myctophid fish which may be part of an alternative food web to krill (Annex 4, paragraphs 2.132 and 4.46).

Advice to the Commission

5.24 The new estimates of B_0 (44.29 million tonnes) potential yield and precautionary catch limit (4 million tonnes) for Area 48 should be accepted as the best available (paragraphs 5.4 and 5.5).

5.25 The subdivision of the potential yield in Area 48 to subareas, as outlined in paragraph 5.9, should be accepted. (For advice on trigger levels to smaller scale subdivision see paragraphs 7.21 to 7.24.)

5.26 The new estimates of B_0, (4.83 million tonnes), potential yield and precautionary catch limit (0.44 million tonnes) for Division 58.4.1 should be accepted as the best available (paragraphs 5.6 and 5.7).

5.27 The Scientific Committee reiterated its advice from last year (SC-CAMLR-XVIII, paragraph 5.14) that investigations into alternative methods of subdividing the krill potential yield as a precautionary measure to avoid concentrating fishing effort was viewed as a matter of priority for the work of WG-EMM.

5.28 The Scientific Committee recommended that krill biomass surveys using standard protocols should be conducted in other areas as soon as is practical. These areas should include regions where fishing has occurred in the past such as the Ross Sea (Subareas 88.1 and 88.2) and Division 58.4.2, as well as in ecologically important areas where no fishing has yet occurred, such as in the vicinity of Bouvet Island (Subarea 48.6) (Annex 4, paragraph 6.23).

Fish Resources

Fish and Squid Biology/Demography/Ecology

5.29 The Scientific Committee welcomed a number of important contributions on *D. eleginoides* and *D. mawsoni* which had been presented to WG-FSA (Annex 5, paragraphs 3.66 to 3.120). These included information on differences in age determination based on scales and otoliths, genetic techniques to separate stocks and identify fillets of *D. eleginoides* and *D. mawsoni* to species, and reproductive investigations on *Dissostichus* spp. ovaries.

5.30 The Scientific Committee noted the conclusions in paragraph 3.68 of WG-FSA's report (Annex 5) that otoliths provide a better estimation of age than scales for *Dissostichus* spp. and should be used for future age studies. The Scientific Committee endorsed the establishment by WG-FSA of an intersessional subgroup to review the biology and demography of species considered by the Working Group, as outlined in Annex 5, paragraph 10.9(v).

5.31 The Scientific Committee stressed that work to refine and validate age-determination methods, including the validation of annual formation of rings in otoliths, is of the highest priority for future assessments.

5.32 The Scientific Committee noted that differences may exist in the growth patterns of *D. eleginoides* between the sexes, and this is not taken into account in the assessment. The Scientific Committee endorsed the conclusion of WG-FSA that high priority should be given to the construction of separate growth curves for males and females of *D. eleginoides*, and techniques to integrate these patterns into the assessment model should be explored.

5.33 Observations made during recent surveys and commercial fishing in Subarea 48.3 indicated that large schools of *C. gunnari* were present pelagically by day. In addition, schools that were present on, or close to, the bottom often extended up to 50 m above the seabed. Such schools are very poorly sampled by bottom trawls used for assessment surveys.

5.34 The Scientific Committee noted other information on the mortality of, and physical damage to, crabs, taken in the experimental pot fishery for *D. eleginoides*.

Developments in Assessment Methods

5.35 The Scientific Committee welcomed the introduction of new or extended assessment methods (Annex 5, paragraphs 3.121 to 3.131). While some of these were not immediately useable by WG-FSA, the Scientific Committee was pleased by the number of new ideas coming forward. These new methods include techniques for integration of CPUE into the GYM models, a method to integrate environmentally driven distributions of fish stocks into the GYM, a method to assess the harvested population based on data from a tag–recapture experiment, and a method to estimate jointly recruitment and natural mortality from a time series of abundance of year classes.

Assessments and Management Advice

Assessed Fisheries

Dissostichus spp.

5.36 Assessments of long-term annual yield were reviewed for Subarea 48.3 and Division 58.5.2. Several input parameters to the GYM were reassessed, and new estimates of parameters were generated for Subarea 48.3 and Division 58.5.2. These assessments are detailed in Annex 5, paragraphs 4.103 to 4.178.

D. eleginoides at South Georgia (Subarea 48.3)

Standardisation of CPUE

5.37 Analysis of CPUE data was undertaken for Subarea 48.3 using the GLM, where new longline haul-by-haul data were available from the 1999/2000 season for vessels operating in Subarea 48.3. Details of the standardisation of the CPUE at South Georgia are described in Annex 5, paragraphs 4.109 to 4.117.

5.38 The Scientific Committee endorsed the CPUE analysis undertaken by WG-FSA this year, including the following modifications:

(i) the use of newly reported historical data for Ukrainian vessels operating in Subarea 48.3 in the seasons 1985/86 to 1988/89 and 1990/91; and

(ii) a reduction in the number of statistically significant effects.

5.39 The Scientific Committee noted that the adjusted, standardised catch rates declined substantially between 1994/95 and 1996/97, but have increased each season since then. The Scientific Committee also noted the trend in recent seasons towards increased longline fishing at shallow depths (300–700 m) has continued in the 1999/2000 season, particularly to the north of Shag Rocks.

Size at Capture

5.40 The Scientific Committee noted the declining modal length of catch-weighted length frequencies around South Georgia and Shag Rocks. This decline may be a result of a change in the size composition of the stock, a change in the fishing pattern, or both. As the smaller fish tend to be found in shallower water, the Scientific Committee recognised that the fishery may have moved into shallower depths in order to target the newly recruited and smaller fish.

Determination of Long-term Annual Yield using the GYM

5.41 The Scientific Committee endorsed the analysis undertaken by WG-FSA to revise the estimate of long-term annual yield using the GYM, with standardised CPUE being integrated into the final calculation of long-term yield, and data on recruitment from an extended series of trawl surveys.

5.42 The Scientific Committee noted that the selectivity pattern of *D. eleginoides* captured in the experimental pot fishery was not substantially different to the longline fishery, and endorsed the combination of catches from both fishing methods in the assessments.

5.43 The Scientific Committee was concerned about the uncertainty in the parameters for growth and the effect they may have on the assessments. A number of alternative approaches were examined by WG-FSA based on a re-evaluation of recruitment and natural mortality (M) (Annex 5, paragraphs 4.130 to 4.142). The Scientific Committee endorsed the use of the k value from last year's assessment pending further work to refine information on age and growth.

5.44 The Scientific Committee discussed the complexity of the relationships between growth, M and recruitment. The Scientific Committee recognised that the complex nature of these relationships precluded the presentation of a simple relationship between M and long-term yields computed by the GYM. However, the Scientific Committee noted that in the analyses conducted this year by WG-FSA, a reduction in M led to an increase in long-term yield, and the current estimate of yield was at the lower end of the range of values calculated this year.

5.45 During the course of the Scientific Committee meeting, an error was detected in the assessment of *D. eleginoides* in Subarea 48.3 in relation to the time series of recruitments used in the GYM (Annex 5, Table 33). The series included an estimate of the number of recruits from the 1998 year class (age-4 recruits in year 2002). This was based on the number of 1-year-old fish from the UK survey in 2000. Because fish of this size range tend to be very poorly represented in trawl survey samples, they are customarily not used in the estimation of recruitment.

5.46 The recruitment estimate in year 2002 was therefore deleted from the recruitment series in Annex 5, Table 33, mean recruit recomputed, and the GYM run with the corrected values. Annex 5, Table 34 is updated as follows: the mean $\log_e$(recruits) = 14.4813; the SE of mean $\log_e$(recruits) = 0.209; and the SD $\log_e$(recruits) = 0.783. The Scientific Committee endorsed these corrections to the assessment.

5.47 The estimate of yield from the GYM was 4 500 tonnes, with a median escapement of 0.54. Because of the reduced level of recruitment, this yield was lower than results obtained at last year's meeting (5 310 tonnes).

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

5.48 The Scientific Committee welcomed the considerable progress made at this year's meeting in refining the data inputs into the GYM, particularly with respect to incorporating a time series of recruitments and integrating the CPUE series into the assessment model. The Scientific Committee encouraged the continued development and testing of methods to integrate different indicators of stock status into assessments.

5.49 The Scientific Committee agreed that the estimate of yield from the revised GYM analysis (4 500 tonnes) should be used to set the catch limit for the 2000/01 season. Other management measures for *D. eleginoides* in Subarea 48.3 in the 2000/01 season should remain as for the 1999/2000 season.

5.50 Any catch of *D. eleginoides* taken in other fisheries in Subarea 48.3, such as the proposed pot fishery, should be counted against this catch limit.

D. eleginoides at South Sandwich Islands (Subarea 48.4)

5.51 Despite a catch limit of 28 tonnes for *D. eleginoides* (Conservation Measure 156/XVII), no fishing in this subarea was reported to the Commission during the 1999/2000 season. No new information was made available to WG-FSA on which to base an update of the assessment.

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

5.52 WG-FSA was unable at this year's meeting to consider the period of validity of the existing assessment. Therefore the Scientific Committee recommended that Conservation Measure 156/XVII be carried forward for the 2000/01 season. As last year, it was also recommended that the situation in this subarea be reviewed at next year's meeting with a view to considering the period of validity of the existing assessment.

D. eleginoides at Ob and Lena Banks (Division 58.4.4)

5.53 The Scientific Committee noted that new data from surveys were made available for Ob and Lena Banks, though due to limited time, these were not rigorously analysed. The Scientific Committee recommended that these data be analysed at the next WG-FSA meeting as they represent potentially valuable information for the evaluation of *D. eleginoides* stock status in Division 58.4.4.

D. eleginoides at Kerguelen Islands (Division 58.5.1)

5.54 A standardisation of CPUE of longline vessels was performed for the first time on data from Division 58.5.1 using the GLM. Results showed that the adjusted and standardised catch rates have increased between the 1996/97 and 1998/99 fishing seasons, while they decreased during the last two seasons, from 1998/99 to 1999/2000.

5.55 The Scientific Committee was informed that recent trawling operations for *D. eleginoides* around Kerguelen had yielded progressively smaller catches, and an increasing proportion of the catch is being taken using longline gear.

5.56 Prof. Duhamel regretted that it had not been possible for a French scientist to attend this year's meeting of WG-FSA. However, he noted that fine-scale data are currently provided to the Secretariat, and that these data could be useful for assessment purposes. Due to some concerns with respect to confidentiality, detailed haul-by-haul data from the Kerguelen EEZ have not been submitted to CCAMLR.

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

5.57 The French authorities have provided information that trawling and longlining will be conducted during the 2000/01 season. A decrease in fishing effort by trawling will continue, as previously decided.

5.58 The Scientific Committee discussed the role of WG-FSA in assessment decisions regarding fisheries for *D. eleginoides* in Division 58.5.1. At present, WG-FSA has a very limited capacity to conduct assessments or give advice concerning *D. eleginoides* population status or exploitation in Division 58.5.1. The Scientific Committee recommended that additional data be made available to WG-FSA for assessment purposes. The Scientific Committee also recommended that the presence of a French scientist would be highly beneficial at WG-FSA, and would greatly add to the understanding of the state of *D. eleginoides* stocks in Division 58.5.1.

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

5.59 The catch limit of *D. eleginoides* in Division 58.5.2 for the 1999/2000 season was 3 585 tonnes (Conservation Measure 176/XVIII) for the period 1 December 1999 to the end of the Commission meeting in November 2000. The catch reported for this division at the time of WG-FSA was 3 008 tonnes.

5.60 The analysis of long-term annual yield was updated with the estimated catch to the end of the season (the current catch limit plus the estimated IUU catches) taken from Division 58.5.2, new recruitment estimates, and the use of the recruitment time series in the GYM (Annex 5, paragraphs 4.170 to 4.174).

5.61 The Scientific Committee endorsed the analysis undertaken at this year's meeting of WG-FSA, including the carrying forward of parameters for growth, natural mortality, maturity and fishing selectivity from the 1999 assessment. The Scientific Committee agreed that the use of a range of M was appropriate due to uncertainties remaining in this parameter.

5.62 The Scientific Committee endorsed the estimate of long-term annual yield of 2 995 tonnes resulting from the decision rule concerning the probability of depletion. The median escapement for this level of catch was 0.547.

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

5.63 The Scientific Committee recommended that the catch limit by trawling for Division 58.5.2 in the 2000/01 season be revised to 2 995 tonnes, representing the long-term annual yield estimate from the GYM.

General Advice on *D. eleginoides* Assessments

5.64 The Scientific Committee expressed concern regarding the continuing level of uncertainty in many of the parameters used in the assessments, such as growth and natural mortality. Although some uncertainties have been taken into account, for example, using ranges of parameters in the assessments, there are critical decisions to be made at different stages in the work of WG-FSA. For example, the assessment of *D. eleginoides* in Subarea 48.3 required choosing between different options regarding growth and natural mortality.

5.65 The Scientific Committee recognised that taking full account of such uncertainties in the assessment process will require further work and sensitivity analyses during the intersessional period. It considered this to be an urgent priority.

5.66 The Scientific Committee requested that WG-FSA seek to develop selectivity functions for trawl surveys in all areas where *Dissostichus* spp. are targeted.

5.67 Regarding annual changes in the estimate of long-term annual yield, the Scientific Committee noted that this resulted in part from adjustment of the recruitment parameters in *D. eleginoides* assessments in Subarea 48.3 and Division 58.5.2. Changes in these parameters are expected from one year to the next in the early years of monitoring using trawl surveys. Figure 23 in WG-FSA's report (Annex 5) suggested that only after estimates of abundance for 15 to 20 cohorts have been obtained can it be expected that recruitment parameters will not change appreciably. Even then estimates may still be biased and result in some adjustments over time.

5.68 The Scientific Committee discussed the need for greater detail in the presentation of yield estimates, for example in the form of confidence limits. However, the Scientific Committee also noted that the current method of examining probabilities in achieving management objectives takes into account a level of confidence about the recommended yields. The Scientific Committee noted the importance of conveying to the Commission the probability of achieving management objectives.

5.69 Given the complexity of the current assessment techniques, there is a potential for error to creep into the quantitative process. The Scientific Committee requested that assessment checklists should be prepared by the Secretariat, in conjunction with WG-FSA, to minimise this potential in the future work of the Working Group.

5.70 Because the quantitative techniques used by WG-FSA have evolved into their current level of complexity, and these techniques sometimes involve non-standard fishery methods, the Scientific Committee recommended that formulas and guidelines for the various components of the assessment be thoroughly documented by the Secretariat in conjunction with WG-FSA.

5.71 The Scientific Committee agreed that much of the work performed at WG-FSA is time consuming, and that every effort should be made to accomplish as much as possible intersessionally. However, due to the fact that much of the data required for the assessment are presently submitted just prior to or at the meeting itself, many of the tasks can only be performed at the time of WG-FSA. The Scientific Committee again emphasised the importance of submitting data in accordance with reporting deadlines to allow for analysis as early as possible.

C. gunnari at South Georgia (Subarea 48.3)

5.72 The Scientific Committee noted that for the first time since the 1989/90 fishing season there had been substantial commercial fishing for *C. gunnari* in Subarea 48.3. Two vessels caught a total of 4 114 tonnes between 11 December 1999 and 31 January 2000.

5.73 WG-FSA undertook a new assessment of the fishery on the basis of catch/effort and biological data from the commercial fishery, including the reports of CCAMLR international scientific observers, and reports and data from two scientific bottom trawl surveys in January and February 2000, by the UK and Russia respectively.

5.74 The short-term projection method used at the last two meetings of WG-FSA was used, updated with the new information on biomass and age structure from the scientific surveys. Whilst endorsing the use of this method, the Scientific Committee noted the advice of WG-FSA that this is an interim approach, used to ensure there is a low probability of depleting the stock in the short term, and increased efforts should be made to address the issue of a longer term approach management of *C. gunnari* fisheries in the Convention Area (paragraph 5.91).

5.75 With a projected fishing mortality of 0.14, the catch limit satisfying the criteria in the projection was 11 895 tonnes over two years. This was made up of 6 760 tonnes in the first year (1 December 2000 to 30 November 2001) and 5 135 tonnes in the second year (1 December 2001 to 30 November 2002).

5.76 The Scientific Committee noted evidence presented to the meeting of WG-FSA that there was high variation in observed biomass of *C. gunnari* from bottom trawl census surveys carried out in various years. These differences in stock estimates could have been, at least in part, due to changes in behavioural patterns of the fish from year to year, especially vertical distribution. The Scientific Committee noted that there was an urgent need to assess patterns of vertical distribution and movements of *C. gunnari* under different circumstances and to seek improvements to the methodology of census surveys for this species, for example, involving acoustic equipment and pelagic fishing gear.

5.77 The Scientific Committee endorsed the advice of WG-FSA that the closed season adopted last year for the *C. gunnari* fishery in Subarea 48.3, to protect fish during the spawning season, should remain in place. In this regard, the Scientific Committee noted the discussion by the Working Group of the need to consider predator requirements and whether a closed season might be appropriate during peak periods of predator foraging activity. The Scientific Committee recommended that this and other topics be considered more fully by WG-FSA during a Workshop on Assessment Methods for Icefish (WAMI) recommended to take place during the intersessional period (paragraphs 5.91 and 5.92).

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

5.78 The Scientific Committee endorsed the advice of WG-FSA regarding the management of the *C. gunnari* fishery in Subarea 48.3 during the 1999/2000 season.

5.79 The total catch limit should be revised to 6 760 tonnes for the period 1 December 2000 to 30 November 2001, with the closed season remaining the same as last year (1 March to 31 May 2001).

5.80 Other management measures for *C. gunnari* in Subarea 48.3 set for the 1999/2000 season, as detailed in Conservation Measure 175/XVIII, should remain in force.

C. gunnari at Kerguelen Islands (Division 58.5.1)

5.81 The Scientific Committee noted the advice of WG-FSA that no new data were available for *C. gunnari* in Division 58.5.1. No commercial fishing for *C. gunnari* took place in this division during the 1999/2000 season and only fine-scale data from surveys had been available to the Working Group.

5.82 Prof. Duhamel reported to the meeting that a survey had been carried out by France in March–April 2000, but virtually no *C. gunnari* had been observed. The intention of the French authorities is that the fishery for *C. gunnari* will remain closed until a survey indicates there are sufficient concentrations to support renewed commercial activity. A survey is planned to take place during 2000/01.

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

5.83 The Scientific Committee endorsed the advice of WG-FSA that prior to any resumption of commercial fishing a survey of *C. gunnari* abundance should be conducted and the results analysed by the Working Group.

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

5.84 The commercial catch of *C. gunnari* in the 1999/2000 fishing season was 39 tonnes out of a catch limit of 916 tonnes. The strong cohort detected in a survey in 1998, now aged 4, had almost disappeared.

5.85 The Scientific Committee noted that a survey conducted on the Heard Island Plateau and Shell Bank in May 2000 detected a high abundance of principally 2-year-old fish on the Heard Plateau, but very few fish on Shell Bank.

5.86 The Scientific Committee endorsed the acceptance by WG-FSA of an assessment of yield over the next two years presented to the Working Group. This assessment had used the short-term projection methodology used previously, adopted during the 1997 meeting and used for the assessment of yield of this species in Subarea 48.3.

5.87 With a projected fishing mortality of 0.14, the catch limit satisfying the criteria in the projection was 2 150 tonnes over two years. This was made up of 1 150 tonnes in the first year (1 December 2000 to 30 November 2001) and 1 000 tonnes in the second year (1 December 2001 to 30 November 2002).

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

5.88 The Scientific Committee endorsed the advice of WG-FSA regarding the management of the *C. gunnari* fishery in Division 58.5.2 during the 1999/2000 season.

5.89 The total catch limit for the Heard Island Plateau part of Division 58.5.2 should be revised to 1 150 tonnes for the period 1 December 2000 to 30 November 2001. The fishery on Shell Bank should remain closed.

5.90 Other management measures for *C. gunnari* in Subarea 48.3 set for the 1999/2000 season, as detailed in Conservation Measure 177/XVIII, should remain in force.

Workshop on Assessment Methods for Icefish (WAMI)

5.91 The Scientific Committee noted the discussion by WG-FSA in paragraphs 10.1 to 10.6 of its report (Annex 5) on the need for a workshop on the development of management procedures for *C. gunnari* (as first discussed by the Scientific Committee in 1997 – SC-CAMLR-XVIII, Annex 5, paragraph 9.10).

5.92 The Scientific Committee noted that a fishery took place in Subarea 48.3 for the first time since the 1989/90 season and the results of two surveys in 2000 increased the urgency of the need to address management issues for this species. Also, discussions at WG-EMM and WG-FSA have indicated that this species has potentially complex interactions with other elements of the ecosystem and that these need to be taken into account when developing management procedures. The Scientific Committee endorsed the recommendation of WG-FSA that the workshop should proceed in the 2000/01 intersessional period, in accordance with the arrangements agreed by the Working Group (Annex 5, paragraphs 10.4 and 10.5).

Other Finfish Fisheries

5.93 The Scientific Committee noted that WG-FSA considered other finfish fisheries in Subarea 48.1 (Antarctic Peninsula), Subarea 48.2 (South Orkney Islands), Subareas 88.2 and 88.3 (Pacific Ocean Sector), and Divisions 58.4.1 and 58.4.2 (Antarctic Coastal Areas).

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

5.94 WG-FSA had received and considered an extensive review of the fisheries, status and biology of fish stocks in Subareas 48.1 and 48.2. The Scientific Committee endorsed the view that there appears to be little scope for reopening the fisheries in these two subareas in the near future given the comparatively low biomass of the most common fish species. The Scientific Committee welcomed the information that two new bottom trawl surveys are planned for these subareas by the USA and Germany in March 2001 and November–December 2001.

Management Advice

5.95 The Scientific Committee endorsed the advice of WG-FSA that Conservation Measures 72/XVII and 73/XVII should remain in force.

Divisions 58.4.1 and 58.4.2

5.96 The Scientific Committee noted that no fishing is planned for the Antarctic coastal area of Division 58.4.1 in the 2000/01 season. The Scientific Committee endorsed the recommendation of WG-FSA that this division should be closed to fishing, including exploratory fishing, until more experience has been gained from the results of exploratory fisheries in other parts of the Convention Area.

5.97 Both Divisions 58.4.1 and 58.4.2 are subject to exploratory trawl and longline fishery notifications, details of which are discussed in paragraphs 9.38, 9.39 and 9.43 to 9.46.

Management Advice

5.98 The Scientific Committee recommended that the Antarctic coastal area (south of 64°S) of Division 58.4.1 should be closed to fishing in the 2000/01 season (Annex 5, paragraph 4.98).

Pacific Ocean Sector (Subareas 88.2 and 88.3)

5.99 The Scientific Committee noted that no fishing took place in Subareas 88.2 and 88.3 during the 1999/2000 season. Both subareas are subject to exploratory fisheries notifications for the 2000/01 season, details of which are discussed in paragraphs 9.40, 9.43, 9.53 and 9.56.

Management Advice

5.100 The Scientific Committee recommended that Subarea 88.3 remain closed until more experience is gained in other exploratory fisheries (Annex 5, paragraph 4.98).

Electrona carlsbergi (Subarea 48.3)

5.101 The Scientific Committee noted that no new advice was available from WG-FSA regarding the fishery for *E. carlsbergi* in Subarea 48.3. The last year in which there were catches from the *E. carlsbergi* fishery was 1991/92 (51 865 tonnes). The fishery has not been assessed by WG-FSA since its meeting in 1994.

Management Advice

5.102 In the absence of new advice, the Scientific Committee recommended that Conservation Measure 174/XVIII be carried forward to the 2000/01 season.

5.103 The Scientific Committee requested WG-FSA to consider, at its next meeting, the currency of the existing assessment of *E. carlsbergi* in the context of the regulatory framework, and whether catch limits should continue to be set on the basis of the advice from the 1994 assessment, while no new information is available.

General By-catch Provisions

5.104 The Scientific Committee noted the discussion of by-catch in fisheries in the Convention Area in Annex 5, paragraphs 4.248 to 4.268. A wide variety of species are taken as by-catch in the Convention Area. Most are taken in small amounts by weight as detailed in Annex 5, Table 46. Skates, rays and macrourids (rat tails) are the principal by-catch species.

5.105 The largest by-catch (255 tonnes) was reported for the *D. eleginoides* longline fishery in Division 58.5.1 based on fine-scale data. Other large by-catches, from fine-scale data, occurred in the *Dissostichus* spp. longline fisheries in Subarea 88.1 (118 tonnes) and in Subarea 58.6 (81 tonnes).

5.106 The Scientific Committee encouraged the production of brief practical guides to help observers identify principal by-catch species at sea, particularly for species groups over which there is some concern, such as skates, rays and macrourids (rat tails) where accurate identification is important.

Management Advice

5.107 The Scientific Committee noted that substantial information regarding the amount of by-catch in various fisheries had been presented, but agreed that there remains an urgent need for the calculation and presentation of by-catch rates in both longline and trawl fisheries.

5.108 The Scientific Committee endorsed the establishment by WG-FSA of an intersessional subgroup to document the extent of by-catch in CCAMLR fisheries, as set out in Annex 5, paragraph 10.9(vi).

Future Work of WG-FSA

5.109 The Scientific Committee endorsed the future work of WG-FSA as outlined in Annex 5, paragraph 10.9, noting that the subgroup to determine total removals of *Dissostichus* spp. (including IUU catches) should be established irrespective of whether new Secretariat staff are hired to assist with the CDS (Annex 5, paragraph 10.9(ii)).

Crab Resources

5.110 The UK, Uruguay and the USA have expressed their intention to fish for crabs in the coming season. WG-FSA acknowledged that the USA has already fulfilled the requirement of an experimental harvest regime set out in Conservation Measure 150/XVIII.

5.111 The Scientific Committee noted the large by-catch rates of crabs in the experimental pot fishery for *D. eleginoides.* Few crabs were males above the legal size that could be retained, and the discard rate was above 95% for all species caught.

5.112 The Scientific Committee was concerned that the survival rates of discarded crab species caught as by-catch or in directed fisheries are insufficiently known and may result in large numbers of animals not surviving after being discarded.

Management Advice

5.113 The Scientific Committee reiterated its advice (SC-CAMLR-XVIII, paragraph 5.130) that since crab stocks have not been fully assessed, the conservative management scheme contained in Conservation Measure 181/XVIII is still appropriate. It tasked WG-FSA to reconsider the precautionary catch level of crabs during its next meeting as new scientific data become available, taking into account the potentially high mortality rates of discarded animals.

5.114 The Scientific Committee recommended that all vessels should conduct Phase 1 of the experimental harvest regime specified in Conservation Measure 150/XVIII. The US vessel notified to fish in 2000/01 has already fulfilled these requirements.

5.115 The Scientific Committee agreed that WG-FSA should continue considering mortality rates of discarded crabs and encouraged further research on this problem.

5.116 The Scientific Committee agreed that crabs caught as by-catch in other fisheries should be counted against the catch limit set for the directed fishery.

Squid Resources

5.117 No fishing took place in the 1999/2000 season. The Republic of Korea and the UK submitted a joint notification (CCAMLR-XIX/8) for an exploratory jig fishery for *M. hyadesi* in Subarea 48.3 (paragraph 9.60). The status of the observer requirement attached to this notification is discussed in paragraph 3.20.

5.118 The scientific basis on which the current precautionary conservation measure was based has not changed.

Management Advice

5.119 The Scientific Committee recommended that as this was an exploratory fishery the conditions of Conservation Measure 65/XII will apply.

ECOSYSTEM MONITORING AND MANAGEMENT

6.1 The sixth meeting of WG-EMM was held at the Hotel Caparena, Taormina, Sicily, Italy, from 17 to 28 July 2000, the second time a SC-CAMLR working group had met in Italy. The Scientific Committee thanked the host of the meeting, Prof. L. Guglielmo, for an efficient and friendly meeting, and the Convener, Dr Hewitt, for chairing the meeting.

Environmental Variables

6.2 The Scientific Committee noted the observations of WG-EMM on spatial and temporal variations of the physical environment (Annex 4, paragraphs 3.27 to 3.44) and encouraged further work to quantify environmental variability. It looked forward to seeing further results on how the environment changes on different time scales.

Ecosystem Analysis

6.3 The Scientific Committee noted the continuing work of WG-EMM to develop Combined Standardised Indices (CSIs) with the objective of combining various CEMP indices (Annex 4, paragraphs 3.45 to 3.47, 3.50 and 3.51). The Scientific Committee endorsed the workplan of WG-EMM in the further development of CSIs (Annex 4, paragraph 3.51).

6.4 The Scientific Committee welcomed the method for assessing krill consumption by predators (Annex 4, paragraphs 3.48, 3.49 and 4.30 to 4.32) and noted that, inter alia, such assessments are sensitive to the estimates of abundance of predators and metabolic rates.

Ecosystem Assessment

Krill-centred Interactions

6.5 The Scientific Committee noted the work of WG-EMM to organise its review and discussion of the working papers available to it around the following questions:

- What is the interaction between krill distribution and oceanography? What are the implications of geographical distribution for assessing which sections of the krill population are being exploited by the fishery and predators? (Annex 4, paragraphs 4.2 to 4.9).

- What are the implications of apparent lack of krill recruitment at the Antarctic Peninsula for predators and the fishery? (Annex 4, paragraphs 4.10 to 4.13).

- Is there evidence of long- or short-term changes in the diets of krill predators that might suggest changes in the ecosystem or in krill availability? (Annex 4, paragraphs 4.14 to 4.22).

- Is there evidence of long- or short-term changes in the populations of krill predators that suggest changes in the ecosystem? (Annex 4, paragraphs 4.23 to 4.28).

- What are the impacts of predators on krill populations? (Annex 4, paragraphs 4.29 to 4.32).

- What is the distribution of predators relative to krill? (Annex 4, paragraphs 4.33 to 4.36).

- Can data from *C. gunnari* be incorporated into the CEMP time series to be used in ecosystem assessments? (Annex 4, paragraphs 4.38 to 4.40).

- How can empirical functional relationships between krill and predators be used to provide advice and what actions need to be taken with respect to the fishery? (Annex 4, paragraphs 4.41 to 4.44).

6.6 The Scientific Committee recognised that these questions are broad and some of the responses and conclusions preliminary, and requested WG-EMM to consider how to tackle these questions in a way that assists the work of CCAMLR.

6.7 Dr Everson elaborated on the report of WG-EMM regarding the status of *Notothenia rossii* in the Convention Area (Annex 4, paragraph 4.26). He indicated that the stocks of this species have been depleted in Subareas 48.1 and 48.3 and in Division 58.5.1. The overfishing that led to this decline occurred prior to CCAMLR and a lack of recovery of this species should not be construed as a failure of CCAMLR.

6.8 The Scientific Committee considered that the example of *N. rossii* indicates that the depletion of longer-lived Antarctic fish species to low levels may result in species being unable to recover to pre-exploitation levels in two to three decades as indicated in Article II of the Convention. Such a situation needs to be avoided in current fisheries in order to meet the objectives of the Convention.

6.9 The Scientific Committee endorsed the work to develop the *C. gunnari* condition index (Annex 4, paragraph 4.40), including addressing the questions:

(i) What is the linkage between *C. gunnari* and krill?
(ii) What density of krill is optimal for feeding *C. gunnari*?
(iii) How can data be collected regularly from both *C. gunnari* and krill to address the above questions using fish surveys and the fishery?

6.10 The Scientific Committee agreed that this work should be integrated into other ecosystem work of WG-EMM. Such questions are important and should be addressed for other krill predators in integrated study regions. It would also be of value to explore these issues in relation to the functional relationships between predators and krill.

Fish and Squid-centred Interactions

6.11 The Scientific Committee noted the issue that krill-centred interactions cannot be viewed in isolation from interactions with other components of the ecosystem. The issues raised about *C. gunnari* as a predator of krill also raised the issue that *C. gunnari* are themselves prey for land-based predators such as fur seals. This complexity needs to be considered in the future development of management procedures for these fisheries (Annex 4, paragraph 4.45).

6.12 The Scientific Committee noted discussion on fish and squid-centred interactions including:

- the role of myctophids as alternative prey to krill (Annex 4, paragraph 4.46);
- the implications of studies of the diet of squid and fish predators for ecosystem assessment (Annex 4, paragraphs 4.47 to 4.51); and
- status and trends of squid and fish predators (Annex 4, paragraphs 4.52 to 4.61).

6.13 The Scientific Committee noted that studies on the Antarctic shag detailed in the report of WG-EMM (Annex 4, paragraphs 4.48 to 4.50) are not new but have been going on for a number of years. Studies on the diet of this species have included a standard method implemented by WG-EMM in 1997 for a testing period of five years.

Status of the Krill-centred Ecosystem

6.14 The Scientific Committee noted the assessment of the krill-centred ecosystem by WG-EMM (Annex 4, paragraphs 4.67 to 4.85). The current year was not particularly unusual. It also noted that updated CSIs for several land-breeding krill predators at Bird Island were reviewed by WG-EMM. These indices did not vary significantly from the average values during 1999 or 2000. However, the indices did not reflect low breeding population sizes observed in 2000, which were likely to have been influenced by conditions prevailing during the previous winter. The indices presented are most likely to reflect the food supply during the summer concurrent with the breeding season. This latest analysis shows that 1984 and 1994 were years with particularly low predator performance in Area 48 followed by 1991 and 1978.

6.15 Prof. Croxall clarified Annex 4, paragraph 4.74, that while there may be no indications at present that low krill abundance may be affecting predators in Subarea 48.1, there is evidence from elsewhere that reproductive success in predators can be affected by periods of low krill availability.

Further Approaches to Ecosystem Assessment

6.16 The Scientific Committee noted the extensive discussions on advancing the ecosystem approach to management through the development of management procedures for krill, elaboration of objectives for predators and the consideration of how to implement management measures at spatial scales smaller than statistical units (Annex 4, paragraphs 4.86 to 4.117). It welcomed the progress made in determining key issues to be pursued in the near future and noted that it will take another five to 10 years to develop a management procedure for krill fisheries.

6.17 The Scientific Committee endorsed the use of Figure 1 of the report of WG-EMM (Annex 4, paragraph 4.102) as a conceptual framework for considering the development of a management procedure by WG-EMM. This is included in this report as Figure 1 and shows the relationships between the different types of information and assessments that are pertinent to the different spatial scales of conservation measures. The Scientific Committee encouraged further development of elements of this framework in WG-EMM.

Future Work

6.18 The Scientific Committee noted the future work identified by WG-EMM (Annex 4, paragraphs 4.118 to 4.137). In so doing, it noted the importance of interactions with other scientific organisations and resource managers.

6.19 The Scientific Committee noted the request by the University of British Columbia (UBC), Canada, for the CCAMLR Data Manager to participate in training and a scoping study of an ECOPATH-based model of the Southern Ocean ecosystem in November 2000 (Annex 4, paragraphs 4.130 to 4.135). Correspondence between the Chairman of the Scientific Committee, Dr Miller, and Prof. Pitcher from UBC was presented in SC-CAMLR-XIX/BG/22.

6.20 The Scientific Committee welcomed the development of ecosystem models of the Antarctic region. It noted that an area of major interest at this time is the consumption of krill on various regional and temporal scales in the South Atlantic region.

6.21 The Scientific Committee endorsed two criteria for examining such proposals in relation to work undertaken by the Secretariat in the future:

(i) Can the work be undertaken effectively by Members at home or in collaboration? and
(ii) Given resource limitations, will the work lead directly to the development of conservation measures?

6.22 The following views were expressed:

(i) The development of an ECOPATH model may help understand the relationships between species and the fishery but is unlikely to facilitate the direct development of conservation measures inside CCAMLR.

(ii) Consideration of these issues and providing for a better understanding of these models would be useful in WG-EMM.

(iii) Members are developing expertise within their countries to use the ECOPATH models.

(iv) The workload of the Data Management section of the Secretariat will be large in the coming year without this additional workload.

6.23 It was indicated that Canada should be encouraged to participate more formally in CCAMLR and bring its expertise with ECOPATH to WG-EMM. It was considered that the development of this expertise within the Secretariat may be beneficial to CCAMLR but for a number of Members it was a low priority at this stage and should follow the initial development of the models by Members. As a result of these differences of view, the Scientific Committee could not agree on supporting the participation of the Data Manager in the training program in November 2000.

Survey of Land-based Marine Predators

6.24 In response to a request of WG-EMM (Annex 4, paragraphs 3.56 to 3.59), Dr Constable reported to the Scientific Committee on correspondence amongst members of WG-EMM and the Scientific Committee on regional surveys of land-based predators, and a future potential synoptic survey of land-based predators (SC-CAMLR-XIX/6). This paper details the nature of the correspondence, the responses of Members to the request, a draft proposal for a survey, issues for consideration in the planning and implementation of a synoptic survey.

6.25 The Scientific Committee noted that a number of Members are currently planning surveys of land-based predators in the Convention Area and that Members supported the development of survey methodologies that would help achieve circum-Antarctic estimates of abundance of land-based marine predators.

6.26 The Scientific Committee agreed that it may be premature at this stage to identify the 2005/06 season as an appropriate time to undertake a synoptic survey. It agreed that a workshop needs to be held in 2002 to review the feasibility of a synoptic survey, survey methodologies and to review the overall requirements for estimating the circum-Antarctic abundances of land-based marine predators. To that end, the Scientific Committee requested that WG-EMM review SC-CAMLR-XIX/6 and develop terms of reference and organisation for an appropriate workshop in 2002.

MANAGEMENT UNDER UNCERTAINTY

IUU Fishing

7.1 The Scientific Committee considered SC-CAMLR-XIX/BG/13 which reported progress made at the FAO Expert Consultation on Illegal, Unreported and Unregulated (IUU) Fishing, held in Sydney, Australia, during May 2000, toward an International Program of Action (IPOA) to deal with IUU. It was noted that the draft IPOA was used as the basis for discussion and negotiation at a Technical Consultation on IUU held in Rome, Italy, from 2 to 6 October 2000, but that final agreement on the IPOA was not reached. Final agreement is expected before the end of the year, however, and the Scientific Committee noted that the adoption of a global plan to combat IUU would aid the work of CCAMLR.

Regulatory Framework

7.2 The Scientific Committee considered SC-CAMLR-XIX/BG/27, a working paper on scientific issues related to a unified regulatory framework for CCAMLR. This had been prepared during the intersessional period 1999/2000 by the ad hoc Task Group on the Development of a Unified Regulatory Framework for CCAMLR. The Scientific Committee noted the discussion of an earlier draft of this document in WG-FSA's report (Annex 5, paragraphs 4.270 to 4.274).

7.3 The Scientific Committee recalled discussion at recent meetings regarding the need for a unified framework for providing management advice on all fisheries in the Convention Area

(CCAMLR-XVII, paragraphs 10.3 to 10.7). In 1999 the Chairman of the Scientific Committee convened the ad hoc task group to explore the scientific basis for a regulatory framework. The first report of this task group was discussed at the 1999 meeting of the Scientific Committee (SC-CAMLR-XVIII, paragraphs 7.11 to 7.23).

7.4 The ad hoc task group described the purpose of the regulatory framework from a scientific perspective under three headings:

(i) to provide clear guidance on the data and information requirements from all fisheries in the Convention Area to support the development of management advice by the Scientific Committee in accordance with the precautionary and the ecosystem approaches to fisheries management;

(ii) to support the design of control mechanisms that will enable the collection of data and information for scientific analysis, and aim to ensure that fisheries in the Convention Area do not expand faster than the acquisition of information necessary for the development of management advice; and

(iii) to streamline the process of annual review and assessment of fisheries by the Scientific Committee and its working groups, in the face of a mounting workload created by the increasing number of fisheries in the Convention Area.

7.5 The aim of the task group was to develop a procedural mechanism to achieve the purpose described in paragraph 7.4. The report recalled previous attempts to do this through the definition of standard fishery types within a general scheme of stages of fishery development, starting with new fisheries and moving through exploratory or developing fisheries to established fisheries and lapsed and/or closed fisheries. The Scientific Committee noted the major difficulties involved in defining stages of fishery development. These have been revealed firstly in preparation of the new and exploratory conservation measures and more recently in the elaboration of the regulatory framework.

7.6 The task group therefore focused on the establishment of a framework encompassing all fisheries, which does not rely on defining the stages of fishery development. The task group proposed a simplified framework within which existing regulatory requirements, including notification, establishment of research and fishery operations plans and data collection plans could be generalised and applied to all fisheries, not just those falling under the remit of the new and exploratory measures (Conservation Measures 31/X and 65/XII). The proposal also addressed the specification of conditions that would apply to closed fisheries that are reopened, and to the interpretation and application of the existing new and exploratory measures.

7.7 A key component of the generalised mechanism proposed by the task group is a new reference document prepared and maintained by the Secretariat for each fishery in the Convention Area, known as the *Fishery Plan*. The *Fishery Plan* would provide a comprehensive summary of information on each fishery, including a list of all the regulatory requirements (i.e. harvest controls, notification requirements, a research and fishery operations plan, and a data collection plan). It would also provide a summary of the fishing activity (e.g. catch limits by year, catches by year, level of effort, number of vessels and vessel days, fishery data available for assessment, notifications received), and a summary list of the data received by the Secretariat for the most recent season in which fishing took place. Having all of this information brought together in one place would help the Scientific Committee and its working groups plan future work, depending on what data are submitted from the fishery and/or what notifications are received. For closed fisheries, the *Fishery Plan* could be used to specify next to each of these elements the conditions under which a reopened fishery would be expected to operate.

7.8 A draft of the structure of the *Fishery Plan* is provided in Table 6. It is expected that among other things the plan will provide a useful successor to the assessment summaries previously provided in the report of WG-FSA. The Scientific Committee agreed that the draft structure should be evaluated by WG-EMM and WG-FSA at their next meetings.

7.9 To provide comprehensive coverage of all CCAMLR fisheries under the framework, a *Fishery Plan* would need to be prepared and maintained for all fisheries which exist, or have existed in the Convention Area (i.e. all those which have been regulated under CCAMLR conservation measures at some time)[1]. This would create a simplified structure of two fishery types: those with fishery plans and those without. For the former, the regulatory and scientific requirements would be specified in the plan. For the latter, the Commission would need to establish entry-level conditions, which it has already done in the context of new and exploratory fisheries.

7.10 The Scientific Committee noted that this would negate the requirement for definitions of fishery types or stages that have become complex and ambiguous and would achieve the two original design criteria of the Regulatory Framework (CCAMLR-XVII/18):

(i) to be sufficiently comprehensive to provide guidelines for the management of all existing and potential fisheries; and

(ii) to be sufficiently flexible to allow the Commission to adopt measures tailored to the specific needs of individual fisheries, on a case-by-case basis.

7.11 Figure 2 illustrates the envisaged function of the *Fishery Plan* in the assessment of fisheries by the Scientific Committee and the regulation of fisheries by the Commission. Information flows from the Scientific Committee to the Commission in the form of management advice, based on analyses of information available at the time of the annual meeting. The Commission uses this information, and the results of its own deliberations, to develop conservation measures and other regulatory requirements. This information will be used to modify the *Fishery Plan* for each fishery taking place during the current season, and each fishery expected to take place during the forthcoming season (starting on 1 December).

7.12 The Scientific Committee noted that the *Fishery Plan* was not intended to be a regulatory instrument of the Commission and would not itself govern harvesting activity within the Convention Area. It would, however, contain information from the conservation measures and other sources, providing a single point of reference for each fishery to support the application of management measures and track developments and changes in individual fisheries over time. The content of the *Fishery Plan* would provide the Scientific Committee with guidance on the current and expected future operation of the fishery and also the operational objectives and decision rules the Scientific Committee should apply in its analysis of fisheries data and information provided by Members.

7.13 Specifically, the Scientific Committee noted that it would enable:

(i) the Scientific Committee to make decisions about whether a new assessment is required and/or possible; and

(ii) the Commission to formulate conservation measures based on all appropriate information about the fishery.

7.14 The Scientific Committee noted that the *Fishery Plan* could also be used by the Commission to develop a standardised structure for the conservation measures.

[1] Only those *Fishery Plans* covering fisheries which have either been active during the current season or are under notification to become active during the forthcoming season, would need to be modified each year.

7.15 The task group's proposal for generalising the existing requirements for new and exploratory fisheries is outlined Table 7. The current requirements for notification, research and fishery operations plans, data collection plans and other management requirements as specified in Conservation Measures 31/X and 65/XII, are summarised in Tables 8 and 9.

7.16 The Scientific Committee noted the comments of the task group regarding the utility of a generalised notification procedure for streamlining the annual review of fisheries by the Scientific Committee and its working groups and aiding in the planning of the increasing workload of scientific analysis (see SC-CAMLR-XVIII, paragraph 7.16). It would, for example, help the working groups to make decisions about whether or not to do assessments for particular fisheries in particular years. Under a generalised notification procedure, those fisheries for which notifications of proposed fishing activity in the forthcoming season are received by the required deadline would be given priority for assessment analyses on the basis of available data.

7.17 The Scientific Committee noted that this would not mean that fisheries without a notification, and thereby having no new management advice, would automatically be closed. There may be scientific advice for those fisheries (which could be considered to be 'lapsed') from previous years that would still be relevant. This advice would need to be suitably modified, in a precautionary sense (for example, the recommended catch level might be reduced), to account for the length of time since it was drafted, and its currency or relevance to the present situation. The duration of the relevance of management advice would ideally be specified by the working group at the time of the assessment. This might also be the case if a notification had been received, but it was not possible to update an assessment because no new data were available, particularly if the original management advice was based on a scientific survey and the relevance of the results of that survey decreased over time (for example, due to uncertainty over recruitment and/or mortality).

7.18 The Scientific Committee agreed that changes proposed by the task group will create a more proactive process for the Scientific Committee and Commission, in which each body specifies the requirements that will trigger future actions. For instance, the task group proposed that if a fishery fails to meet all the scientific requirements (essentially data collection from a variety of possible sources) and/or no notification of future interest in the fishery is received by CCAMLR, then the Scientific Committee (and its working groups) would not be expected to attempt to undertake a new assessment. This will allow the Scientific Committee to adjust its work to the needs of fisheries as those needs arise and according to whether the regulatory requirements have been met. General default requirements can be specified for fisheries that do not yet exist or are not known about. But in all cases there will be an expectation to notify each year and to collect and submit data depending on the requirements prescribed by the Scientific Committee.

7.19 The Scientific Committee expressed its appreciation to Drs Parkes, Agnew and Constable for the preparation of SC-CAMLR-XIX/BG/27. Considerable discussion ensued regarding the implementation of the proposed uniform regulatory framework, the submission of notifications to fish, the development of fishery plans, and the corresponding responsibilities of Members and the Secretariat. It was noted that no new requirements are being suggested and that the proposed *Fishery Plans* would provide a framework to formalise existing documentation, including research exemptions. It was also noted that notification requirements may need to be refined, that default positions in the absence of new information need to be defined, and that changes to existing definitions of fishery management units need to be accommodated.

7.20 The Scientific Committee endorsed the concept of the *Fishery Plan* and requested that example plans be developed as a means of refining the procedure and generating future discussion. Accordingly, the Scientific Committee requested that the Secretariat be tasked with preparing fishery plans for krill and for *C. gunnari* in time for the 2001 meetings of WG-EMM and WG-FSA respectively.

Trigger Levels in the Management of the Krill Fishery

7.21 At its last meeting, the Scientific Committee recognised that the setting of a new precautionary catch limit is the beginning of the process for further developing a management procedure for krill in the South Atlantic. It recognised that the procedure will need to include consideration of the subdivision of the catch limit into smaller management units. It further stated that the size of these management units and the trigger level at which the catch limit would be subdivided needed to be determined by WG-EMM at its 2000 meeting (SC-CAMLR-XVIII, paragraph 5.14; Annex 4, paragraphs 6.1 to 6.4 and 6.11).

7.22 The Scientific Committee endorsed the recommended subdivision of the yield for krill in Area 48 to provide catch limits in each of the Subareas 48.1, 48.2, 48.3 and 48.4 (paragraph 5.9) based on the results of the CCAMLR-2000 Survey. The Scientific Committee agreed that smaller spatial scales within each statistical subarea should be considered in relation to addressing management requirements and achieving conservation objectives for krill predators at various spatial scales (paragraph 5.14). It recognised that even the catch limits in each subarea could cause localised depletion if all the catch was taken from within a confined area, especially in relation to the foraging needs of land-based marine predators.

7.23 The Scientific Committee also noted that another five to 10 years will be required to develop a management procedure consistent with Article II of the Convention (paragraph 5.15) that takes full account of spatial, particularly small-scale, requirements of land-based predators. It agreed that in the absence of advice on these requirements, the Scientific Committee is unable to judge how the dynamics of local populations may be affected by the proposed krill catch limits within subareas. To that end, the Scientific Committee recommended to the Commission that krill catches do not exceed a set (i.e. 'trigger') level in Area 48 until a procedure for division of the overall catch limit into smaller management units has been established. This is consistent with the current Conservation Measure 32/X which sets such a trigger level at 620 000 tonnes which is slightly above the historical maximum annual catch in Area 48 to date.

Advice to the Commission

7.24 The Scientific Committee advised that an alternative to the current trigger level contained in Conservation Measure 32/X could be 1 million tonnes which is approximately the harvest level suggested for each of the subareas in Area 48, from the division based on the CCAMLR-2000 Survey results.

SCIENTIFIC RESEARCH EXEMPTIONS

8.1 The Scientific Committee noted the following scientific research surveys planned for the 2000/01 intersessional period and notified under Conservation Measure 64/XII (CCAMLR-XIX/BG/5 Rev. 1):

(i) Australia (*Aurora Australis*) in Division 58.4.2 (krill);

(ii) Germany (*Polarstern*) in Subarea 48.1 (krill);

(iii) UK (*Argos Georgia)* in Subarea 48.3 (experimental pot fishery for *D. eleginoides*);

(iv) UK (*James Clark Ross*) in Subarea 48.3 (krill);

(v) Ukraine (*RK-1*) in Division 58.4.4 *(D. eleginoides)*; and

(vi) USA–Germany (*Yuzhmorgeologiya*) in Subareas 48.1 and 48.2 (finfish).

8.2 With the exception of the experimental pot fishing for *D. eleginoides* planned by the UK in Subarea 48.3, the total catch of finfish and krill in each survey notified for 2000/01 was expected to be less than 50 tonnes.

8.3 The Scientific Committee noted that the UK expected to catch up to 150 tonnes of *D. eleginoides* during the planned experimental pot fishing. Details of the experimental design were submitted in CCAMLR-XIX/9 and had been considered by WG-FSA (Annex 5, paragraph 4.70). It was also noted that the experimental pot fishing conducted in 2000 had produced encouraging results; no seabird by-catch had been reported in association with the use of pots in Subarea 48.3 (Annex 5, paragraph 7.129). Further work was required to reduce the by-catch of juvenile crabs (*Paralomis* spp.) and demonstrate commercial viability of the method.

8.4 The Scientific Committee discussed the justification of conducting further experimental potting for *D. eleginoides* under Conservation Measure 64/XII. It was agreed that the development of mitigating measures for crabs and other by-catch was a suitable research activity under this conservation measure. However, the Scientific Committee agreed that the demonstration of commercial viability was not a research activity within the remit of the Scientific Committee.

8.5 The Scientific Committee noted that the fishing selectivity of pots used in the experimental trials was comparable to that of longlines in the commercial fishery (Annex 5, paragraph 4.71). Consequently, the Scientific Committee recommended that the conservation measure regulating the longline fishery for *D. eleginoides* in Subarea 48.3 should be broadened to include year-round commercial fishing for that species using pots. This would allow further evaluation of the commercial viability of pots.

8.6 The Scientific Committee agreed that the catch of *D. eleginoides* taken in pots should be deducted from the catch limit for that species in Subarea 48.3 in the 2000/01 season (Annex 5, paragraph 4.70). It was also recalled that experimental pot fishing for *D. eleginoides* may result in significant levels of by-catch, particularly crabs, and that this should also be taken into consideration when monitoring the catch limits for other fisheries (including crabs) in Subarea 48.3.

8.7 The Scientific Committee reviewed the 50 tonne catch limit for *Dissostichus* spp. for scientific research activities defined in Conservation Measure 64/XII, and the 10 tonne catch limit for *Dissostichus* spp. in exploratory fisheries under Conservation Measure 182/XVIII. The Scientific Committee noted that these two conservation measures were inconsistent in their application to *Dissostichus* spp. (Annex 5, paragraphs 4.101 and 4.102).

8.8 The Scientific Committee recommended that Conservation Measure 64/XII should be amended so that a 10 tonne catch limit applies to the taking of *Dissostichus* spp. by longline, trawl and any other type of gear, including pots. The total aggregate catch limit for finfish should remain at 50 tonnes. The Scientific Committee agreed that research plans for research vessel activity involving catches of *Dissostichus* spp. exceeding 10 tonnes should be subject to a full review by WG-FSA and the Scientific Committee.

NEW AND EXPLORATORY FISHERIES

New and Exploratory Fisheries in 1999/2000

9.1 One conservation measure relating to new fisheries and 13 conservation measures relating to exploratory fisheries were in force during 1999/2000. In only five of these 14 new or exploratory fisheries, did fishing actually occur during 1999/2000. Information on these fisheries is summarised in Annex 5, Table 19. In most cases, the numbers of days fished and the catches reported were very small. The notable exception was the exploratory fishery for *Dissostichus* spp. in Subarea 88.1 conducted under Conservation Measure 190/XVIII, where three vessels fished for a total of 162 days, taking 745 tonnes of *D. mawsoni*.

9.2 Reviewing the information in Annex 5, Tables 18 and 19, the Scientific Committee strongly reiterated its concern, expressed at previous meetings, about the number of times that new and exploratory fisheries have been notified but never actually activated. The Scientific Committee also noted that often the same or similar notifications have been made repeatedly, but in each case no fishing had eventuated. Of all the notifications made since 1995/96, two thirds had not been activated.

9.3 The Scientific Committee noted that each time a notification is made, WG-FSA is required to review it, and to the extent possible, provide advice on precautionary catch limits. Given the large number of notifications received over the last few years, an increasingly large proportion of the time available has had to be devoted to consideration of new and exploratory fisheries. Despite this, and despite notifications having been made for a large number of subareas and divisions, once again WG-FSA had received essentially no new information on *Dissostichus* spp. stocks in most of these areas. That concern is further heightened by the fact that substantial amounts of IUU fishing are believed to have occurred in these areas.

9.4 The large proportion of notifications following which no fishing activity occurred was discussed by the Scientific Committee. It was noted that although notifications were made in good faith, changes in the economic situation sometimes meant that fishing companies did not go to the notified areas for commercial reasons. Arising from this, repeat notifications were being made in subsequent years. Whilst accepting this view, the Scientific Committee decided that an assessment would be made following a first submission but, in the absence of fishing, no further assessments would be made until new data were received.

9.5 The Scientific Committee agreed that some of these difficulties may be alleviated if changes were made to the system of notification and classification of fisheries. This is discussed further under 'Regulatory Framework' (section 7).

9.6 The Scientific Committee discussed Conservation Measure 182/XVIII governing exploratory fisheries. This requires for each individual vessel that, once the catch in a small-scale research unit (SSRU) has exceeded a trigger level (10 tonnes or 10 hauls), then research hauls must be carried out and the results reported to CCAMLR. In only three of the active exploratory fisheries were the catches taken in SSRUs sufficiently large that the requirement to undertake research hauls was triggered. This occurred in SSRUs A, B and C in respect of the Uruguayan exploratory longline fishery in Division 58.4.4, in SSRUs A and B in respect of South African longline fishery in Subarea 58.6, and in SSRUs A, B, C and D in respect of the New Zealand exploratory longline fishery in Subarea 88.1.

9.7 The Scientific Committee noted that in many instances no research data were available for most of the SSRUs in which fishing had taken place (CCAMLR-XIX/BG/5 Rev. 1), and it was noted that failure to provide such data seriously undermines the ability of WG-FSA to make assessments, a notable exception being the extensive data submission provided by New Zealand.

9.8 Representatives from South Africa and Uruguay stated that some research data had been collected from their vessels in accordance with Conservation Measure 182/XVIII but their vessels, although ceasing to fish on 31 August 2000, had not returned to port until some weeks later. These data had now been submitted to the Secretariat.

9.9 The Scientific Committee noted that it is stated in Conservation Measure 182/XVIII that the last reporting date for which data collected as a result of fishing up to 31 August 2000 is 30 September 2000. The linkage to Annexes 182/A and 182/B could be made more explicit.

9.10 The Scientific Committee also emphasised that the research plans mandated by Conservation Measure 182/XVIII represented minimum research requirements. Thus, although the minimum requirement for a single vessel to fish is 20 research hauls, the assessments undertaken at this year's meeting of WG-FSA for Subarea 88.1 used data from about 100 hauls and even so, information from other localities had had to be used in order to complete that assessment. Accordingly it is likely that additional research data will need to be collected for a number of years before reliable assessments will be possible. In this context, WG-FSA encouraged the submission, wherever possible, of more comprehensive research plans, extending further than those required under Conservation Measure 182/XVIII.

9.11 In this regard the Scientific Committee recommended that proposals for new or exploratory fisheries with specific research plans endorsed by the Scientific Committee can be exempted from the general research requirements under Conservation Measure 182/XVIII, such as those submitted this year for trawl fisheries in Divisions 58.4.1, 58.4.2 and 58.4.3.

9.12 Concern was expressed that if several vessels made fewer than 10 hauls or caught less than 10 tonnes of fish in those hauls within an SSRU, thus obviating the need to undertake the research component of Conservation Measure 182/XVIII, a significant amount of fish might be taken from which very little research data might arise. Mechanisms by which this requirement might be strengthened for proposals for which an alternative research plan has not been endorsed were discussed in a subgroup and the following proposals applicable to each vessel entering the fishery made:

(i) All catches of target species should be included in the catch limit. Catches of by-catch species are considered separately in paragraph 9.14.

(ii) On first entry into an SSRU, the first 10 hauls, designated 'first series', whether by trawl or longline, should be designated 'research hauls' and must satisfy the criteria set out in Annex 182/B paragraphs 3(ii) to 3(iv).

(iii) The next 10 hauls or 10 tonnes of catch, whichever trigger level is achieved first, are designated the 'second series'. Hauls in the second series can, at the discretion of the skipper, be fished as part of normal exploratory fishing. However, provided they satisfy the requirements of Annexes 182/A and 182/B, paragraphs 3(ii) to (iv), these hauls can also be designated as 'research hauls'.

(iv) The nomination of 'research hauls' is to be made prior to or at the time of setting the gear.

(v) On completion of the first and second series of hauls, if the skipper wishes to continue to fish within the SSRU, the vessel must undertake a second research phase which will result in a total of 20 'research hauls' being made. The second series of hauls should be undertaken during a single visit to a SSRU.

(vi) On completion of 20 'research hauls' the vessel may continue to fish within the SSRU.

(vii) When either the catch limit or the end of the fishing season is reached, all fishing within the designated area should cease.

9.13 The Scientific Committee endorsed the proposal from WG-FSA regarding Annex 182/B that while length-frequency and sex data should continue to be recorded for at least 100 fish, samples for biological studies (otoliths, scales, stomach contents) should be taken and gonad stages recorded for at least 30 fish.

9.14 The subgroup discussed by-catch provisions in Conservation Measure 182/XVIII noting that hauls made in previously unfished areas might take significant by-catches to the extent that they might account for much of the catch limit for a by-catch. Three options were considered, maintaining a 50 tonne catch limit for each statistical subarea (the current provision of Conservation Measure 182/XVIII), excluding the by-catch arising from the first 10 'research hauls' from the by-catch catch limit or altering the by-catch catch limit. The first option was considered inappropriate because the anticipated by-catch rates during the exploratory phase might be incompatible with current reporting requirements. Following discussion it was agreed that

- EITHER: by-catches arising from the first 10 'research hauls' should not be set against the by-catch catch limit although they should be included in reported catches;

- OR: the by-catch catch limit should be changed to 50 tonnes for each SSRU.

9.15 The Scientific Committee noted that an exploratory longline fishery and an exploratory trawl fishery were proposed for Division 58.4.2. The Scientific Committee had endorsed the fishing and research plans for the trawl fishery, noting that these plans aimed to identify whether bottom trawling for *D. mawsoni* would be detrimental to benthic habitats in this division. In this regard, these plans were intended to determine relationships between the densities of fish and benthic habitat features. Also, the plans were designed to provide for interim protection of habitats through the implementation of open and closed areas until a management plan can be developed for this region that will ensure appropriate protection of benthic habitats. The Scientific Committee recommended that the fishing and research plans for the longline fishery be consistent with the trawl fishery such that the system of open and closed areas be applied and the research plan helps understand the relationships between *D. mawsoni* and benthic habitats.

9.16 The Scientific Committee recommended that the procedure set out in paragraphs 9.12 to 9.14 might be taken forward for the forthcoming season and reviewed at next year's meeting of WG-FSA.

9.17 A further practical problem arises when there are multiple exploratory fisheries operating in a subarea or division. Conservation Measure 182/XVIII requires that fishing in any fine-scale rectangle shall cease when the reported catch reaches 100 tonnes, and that only one vessel at a time may fish in any fine-scale rectangle. Currently catches within SSRUs are monitored by the Secretariat via the five-day reporting system. It is clear from CCAMLR-XIX/BG/5 however, that the timeliness of five-day report submissions last season was not very good. If similar performance occurs next season, the five-day reporting system may not be sufficient to monitor accurately compliance with the requirements of Conservation Measure 182/XVIII with respect to SSRUs, when more than one exploratory fishery is operating in an area. In principle, the presence of VMS on each vessel would allow accurate monitoring of vessel position. But without a central coordinating body it is difficult to see how this information could be used (Annex 5, paragraph 4.87).

9.18 The only exploratory longline fishery for which WG-FSA was able to make an assessment was for *D. mawsoni* in Subarea 88.1. The Scientific Committee was pleased to note that new data from 489 longline hauls had been supplied by New Zealand. A total of 76 fine-scale rectangles has been fished in the past three years (Annex 5, paragraph 4.15). These data included a large amount of biological information on the species.

9.19 An estimate of yield was made by using a similar approach to that used at last year's meeting to calculate precautionary catch limits for Subarea 88.1. Yields were estimated for Subarea 88.1 by relating the CPUE from research sets and biological parameters for *D. mawsoni* to the CPUE, biological parameters and yield estimate for *D. eleginoides* in Subarea 48.3. The method, along with descriptions of modifications to that used in 1999, is described in Annex 5, paragraphs 4.20 to 4.32.

9.20 The resulting estimates of yield are based on the known adult habitat of *D. mawsoni* in Subarea 88.1. The Scientific Committee endorsed the view of WG-FSA that the best available estimate of yield for *D. mawsoni* in Subarea 88.1 is 3 778 tonnes (NB: this estimate had been revised during the Scientific Committee meeting (see paragraph 5.45)).

9.21 The Scientific Committee noted that, whilst the current assessment provided several improvements to earlier assessments of this area, there was still considerable uncertainty present. This stems from uncertainty in biological and fishery parameters for both *Dissostichus* spp., and the assumption of the relationship between CPUE and density. However, γ values appear to be similar for both species (Annex 5, paragraph 4.30).

9.22 In light of this uncertainty, the Scientific Committee agreed that some discount still needs to be applied to the results of this assessment. The Scientific Committee noted that in previous years a range of discount factors (from 0.25 to 0.5) has been applied to new and exploratory fisheries for *Dissostichus* spp.

9.23 Currently CPUE is the main source of information to provide indices of relative abundance and information from alternative methods, such as tagging, is urgently required.

9.24 It was noted that a tagging program directed not only at *D. mawsoni*, the target species, but also at skates, a significant component of the by-catch, is in progress in Subarea 88.1. The results from these studies are likely to provide much useful information towards reducing the uncertainty over assessments. The Scientific Committee noted this study and encouraged other participants in the fishery in Subarea 88.1 to undertake similar tagging studies.

New and Exploratory Fisheries Notified for 2000/01

General Issues

9.25 A total of nine notifications for new or exploratory longline or trawl fisheries for *Dissostichus* spp. in the 2000/01 season pertaining to 16 subareas or divisions had been received. All had been received by the Secretariat on or before the due date. Recalling the experiences of the previous year, WG FSA had recommended that in future years it would not consider any notifications received after the due date. This was endorsed by the Scientific Committee.

9.26 Dr K. Sullivan (New Zealand) stated that it is New Zealand's position that it did not support proposals for expanded effort in the Ross Sea, an area with which New Zealand has had a long association and commitment to manage and protect the environment from any adverse impacts. In any previous year of the exploratory fishery in Subarea 88.1 a maximum of three vessels have operated. However, this year there are notifications of a total maximum of 10 vessels (Annex 5, Table 25). New Zealand does not believe this escalation in effort is warranted for the purposes of researching this exploratory fishery. There is also the danger that the current research program may be undermined in the following manner:

(i) there is potential for the short total season length to be further shortened if the catch limit was reached. This would then restrict the collection of research data to a shorter period than required;

(ii) difficulties may be encountered in trying to replicate research sets previously fished within SSRU's for research purposes; and

(iii) interpretation of longline CPUE data is confounded by changes in vessels from year to year.

9.27 Dr Sullivan further advised that New Zealand could not support proposals for multiple exploratory fishing operations in Subarea 88.1 unless a fisheries management system was developed to address practical issues which will arise relating to compliance with Conservation Measure 182/XVIII. In particular, the current requirement for the maintenance of a maximum of only one vessel per fine-scale rectangle presents a major difficulty to operational management.

9.28 Mr B. Watkins (South Africa) indicated that the Scientific Committee had offered clear advice concerning the notifications for exploratory fisheries in Subareas 88.1 and 88.2. In his view the matter alluded to in paragraphs 9.26 and 9.27 were for the Commission to consider and were not well placed within the Scientific Committee's deliberations.

9.29 Dr E. Barrera-Oro (Argentina) and Prof. J. Croxall (UK) supported the views of Mr Watkins.

9.30 Concern was expressed that many notifications failed to specify an anticipated level of fishing effort or total catch. In some instances the total catch specified was the same as the catch limit for the appropriate statistical subarea. It was agreed that WG-FSA should develop for its next meeting, criteria to determine whether the information contained in notifications was acceptable.

9.31 Some notifications had been received which applied to subareas or divisions containing national EEZs. It was accepted that such notifications referred to waters within the subarea or division that are outside the relevant EEZ.

9.32 WG-FSA had noted that there were notifications of intent to fish in Subareas 48.1, 48.2 and 58.7. Conservation Measures 72/XVII, 73/XVII and 160/XVII clearly state that the taking of finfish in these subareas, other than for research purposes, is prohibited until such time as a survey of stock biomass is carried out, its results reported to and analysed by the Working Group, and a decision that the fishery be reopened is made by the Commission based on the advice of the Scientific Committee. As these conditions have not yet been met, the Scientific Committee recommended that new or exploratory fisheries for finfish should not take place in these subareas in the coming season. For Subarea 58.7, no information was available to indicate what activities are intended arising from the French notification.

9.33 The Brazilian notification (CCAMLR-XIX/5) also indicated an intent to fish for *D. eleginoides* in Subareas 48.3 and 48.4. The fisheries in these subareas are regulated under Conservation Measures 179/XVIII and 180/XVIII respectively. The Scientific Committee welcomed what it believed to be the primary intent of the Brazilian notification, which is to inform CCAMLR that Brazil intended, for the first time, to participate in fisheries in these areas.

9.34 The Scientific Committee noted that for Divisions 58.5.1 and 58.5.2, the amount of fishable ground lying outside national EEZs was very small and that new or exploratory fisheries are unlikely to be viable. This view had been endorsed by the Commission (CCAMLR-XVIII, paragraph 7.23).

9.35 In all but one of the nine other subareas and divisions, more than one new or exploratory fishery notification had been made and three or more notifications had been made for six of these. In Division 58.4.4, six notifications had been made involving up to a maximum of 14 vessels. It was noted that this strongly affects the average catch available per vessel and, since such a catch would most likely be taken within a short period of time, might result in a serious overshoot of the catch limit.

9.36 Regarding Conservation Measure 182/XVIII, WG-FSA had discussed the appropriateness of the 100 tonne catch limit per fine-scale rectangle (Annex 5, paragraph 4.88). This had been included to ensure that exploratory fishing occurs over as wide a geographic area as possible. In most cases, the reported catches per fine-scale rectangle have been less than

50 tonnes and catches over 50 tonnes have only been recorded in Subarea 88.1. Obviously a reduction of the 100 tonne limit per fine-scale rectangle would encourage a wider geographical distribution of effort. It was agreed that this topic should be reviewed at the next meeting of WG-FSA.

9.37 Pending the review by WG-FSA, the Scientific Committee recommended that the 100 tonne catch limit in fine-scale rectangles be retained. As such, it endorsed the method by which the Commission determined overall catch limits for statistical areas for these fisheries (CCAMLR-XVIII, paragraphs 7.10 to 7.17).

9.38 Both longline and trawl fisheries have been notified for Divisions 58.4.1, 58.4.2 and 58.4.3. WG-FSA had considered these in terms of gear selectivity on the stocks, impact on benthos and the amount and type of information likely to accrue from such fishing activities (Annex 5, paragraphs 4.88 to 4.91). Arising from the discussions, WG-FSA had recommended that precautionary catch limits in Divisions 58.4.1 for Elan Bank should be 145 tonnes for trawl and 145 tonnes for longline fishing. In Division 58.4.3, for BANZARE Bank, the recommended precautionary catch limits were 150 tonnes for trawl fishing and 150 tonnes for longline fishing. The Scientific Committee endorsed these recommendations.

9.39 For Division 58.4.2, the Scientific Committee recommended that the method for calculating precautionary catch limits apply to this division (paragraph 9.37). It also recommended that catch limits be consistent with the principles outlined in paragraph 9.12 and that the catch limit for *Dissostichus* spp. should be split evenly between trawl and longline fishing.

9.40 For Subareas 48.6, 58.6 and 88.2 and Divisions 58.4.3 and 58.4.4, precautionary catch limits for *Dissostichus* spp. had been set at CCAMLR-XVIII. The Scientific Committee recommended that the provisions of Conservation Measures 184/XVIII, 187/XVIII, 188/XVIII, 189/XVIII and 191/XVIII be carried forward for a further year. However, Conservation Measure 172/XVIII prohibits directed fishing for *Dissostichus* spp. in subareas and divisions for which no specific conservation measures have been adopted. Accordingly, WG-FSA had agreed that, until it had gained more information on areas currently fished for *Dissostichus* spp. under new and exploratory fishery regimes and more experience with the operations of SSRUs, it would be inappropriate to open previously unfished areas to fishing for *Dissostichus* spp., or to reopen areas that have not been fished for *Dissostichus* spp. in recent years. The Scientific Committee therefore recommended that Subarea 48.5, the Antarctic coastal part of Division 58.4.1 south of 64°S, and Subarea 88.3 be closed to directed fishing for *Dissostichus* spp.

9.41 In the Uruguayan exploratory fishery during 1999/2000 in Division 58.4.4, 55 tonnes of *D. eleginoides* had been taken outside designated SSRUs. As catches outside SSRUs do not have the potential to trigger research activities regardless of their size, the Scientific Committee recommended that the entire area of Division 58.4.4, currently not contained in designated SSRUs, be designated as an SSRU.

9.42 The ASOC Observer made the following statement:

> ‘ASOC calls for a moratorium on all toothfish fisheries, in light of this, ASOC must oppose all new and exploratory fisheries. Regardless of ASOC’s call for a moratorium, opening any new and exploratory fisheries is a step in the wrong direction.
>
> ASOC argues that a critical short-term measure toward ending IUU fishing and its devastating by-catch of endangered albatrosses and petrels is for CCAMLR to establish a moratorium on legal fisheries for Antarctic and Patagonian toothfish. It is insupportable to continue the legal fishery when the real catch is already far above what CCAMLR estimates as a precautionary level. The large IUU fishery

substantially undermines CCAMLR's capacity for scientific and environmental management of the impact of fishing activities on both target species and on highly endangered by-catch species. ASOC reminds this Committee that the fish stock assessment estimates that as many as 333 000 seabirds have been drowned by IUU fishers since 1996.

The moratorium would be a short-term measure to remain in place until: IUU fishing has been eliminated in CCAMLR waters; the incidental catches of albatross and petrels has been eliminated; robust and independent scientific data has been acquired on the status and demographic trends of toothfish stocks; and CCAMLR has a fully functioning catch certification system integrated with the more broadly based trade regulation system available under CITES.'

Review of Individual Notifications

9.43 Argentina had submitted a notification (CCAMLR-XIX/12) for exploratory longline fisheries for *Dissostichus* spp. in Subareas 48.1, 48.2, 48.6, 58.6, 88.1, 88.2, 88.3 and Divisions 58.4.1, 58.4.2, 58.4.3, 58.4.4 and 58.5.1 outside EEZs.

9.44 Aside from the recommendation above regarding Subareas 48.1 and 48.2, the Scientific Committee noted that the available area outside national EEZs in Divisions 58.5.1 and 58.5.2 was small, so appropriate precautionary catch limits for these areas should also be similarly small.

9.45 Australia had submitted a notification (CCAMLR-XIX/10) for exploratory bottom trawl fisheries for *Dissostichus* spp. in Divisions 58.4.1 and 58.4.3, and a notification (CCAMLR-XIX/11) for an exploratory trawl fishery for *Dissostichus* spp., *Chaenodraco wilsoni*, *Lepidonotothen kempi*, *Trematomus eulepidotus*, *Pleuragramma antarcticum* and other species in Division 58.4.2. The second notification was a resubmission of a notification made last year.

9.46 It was noted that, due to the presence of rough ground, most of the area of Divisions 58.4.1 and 58.4.3 was unsuitable for trawling. The research plan includes specific experiments to examine the effects of bottom trawling on benthic communities.

9.47 Brazil submitted a notification (CCAMLR-XIX/5) for exploratory longline fisheries for *D. eleginoides* in Subareas 48.2, 48.3, 48.4 and 48.6 and Divisions 58.4.4, 58.5.1 and 58.5.2 (outside national EEZs of South Africa, France and Australia).

9.48 Comments regarding these subareas and divisions are given in paragraphs 9.32 to 9.41.

9.49 France had submitted a notification (CCAMLR-XIX/13) for new and exploratory longline fisheries for *D. eleginoides*, *Raja*, *Bathyraja* and *Macrourus* in Subareas 58.6 and 58.7 and Divisions 58.4.3, 58.4.4, 58.5.1 and 58.5.2 outside the EEZs of South Africa, Australia and France.

9.50 Aside from noting that clarification was needed of the intentions within Subarea 58.7, comments regarding the other subareas and divisions are given in paragraphs 9.32 to 9.41. In addition, it was noted that it was a strict requirement of Conservation Measure 182/XVIII that exploratory fishing vessels should carry an observer under the CCAMLR Scheme of International Scientific Observation.

9.51 New Zealand submitted a notification (CCAMLR-XIX/17) for an exploratory longline fishery for *Dissostichus* spp. in Subarea 88.1. This represents a continuation of the exploratory fishing program carried out by New Zealand in previous years in this subarea, for which considerable catch and research information has been submitted.

9.52 Arising from the data submitted for this subarea, WG-FSA had been able to provide an estimate of sustainable yield (paragraph 9.20). Furthermore, consideration of the implementation of the research plan had been instrumental in considerations of suggested revisions to Conservation Measure 182/XVIII that have been described in paragraphs 9.12 and 9.14.

9.53 South Africa had submitted a notification (CCAMLR-XIX/6) for exploratory longline fisheries for *Dissostichus* spp. in Subareas 48.6, 58.6, 88.1 and 88.2 and Division 58.4.4. No specific comments were made regarding this notification.

9.54 Ukraine had submitted a notification (CCAMLR-XIX/7) for an exploratory longline fishery for *Dissostichus* spp. in Division 58.4.4. No specific comments were made regarding this notification.

9.55 Ukraine is also carrying out longline research in Division 58.4.4 under the provisions of Conservation Measure 64/XII, with an estimated catch of less than 50 tonnes. It was noted that the provisions of this conservation measure are incompatible with those of Conservation Measure 182/XVIII. This topic is discussed further under 'Research Exemption' (paragraph 8.7).

9.56 Uruguay had submitted a notification (CCAMLR-XIX/15) for exploratory longline fisheries for *Dissostichus* spp. in Subareas 88.1, 88.2 and 88.3 and Division 58.4.4.

9.57 Recalling that Uruguay had conducted an exploratory longline fishery in Division 58.4.4 during 1999/2000, but that data for that fishery had been received too late for consideration by WG-FSA, no assessment of the various fishery and research plans proposed in the notification could be made.

9.58 Uruguay had submitted a notification (CCAMLR-XIX/16) for an exploratory pot fishery for *D. eleginoides* in Subarea 48.3. It also submitted a notification (CCAMLR-XIX/16) for an exploratory pot fishery for crabs in Subarea 48.3. In accordance with Conservation Measure 64/XII, the UK had submitted a notification (CCAMLR-XIX/9) of research vessel activity involving pot fishing for *D. eleginoides* with an expected catch over 50 tonnes in Subarea 48.3. The USA had also notified (CCAMLR-XIX/BG/18) its intention to participate in the crab fishery in Subarea 48.3 in accordance with Conservation Measure 181/XVIII.

9.59 The Scientific Committee reaffirmed its recommendation of 1999 (SC-CAMLR-XVIII, paragraphs 8.3 to 8.5) that pot catches of *D. eleginoides* should be counted against the *D. eleginoides* catch limit for Subarea 48.3. Similarly any retained catch of crabs should be counted against the crab catch limit for Subarea 48.3.

9.60 The Republic of Korea and the UK submitted a notification (CCAMLR-XIX/8) for an exploratory jig fishery for *M. hyadesi* in Subarea 48.3.

9.61 The Scientific Committee noted that, in accordance with Conservation Measure 148/XVII, it was mandatory for VMS to be installed on the exploratory fishing vessel. It also noted that Conservation Measure 183/XVIII requires the presence of a CCAMLR scientific observer.

DATA MANAGEMENT

10.1 Dr Ramm (CCAMLR Data Manager) reported on the work undertaken by the Secretariat's Data Centre in the 1999/2000 intersessional period (SC-CAMLR-XIX/BG/9). The three main functions of the Data Centre are: management of CCAMLR data; monitoring of CCAMLR fisheries; and development of data analysis routines.

Management of CCAMLR Data

10.2 The amount of data managed in 1999/2000 was high, and continued to follow the trend reported in recent years. About one third of all data held in the CCAMLR databases has been submitted within the past three years, and approximately 15% of all records were processed in the 1999/2000 intersessional period.

10.3 A major, unbudgeted, task of the Secretariat during 1999/2000 was the implementation of the new CDS. This involved the development of a database, data processing routine and a confidential web-based reporting system. The implementation of the CDS and the significant budgetary constraints imposed on the Secretariat in 2000 has impacted on the work of the Data Centre, its computing facilities and the level of support at the various meetings.

10.4 The data section of the CCAMLR website was updated to include information on CCAMLR data requirements and the submission of data. Electronic data forms, in Microsoft Excel format, are now available for submitting catch and effort reports, fine-scale data, STATLANT data, scientific observer data and CEMP data. The *Scientific Observers Manual*, *CEMP Standard Methods* and the *Fishery Data Manual* are available online.

10.5 In spite of increasing efficiencies in data management and computer technology, CCAMLR data place ever-increasing demands on the Secretariat's resources. These resources were insufficient in 1999/2000 to allow the archiving of core data from the CCAMLR-2000 Survey (see Section 14).

Fishery Monitoring

10.6 The Data Centre monitors all fisheries conducted under conservation measures in force. Information of fishing activities is submitted on five-day, 10-day or monthly catch and effort reports; most fisheries are monitored by five-day catch and effort reports. New and exploratory fisheries are the most demanding in terms of monitoring by the Data Centre. Monitoring includes:

- correspondence with Contracting Parties regarding their data and/or overdue reports;
- monitoring of catches of target species by fine-scale rectangle in new and exploratory fisheries, and closure of fine-scale rectangles when catches exceed 100 tonnes;
- monitoring of by-catch;
- revision of fishery closure dates;
- regular reporting of catches, aggregated by reporting period and species, to Contracting Parties; and
- monthly reporting of total catches of target species to all Members.

10.7 A new format was developed in 1999/2000 to report catches, aggregated by reporting period and species, to Contracting Parties. These reports are now in Microsoft Excel format, and are disseminated to Contracting Parties via email only.

Data Analysis

10.8 Staff at the Data Centre have continued to develop the analysis and presentation of the CEMP indices. Developments over the past two years have resulted in a significant improvement in the presentation of CEMP information, and a reduction in the size of the annual report on CEMP indices.

10.9 Data Centre staff have also undertaken a major overhaul of the research survey database and the routine used in length-density analyses. This overhaul was necessary because of the increasing quantity and diversity of survey data and their importance in the assessments of WG-FSA. Trawl survey data and commercial trawl data had been initially managed as a single dataset. While appropriate in earlier years, this procedure constrained the type of survey data that could be stored in the CCAMLR database and placed limitations on their interpretation. The overhaul of the survey database has resolved these historical difficulties.

Projections for the Intersessional Period 2000/01

10.10 Dr Ramm made the following projections for the intersessional period 2000/01:

- the data processing load is expected to increase further due to the high number of exploratory fisheries notified in 2000/01, an overall increase in the quality and level of detail in the data reported, and a likely increase in the level of scientific observer coverage in krill fisheries;
- development of management procedures and analysis/reconciliation routines for CDS data;
- increased support for the Scientific Committee and working groups, including the workshop on C. *gunnari*; and
- pending budget allocation, development of computing resources to support the activities of WG-FSA and archive the CCAMLR-2000 Survey datasets.

10.11 The Scientific Committee noted the report, and thanked the staff of the Data Centre for their continued high level of support to the Scientific Committee and its working groups during the past year. It also noted that additional comments on CCAMLR Data Management, including the status of computing facilities, are offered in a number of sections of this report (paragraphs 12.11 and 14.2).

10.12 Dr Miller advised the Scientific Committee that CEP had requested information on the Secretariat's experience with data management (SC-CAMLR-XIX/BG/17). This information would assist CEP in developing its own capacity for exchanging information and data. The Scientific Committee sought the Commission's approval to recommend that the Secretariat submit a paper on this topic at CEP-IV.

COOPERATION WITH OTHER ORGANISATIONS

11.1 The Scientific Committee noted the following papers of relevance to this agenda item:

(i) SC-CAMLR-XIX/BG/7, BG/8, BG/12, BG/13, BG/15, BG/16, BG/19, BG/20, BG/24, BG/25, BG/31; and

(ii) CCAMLR-XIX/BG/21 and BG/34.

11.2 It was suggested that plenary discussion be confined to key points.

Cooperation with the Antarctic Treaty System

CEP

11.3 Dr Miller noted that CEP was in a process of evolution (SC-CAMLR-XIX/BG/17). The delineation between the objectives of CEP to protect the environment and the dual goal of CCAMLR to achieve conservation and rational use, will need to be developed.

SAER

11.4 The Chairman drew attention to CCAMLR-XIX/BG/25 where Dr Walton, the convener of GOSEAC, requested the assistance of the Scientific Committee in preparing a SCAR paper on *The State of the Antarctic Environment Report (SAER)* for the 2001 meeting of CEP. The input requested from CCAMLR was information on the extent of data available on the Southern Ocean fisheries.

11.5 In response to SCAR's request, the Scientific Committee agreed to provide:

(i) copies of all volumes of the *Statistical Bulletin*;
(ii) *Understanding CCAMLR's Approach to Management*; and
(iii) Constable et al., 2000.

11.6 Furthermore, the Science Officer would be indicated as the liaison point within CCAMLR.

11.7 Dr Fanta volunteered to also assist in undertaking this activity.

11.8 The Scientific Committee noted that *The State of the Antarctic Environment Report* was a daunting undertaking and that the recent report of WG-EMM provided guidance on what is required to assess the status of the Antarctic marine ecosystem. This is likely to take five to 10 years to complete.

Balleny Islands Proposal (Annex 4, paragraphs 5.38 to 5.51)

11.9 The Convener of WG-EMM reported that the Working Group had considered the Balleny Islands management plan at the request of the Commission. It was noted that the plan had been modified based on advice from GOSEAC in 1999 and that the modified plan had been recommended for approval by SCAR WG-Biology.

11.10 The Scientific Committee noted that, at the request of WG-EMM, the boundary of the proposed protected area was adjusted in the latest proposal (CCAMLR-XIX/21) so as to include the whole Balleny seamount.

11.11 The Scientific Committee agreed that the proposal contained the only scientific evidence available at this time and is therefore the best evidence available.

11.12 After extensive discussions in both WG-EMM and the Scientific Committee, there were two views concerning the proposal to enlarge the Balleny Islands Specially Protected Area.

11.13 Several Members did not support the scientific merits of the proposal to expand the Balleny Islands Specially Protected Area on the basis that:

(i) the area was an important area in respect to potential future fishery;

(ii) more research was needed before it would be possible to evaluate the significance of the region, for example, the proposed area is excessively large and not justified on the basis of known foraging areas;

(iii) WG-EMM has only just begun to develop criteria for assessing proposals for marine protected areas and these needed to be developed first before a decision could be taken; and

(iv) there were no research plans indicating how CEMP sites are to be developed or on how this proposal relates to understanding the ecology of the region including dependent species and predators.

11.14 Many Members supported the proposal on the basis that:

(i) this proposal would not diminish rational use of resources in the Convention Area;
(ii) it would provide an undisturbed reserve with rich biodiversity; and
(iii) this proposal is consistent with the precautionary approach used by CCAMLR.

11.15 The CEP Observer (Dr A. Press) advised the Scientific Committee that CEP is required to consult CCAMLR to determine if a proposed marine protection area under the Madrid Protocol would conflict with CCAMLR.

11.16 To that end, the Scientific Committee agreed that it needed to determine whether the proposal contained the best scientific evidence available. Given the responsibilities of the Scientific Committee of CCAMLR, it was considered difficult for it to judge against criteria set by the Madrid Protocol and by CEP. The extent to which the proposal is in conflict with the work of the Commission is a matter for the Commission to consider.

11.17 The Scientific Committee noted that the divergent views in paragraphs 11.13 and 11.14 were relevant to discussions as to whether the proposal would assist in the management of fisheries according to Article II of the Convention. To this end, the Commission may wish to consider how the precautionary approach may be applied in this regard. It requested guidance from the Commission on how the Scientific Committee could proceed in this matter.

Terra Nova Bay Proposal (Annex 4, paragraphs 5.32 to 5.37)

11.18 The Convener of WG-EMM reported that the Working Group had reviewed a proposal to establish a Special Site of Scientific Interest at Terra Nova Bay. The values to be protected at this site included a unique marine benthic community and a colony of Adélie penguins. A long-term research program established at the site was also described. The proposal had been submitted simultaneously to both SCAR WG-Biology and WG-EMM. WG-EMM welcomed the proposal, but noted that the plan has been referred to GOSEAC for comment.

11.19 The Scientific Committee endorsed the views of WG-EMM that it was premature to make comments regarding the plan in the absence of comments from GOSEAC.

Management Plans forwarded by the ATCM (Annex 4, paragraphs 5.52 to 5.61)

11.20 The Convener of WG-EMM reported that the Working Group considered further development of a methodology for the assessment of proposals for marine protected areas forwarded to CCAMLR by the ATCM in accordance with Annex V of the Protocol of Environmental Protection to the Antarctic Treaty. The view was expressed that management plans forwarded by the ATCM were written to further the objectives of the ATCM and not necessarily those of CCAMLR. It was agreed, however, that this should not be considered a negative aspect of a plan and that the main focus of the CCAMLR review process should be to determine whether the plan would prejudice the objectives of CCAMLR. Nevertheless, the review of management plans affords the opportunity for CCAMLR to review such plans for proposed research and/or monitoring in the area subject to notification, to consider whether the closure of a marine area could be of value to CCAMLR, and to evaluate the plan with respect to fisheries. The Working Group agreed that the potential application of marine protected areas by CCAMLR for its own purposes should be evaluated in the context of experiences in other parts of the world. While there was insufficient time for a complete review of the topic by WG-EMM, some progress was made in the development of a methodology for the assessment of proposals for marine protected areas forwarded to CCAMLR by the ATCM.

11.21 The Scientific Committee agreed that future proposals on marine protected areas should include:

(i) information on the values for which protection is required (e.g. unique habitat, species diversity); and

(ii) sufficient details in the text, maps and figures for a scientific review.

11.22 The Scientific Committee also agreed that future proposals should include an assessment of available information relevant to CCAMLR and its objectives, such as:

(i) location of breeding sites of seals and seabirds;
(ii) location of foraging areas of seabirds and seals;
(iii) description of known marine fauna;
(iv) description of current or potential fisheries;
(v) location and details of research directly relevant to CEMP; as well as
(vi) any other matters which may be relevant to the implementation of Article II of the Convention.

11.23 The Scientific Committee recognised the value of transmitting the scientific interests and concerns of CCAMLR to ATCM as a means to improve the protected area process in relation to marine areas and thus further the aims of both organisations. The Scientific Committee supported the need for further work on defining a methodology for the review of management plans forwarded by the ATCM and endorsed the process instituted by WG-EMM to carry the matter forward (Annex 4, paragraphs 5.57 and 5.59).

11.24 The Scientific Committee noted the discussion of WG-EMM on further development of a methodology for the assessment of proposals for marine protected areas forwarded to CCAMLR by the ATCM in accordance with Annex V of the Protocol of Environmental Protection to the Antarctic Treaty (Annex 4, paragraph 5.47). The Scientific Committee endorsed the examination of potential application of marine protected areas by CCAMLR for its own purposes and that it could be evaluated in the context of experiences in other parts of the world.

11.25 The Scientific Committee endorsed the WG-EMM recommendations on information requirements for future proposals (Annex 4, paragraphs 5.57 to 5.59) and on interactions with ATCM (Annex 4, paragraphs 5.60 and 5.61). The Scientific Committee agreed that attention needs to be given to how proposals for marine protected areas need to be considered and requested advice from the Commission on how it should proceed in this regard.

11.26 Prof. Moreno pointed out that marine protected area criteria should be evaluated in both WG-EMM and WG-FSA and that protected areas should be thought of as both modern conservation instruments and as a management tool.

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

IWC

11.27 Dr Kock, IWC Observer, drew attention to the planned cooperation described in CCAMLR-XIX/BG/11 between the IWC and CCAMLR in respect to analyses from the recent synoptic survey.

11.28 The Scientific Committee agreed that the Chairman should write to the IWC and invite participation in the planned CCAMLR-2000 Survey analysis in Cambridge, UK, in 2001. The IWC should also be asked for information in respect to its plans for any future joint IWC/CCAMLR workshop.

SCAR

11.29 Dr Fanta, SCAR Observer, noted CCAMLR-XIX/BG/34 and emphasised:

(i) The SCAR Biology Symposium will occur from 27 August to 1 September 2001 in Amsterdam, Netherlands, and all Antarctic biology scientists were encouraged to participate.

(ii) SCAR WG-Biology had discussed chiefly on the basis of the proposed listings in the IUCN Red List (see paragraphs 4.92 and 4.93) specially protected species and agreed that *Arctocephalus* spp. no longer need to be considered as protected species, but that Ross seals should retain specially protected status. Birds were also discussed. The suggestion was made to include *Dissostichus* spp. as specially protected species in recognition of high levels of fishing on these species in the Southern Ocean.

(iii) Discussions about disease in Antarctic wildlife emanated from the report of the Workshop on Diseases in Antarctic Wildlife. It was also suggested to develop a proposal to SCAR WG-Biology for a research program on pathology of wildlife.

(iv) The proposal of the new SCAR EVOLANTA Program is focused on providing a framework for research to improve our understanding of the evolutionary history and biology of the Antarctic biota. Molecular genetics will be a useful tool for these studies facilitating the identification of species and populations (paragraph 4.13(iii)) as well as studies of their interrelationships.

(v) The idea of a spatial information network on Antarctic biodiversity to also include CCAMLR information was discussed without reaching conclusion about the implementation.

(vi) Close cooperation between SCAR WG-Biology and CCAMLR is encouraged.

11.30 Prof. Torres, in response to the disease agenda of SCAR WG-Biology, noted SC-CAMLR-XIX/BG/10 where more information on seal pathogens was provided. He indicated that this paper will be tabled at WG-EMM's next meeting.

11.31 At the time of the adoption of the report Dr Fanta made the following statement:

> 'An important link exists between CCAMLR and SCAR, and this is the research that is developed on Antarctic organisms or Antarctic ecosystems. The presence of SCAR and CCAMLR observers or representatives at each other's meetings

promotes the exchange of information, facilitating possible collaborations, for the benefit of both SCAR and CCAMLR. In several countries the Antarctic National Programs have no contact with the science developed by CCAMLR and vice versa. The reports that are presented at the SCAR and the CCAMLR meetings at least try to establish connections, and make both organisations aware of their common interests. Research within national Antarctic programs includes, inter alia, food chains, predator–prey interactions, molecular biology for the definition of species or populations, birds, seals and fish biology, pollution, all of which are related to CCAMLR's interests. I want to express my concern about the fact that very little time was allowed to the CCAMLR Observer to SCAR, or the SCAR Observer to CCAMLR, to report. Simple cross reference to background papers in the Scientific Committee's report is of limited use because these background papers are not included as attachments to the Scientific Committee report, and therefore the information they contain may be lost. I would like to recommend that at the next Scientific Committee meeting, more consideration be given to the agenda item on cooperation with other organisations, especially in relation to the collaboration with SCAR.'

SCOR

11.32 Prof. Croxall, SCOR Observer, drew attention to SC-CAMLR-XIX/BG/15, reporting on the GLOBEC–IOC initiative relating to the use of environmental indices in the management of pelagic fish populations. This topic is very relevant to the interests of WG-FSA. Although the closing date for requesting attendance at the first workshop for this program is imminent (10 November 2000), he felt that WG-FSA should receive a report on the meeting outcome and on any other relevant developments in this program. He suggested that Dr Everson might be well placed to arrange this. The Scientific Committee concurred.

11.33 Prof. Croxall also reported that the International Southern Ocean GLOBEC Program (see also Annex 4, paragraphs 4.121 to 4.123) will commence in the austral summer 2001 with the start of a major marine research program by the USA in the Marguerite Bay area of the Antarctic Peninsula. This program will address shelf-circulation processes and their effect on sea-ice formation and Antarctic krill (*E. superba*) distribution and will also examine the factors that govern krill survivorship and availability to higher trophic levels. Full details of this year's program, which will involve two sets of two-ship surveys and process studies in April–May and July–August 2001, can be obtained from the US GLOBEC website (www.usglobec.org).

Future Cooperation

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

(i) International Fishers' Forum – Solving the Incidental Capture of Seabirds in Longline Fishing Operations, 6 to 9 November 2000, Auckland, New Zealand – Mr West;

(ii) Fifteenth Scientific Technological Symposium – Responsible Fishing in the New Millennium, 22 to 24 November 2000, Mar del Plata, Argentina – Dr O. Wöhler (Argentina);

(iii) International Fisheries Symposium, 4 to 6 December 2000, Bergen, Norway – no nomination;

(iv) Albatross and Petrel Agreement Meeting, 26 January to 9 February 2001, Cape Town, South Africa – Dr Miller;

(v) SCAR–GOSEAC, April 2001, College Station, Texas, USA – Dr Fanta;

(vi) Fifty-third Meeting of IWC Scientific Committee, July 2001, London, UK – Dr Kock;

(vii) Committee for Environmental Protection (CEP), May 2001, St Petersburg, Russia – Scientific Committee Chairman;

(viii) Nineteenth Session of CWP, 10 to 13 July 2001, Noumea, New Caledonia – Dr Ramm;

(ix) VIIIth SCAR Antarctic Biology Symposium, 27 August to 1 September 2001, Amsterdam, the Netherlands – Dr Fanta;

(x) ICES Annual Science Conference, 26 September to 9 October 2001, Oslo, Norway – Mr W. Vanhee (Belgium).

PUBLICATIONS

12.1 The seventh volume of *CCAMLR Science* was published immediately prior to CCAMLR-XIX. The Scientific Committee praised Dr Sabourenkov (Editor) and the Secretariat's production team for the high quality of their work. The seventh volume is the first volume of *CCAMLR Science* to be included in the *Science Citation Index.* This was a major development for the journal and reflects on the high scientific standing achieved by *CCAMLR Science.*

12.2 The following documents were also published during 2000:

- *CCAMLR Scientific Abstracts*;
- *Statistical Bulletin*, Volume 12 (1990–1999); and
- Revisions of *Scientific Observers Manual* and *CCAMLR Inspectors Manual*.

12.3 The Scientific Committee reviewed its decision regarding the publication of a synopsis of the electronic book *Understanding CCAMLR's Approach to Management*. The Scientific Committee agreed that the publication of the synopsis as a pamphlet should proceed as planned.

12.4 The Scientific Committee noted that the *Fishery Data Manual* was available only on the CCAMLR website, and only in English. The Scientific Committee also noted the usefulness of this manual and the need for wider dissemination of these guidelines. However, it was agreed to postpone the translation of the manual, and its publication in loose-leaf format, due to financial limitations in 2001.

12.5 Last year the Scientific Committee recommended that the headings and figure and table captions of the Russian publication *Fish and Fish Resources of Antarctica* should be translated into English so that the Editorial Board could evaluate further translation of this book (SC-CAMLR-XVIII, paragraphs12.12 and 12.13).

12.6 Dr Miller advised that the Board had meet in October 2000 to consider the general contents of the book, and the headings and figure and table captions which had been translated by the Secretariat. The Editorial Board had decided that further translation of the book was not appropriate. However, the Board recommended that Dr Sabourenkov should review the book, and that his review be published in *CCAMLR Science*.

12.7 Dr Ramm reported on the main new features of the CCAMLR website which were of direct relevance to the Scientific Committee (CCAMLR-XIX/BG/7). Significant developments had been achieved since CCAMLR-XVIII, and major sections of the website were now available in all four languages of the Commission.

12.8 Major publications available on the website included:

- Commission and Scientific Committee Reports, 1998 and 1999;
- *CCAMLR Science* table of contents and abstracts;
- *Schedule of Conservation Measures in Force* 1998/99 and 1999/2000;
- *Statistical Bulletin*;
- *Understanding CCAMLR's Approach to Management*; and
- CCAMLR Newsletters.

12.9 The website also contained information on secure (password-protected) sections. This information included meeting documents, information supporting the activities of SCOI, and real-time access to CDS information and selected data. The Secretariat issues usernames and passwords for accessing these sections to the official contacts of the Commission and Scientific Committee. These contacts are responsible for forwarding this information to the members of their CCAMLR delegations.

12.10 The Scientific Committee briefly discussed the issue of passwords and access to the secure pages of the website and recommended that this process be simplified, where possible, so as to improve the ease of navigation within the website while maintaining appropriate levels of security.

12.11 The Scientific Committee recognised the need for high-speed access to the CCAMLR website during the periods leading up to major meetings, such as those of WG-FSA (Annex 5, paragraphs 9.5 and 9.6). It recommended that sufficient funds should be made available to allow the Secretariat to increase the speed of its internet connection at the time of meetings (see Section 14).

12.12 The Scientific Committee noted that the public profile of the CCAMLR website was increasing. So far this year, the website has received more than 16 650 visits from 56 countries.

12.13 The Scientific Committee agreed that the CCAMLR website had become a very useful tool. Further developments would, in the long term, lead to a reduction in the costs of publication and dissemination of information via mail or facsimile. However, the Scientific Committee agreed that such long-term savings could only be achieved by investing, over the short term, in new infrastructure in support of the website and related office technology.

12.14 The Scientific Committee commended Mrs R. Marazas (webmaster), Mr F. Cariaga and the other Secretariat staff involved, for their continued efforts in developing the website.

SCIENTIFIC COMMITTEE ACTIVITIES DURING THE 2000/01 INTERSESSIONAL PERIOD

13.1 The following activities of the Scientific Committee are planned for the 2000/01 intersessional period:

(i) second CCAMLR-2000 Survey analysis workshop (May–June 2001, UK);
(ii) meeting of WG-EMM (2–13 July 2001, Sweden);
(iii) Workshop on Assessment Methods for Icefish (3–5 October 2001, Australia); and
(iv) meeting of WG-FSA (8–18 October 2001, Australia).

13.2 The Scientific Committee thanked Prof. Fernholm for the offer to host the seventh meeting of WG-EMM at the Kristineberg Marine Research Station in Fiskebäckskil, Sweden, in July 2001. The Scientific Committee recalled that Sweden had very successfully hosted a previous Working Group meeting in 1990.

13.3 The Secretariat intersessional work in 1999/2000 in support of the working groups had been reported at the meetings of WG-EMM (WG-EMM-00/24) and WG-FSA (WG-FSA-00/5). The working groups had reviewed this work and had further developed their requirements for future work (WG-EMM – Annex 4, Section 7; WG-FSA – Annex 5, Section 10). Major activities scheduled by the Scientific Committee in 2000/01 intersessional period are listed in Annex 7.

13.4 The Scientific Committee endorsed the future work of WG-EMM as outlined in SC-CAMLR-XIX/6 and congratulated Dr Hewitt for outlining these developments. The Scientific Committee agreed that WG-EMM should:

(i) hold meetings at locations with expertise relevant to its work;

(ii) encourage young scientists in Member countries to participate in the work of WG-EMM;

(iii) promote the work of CCAMLR; and

(iv) develop the format of future meetings so as to include mini-symposia and thematic workshops.

13.5 The Scientific Committee encouraged WG-EMM to continue developing its core work, including a review of the status and trends in krill fisheries, assessing the ecosystem and developing management action.

13.6 With respect to future meetings of WG-EMM, the Scientific Committee urged Members to support participation by experts. Also, future meetings of WG-EMM should not exceed a duration of two weeks.

BUDGET FOR 2001 AND FORECAST BUDGET FOR 2002

14.1 The budget of the Scientific Committee for 2001, and the forecast budget for 2002, as agreed by the Scientific Committee is summarised in Table 10. The following points were agreed:

(i) It was vital that meetings of WG-EMM continue to be held in locations outside Australia, and that these meetings should be supported by four Secretariat staff.

(ii) A three-day Workshop on Assessment Methods for Icefish should take place immediately prior to the 2001 meeting of WG-FSA; subject to a final decision by the Convener of WG-FSA, the Chairman of the Scientific Committee and the Data Manager (see Annex 5, paragraph 10.4).

(iii) Secretarial support by the Secretariat, and the participation of the Data Manager, was not required at the second CCAMLR-2000 Survey analysis workshop; however, a report on the workshop would be produced and this would involve the Secretariat.

14.2 In addition, the Scientific Committee endorsed the following expenditures under the Commission's budget for 2001:

(i) participation by the Chairman in the 2001 meeting of CEP;

(ii) additional data processing arising from the likely submissions of observer data from krill fisheries;

(iii) participation of the Data Manager in the 2001 meeting of CWP;

(iv) staff support for the analysis of data from the CDS and the evaluation of IUU fishing;

(v) development of computing facilities to enable the archiving of the data from the CCAMLR-2000 Survey;

(vi) development of computing facilities in support of the analyses of WG-FSA; and

(vii) development of internet facilities to improve the electronic dissemination of working group papers.

ADVICE TO SCOI AND SCAF

15.1 The Chairman presented the Scientific Committee advice to SCOI and SCAF during the meeting. This advice is detailed in Sections 3 and 14.

ELECTION OF CHAIRMAN

16.1 Dr Fanta nominated Dr Holt as Chairman of the Scientific Committee. This nomination was seconded by Dr Nicol. No further nominations were received, and Dr Holt was unanimously elected to this position for 2001 and 2002. The Scientific Committee congratulated Dr Holt on his appointment.

NEXT MEETING

17.1 The next meeting of the Scientific Committee would be held in Hobart from 22 to 26 October 2001.

OTHER BUSINESS

Commemoration of CCAMLR-XX

18.1 The Scientific Committee explored options for commemorating the Twentieth Meeting of CCAMLR in 2001. These options included:

- dedicating part of the 2001 edition of *CCAMLR Science* to the results of the CCAMLR-2000 Survey (e.g. an introductory page followed by selected papers on the CCAMLR-2000 Survey);

- hosting a commemorative dinner during CCAMLR-XX, with invited special guests who had made significant contributions to the work of CCAMLR;

- casting a commemorative badge and T-shirt, the designs of which could be determined by holding a competition; and

- issuing a commemorative postal stamp.

18.2 These options were brought to the attention of the Commission.

Species Identification Sheets

18.3 In the course of discussion, the Scientific Committee identified the need to revise the publication of *FAO Species Identification Sheets*. Mr R. Shotton (FAO Observer) advised that this revision could be undertaken in collaboration with FAO. This process would require the letting of author contracts, and the publication of the revised volumes.

Rapporteur Support

18.4 The Scientific Committee noted the difficulties experienced by rapporteurs using the computer provided by the Secretariat (e.g. the computer had crashed at least three times on the fourth day of the meeting). The Scientific Committee recommended that the facilities provided to rapporteurs be improved substantially at future meetings. As a minimum requirement, these facilities should include:

- a reliable computer and printer;
- internet connection; and
- adequate office space.

ADOPTION OF THE REPORT

19.1 The Report of the Nineteenth Meeting of the Scientific Committee was adopted.

CLOSE OF THE MEETING

20.1 This was the last meeting chaired by Dr Miller. In stepping down from the Chair, Dr Miller reflected on his 17-year association with CCAMLR.

> ‘As I step down from the Scientific Committee Chair, I am moved to reflect on my some 17-year association with CCAMLR.
>
> Firstly, I have been very fortunate and am humbled by the privilege I have enjoyed in serving as an office-bearer during what I view to be have been a number of CCAMLR’s major achievements. During my tenure as WG-Krill Convener I was fortunate enough to be involved in:
>
> (i) the adoption of catch limits for krill which constituted a major leap forward in precautionary fisheries management; and

(ii) the merging of WG-Krill and WG-CEMP which not only resulted in WG-EMM but also set the stage for effective ecosystem management which is at the core of Article II.

During my stint as CCAMLR Scientific Committee Chair, I also saw:

(i) the reassessment of krill in Area 48 by the CCAMLR-2000 Survey;

(ii) the introduction of trade-related measures via the toothfish Catch Documentation Scheme;

(iii) advancement of the unified regulatory framework; and

(iv) the setting up of an experimental fishing strategy for the toothfish longline fishery.

Second, I have been blessed with the support and friendship offered to me by all the Members of the Commission, Scientific Committee and the latter's various Working Groups. This has allowed me to work with a group of dedicated, professional, passionate and exceptional people. My personal associations have left me with an admiration and respect for all of CCAMLR's endeavours.

Third, I am eternally grateful for the tireless support of the Secretariat whose staff have been invaluable in ensuring that I managed to get anything done at all. Without their support, I know that CCAMLR, and the Scientific Committee in particular, would be a great deal poorer. To my successor, Dr Holt, I say good luck and assure you that with the continued support of the Secretariat your future task will be much the easier and that you will be in good hands so to speak.

Finally, I look forward very much to assisting my successor in his tasks and once again interact with all my colleagues on the floor. With the latter threat, I look forward to my future with CCAMLR in general and the Scientific Committee in particular.'

20.2 In closing the meeting Dr Miller said a big thank you to all at CCAMLR.

20.3 Dr Everson, on behalf of the Scientific Committee, thanked Dr Miller for his untiring leadership, as well as his other work within CCAMLR. All members of the Scientific Committee looked forward to welcoming Dr Miller back to future meetings.

20.4 On behalf of the Scientific Committee, and all those at CCAMLR, Dr Ramm presented Dr Miller with a gavel in commemoration of his time in the chair.

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Yoshida, H. 1995. A study on the price formation mechanism of *Euphausia pacifica*. *Bull. Jap. Soc. Fish. Oceanogr.*, 59: 36–38 (in Japanese).

Table 1: Total reported catch (tonnes) of krill in the Convention Area, by region and country, in the 1998/99 and 1999/2000 split-years. Source: STATLANT data.

Nationality	1998/99				1999/2000				
	Subarea 48.1	Subarea 48.2	Subarea 48.3	Total	Area 48	Subarea 48.1	Subarea 48.2	Subarea 48.3	Total
Argentina	4 640	1 884		6 524					
Japan	26 106	35 810	9 402	71 318		39 952	22 565	4 671	67 188
Rep. of Korea			1 228	1 228		4 677	767		5 444
Poland	8 150	6 891	3 513	18 554		17 959	2 762		20 721
Ukraine		5 694		5 694	985				985
Uruguay				0		4 428	2 520		6 948
Total	38 897	50 279	14 143	103 318	985	67 016	28 614	4 671	101 286

Table 2: Total reported catches (tonnes) of krill in the Convention Area, by country, since the 1990/91 split-year. Source: STATLANT data.

Country	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00
Argentina									6 524	
Chile	3 679	6 066	3 261	3 834						
India						6				
Japan	67 582	74 325	59 272	62 322	60 303	60 546	58 798	63 233	71 318	67 188
Rep. of Korea	1 211	519						1 621	1 228	5 444
Latvia			71							
Panama					141	496				
Poland	9 571	8 607	13 406	7 915	9 384	20 610	19 156	15 312	18 554	20 721
Russia		151 725	4 249	965						
Sth Africa				3						
Ukraine		61 719	6 083	8 852	48 886	20 056	4 246		5 694	985
UK							308	634		
USSR*	275 495									
Uruguay										6 948
Total	357 538	302 961	86 342	83 891	118 715	101 714	82 508	80 801	103 318	101 286

* Although the USSR was formally dissolved on 1 January 1992, for comparative purposes, statistics are compiled here for Russia and Ukraine separately for the 1991/92 split-year.

Table 3: Total reported catch (tonnes) of finfish in the Convention Area, by region and country, in the 1998/99 and 1999/2000 split-years. Source: STATLANT data.

Country	Subarea/Division										
	48.2	48.3	58.4.1	58.4.2	58.4.3	58.5.1	58.5.2	58.6	58.7	88.1	Total
1998/99											
Argentina		10									10
Australia			<1		<1		5 546				5 546
Chile		1 668									1 668
France						4 667		1 619			6 285
Rep. of Korea		259									259
New Zealand										342	342
Russia		273									273
South Africa		451						324	230		1 004
Spain		154									154
Ukraine						760					760
UK		1 254									1 254
USA	16										16
Uruguay		522									522
Total	16	4 591	<1		<1	5 427	5 546	1 942	230	342	18 094
1999/2000											
Australia				<1			2 665				2 665
Chile		2 324									2 324
France						5 214		556			5 769
Rep. of Korea		381									381
New Zealand										869	869
Russia		3 462									3 462
South Africa		324						233	854		1 411
Spain		264									264
Ukraine		128									128
UK		1 242									1 242
Uruguay		767									767
Total		8 892		<1		5 214	2 665	789	854	869	19 283

Table 4: National reported catch (tonnes) of finfish in the Convention Area, by country, since the 1990/91 split-year. Source: STATLANT data.

Country	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00
Argentina				13	877	108			10	
Australia	1	6		4			1 092	2 494	5 546	2 665
Bulgaria		115	223	71	179					
Chile		2 917	2 125	151	1 896	3 098	1 275	1 494	1 668	2 324
France	1 576	1 590	826	4 211	4 173	3 673	3 681	3 879	6 285	5 769
India						<1				
Japan						264	335	76		
Rep. of Korea				146	423	389	459	178	259	381
New Zealand							<1	56	342	869
Poland	41									
Russia		48 589	283	266	12	103			273	3 462
Sth Africa							2 106	1 197	1 004	1 411
Spain	41						293	199	154	264
Ukraine		11 267	2 348	942	5 473	1 004	1 007	997	760	128
USSR*	97 240									
UK	13	15		11			408	595	1 254	1 242
USA						187			16	
Uruguay								263	522	767
Total	98 912	64 504	5 804	5 815	13 034	8 826	10 655	11 428	18 094	19 283

* Although the USSR was formally dissolved on 1 January 1992, for comparative purposes, statistics are compiled here for Russia and Ukraine separately for the 1991/92 split-year.

Table 5: Reported catches (tonnes) of *Dissostichus eleginoides* and *Dissostichus mawsoni* by Members and Acceding States in EEZs and in the Convention Area, and estimates of unreported catches from the Convention Area by Members and Acceding States in the 1999/2000 split-year. Catches for the 1998/99 split-year are given in parentheses. The information in this table may be incomplete.

Member/ Acceding State	Outside CCAMLR Area Catch in EEZs		CCAMLR Area Reported Catch		CCAMLR Area Estimates of Unreported Catches by Members		Estimated Total Catch All Areas	
Argentina	4 667	(8 297)	0	(10)	0	(800)	4 667	(9 107)
Australia	82	(100)	2 579	(5 451)	0	(0)	2 661	(5 551)
Chile	2 704[1]	(9 093)[2]	1 609	(1 668)	0	(3 280)	4 313	(14 120)
France	0	(0)	5 503	(6 260)	0	(0)	5 503	(6 260)
Japan	0	(0)	0	(0)	0	(0)	0	(0)
Rep. of Korea	0	(0)	380	(255)	0	(0)	380	(255)
New Zealand	<1	(<1)	751	(296)	0	(0)	751	(323)
Peru	0	(0)	0	(0)	0	(0)	0	(0)
South Africa	180	(75)	1 239	(948)	0	(0)	1 419	(957)
Spain	0	(0)	264	(154)	0	(0)	264	(154)
UK	3 919[3]	(>1 416)[3]	1 221	(1 238)	0	(0)	5 140	(2 654)
Ukraine	0	(0)	128	(760)	0	(0)	128	(760)
Uruguay	0	(1 059)	767	(517)	0	(0)	767	(1 576)
USA	0	(0)	0	(<1)	0	(0)	0	(<1)
All countries	11 553	(20 041)	14 441	(17 558)	0	(4 080)	25 993	(41 718)

1 Based on reports from CDS to August 2000
2 1998 calendar year
3 From Falkland/Malvinas Islands

Table 6: Draft structure of the Fishery Plan.

CCAMLR Fishery Plan – DRAFT Fishery details — Species: Area, subarea or division, or subdivision: Gear types:			Closed Fisheries
	CCAMLR Season		
	1999/2000	2000/2001 (expectations)	Specify Conditions for Reopened Fishery
Conservation Measure adopted?			
1. Harvest Controls Closed areas Open and/or closed seasons Total allowable catch Effort limitation (number of vessels, Member states etc.) Fish size limits By-catch limits			
2. Data Reporting Requirements (e.g. fishery closure when the TAC is reached, VMS) Within season and/or post season data reporting to support stock assessment by the Scientific Committee International CCAMLR scientific observer requirements Other observer requirements Any other provisions (specify)			
3. Notification Requirements Notification required? Notification deadline Notification preferences (i) Research and fishery operations plan The nature of the proposed fishery including target species, methods of fishing, proposed region. Any minimum level of catches that would be required to develop a viable fishery. Biological information from comprehensive research/survey cruises, such as distribution, abundance, demographic data and information on stock identity. Details of dependent and associated species and the likelihood of them being affected by the proposed fishery. Information from other fisheries in the region or similar fisheries elsewhere that may assist in the valuation of potential yield. Other requirements (specify)? (ii) Limits on fishing capacity and effort. (iii) The name, type, size, registration number and radio call sign of each vessel participating. (iv) Other notification preferences (specify)?			
4. Data Collection Plan (in addition to standard CCAMLR reporting requirements) Data collection plan required/prepared? Data collection plan contents A description of the catch, effort, and related biological, ecological, and environmental data required to undertake an evaluation of the status and potential of the fishery, in accordance with Article II. A plan for directing fishing effort during the exploratory phase. An evaluation of the time-scales involved in determining the responses of harvested, dependent and related populations to fishing activities.			
5. Fishing Activity Total allowable catch Total reported catch Number of vessels Days fished Period of season Major by-catch species			
6. Data Reported to CCAMLR Notifications received by CCAMLR Within season Haul by haul Biological data Data collection plan (in addition to standard CCAMLR reporting requirements) Research and fishery operations plan			
7. Assessment Most recent assessment performed? Method of discounting for lapse since last assessment			

Table 7: Summary proposals for the application of regulatory requirements to all fisheries under a unified framework.

Regulatory Requirement	Current Application	Proposed Application
1. Prior notification of the intent to harvest with details of the proposed harvesting activity as required.	New and exploratory fisheries	Some form of prior notification should be required of all fisheries in the Convention Area. The Scientific Committee needs to know the likely distribution of effort in the coming season to determine whether effort is going to become a problem, requiring specific conservation measures, such as closed areas etc. or measures to spread effort.
2. Submission of research and fisheries operations plans (RFOPs).	Exploratory fisheries	For all fisheries where the requirement has been identified.
3. Modification and/or approval of fishing plans.	New and exploratory fisheries[1]	For all fisheries where the requirement has been identified.
4. Preparation of data collection plans (DCPs).	New and exploratory fisheries[2]	Data requirements should be specified by the Scientific Committee for all fisheries. These may include: fisheries-based data, observer data, experimental data (usually based on an RFOP), and/or fishery-independent (survey) data.
5. Assessment of stock status and potential.	All fisheries	All fisheries. The types of stock assessment that can be performed and the currency of those assessments can be forecast on the basis of the presence or absence of data. If a fishery has lapsed or been closed and no data are available, data requirements can be specified. A new assessment by the Scientific Committee will only be undertaken when these specifications (or agreed modifications to these specifications) have been met.
6. Preparation of management advice.	All fisheries	All fisheries. The decisions that can be made (e.g. decision rules) can be forecast on the basis of the presence or absence of data.
7. Collection and submission of data and information from active fisheries.	All active fisheries	All active fisheries.

[1] Although the modification and/or approval of fishing plans and the preparation of data collection plans are not specifically required under the new fisheries conservation measure (there is no specific requirement for a fishing plan to be submitted with a new fisheries notification), in practice the Scientific Committee has applied the same standards for these activities to new fisheries, as are presently required for exploratory fisheries.

[2] The Research and Fishery Operations Plan must include a description of how the Members' activities will comply with the Data Collection Plan developed by the Scientific Committee. However, the Data Collection Plan may not be developed until after the deadline for submission of the Research and Fisheries Operation Plan, at least in the first year of the exploratory fishery (see Table 6).

Table 8: Existing guidance on notifications in the new and exploratory fisheries conservation measures.

Item	New Fisheries	Exploratory Fisheries
Notification of submission deadline	Not less than three months in advance of the next regular meeting of the Commission	Not less than three months in advance of the next regular meeting of the Commission, and the Member shall not enter the exploratory fishery until the conclusion of that meeting.
The nature of the proposed fishery including target species, methods of fishing, proposed region and any minimum level of catches that would be required to develop a viable fishery.	Specifically requested	Included in the Research and Fishery Operations Plan.
Biological information from comprehensive research/survey cruises, such as distribution, abundance, demographic data and information on stock identity.	Specifically requested	Included in the Research and Fishery Operations Plan.
Details of dependent and associated species and the likelihood of them being affected by the proposed fishery.	Specifically requested	Included in the Research and Fishery Operations Plan.
Information from other fisheries in the region or similar fisheries elsewhere that may assist in the valuation of potential yield.	Specifically requested	Not specifically requested, but implied, because any fishery designated as an exploratory fishery must have been previously classified as a new fishery.
Research and Fishery Operations Plan	Not specified	Must be submitted by each Member active in the fishery or intending to authorise a vessel to enter the fishery.[1]
Limits on fishing capacity and effort	Not specified	Limited by a precautionary catch limit at a level not substantially above that necessary to obtain the information specified in the Data Collection Plan.
The name, type, size, registration number, and radio call sign of each vessel participating.	Not specified	Registered with the CCAMLR Secretariat at least three months in advance of starting fishing each season.
Scientific observer	Not specified	Required for each vessel.

[1] The Research and Fishery Operations Plan must include a description of how the Members' activities will comply with the Data Collection Plan developed by the Scientific Committee. However, the Data Collection Plan may not be developed until after the deadline for submission of the Research and Fisheries Operation Plan, at least in the first year of the exploratory fishery (see Table 6).

Table 9: Existing guidance on data collection and management of new and exploratory fisheries.

Item	New Fisheries	Exploratory Fisheries
Data Collection Plan	Not specified	Formulated and updated by the Scientific Committee following receipt of a notification for an exploratory fishery by a Member.
Limits on fishing capacity and effort.	Not specified	Limited by a precautionary catch limit at a level not substantially above that necessary to obtain the information specified in the Data Collection Plan.
A description of the catch, effort, and related biological, ecological, and environmental data required to undertake an evaluation of the status and potential of the fishery, in accordance with Article II.	Not specified	Included in the Data Collection Plan, where appropriate, to facilitate evaluation of the distribution, abundance, and demography of the target species, leading to an estimate of the fishery's potential yield; to review the fishery's potential impacts on dependent and related species; and to allow the Scientific Committee to formulate and provide advice to the Commission on appropriate harvest catch levels, as well as effort levels and fishing gear, where appropriate.
A plan for directing fishing effort during the exploratory phase.	Not specified	Required as part of the Data Collection Plan, where appropriate, 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.
An evaluation of the time-scales involved in determining the responses of harvested, dependent and related populations to fishing activities.	Not specified	Included in the Data Collection Plan, where appropriate.
Scientific observer	Not specified	Required for each vessel.
Penalty for non-submission of data.	Not specified	If the data specified in the Data Collection Plan have not been submitted to CCAMLR for the most recent season in which fishing occurred, continued exploratory fishing by the Member which failed to report its data shall be prohibited until the relevant data have been submitted to CCAMLR and the Scientific Committee has been allowed an opportunity to review the data.

Table 10: Scientific Committee budget for 2001 and forecast for 2002.

2000 Budget			2001 Budget		2002 Forecast	
		WG-FSA				
		Meeting				
0		Computing Facilities	6 900		6 900*	
16 800		Preparation and Secretariat support	18 400		19 300	
27 000		Report completion and translation	28 100		30 000	
	43 800			53 400		55 000
	0	Workshop on *C. gunnari*		4 000		0
		WG-EMM				
		Meeting				
20 100		Preparation and Secretariat support	20 900		21 200	
25 100		Report completion and translation	25 900		26 200	
	45 200			46 800		47 400
		Travel for Scientific Committee Program				
	*42 300	WG-EMM meeting (freight, flights and subsistence)		43 600		44 200
		CCAMLR 2000 Workshop				
3 900		Data Manager travel	0		7 000	
3 900		Secretarial support	0		7 000	
10 000		Report costs	8 600		8 800	
	17 800			8 600		22 800
	1 100	**Contingency**		1 100		1 200
	A$150 200	Total		A$157 700		A$170 600

* Includes an additional A$1 200 recommended by the Scientific Committee at the time of adoption.

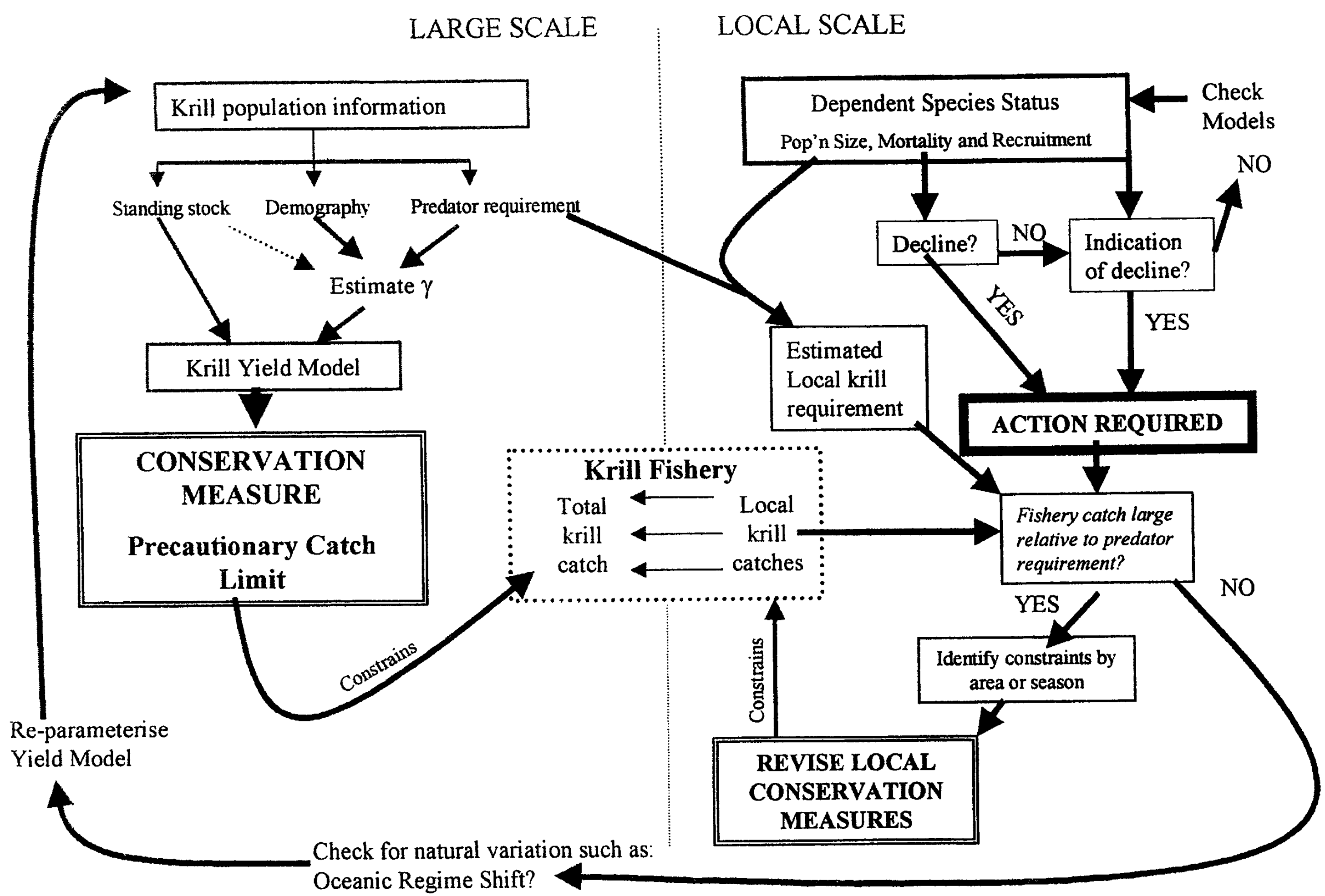
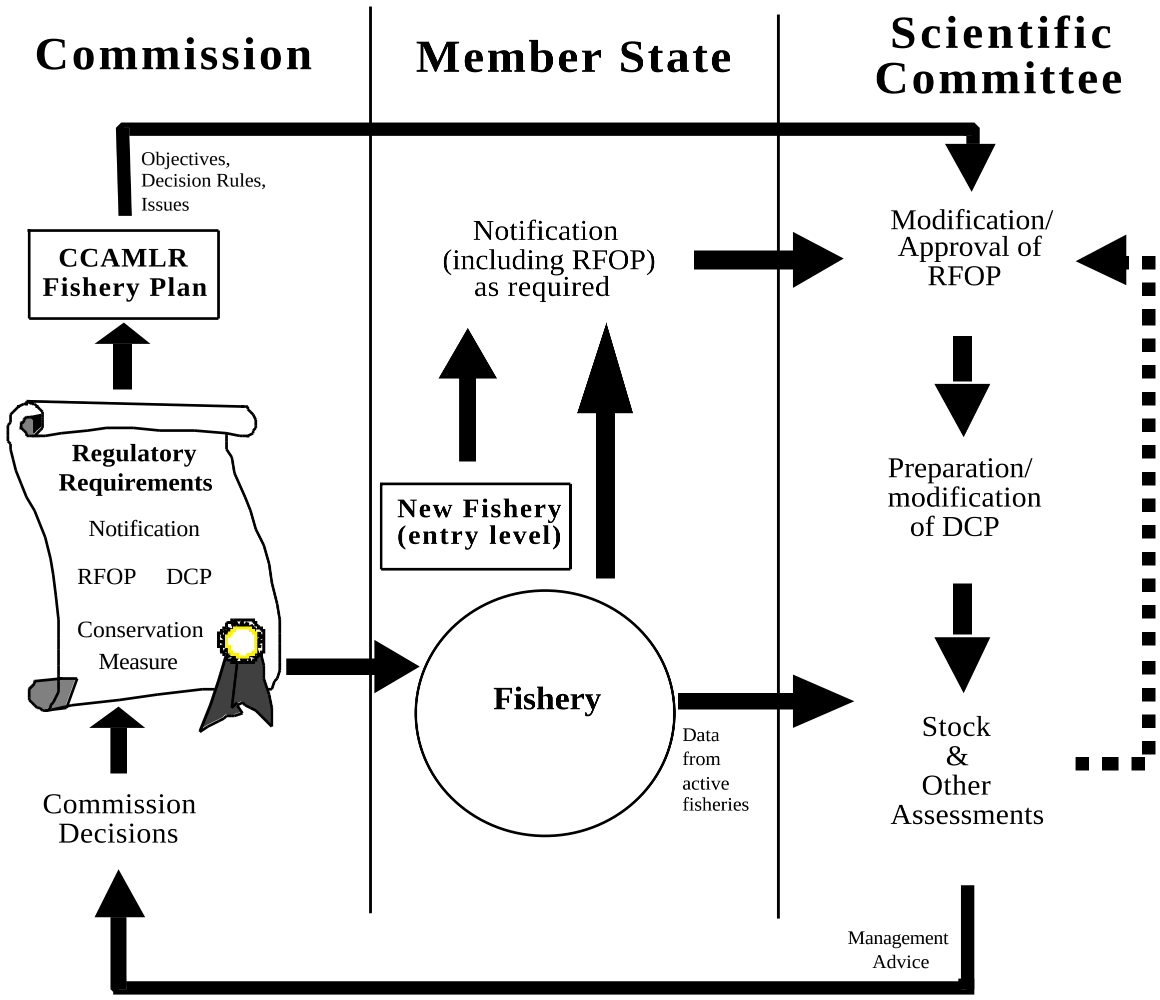


Figure 1: Decision processes incorporating information from dependent species into a mechanism to provide advice for management of a krill fishery.



RFOP = Research and Fisheries Operation Plan
DCP = Data Collection Plan

Figure 2: Information flows between the Scientific Committee, the Commission and the fishing Members, showing the function of the *Fishery Plan* (see text for explanation).

ANNEX 1

LIST OF PARTICIPANTS

LIST OF PARTICIPANTS

CHAIR	Dr A.E. Muthunayagam Secretary to Government of India Department of Ocean Development New Delhi, India
CHAIR, SCIENTIFIC COMMITTEE	Dr Denzil Miller Marine and Coastal Management Department of Environment Affairs Cape Town, South Africa

ARGENTINA

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Alternate Representative:	Dr. Esteban R. Barrera-Oro Instituto Antártico Argentino Buenos Aires
Advisers:	Ministro Rubén N. Patto Director de Antártida, Ministerio de Relaciones Exteriores, Comercio Internacional y Culto Buenos Aires
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	Secretario Gabriel A. Servetto Dirección de Antártida, Ministerio de Relaciones Exteriores, Comercio Internacional y Culto Buenos Aires

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Alternate Representatives:	Dr Stephen Nicol Australian Antarctic Division Environment Australia Tasmania

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Mr Richard Williams
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Mr Michael Bliss
Legal Branch
Department of Foreign Affairs and Trade
Canberra

Mr Martin Exel
Representative of Australian Fishing Industry
Kailis and France Group
Western Australia

Mr Alistair Graham
Representative of Australian Conservation Organisations
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ANNEX 2

LIST OF DOCUMENTS

LIST OF DOCUMENTS

SC-CAMLR-XIX/1	Provisional Agenda for the Nineteenth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources
SC-CAMLR-XIX/2	Provisional Annotated Agenda for the Nineteenth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources
SC-CAMLR-XIX/3	Report of the Working Group on Ecosystem Monitoring and Management (Taormina, Sicily, Italy, 17 to 28 July 2000)
SC-CAMLR-XIX/4	Report of the Working Group on Fish Stock Assessment Hobart, Australia, 9 to 19 October 2000
SC-CAMLR-XIX/5	Regional surveys of land-based predators, and a future synoptic survey of land-based predators Report of correspondence on behalf of the SC-CAMLR Working Group on Ecosystem Monitoring and Management Delegation of Australia
SC-CAMLR-XIX/6	Future work of the Working Group on Ecosystem Monitoring and Management and implications for the format of its meetings Convener WG-EMM
SC-CAMLR-XIX/7	Report on implications of meeting schedules Chairman of the Scientific Committee

****

SC-CAMLR-XIX/BG/1 Rev. 1	Catches in the Convention Area in the 1999/2000 split-year Secretariat
SC-CAMLR-XIX/BG/2	Entanglement of Antarctic fur seals *Arctocephalus gazella* in man-made debris at Bird Island, South Georgia during the 1999 winter and the 1999/2000 pup rearing season Delegation of the United Kingdom
SC-CAMLR-XIXBG/3	Entanglement of Antarctic fur seals *Arctocephalus gazella* in man-made debris at Signy Island, South Orkney Islands 1999/2000 Delegation of the United Kingdom
SC-CAMLR-XIX/BG/4	Anthropogenic feather soiling, marine debris and fishing gear associated with seabirds at Bird Island, South Georgia, 1999/2000 Delegation of the United Kingdom

SC-CAMLR-XIX/BG/5	Beach debris survey – Main Bay, Bird Island, South Georgia 1998/99 Delegation of the United Kingdom
SC-CAMLR-XIX/BG/6	Beach debris survey Signy Island, South Orkney Islands 1999/2000 Delegation of the United Kingdom
SC-CAMLR-XIX/BG/7	Sixth conference of parties to the Convention on the Conservation of Migratory Species of Wild Animals (Somerset West, South Africa, November 1999) CCAMLR Observer (J. Cooper, South Africa)
SC-CAMLR-XIX/BG/8	Observer's report from the 52nd Meeting of the Scientific Committee of the International Whaling Commission (Adelaide, 14 to 16 June 2000) CCAMLR Observer (K.-H. Kock, Germany)
SC-CAMLR-XIX/BG/9	Data Management report on activities during 1999/2000 Secretariat
SC-CAMLR-XIX/BG/10	New data on anti-*Brucella* antibodies detection in *Arctocephalus gazella* from Cape Shirreff, Livingston Island, Antarctica Delegation of Chile (*CCAMLR Science*, 8: submitted)
SC-CAMLR-XIX/BG/11	The direct impact of fishing and fishery-related activities on marine life in the CCAMLR Convention Area with particular emphasis on longline fishing and its impact on albatrosses and petrels – a review Delegation of Germany (*Reviews in Fish Biology*, submitted)
SC-CAMLR-XIX/BG/12	Albatross and petrel mortality from longline fishing: Report on an international workshop held in Honolulu, Hawaii, USA, 11 and 12 May 2000 CCAMLR Observer (J. Cooper, South Africa)
SC-CAMLR-XIX/BG/13	Report to SC-CAMLR on the expert consultation on illegal, unreported and unregulated fishing Sydney, Australia, 15–19 May 2000 Presented by the Chairman of the Scientific Committee
SC-CAMLR-XIX/BG/14	Report on assessment and avoidance of incidental mortality in the Convention Area 1999/2000 United Kingdom
SC-CAMLR-XIX/BG/15	GLOBEC/IOC Initiative: 'Use of Environmental Indices in the Management of Pelagic Fish Populations' Submitted by SCOR/IOC
SC-CAMLR-XIX/BG/16	Report of the Meeting of the SCAR Group of Specialists on Seals Submitted by SCAR

SC-CAMLR-XIX/BG/17	Report on attendance at the Third Meeting of the Committee for Environmental Protection Under the Madrid Protocol Chairman of the Scientific Committee
SC-CAMLR-XIX/BG/18	Summary of observations conducted in the 1999/00 season by designated CCAMLR Scientific Observers Secretariat
SC-CAMLR-XIX/BG/19	Information on the development of a methodology for the assessment of marine protected areas by the Committee on Environmental Protection Antarctic Treaty Secretariat
SC-CAMLR-XIX/BG/20	Calendar of meetings of relevance to the Scientific Committee – 2000/2001 Secretariat
SC-CAMLR-XIX/BG/21 Rev. 1	Avoidance of seabird by-catch in longline fisheries: catch fish not birds Submitted by ASOC
SC-CAMLR-XIX/BG/22	Information on UBC's ECOPATH proposal Chairman, Scientific Committee
SC-CAMLR-XIX/BG/23	Summary of notifications for new and exploratory fisheries in 2000/2001 Secretariat
SC-CAMLR-XIX/BG/24	Informe del Observador de la CCRVMA a la Reunión del Grupo de Especialistas en Pinnípedos del SCAR (Tokio, Japón, 6–9 de julio de 2000) CCAMLR Observer (D. Torres, Chile)
SC-CAMLR-XIX/BG/25	Fisheries Society of the British Isles Annual Symposium 'Biology of Polar Fish' SC-CAMLR Observer (I. Everson, United Kingdom)
SC-CAMLR-XIX/BG/26	Relevamiento de Desechos Marinos en la Costa de la Base Científica Antártica Artigas (BCAA) en la Isla Rey Jorge / 25 de Mayo, y en la Estacíon Científica Antártica T/N Ruperto Elichiribehety (ECARE) en la Península Antártica – Temporada 1999–2000 Delegación de Uruguay
SC-CAMLR-XIX/BG/27	Working paper on scientific issues related to a Unified Regulatory Framework for CCAMLR Ad Hoc Task Group on the Development of a Unified Regulatory Framework for CCAMLR
SC-CAMLR-XIX/BG/28	CCAMLR activities on monitoring marine debris in the Convention Area in 1999/2000 Secretariat
SC-CAMLR-XIX/BG/29	Cuarta Conferencia Internacional sobre Desechos Marinos Delegación de Chile

SC-CAMLR-XIX/BG/30	A proposal to host the Second CCAMLR 2000 Survey Analysis Workshop Delegation of the United Kingdom
SC-CAMLR-XIX/BG/31	The ICES Annual Science Conference CCAMLR Observer (W. Vanhee, Belgium)

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CCAMLR-XIX/1	Provisional Agenda for the Nineteenth Meeting of the Commission for the Conservation of Antarctic Marine Living Resources
CCAMLR-XIX/2	Provisional Annotated Agenda for the Nineteenth Meeting of the Commission for the Conservation of Antarctic Marine Living Resources
CCAMLR-XIX/3	Examination of the audited financial statements for 1999 Executive Secretary
CCAMLR-XIX/4	Review of the 2000 budget, draft 2001 budget and forecast budget for 2002 Executive Secretary
CCAMLR-XIX/5	Notification of an exploratory longline fishery for *Dissostichus eleginoides* in CCAMLR areas Delegation of Brazil
CCAMLR-XIX/6	Notification of exploratory fisheries for *Dissostichus* spp. in the 2000/2001 season Delegation of South Africa
CCAMLR-XIX/7	Notification of Ukraine's intention to initiate exploratory fisheries for *Dissostichus eleginoides* in Division 58.4.4 Delegation of Ukraine
CCAMLR-XIX/8	Proposal for an exploratory jig fishery for squid in Subarea 48.3 in the 2000/2001 fishing seasons Delegations of the United Kingdom and the Republic of Korea
CCAMLR-XIX/9	Proposal for an extension of the CCAMLR pot fishing trial for 2000/2001 Delegation of the United Kingdom
CCAMLR-XIX/10	Notification of an exploratory fishery for *Dissostichus* spp. on Elan and BANZARE Banks (Divisions 58.4.3 and 58.4.1) and a proposed research plan Delegation of Australia
CCAMLR-XIX/11	Notification of Australia's intention to continue an exploratory fishery in Division 58.4.2 Delegation of Australia

CCAMLR-XIX/12	Notification of Argentina's intention to initiate exploratory longline fisheries for *Dissostichus* spp. in CCAMLR areas Delegation of Argentina
CCAMLR-XIX/13	Notification by France of new and exploratory fisheries in CCAMLR Statistical Area 58 during the 2000/2001 season Delegation of France
CCAMLR-XIX/14	Notification of an exploratory pot fishery for crabs in Subarea 48.3 Delegation of Uruguay
CCAMLR-XIX/15	Notification of exploratory fisheries in Subareas 88.1, 88.2, 88.3 and Division 58.4.4 Delegation of Uruguay
CCAMLR-XIX/16	Notification of an exploratory pot fishery for *Dissostichus eleginoides* in Subarea 48.3 Delegation of Uruguay
CCAMLR-XIX/17	Notification by New Zealand of its intention to continue an exploratory fishery for *Dissostichus* spp. in CCAMLR Subarea 88.1 Delegation of New Zealand
CCAMLR-XIX/18	Cooperation with International Coalition of Fisheries Associations (ICFA) Secretariat
CCAMLR-XIX/19	Deadlines set by CCAMLR for the submission of information by Member countries Delegation of Chile
CCAMLR-XIX/20 Rev. 1	Cooperation with the Committee on Trade and Environment of the World Trade Organisation Secretariat
CCAMLR-XIX/21 Rev. 1	Protection of Balleny Islands (Specially Protected Area) draft resolution Delegation of New Zealand
CCAMLR-XIX/22	The work of SCOI in relation to the operational structure of the Commission: a discussion paper Delegation of the European Community
CCAMLR-XIX/23 Rev. 1	Procedures for Recruiting Executive Secretary Standing Committee on Administration and Finance (SCAF)
CCAMLR-XIX/24	Report of the Standing Committee on Administration and Finance (SCAF)
CCAMLR-XIX/25	Report on the Standing Committee on Observation and Inspection (SCOI)

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CCAMLR-XIX/BG/1 Rev. 1	List of documents
CCAMLR-XIX/BG/2	List of participants
CCAMLR-XIX/BG/3	Report from the CCAMLR Observer at the Eleventh Meeting of the Conference of the Parties for CITES CCAMLR Observer (New Zealand)
CCAMLR-XIX/BG/4	Summary of current conservation measures and resolutions 1999/2000 Secretariat
CCAMLR-XIX/BG/5 Rev. 1	Implementation of conservation measures in 1999/2000 Secretariat
CCAMLR-XIX/BG/6	Resourcing the work of CCAMLR for the longer term Secretariat
CCAMLR-XIX/BG/7	Report on CCAMLR's website (www.ccamlr.org) Secretariat
CCAMLR-XIX/BG/8	Review of Members comments and observations on the implementation and operation of the Catch Documentation Scheme for *Dissostichus* spp. Secretariat
CCAMLR-XIX/BG/9 Rev. 1	Timing of contribution payments Secretariat
CCAMLR-XIX/BG/10	Report on a meeting to discuss an agreement on the conservation of Southern Hemisphere albatrosses and petrels Delegation of Australia
CCAMLR-XIX/BG/11	Report about court's process in Chile for infraction CCAMLR measures at July 2000 Delegation of Chile
CCAMLR-XIX/BG/12	Informe del observador de la CCRVMA a la conferencia internacional sobre monitoreo, control y vigilancia pesquera Observador e la CCRVMA (V. Carvajal, Chile)
CCAMLR-XIX/BG/13	Sistema de posicionamiento automatico de naves pesqueras y de investigacion pesquera Delegación de Chile
CCAMLR-XIX/BG/14	Report of the FAO Working Party on Status and Trends of Fisheries (Rome, Italy, 30 November to 3 December 1999) CCAMLR Observer (Italy)
CCAMLR-XIX/BG/15	Report of the CCAMLR Observer at the Meeting on the Development of a Regional Agreement for Southern Hemisphere albatross and petrels under the Convention on the Conservation of Migratory Species of Wild Animals (CMS) Secretariat

CCAMLR-XIX/BG/16	Aplicación en Chile de la Medida de Conservación 170/XVIII de la CCRVMA Delegación de Chile
CCAMLR-XIX/BG/17	Implementation and operation of the Catch Documentation Scheme in 1999/2000 Secretariat
CCAMLR-XIX/BG/18	US plans for fishing for crab in Subarea 48.3 in accordance with Conservation Measures 150/XVIII and 181/XVIII Delegation of the USA
CCAMLR-XIX/BG/19	Évaluation de la pêche illicite dans les eaux françaises adjacentes aux îles Kerguelen et Crozet pour la saison 1999/2000 (1er juillet 1999–30 juin 2000) – informations générales sur la zone CCAMLR 58 et tendances 2000/2001 Délégation française
CCAMLR-XIX/BG/20	Background information for a review of the formula for calculating Members' contributions to the annual budget Secretariat
CCAMLR-XIX/BG/21	Commission decisions relating to the procedures for selecting a new Executive Secretary Secretariat
CCAMLR-XIX/BG/22	Calendar of meetings of relevance to the Commission – 2000/2001 Secretariat
CCAMLR-XIX/BG/23	Member's reporting obligations and circulation of reports Secretariat
CCAMLR-XIX/BG/24	Implementation of the System of Inspection and other CCAMLR enforcement provisions in the 1999/2000 season Secretariat
CCAMLR-XIX/BG/25	State of the Antarctic environment Chairman of the Scientific Committee
CCAMLR-XIX/BG/26	Report of the Antarctic and Southern Ocean Coalition (ASOC) to the XIX Meeting of the Convention on the Conservation of Antarctic Marine Living Resources Submitted by ASOC
CCAMLR-XIX/BG/27	Notification of a longline fishery for *Dissostichus eleginoides* in CCAMLR areas Delegation of Brazil
CCAMLR-XIX/BG/28	Report on the trade in *Dissostichus eleginoides* (Patagonian toothfish or Chilean sea bass) in Canada (Canada)
CCAMLR-XIX/BG/29 Rev. 1	The ASOC evaluation of the CDS Submitted by ASOC

CCAMLR-XIX/BG/29 Rev. 1	Addendum – The ASOC evaluation of the CDS Submitted by ASOC
CCAMLR-XIX/BG/30	Report of the consultation on illegal, unreported and unregulated fishing Rome, Italy, 2–6 October 2000 Observer, Italy
CCAMLR-XIX/BG/31 Rev. 1	FAO Observer's Report FAO Observer (R. Shotton)
CCAMLR-XIX/BG/32	Observer report to CCAMLR of outcomes of Sixth Annual Meeting of the Commission for the Conservation of Southern Bluefin Tuna CCAMLR Observer (Australia)
CCAMLR-XIX/BG/33	Summary report of the 66th Meeting of the Inter-American Tropical Tuna Commission San Jose, Costa Rica, June 12, 14–16, 2000 CCAMLR Observer (USA)
CCAMLR-XIX/BG/34	Report on the SCAR Working Group on Biology Meeting Observer (E. Fanta, Brazil)
CCAMLR-XIX/BG/35	Report from the Australian Delegation at the Second IUCN World Conservation Congress held from 4–11 October 2000 CCAMLR Observer (Australia)
CCAMLR-XIX/BG/36	Observer's report from the 52nd Meeting of the International Whaling Commission CCAMLR Observer (B. Fernholm, Sweden)
CCAMLR-XIX/BG/37	Trade measures and IUU fishing Submitted by ASOC
CCAMLR-XIX/BG/38	FAO Subcommittee on Fisheries – Subcommittee on Fish Trade Seventh Session Draft Report CCAMLR Observer (K.-H. Kock, Germany)
CCAMLR-XIX/BG/39	Report from the CCAMLR Observer (Brazil) at the XVI Regular Meeting of the International Commission for the Conservation of the Atlantic Tuna (ICCAT) CCAMLR Observer (Brazil)
CCAMLR-XIX/BG/40	13th Meeting of the Permanent Committee on Tunas and Marlins (Noumea, 5–11 July 2000) CCAMLR Observer (France)
CCAMLR-XIX/BG/41	IUCN Report to the Nineteenth Meeting of the Commission for the Conservation of Antarctic Marine Living Resources Submitted by the IUCN
CCAMLR-XIX/BG/42	New Zealand Government views Delegation of New Zealand

CCAMLR-XIX/BG/43	Notes on the Consideration of the Implementation of the Objective of the Convention Delegation of Chile
CCAMLR-XIX/BG/44	Report of the SCAR Observer to CCAMLR and the CCAMLR Observer to SCAR Observer (E. Fanta, Brazil)
CCAMLR-XIX/BG/45	Statement by the Acting Prime Minister of Mauritius on illegal fishing Delegation of Australia
CCAMLR-XIX/BG/46	CCAMLR-related resolutions adopted by IUCN at the 2nd World Conservation Congress Submitted by the IUCN
CCAMLR-XIX/BG/47	Preliminary announcement for the birth of Antarctic krill at Port of Nagoya Public Aquarium in Japan Delegation of Japan

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Other Documents

CCAMLR-XVIII/19	Review of working arrangements for the Standing Committee on Observation and Inspection Secretariat
WG-EMM-00/16	A statistical assessment of the status and trends of Antarctic and sub-Antarctic seabirds Prepared for the SCAR Bird Biology Subcommittee and SC-CAMLR Working draft as of June 2000 E.J. Woehler (Australia), J. Cooper (South Africa), J.P. Croxall (United Kingdom), W.R. Fraser (USA), G.L. Kooyman (USA), D.G. Miller (South Africa), D.C. Nel (South Africa), D.L Patterson (USA), H.-U. Peter (Germany), C.A. Ribic (USA), K. Salwicka (USA), W.Z. Trivelpiece (USA) and H. Weimerskirch (France)

AGENDA OF THE NINETEENTH MEETING OF THE SCIENTIFIC COMMITTEE

AGENDA OF THE NINETEENTH MEETING
OF THE SCIENTIFIC COMMITTEE

1. Opening of the Meeting
   (i) Adoption of the Agenda
   (ii) Report of the Chairman
   (iii) Preparation of Advice to SCAF and SCOI

2. Fishery Status and Trends
   (i) Krill
   (ii) Fish
   (iii) Crab
   (iv) Squid

3. CCAMLR Scheme of International Scientific Observation
   (i) Scientific Observations Conducted in the 1999/2000 Fishing Season
   (ii) Advice to the Commission

4. Dependent Species

   (i) Species Monitored under the CCAMLR Ecosystem Monitoring Program (CEMP)
      (a) Report of WG-EMM
      (b) Proposals for Extension of CEMP Activities
      (c) Proposals for CEMP Sites
      (d) Data Requirements
      (e) Advice to the Commission

   (ii) Assessment of Incidental Mortality
      (a) Incidental Mortality in Longline Fisheries
      (b) Incidental Mortality in Trawl Fisheries
      (c) Marine Debris
      (d) Advice to the Commission

   (iii) Marine Mammal and Bird Populations
      (a) Advice to the Commission

5. Harvested Species

   (i) Krill
      (a) Report of WG-EMM
      (b) Data Requirements
      (c) Advice to the Commission

   (ii) Fish Resources
      (a) Report of WG-FSA
      (b) Data Requirements
      (c) Advice to the Commission

   (iii) Crab Resources
      (a) Report of WG-FSA
      (b) Data Requirements
      (c) Advice to the Commission

(iv) Squid Resources
   (a) Report of WG-FSA
   (b) Advice to the Commission

6. Ecosystem Monitoring and Management
   (i) Report of WG-EMM
   (ii) Data Requirements
   (iii) Advice to the Commission

7. Management under Conditions of Uncertainty about Stock Size and Sustainable Yield

8. Scientific Research Exemption

9. New and Exploratory Fisheries
   (i) New Fisheries in the 1999/2000 Season
   (ii) Exploratory Fisheries in the 1999/2000 Season
   (iii) Proposals for New and Exploratory Fisheries for the 2000/2001 Season
   (iv) Items of Future Work Identified by SC-CAMLR

10. CCAMLR Data Management

11. Cooperation with Other Organisations
   (i) Cooperation with the Antarctic Treaty System
   (ii) Reports of Observers from International Organisations
   (iii) Reports of SC-CAMLR Representatives at Meetings of Other International Organisations
   (iv) Future Cooperation

12. Publications

13. Scientific Committee Activities during the 2000/2001 Intersessional Period

14. Budget for 2001 and Forecast Budget for 2002

15. Advice to SCOI and SCAF

16. Election of Chairman of the Scientific Committee

17. Next Meeting

18. Other Business
   (i) CCAMLR-XX Commemorative Arrangements

19. Adoption of the Report of the Nineteenth Meeting of the Scientific Committee

20. Close of the Meeting.

ANNEX 4

REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT

(Taormina, Sicily, Italy, 17 to 28 July 2000)

CONTENTS

Page

INTRODUCTION 117
Opening of the Meeting 117
Adoption of the Agenda and Organisation of the Meeting 117

HARVESTED SPECIES 117
Fisheries Information 117
Catch Status and Trends 117
Trends in Fishery Development 118
Economics 118
Conversion Rates 118
Fishing Strategies 119
Assessment of Trends in the Distribution of Fishing 119
Observer Scheme 120
By-catch of Fish in the Krill Fishery 121
Regulatory Framework 121
Regional and Local Surveys 122
Krill Length-frequency Data, Biomass and Distribution during the CCAMLR-2000 Survey 122
Krill Length-frequency Data, Biomass and Distribution during Ancillary Surveys Conducted in Area 48 in 1999/2000 123
Krill Length-frequency Data Collected from Predators in Area 48 during the CCAMLR-2000 Survey 125
Krill Length-frequency Data from the Commercial Fishery in Area 48 during the CCAMLR-2000 Survey 126
Krill Length-frequency Data, Biomass and Distribution from other Areas of the Southern Ocean during the CCAMLR-2000 Survey 126
Krill Length-frequency Data, Biomass and Distribution from Area 48 during Years prior to the CCAMLR-2000 Survey 126
Krill Length-frequency Data, Biomass and Distribution from other Areas of the Southern Ocean during Years prior to the CCAMLR-2000 Survey 127
Summary of Observations on Krill Length-frequency Data, Biomass and Distribution 128
B_0 Workshop (results from the CCAMLR-2000 Survey in Area 48) 128
Data 129
Methodology 129
Estimate of Krill Biomass for Area 48 129
Variance associated with Estimate of Krill Biomass 129
Estimation of Potential Yield 130
Estimation of γ 130
Subdivision of Potential Yield in Area 48 132
Subdivision of Division 58.4.1 133
Future Work 133

DEPENDENT SPECIES 134
CEMP Indices 134
CEMP Species – Seabirds 135
CEMP Species – Pinniped Studies 137
Predator Abundance Surveys 138
Non-CEMP Species 138
Indices of Key Environmental Variables 139
Environmental Influences on Fishing Operations 139
Spatial and Temporal Environmental Variability 140
The Environment in 1999/2000; the Year of the CCAMLR-2000 Survey 141

Analytical Procedures and Combination of Indices ... 142
Combining Indices ... 142
Future Work ... 145

ECOSYSTEM ASSESSMENT ... 146
Krill-centred Interactions ... 146
Implications of Krill Distributions ... 146
Predator Responses to Changes in Krill Abundance ... 147
Diet of Krill Predators ... 148
Status and Trends of Krill Predator Populations ... 149
Assessment of the Impacts of Predators on Krill ... 150
Distribution of Predators relative to Krill ... 150
Functional Relationships between Predators and Krill ... 151
Fish and Squid-centred Interactions ... 152
The Importance of Fish and Squid ... 152
Diet of Fish and Squid Predators ... 153
Status and Trends of Squid and Fish Predators ... 153
Effects of Environment on Predator Distributions ... 155
Status of the Krill-centred Ecosystem ... 155
Development of Assessment Methods ... 155
Current Status ... 156
Historical Status of the Ecosystem ... 157
Further Approaches to Ecosystem Assessment ... 158
Future Work ... 162

METHODS AND DESIGNATION OF CEMP SITES ... 164
Harvested Species Methods ... 164
CEMP Methods ... 166
Designation and Protection of CEMP Sites ... 167
Future Work ... 172

ADVICE TO THE SCIENTIFIC COMMITTEE ... 172
Precautionary Catch Limits for Area 48 ... 172
Regulatory Framework for CCAMLR Fisheries ... 173
Consideration of other Management Measures ... 173
Future Work ... 175

FUTURE WORK ... 176
Future Intersessional Work of WG-EMM ... 176
Future Meetings of WG-EMM ... 176
Financial Implications ... 176
Impact on the Work ... 177
Recommendation ... 178

CCAMLR WEBSITE ... 178

OTHER BUSINESS ... 180
Future Meetings ... 180
Meeting Papers ... 180

ADOPTION OF THE REPORT ... 181

CLOSE OF THE MEETING ... 181

REFERENCES 181

TABLES 183

FIGURE 189

APPENDIX A: Agenda 190

APPENDIX B: List of Participants 192

APPENDIX C: List of Documents 197

APPENDIX D: An Example of an Examination of Trends in Krill Catches in Area 48 using Non-metric Multidimensional Scaling (nMDS) 203

APPENDIX E: Examination of Potential Changes in γ arising from the Yield Calculations as a result of Surveying Biomass after Different Fractions of the Year 206

APPENDIX F: Draft Terms of Reference for the CCAMLR-2000 Survey Analysis Steering Committee 208

APPENDIX G: Report of the B_0 Workshop 209

REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT
(Taormina, Sicily, Italy, 17 to 28 July 2000)

INTRODUCTION

Opening of the Meeting

1.1 The sixth meeting of WG-EMM was held at the Hotel Caparena, Taormina, Sicily, Italy, from 17 to 28 July 2000. Dr R. Hewitt (USA), Convener, welcomed participants and outlined the program for the meeting.

1.2 During an evening reception hosted by Prof. M. Bolognari, Mayor of Taormina, Prof. L. Guglielmo (Italy) welcomed participants. Ambassador Jacoangeli, Ministry of Foreign Affairs, officially opened the meeting and outlined key challenges facing the management of Antarctica and the Southern Ocean, and recent progress including the establishment of the Committee on Environmental Protection and the work of CCAMLR. Prof. Bolognari also welcomed participants to Taormina and hoped that the meeting would be successful in furthering the work of WG-EMM.

1.3 On behalf of CCAMLR, Dr D. Miller, Chairman of the Scientific Committee, thanked Prof. Guglielmo for hosting the meeting in Taormina, and Ambassador Jacoangeli and Prof. Bolognari for their warm welcome.

Adoption of the Agenda and Organisation of the Meeting

1.4 The Provisional Agenda was introduced and discussed. With the addition of one item, '7.3 Future Meetings of WG-EMM', the Agenda was adopted (Appendix A).

1.5 The List of Participants is included in this report as Appendix B and the List of Documents submitted to the meeting as Appendix C.

1.6 The report was prepared by Prof. I. Boyd (UK), Drs A. Constable (Australia), D. Demer (USA) and I. Everson (UK), Mr M. Goebel (USA), Drs D. Miller (Chairman of the Scientific Committee), E. Murphy (UK), S. Nicol (Australia), P. Penhale (USA) and D. Ramm (Data Manager), Mr K. Reid (UK) and Drs P. Trathan (UK), W. Trivelpiece (USA), J. Watkins (UK) and P. Wilson (New Zealand).

HARVESTED SPECIES

Fisheries Information

Catch Status and Trends

2.1 In the 1998/99 season, 103 318 tonnes of krill were caught entirely from the Atlantic sector. The catch came from Subareas 48.1 (38%), 48.2 (49%) and 48.3 (13%). Most of the winter krill catch was taken from Subarea 48.2 in contrast to previous seasons when the winter fishery had concentrated in Subarea 48.3. Of the catches reported in 1998/99, 88% had been reported as fine-scale data, mostly by 10-day periods.

2.2 A Polish catch of 254 tonnes was reported from Area 47, in the southeast Atlantic and outside the CCAMLR Convention Area. The Working Group expressed interest in receiving biological information on krill caught in this area.

2.3 Argentina had reported catches in 1998/99 but no notification had been made to the Working Group prior to commencement. The Working Group indicated that prior notification of new entrants into the krill fishery was extremely useful for determining trends in the krill fishery and all nations intending to enter the fishery should be encouraged to notify the Secretariat of their intentions.

2.4 In the 1999/2000 season, a total of 82 913 tonnes of krill have been reported by 5 July 2000. Catches have been reported by Japan (51 508 tonnes; four vessels), Republic of Korea (3 785 tonnes; two vessels), Poland, (19 093 tonnes; five vessels), Ukraine (823 tonnes; two vessels) and Uruguay (7 704 tonnes; one vessel). The Secretariat had received no reports of catches by vessels from other nations. All catches reported were from Area 48 (WG-EMM-00/25).

2.5 Five Member countries expected to be fishing for krill in the 2000/01 season. Japan expects to send four vessels and to catch at similar levels to 1999/2000, the Republic of Korea would send two vessels and expected to catch ~10 000 tonnes, the USA expects to have two vessels fishing for krill, Russia may send two vessels and South Africa may send one vessel for 180 days to produce whole krill and produce meal. No information was available from Ukraine, Poland, Argentina or Uruguay which have fished in recent seasons, and there was also no further information on the krill fishing venture proposed by Canada, a non-Member nation, which had been discussed at previous meetings (SC-CAMLR-XVIII, paragraph 2.2).

Trends in Fishery Development

Economics

2.6 The average wholesale price of krill from the Sydney Fish Market ranged between A$2.65 and 6.91 per kg in the period between 1992 and 1999 (WG-EMM-00/25, Table 4). Information on krill prices from markets where larger quantities of krill were frequently traded was still not available despite requests by the Working Group for these figures (SC-CAMLR-XVIII, Annex 4, paragraph 2.11).

2.7 The Working Group acknowledged that there were difficulties in accessing economic information on the krill fishery but reiterated the need for this information. The Working Group noted that an economic analysis of the relationship between the fisheries for *Euphausia superba* and *E. pacifica* had been produced recently (Yoshida, 1995) which indicates that economic information on krill fisheries is available and is reliable enough for predictions to be made from these analyses. The Working Group strongly encouraged the completion and submission of an economic analysis of the Antarctic krill fishery so that the economic trends underlying the development of this fishery can be determined.

Conversion Rates

2.8 Some descriptive information on conversion rates for krill products was presented (WG-EMM-00/12), but there was little information on the exact conversion rates which relate the amount of krill caught to the different products of the krill fishery from different fishing fleets, fishing areas or seasons. The Working Group encouraged the provision of detailed information on conversion rates of krill from Members involved in the krill fishery.

2.9 Although data presented on conversion rates from the fishery were largely descriptive, it was noted that there was additional information in the literature, particularly in the series of FAO reports which have dealt with krill: Budzinski et al. (1985), Everson (1977), Grantham (1977) and Nicol and Endo (1997) which might allow a more rigorous approach to estimating the conversion rate of fresh to processed krill. Drs Everson, Miller and Nicol agreed to analyse the information in these reports and present a summary of the results to the next meeting of the Working Group.

Fishing Strategies

2.10 Analyses of haul-by-haul data from a vessel from the Polish krill fishery provided further information on commercial fishing strategies (WG-EMM-00/17). Between 7 and 9.5 hauls were carried out per day, each lasting 60 to 70 minutes. Hauls during the day were deeper and had higher catch rates (4.35–9.33 tonnes per haul) than those at night (0.8–3.33 tonnes per haul). There were also regional and seasonal differences in catch rates.

2.11 Further information from the Japanese krill fishery included analyses of CPUEs and body lengths, krill trawling positions and by-catch. Relatively stable CPUEs, expressed as catch per haul, may be a result of efforts to keep catches constant and krill in good condition for processing. Seasonal movements of the fleet in 1998/99 were associated with changes in CPUEs and with changes in the length frequency of the catch (WG-EMM-00/57).

2.12 Krill trawling positions north of the South Shetland Islands in the period between 1980/81 and 1998/99 were not correlated with krill densities from scientific surveys but were correlated with scientifically sampled salp densities (WG-EMM-00/58). When salp densities were high in the scientific surveys the krill trawlers were found further to the south possibly to avoid salp by-catch. The Working Group encouraged further development of the model used in this investigation. Highest by-catch of salps in the commercial fishery was found in hauls with low krill catch rates (WG-EMM-00/54).

Assessment of Trends in the Distribution of Fishing

2.13 Dr Constable proposed that the time series of fine-scale catches shown in WG-EMM-00/25, Annex 1, was sufficient to examine long-term trends in the distribution of catches across Area 48 using a multivariate technique known as non-metric Multidimensional Scaling (nMDS). Such a technique would allow the Working Group to assess whether significant shifts were occurring in the pattern of fishing, including location and amount caught (Appendix D).

2.14 The Working Group agreed that this procedure may provide a useful tool for determining when the pattern of fishing might be changing in a particular season or over years, both in terms of the spatial distribution of catches and their relative location to sensitive areas and in the amount taken in different areas. The Working Group thanked Dr Constable for providing this analysis and recommended that the Secretariat explore this procedure further for the next Working Group meeting. Such exploration could involve examining the relative sensitivity of the outputs to different data transforms and different spatial scales for pooling the data, the method by which the results are presented, and the summary information that would be required to interpret the results.

Observer Scheme

2.15 At previous meetings, WG-EMM had encouraged implementation of the CCAMLR Scheme of International Scientific Observation in order to provide information to include in assessments and also to provide greater insight into ecosystem analysis. The CCAMLR 2000 Krill Synoptic Survey of Area 48 carried out in January and February 2000 (hereafter referred to as 'the CCAMLR-2000 Survey') was seen as a valuable opportunity to obtain information on the krill fishery for comparison with direct field observations.

2.16 The USA had designated one CCAMLR international scientific observer who had been accepted on the stern trawler *Chiyo Maru No. 5* by Japan. The observer's scientific report was tabled as WG-EMM-00/12. In addition, a national observer had reported on activities on the Ukrainian stern trawler *Konstruktor Koshkin* in WG-EMM-00/4.

2.17 Other reports on national surveys were tabled indicating that data had been collected in accordance the CCAMLR scientific observer protocols.

2.18 Prior to the 1999/2000 season, the Working Group had limited success in requesting that CCAMLR international scientific observers be placed on krill fishing vessels. It noted with pleasure that the necessary bilateral arrangement had been set up between the USA and Japan to effect such placement in 2000. This was the second such venture between two countries. However, several difficulties had been encountered which the Working Group discussed in order to provide better guidance for future such arrangements (paragraph 2.29).

2.19 The main problems encountered were associated with the estimation of total catch, the representivity of samples for determination of by-catch, time budgets and factors to estimate the weight of fresh krill from product weights.

2.20 Currently it appears that the total catch is estimated from product weights and that these may be in error due to inappropriate conversion factors being applied and no account being taken of discards (see also SC-CAMLR-XVIII, paragraph 2.5). The Working Group considered this a high priority and requested the Secretariat to obtain information on the methods used by fishers to determine the total removals.

2.21 Following WG-EMM in 1999, the Secretariat had developed a questionnaire (WG-EMM-00/25), seeking information on krill fishing strategies, which had been sent to all Members on 4 May 2000. The Data Manager reported that no responses had been received. This was regretted and the Working Group reiterated the urgent need for such information. The Working Group also requested that the questionnaire be sent out again with a strong request for responses particularly from fishers and Members designating observers whether national or as part of the international scheme.

2.22 Whilst there was value in conversion factors determined from biochemical analyses of fresh krill and krill products, as outlined in paragraphs 2.8 and 2.9, these should not be seen as a substitute for direct estimates from on-board processing. In this context the current procedure was considered to be inadequate. The Working Group recommended that facilities should be made on board for observers to make such estimates.

2.23 Dr S. Kim (Republic of Korea) stated that the reported Korean catch was derived from the mass of fresh krill caught. The krill were immediately frozen into 12 kg blocks, the water content of which was about 18%. This was equivalent to a catch-to-product conversion of 1:1.

2.24 The Working Group noted that the catch reporting procedure described in paragraph 2.23 did not necessarily provide information on the discarded portion of the catch.

2.25 Dr S. Kawaguchi (Japan) indicated that Japanese krill fishing vessels collect and report catch discards. These are taken into account when reporting total krill catches. The methods for reporting landed and processed catches by the Japanese krill fishery have been detailed in SC-CAMLR-XVIII, paragraph 2.5, along with the current conversion factors for various krill products in relation to fresh weight.

2.26 The CCAMLR international scientific observer on the *Chiyo Maru No. 5* had indicated that there were problems interpreting the protocols as set out in the *Scientific Observers Manual*. The observer was now working elsewhere but had been debriefed by Mr C. Jones (USA) who would be requested to seek clarification on the nature of the problems. Following discussion with interested parties, these matters would be set out as a proposal for consideration at the WG-EMM meeting in 2001.

2.27 The Working Group noted that even though the Scheme of International Scientific Observation had been in place since the 1992/93 fishing season, this was the first year in which an observer had been designated under the scheme in Area 48. Whilst welcoming this development, the Working Group noted that this provided information for only a very small part of the commercial fishery. Accordingly, the Working Group recommended to the Scientific Committee that a greater level of implementation of the program, including wider reporting of observer information, ideally to the extent of including all vessels engaged in the fishery, should be made. Information provided by national observers should be compatible with information required under the CCAMLR scheme. This will facilitate comparability of information provided from a wider areal coverage.

2.28 Both the USA and South Africa (see paragraph 2.5) noted an intention to make the carrying of scientific observers part of the permit conditions for their vessels on entering the krill fishery.

By-catch of Fish in the Krill Fishery

2.29 The CCAMLR international scientific observer on the *Chiyo Maru No. 5* had analysed 20 kg subsamples of the krill catch from 22 hauls (WG-EMM-00/12). Five small fish had been found suggesting that the overall by-catch of finfish was low. However, the observer did not have free access to the sample catches.

2.30 The national observer working in June–July on board the Ukrainian vessel *Konstruktor Koshkin* also reported on fish by-catch. Several hauls in water 110–170 m deep to the west of the South Orkney Islands (Subarea 48.2) were found to contain mackerel icefish (*Champsocephalus gunnari*) (length range 5–7 cm, maximum 12 cm). The largest catch was at 60°41'S 46°23'W where 200 icefish per tonne of krill were taken. At other stations in the vicinity the catch rate was 1–20 per tonne of krill.

2.31 The Working Group noted that these catch rates did not appear to be large and, in the case of the Ukrainian information, were confined to a limited area. Thus, as well as providing information on the potential impact of krill fishing on juvenile fish, the primary reason for the sampling, the data could also provide information on the distribution of the juvenile fish. It was agreed that consideration should be given to stratifying the sampling program to take account of anticipated density of juvenile fish. It was also agreed that those hauls which had been examined for the presence of fish larvae should be clearly identified.

Regulatory Framework

2.32 WG-EMM noted that progress has been made in elaborating a regulatory framework for the development of CCAMLR fisheries (SC-CAMLR-XVIII, paragraphs 7.11 to 7.23).

2.33 The Commission (CCAMLR-XVIII, paragraphs 10.6 to 10.11) has noted that the development of a unified regulatory framework for CCAMLR fisheries is an iterative process which may take some time to complete. Such development requires consideration of:

(i) steps in the development of a fishery;
(ii) procedures to guide the development of a fishery; and
(iii) designation of status to different categories or levels of the fishery.

2.34 WG-EMM noted that the Commission had tasked a small ad hoc group convened by the Chairman of the Scientific Committee with developing the regulatory framework further. It was agreed that a key consideration of how the current and future krill fishery would fit into such a framework is of concern to WG-EMM and that the framework is uniform across all fisheries while accounting for the special needs of individual fisheries. The ad hoc group was therefore requested to note this concern and to ensure that it is included in the Working Group's deliberations.

2.35 WG-EMM also recognised the strategic importance of having a regulatory framework to guide fishery development and to facilitate the formulation of appropriate management measures for, and data collection requirements from, a fishery. The ad hoc group was therefore encouraged in its work.

Regional and Local Surveys

2.36 Over 20 papers were presented to WG-EMM with information on krill derived from local and regional surveys. These surveys cover a number of years and various research areas around the Antarctic. The discussion of these papers was structured according to the spatial and temporal relationship of each dataset to the CCAMLR-2000 Survey that was carried out in January and February 2000.

2.37 Papers relating to aspects of the CCAMLR-2000 Survey itself (i.e. those papers that discuss surveys that formed part of the actual synoptic survey) were considered first. Note, however, that the presentation of the estimate of B_0 (i.e. krill standing stock) and variance from the CCAMLR-2000 Survey are presented in paragraphs 2.84 to 2.95. Papers containing information on krill that were taken within Area 48 (i.e. within the region covered by the synoptic survey) and in the same season as the CCAMLR-2000 Survey were considered second. These papers included ancillary surveys that were carried out within parts of Area 48, krill data obtained from krill predator studies and observer or commercial fishery data collected from Area 48. Third, data from surveys outside Area 48 but still within the same season as the CCAMLR-2000 Survey were considered. Then any data presented from surveys conducted within Area 48 in seasons prior to the CCAMLR-2000 Survey were considered. Finally, data presented for surveys outside Area 48 in the seasons prior to the CCAMLR-2000 Survey were considered.

Krill Length-frequency Data, Biomass and Distribution during the CCAMLR-2000 Survey

2.38 WG-EMM-00/6 Rev. 1 presented an analysis of the krill distribution patterns in Area 48 using data collected by Japan, Russia, UK and the USA during the CCAMLR-2000 Survey in January and February 2000. A cluster analysis of the krill length data revealed that there were three geographically distinct clusters of krill found across the Scotia Sea. Krill forming cluster 1 were essentially small krill with a modal size of 26 mm and were distributed in the south and east of the Scotia Sea, from an area adjacent to the South Sandwich Islands up to the eastern end of South Georgia. Krill from cluster 3, the largest and most mature krill with a modal size of 52 mm, occurred in the western oceanic waters of the Drake Passage and the Scotia Sea. Krill in cluster 2, of a size range intermediate between cluster 1 and cluster 3, were found in the inshore waters around the Antarctic Peninsula, separating the other two clusters in the Scotia Sea, and at the northeastern part of the survey area.

2.39 The krill length-density distributions for Subareas 48.1, 48.2, 48.3 and 48.4 are also presented in WG-EMM-00/6 Rev.1. For the period of the CCAMLR-2000 Survey the population structure in each of these subareas was very different. The Working Group noted that, during this survey at least, it appeared that the population structure observed in any particular subarea was not representative of the overall population structure in Area 48.

2.40 The Working Group also noted that there were differences between the length-density distributions presented for the subareas and the length-frequency composition of clusters above. For instance the lengths of the dominant modal size classes were different. It was suggested that such changes were attributable to differences between presentation of length-density and length-frequency data. The Working Group recommended therefore that further comparisons should be undertaken when all the data had been transformed to length-density data.

2.41 The Working Group also recognised that care should be taken when conditions observed in a regional survey were assumed to apply to a much larger management region. The important role of the large-scale synoptic survey to set local and regional surveys in a context of variation at larger spatial and temporal scales was re-emphasised.

2.42 The general pattern observed in WG-EMM-00/6 Rev.1 above, was presented in more detail in length-frequency data from individual RMT8 net hauls undertaken as part of the Russian contribution to the CCAMLR-2000 Survey carried out in Subarea 48.4 (WG-EMM-00/33). Three types of krill were identified in this subarea: juvenile krill (modal sizes 25–29 mm), subadult krill (modal sizes 35–49 mm) and mature krill (modal sizes 50–56 mm). A distinct distribution pattern was observed with hauls containing predominantly small krill occurring to the southwest of the South Sandwich Islands and with the largest krill occurring to the north of the islands. The maximum krill density (estimated from RMT8 net hauls) detected within Subarea 48.4 during the CCAMLR-2000 Survey occurred in the southwest of the survey area (1.67 g/m^3). Densities in the north and northeast of the survey area were generally low (0.005 g/m^3). The distribution of acoustic density attributed to Antarctic krill (defined where the difference between mean volume backscattering strength at 120 and 38 kHz was between 2 and 16 dB) also showed a similar pattern with the highest density being confined to the southwest of the South Sandwich Islands.

2.43 The distribution of acoustically detected krill was contrasted with distribution of acoustic backscattering from other zooplankton organisms in Subarea 48.4 (WG-EMM-00/50). Acoustic backscattering from zooplankton (defined where the difference between mean volume backscattering strength at 120 and 38 kHz was greater than 16 dB) occurred over the entire area studied in Subarea 48.4, but formed a greater proportion of the acoustic backscattering in the northern area of the survey. Backscattering attributed to targets larger than krill (defined where the difference between mean volume backscattering strength at 120 and 38 kHz was less than 2 dB), and so considered to represent myctophid fish, were observed in the north of the study area in water associated with the ACC.

Krill Length-frequency Data, Biomass and Distribution during Ancillary Surveys Conducted in Area 48 in 1999/2000

2.44 WG-EMM-00/52 presents length-frequency data obtained during the Korean cruise on the north side of the South Shetland Islands during January 2000. These data were collected with a bongo net with a much smaller mouth opening than the RMT8 used on the CCAMLR-2000 Survey. The overall length-frequency distribution had a modal size of 50 mm and again very few krill smaller than 40 mm were caught.

2.45 WG-EMM-00/10 presents length-frequency data obtained during the Peruvian cruise on the north side of the South Shetland Islands during January 2000. These data were collected using Methot and Engel nets (13 of the 15 hauls taken with the larger Engel trawl) rather than the RMT8 net specified for the CCAMLR-2000 Survey. The overall length-frequency distribution of krill caught during this survey had a modal size of 49 mm and few krill below 44 mm were seen.

2.46 The length-frequency data from the Korean and Peruvian cruises described above are taken from surveys that cover exactly the same area as the South Shetland Island mesoscale survey box sampled by Japan during the CCAMLR-2000 Survey. Even though the nets used in these three studies are different there was a great similarity in the krill sampled both during the CCAMLR-2000 Survey and in these two ancillary surveys. In all cases it was noted that no juvenile krill had been sampled.

2.47 The biomass estimated during the Korean survey of the South Shetland mesoscale region in January 2000 (WG-EMM-00/52) was 475 000 tonnes (krill density 12 g/m^2, CV 14.52%). This estimate appears to be directly comparable, in terms of technique used and transects surveyed, with the estimate obtained for this region during the CCAMLR-2000 Survey (see Appendix G, Table 25b).

2.48 Although a biomass estimate was presented for the Peruvian survey of the South Shetland mesoscale region (WG-EMM-00/10), it was noted that the conversion factor used to obtain areal krill biomass density was significantly higher than that used during the B_0 Workshop for the CCAMLR-2000 Survey. In addition, the survey area was estimated using a different technique from that used for the CCAMLR-2000 Survey. The Working Group agreed that this survey result would be a valuable addition to the ancillary survey dataset once these discrepancies had been removed and encouraged reanalysis of the data.

2.49 Dr Hewitt informed the Working Group that the USA had conducted an ancillary survey in the South Shetland Island area in February and March 2000. Densities of krill in the region of 20–25 g/m^2 had been obtained.

2.50 WG-EMM-00/55 listed the datasets collected by Japan for the ancillary survey of the South Shetland mesoscale region in December 1999. Although no data analysis was presented, the Working Group noted that taken together the ancillary datasets of Japan, Republic of Korea, Peru and USA provided a very valuable dataset and encouraged the timely analysis of these data (see also paragraph 2.124).

2.51 WG-EMM-00/51 presents information on the length-frequency data obtained during the AtlantNIRO–BAS Core Programme cruise around South Georgia (Subarea 48.3) in January 2000. This survey repeated the Core Programme transects carried out between 1995/96 and 1998/99 by BAS. In 1999/2000 krill were generally small (modal size 32 mm) in the core box to the northeast of South Georgia, while larger krill (modal size 41 mm) were seen in the western core box to the northwest of South Georgia. Krill density in the South Georgia region during early January 2000 was generally very low. In the western BAS Core Programme survey box the mean net (RMT8) density was less than 0.2 g/1 000 m^3, while in the eastern Core Programme survey box the densities were higher but still low at 1.8–4.7 g/1 000 m^3. It was noted that no concentrations of krill suitable for commercial fishing were detected.

2.52 The Working Group were informed that further analysis of the South Georgia Core Programme data collected in this year would be undertaken at a joint analysis workshop between AtlantNIRO and BAS in Cambridge, UK, in September 2000.

2.53 The Working Group recognised that the regional and local surveys in Area 48 during the same period as the CCAMLR-2000 Survey had provided a rich source of information which could be used to address questions such as when is the best time to sample the biomass and characteristics of the krill population.

Krill Length-frequency Data Collected from Predators
in Area 48 during the CCAMLR-2000 Survey

2.54 Four papers presented information on the length frequency of krill in the diet of predators sampled during the CCAMLR-2000 Survey. The size of krill in the diet of fur seals and penguins (Adélie, chinstrap and gentoo) at Admiralty Bay, South Shetland Islands, is described in WG-EMM-00/41. The modal size of krill in both fur seal and penguin diets was in the 46–50 mm size class; however the penguins took smaller krill than the fur seals. Given the different time periods when fur seals and penguins were sampled (penguins from December to February, fur seals from February to March), it was suggested that much of this variability could be explained by krill growth (approximately 0.1 mm/day).

2.55 The mean size of krill in the diet of fur seals at Cape Shirreff on Livingston Island in the South Shetland Islands between December 1999 and March 2000 was 55 mm (SD 3.15) (WG-EMM-00/59). In this case, visual examination of the weekly length-frequency plots did not show any obvious evidence of growth, although the lack of apparent growth could be due to the fact that the krill were approaching their maximum size.

2.56 The size of krill in the diet of chinstrap and gentoo penguins at this site also showed a modal value in the 46–50 mm size class in the year of the CCAMLR-2000 Survey (WG-EMM-00/62). Comparable samples from the two previous seasons had shown that there had been a consistent increase in the modal size of krill taken during the time series (36–40 mm in 1997/98 and 41–45 mm in 1998/99).

2.57 A different pattern was observed for krill length-frequency distributions obtained from fur seals at Bird Island on South Georgia in the period between July 1999 and early February 2000 (WG-EMM-00/19). Over the winter period (September–October 1999) a single-size mode of 44 mm krill was present. This mode increased in size during November reaching 50 mm by early December and 58 mm by the end of December 1999. In early December a new size class of krill (mode 42 mm) appeared and increased in abundance such that it dominated the population structure by February. Such a pattern of bimodality had been observed in previous seasons, particularly 1991, 1994 and 1998.

2.58 The Working Group discussed some of the problems associated with using predator diet data to obtain information on the population structure of krill. It was noted that, while some degree of selectivity had been described in previous studies, there was good evidence to suggest that when small krill are found in net samples they are also sampled by many of the predators. It was also noted that work on modelling the effect of krill selectivity by predators on length-frequency distribution of krill in diets was being carried out and would be presented in due course.

2.59 The Working Group noted that many of the size differences observed in predator diets fitted well with known differences in the distribution of krill. Thus size differences of krill consumed by penguins feeding inshore and fur seals feeding offshore were entirely consistent with the distribution of krill determined from net sampling. In addition it was noted that differences in the size of krill taken by fur seals at Cape Shirreff and Admiralty Bay were consistent with differences in the size and distribution of krill from these sites.

2.60 The Working Group also noted that at times there were abrupt changes from one week to the next in the length-frequency distributions of krill (WG-EMM-00/19). Such changes could be brought about through the interaction of growth of krill and predator selectivity. The effect of changes in predator foraging areas or krill transport were also considered, although there was no suggestion from satellite tracking of predators at South Georgia that changes in foraging areas occurred through the season.

Krill Length-frequency Data from the Commercial Fishery in Area 48 during the CCAMLR-2000 Survey

2.61 WG-EMM-00/15 described the size and maturity of krill collected by a CCAMLR international observer during commercial fishing in Subarea 48.1 during February 2000. Krill were sampled from five regions to the northwest of the South Shetland Islands and the average length of krill was 49.1 mm (modal size 50 mm). Region 3 was located on the shelf to the northeast of Cape Shirreff and the smallest krill were found at this site (modal size 46 mm). There was a general trend for larger krill to be found offshore as has been seen previously in this area.

2.62 The Working Group noted that the small krill found in region 3 and the somewhat larger krill found in region 4 (modal size 50 mm) were within the foraging range of penguins and fur seals breeding at Cape Shirreff respectively.

2.63 The Working Group recognised that such data from the commercial fishery was a valuable addition to the data collected from scientific cruises and acknowledged the considerable effort by the Governments of Japan and USA and the Japan Deep Sea Trawlers Association in setting up such a collaborative venture (see also paragraph 2.18).

Krill Length-frequency Data, Biomass and Distribution from other Areas of the Southern Ocean during the CCAMLR-2000 Survey

2.64 The size of krill in the Ross Sea during January and February 2000 was described in WG-EMM-00/38. The majority of the krill were allocated to year classes 3+ and 4+ with modal sizes for male and female krill of 43–45 and 47 mm respectively. Relatively few krill smaller than 40 mm were found during the study.

2.65 The geometric mean density of *E. superba* in the surveyed area of the Ross Sea (from latitude 70°–77°S and from longitude 167.5°E–178°W) in January and February 2000 determined from 63 net (HPN) hauls was 9.4 g/1 000 m^3. This species was found dominating catches north of 74°S, while *Euphausia crystallorophias* dominated in catches south of 74°S. On 33 hauls carried out south of 74°S, the geometric mean density of *E. crystallorophias* was around 3.0 g/1 000 m^3 (WG-EMM-00/38). These were a mixture of targeted and oblique tows.

2.66 The Working Group recognised that data presented in WG-EMM-00/38 had shown the importance of *E. crystallorophias* in the Ross Sea where it may form a significant proportion of the krill biomass. The Working Group also noted that it was valuable to be able to separate these two euphausiid species acoustically (see also paragraphs 5.1 to 5.11).

Krill Length-frequency Data, Biomass and Distribution from Area 48 during Years prior to the CCAMLR-2000 Survey

2.67 The length-frequency distributions of krill taken by the commercial fishing vessel *Konstruktor Koshkin* around the South Orkney Islands from May to July 1999 (WG-EMM-00/4) indicated that two size groups of krill dominated the catches. The dominant group with a size between 39 and 45 mm were identified as krill probably from the 1996 year class, while the less abundant size group between 45 and 51 mm were identified as krill from the 1995 year class.

2.68 Information on krill length frequency in Subareas 48.1 and 48.2 during March and April 1998 (WG-EMM-00/5) indicated that krill from the successful 1995 spawning season were identified in the catches of adult krill. Krill of size 42–51 mm dominated the catches in Subarea 48.2, while krill of 38–46 mm dominated catches in Subarea 48.1. In both areas juvenile krill were present only in very small numbers although reference was made to the large number of krill larvae observed in 1997.

2.69 Length-frequency data from the Japanese commercial fishery in Subareas 48.1 and 48.2 during the 1998/99 season are given in WG-EMM-00/57. Plots of krill length sampled at 10-day intervals show that the catch was dominated by krill of size 40–50 mm. Within Subarea 48.2 there was evidence of some krill larger than 50 mm. Only a very small number of krill smaller than 40 mm were detected in the net hauls.

2.70 Information on the depth of trawling was available from WG-EMM-00/4, 00/15 and 00/17. Although there is much evidence to show that krill during the daytime are usually found deeper than during the night (e.g. WG-EMM-00/22) it was evident that sometimes during the day the commercial fishery fished close to the surface (within 20 m).

2.71 The Working Group was informed that near-surface aggregations were often detected in both the Japanese and Russian fisheries using sonar or echosounder. The implication of this for acoustic estimates of krill which are usually derived from depths greater than 10–15 m remains an issue for future consideration and study.

2.72 The scales of interannual variability in acoustic density of Antarctic krill at South Georgia were discussed in WG-EMM-00/56. The relative importance of temporal and spatial variability to observed changes in overall mean krill abundance was investigated using an analysis of variance of the individual survey transect mean krill densities. In the four-year period from 1996 to 1999, krill density around the northwest end of South Georgia was very consistent (12–27 g/m^2), while krill density to the northeast of the island tended to be higher than in the west and was highly variable from year to year (11–150 g/m^2). The variance over small temporal and spatial scales (within and between BAS Core Programme boxes in the same year) was similar to variation between years.

2.73 The Working Group noted with interest the observation that krill density at the western end of South Georgia was generally lower than in the east and that this was consistent with the observation that the pressure from land-based predators was likely to be higher at the western end of the island. However it was also noted that there was far less information on the demand from pelagic predators, although Everson (1984) indicated that historically whales had been very abundant at the eastern end of the island. The Working Group also noted that the commercial krill fishery tended to focus on the northeast of South Georgia, although there was often a westerly movement along the coast as the fishery season progressed (see also WG-EMM-00/25).

Krill Length-frequency Data, Biomass and Distribution from other Areas of the Southern Ocean during Years prior to the CCAMLR-2000 Survey

2.74 WG-EMM-00/39 presented data on krill size in the Ross Sea in 1997/98, two years before the CCAMLR-2000 Survey. This Ross Sea survey took place earlier in the season (December) than the Ross Sea survey in 1999/2000. In contrast to the latter, a large proportion (81%) of the krill population was in the size range 40–45 mm (mean length 41 mm) and there was also a substantial proportion (19%) of juvenile krill (10–25 mm; mean length 17.7 mm) detected in the net hauls.

2.75 An estimate of krill biomass of 1.95 million tonnes for the Ross Sea area (22 200 n miles^2; krill density 25.6 g/m^2) is presented in WG-EMM-00/37 and 00/39. These estimates were based on survey track lines which were determined at the time of the cruise according to where ice was encountered. The three-frequency method was used to separate *E. superba* from *E. crystallorophias* (WG-EMM-00/39).

2.76 The Working Group recognised the value of these estimates of biomass from the Ross Sea area where relatively little information had previously been available. The Working Group also recognised that at present there was no precautionary catch limit for krill in the Ross Sea (Subareas 88.1 and 88.2), but that a survey to undertake an estimate of B_0 should be encouraged.

2.77 Dr M. Azzali (Italy) informed the Working Group that Italy would consider carrying out such a survey in December 2001. The Working Group thanked Dr Azzali for this offer and asked that the design and protocols of any survey to estimate B_0 in the Ross Sea should have the prior approval of the Working Group. Such a procedure of submitting plans for approval prior to undertaking the survey had been followed previously for the Australian cruise in Division 58.4.1 and for the CCAMLR-2000 Survey.

2.78 The Working Group therefore requested Italy to bring forward plans for approval at the WG-EMM meeting in 2001 for a standardised survey design in the Ross Sea.

2.79 A total biomass of 6.67 million tonnes (CV 27%) of krill in Division 58.4.1 in January to March 1996 had been originally presented in WG-EMM-96/28. Since that time a more detailed analysis of the survey data had been undertaken and a revised biomass estimate of 4.83 million tonnes (CV 17%) had been calculated (WG-EMM-00/30). The change in the estimate of the biomass was due mainly to a correction of the absorption coefficient (α) used in the original estimate.

2.80 The Working Group agreed that this new estimate of the biomass and CV of krill in Division 58.4.1 now represented the best estimate available for this division and recommended that a new value of γ for this division should be calculated.

2.81 The density of krill found in Division 58.4.1 was very low (5.5 g/m^2) in comparison with many of the density estimates derived for different parts of Area 48. However, within this division the distribution of krill is not homogeneous. The density of krill in the western part of the division (80–115°E) was approximately twice that in the eastern part of the division (115–150°E) (WG-EMM-00/30). The proposal to subdivide this division is discussed further in paragraphs 2.96 to 2.119 and 6.6 to 6.19.

Summary of Observations on Krill Length-frequency Data, Biomass and Distribution

2.82 The Working Group noted that a consistent pattern had been observed by all the different sampling techniques utilised within the last few years in Subarea 48.1. Only large krill had been detected and it was generally assumed that these had originated from the last major spawning episode observed in the area which had taken place in 1994/95 and 1995/96.

2.83 In contrast, in Subareas 48.2 and 48.3, small krill had been detected in the 1999/2000 season that had not been seen in Subarea 48.1. The Working Group recognised that the more detailed analysis of the various attendant datasets should be accorded a high priority.

B_0 Workshop (results from the CCAMLR-2000 Survey in Area 48)

2.84 The workshop to analyse data from the CCAMLR-sponsored multinational, multiship acoustic survey for krill biomass in Area 48 undertaken in January and February 2000 was held at the Southwest Fisheries Science Center, La Jolla, California, from 30 May to 9 June 2000. The full report of the workshop was presented in WG-EMM-00/21 Rev. 1 and is attached as Appendix G. This report was presented to the Working Group by Dr Hewitt, the Convener of the workshop.

Data

2.85 The acoustic data and krill length-frequency data from the surveys conducted as part of the CCAMLR-2000 Survey by Japan, Russia, UK and USA had been made available prior to the workshop. In addition, CTD data from Japan, UK and USA were available prior to the workshop. All these data, including CTD data from Russia, are core datasets and copies of these data will be stored by the CCAMLR Secretariat.

Methodology

2.86 Data were processed through a series of stages which:

- delineated acoustic backscatter attributed to krill from other sources of backscattering;
- converted backscatter due to krill to an areal krill biomass density;
- summed areal krill biomass densities over the survey area; and
- estimated the uncertainty associated with an estimate of B_0.

The methods used are detailed in Appendix G.

Estimate of Krill Biomass for Area 48

2.87 The B_0 Workshop had agreed that the results obtained from the 120 kHz dataset would be used for the estimation of krill standing stock in Area 48. The estimate of 44.29 million tonnes (CV 11.38%) (Appendix G, Table 25b) was therefore endorsed as the best available for Area 48.

Variance associated with Estimate of Krill Biomass

2.88 The B_0 Workshop noted that it had only been possible to provide an estimate of the sampling variance of the survey (Appendix G, paragraphs 4.9). However, it was recognised that there are other components of uncertainty which should be identified so that they could be incorporated into the estimation of γ using the GYM. There was insufficient time to provide an estimate of combined measurement and sampling uncertainty and Dr Demer had offered to undertake such an analysis and present the results to WG-EMM-2000.

2.89 WG-EMM-00/49 presented this analysis of some of the components of uncertainty in the CCAMLR-2000 Survey. In addition to sampling variance which is traditionally given for acoustic surveys, this paper considered uncertainty that could arise from variation in physical parameter values used in the sonar equation (such as sound speed, absorption and equivalent two-way beam angle), the effect of noise and the detection probability of krill down through the water column. Finally uncertainty in the identification of krill, the estimation of TS and the effect of behaviour such as diurnal migration were considered.

2.90 Uncertainty of TS and krill delineation techniques were estimated using a DWBA model of krill TS and measured distributions of animal lengths derived from the survey and orientation distributions derived from literature. A combined measurement and sampling variance was estimated from a simulation which assumed that the three-frequency measurements provided independent estimates of krill biomass.

2.91 The overall variance (CV 11.33%) was similar to the sampling variance (CV 13.38%). Thus measurement variance may be considered negligible relative to the sampling variance due to the large number of measurements averaged to derive the final biomass estimate.

2.92 The Working Group recognised that this was an extremely thorough and well-documented study which demonstrated how an understanding of the factors contributing to the measurement of uncertainty in an acoustic survey had improved over the period that acoustic techniques had been used to estimate krill biomass.

2.93 While such an understanding of the uncertainty attached to acoustic surveys will no doubt be improved further in the future, the Working Group endorsed the level of uncertainty derived from this paper as the best estimate available at the present time.

2.94 WG-EMM-00/49 also considered some of the potential sources of bias, such as those arising from errors in species delineation or TS, that might arise in the calculation of B_0. The Working Group recognised that there had been insufficient time to investigate thoroughly the effect of such biases prior to this meeting and requested that such studies should be continued.

2.95 In a discussion on the identification of krill using multifrequency acoustics, the Working Group noted that there is no universal agreement on the exact dual-frequency algorithm to delineate krill (a different example of which can be seen in WG-EMM-00/37 and is discussed further in paragraphs 5.5 to 5.7) nor on the most appropriate level of spatial and temporal integration at which such delineation should occur. However it was agreed that unlike previous biomass estimates (i.e. FIBEX), the krill delineation algorithm had been accepted by all participants to the B_0 Workshop, was totally objective and was believed to represent the best available to the workshop at the time of analysis.

Estimation of Potential Yield

Estimation of γ

2.96 Last year, the Scientific Committee endorsed the need to re-estimate γ to take account of the variance in the estimate of biomass arising from the CCAMLR-2000 Survey in the South Atlantic (SC-CAMLR-XVIII, paragraph 6.40). No other analyses were presented to the Working Group regarding the revision of other parameters used in the estimation of γ, indicating that only the survey details would be altered in the input parameters to the assessment of yield (SC-CAMLR-XVIII, Annex 4, paragraph 7.16). The Working Group agreed to estimate γ using the GYM, which had been agreed by the Working Group to be used in place of the KYM (SC-CAMLR-XVI, Annex 4, paragraph 7.3), and has since been validated by the Secretariat (SC-CAMLR-XVII, paragraph 5.36). It was noted that the Scientific Committee had requested Members to participate in evaluating the GYM and to submit such tests to the Secretariat for archiving as appropriate (SC-CAMLR-VII, paragraph 5.36). The Working Group encouraged Members to continue with this work.

2.97 To this end the Working Group suggested that it would be advantageous to develop a pro-forma format for the submission and archiving of any tests of the GYM.

2.98 The Working Group considered whether to incorporate recruitment information more recent than that used in the estimation of parameters in 1994. It was agreed that more work was still required before such information could be used (see SC-CAMLR-XVI, Annex 4, paragraphs 3.27 to 3.29; SC-CAMLR-XVII, Annex 4, paragraphs 4.28 to 4.37). The parameters used in the estimation of γ are given in Table 1. The new survey CV is 0.114. GYM requires a single date to represent the survey period; this was taken as 1 February 2000 (see also paragraph 2.106).

2.99 The Working Group also considered the parameter values used for the fishing season. Although the Working Group recognised that the krill fishery also took place currently in the winter in Subarea 48.3, the fishery is still small compared to the likely estimate of yield. The Working Group has no information on how the effort will be spread across the year when the fishery is fully developed. The Working Group agreed therefore that the fishing season should remain as 1 December to 1 March in the model as it was likely to represent a more precautionary approach than spreading fishing effort throughout the year.

2.100 The results for Area 48 from running the GYM according to the decision rules were:

> recruitment criterion – 'that the probability that the spawning biomass falls below 20% of the median pre-exploitation spawning biomass after 20 years should not exceed 10%' –
> γ_1 = 0.118; and
>
> predator criterion – 'that the median spawning biomass should not fall below 75% of the pre-exploitation spawning biomass after 20 years' –
> γ_2 = 0.091.

According to the decision rules, the lowest γ is used. Thus, the Working Group agreed that the new γ is 0.091.

2.101 The new potential yield for krill in Area 48 is 4.0 million tonnes (γ = 0.091, B_0 = 44.29 million tonnes). The Working Group accepted this as the best estimate of potential yield available at the present time.

2.102 The Working Group noted that this result is slightly less than the previous Area 48 potential yield estimate of 4.1 million tonnes which had been calculated in 1994 (SC-CAMLR-XIII, Annex 5, Table 2).

2.103 The Working Group discussed a number of factors which were likely to have had an effect on the estimate of potential yield.

2.104 The Working Group recalled that γ_1 was sensitive to a change in the CV of the B_0 estimate but that γ_2, as used in the present estimate, was not (SC-CAMLR-XIV, Annex 4, paragraphs 4.51 to 5.57).

2.105 Apart from refinements in the algorithm associated with using the GYM (SC-CAMLR-XVI, Annex 4, paragraph 7.3), the main reason for the decrease in γ is the difference in timing of the surveys used in the model – the KYM had the surveys timed as one month after the start of the nominal growth period (1 November) whereas this survey (1 February) is three months later. Consequently, a reduction in γ would be expected because of the combined effects of growth and mortality occurring between the beginning of the year and the survey period (see Appendix E).

2.106 In addition, the GYM uses a single date to represent the CCAMLR-2000 Survey (1 February 2000, Table 1) although the survey had spanned the period 11 January to 10 February 2000. The Working Group noted that such an assumption had implications for the calculation of γ (see preceding paragraph). Thus a change in the date representing the survey, changed the estimated value of γ. The Working Group felt that the date used in the present calculation was likely to have resulted in a precautionary approach to the assessment of γ (Appendix E, Figure 1).

2.107 The Working Group recommended that the sensitivity of γ to changes in the date of the CCAMLR-2000 Survey used in the GYM should be investigated in the future.

2.108 The Working Group recollected that tests of the comparability of the KYM and GYM had been conducted in WG-FSA since 1995 and in WG-EMM in 1997. Given the improved transparency of the GYM over the KYM, the Working Group recommended that future work should concentrate on understanding the sensitivity and performance of the GYM to changing parameter values.

2.109 The Working Group noted that the rationale and methods for estimating and choosing parameters used in the yield model are embedded in the WG-Krill and WG-EMM reports and papers presented to those groups. The Working Group agreed that a compiled history of the yield assessment is necessary to facilitate future calculations and to ensure that a collective memory of these assessments is retained. This will involve collating relevant paragraphs of the reports, compiling descriptions and the rationale of estimation methods, including mathematical formulae and algorithms, and summarising the rationale for accepting estimates of the parameters. This will be facilitated by completing the archiving of the KYM (SC-CAMLR-XVIII, Annex 4, paragraph 6.8).

2.110 The Working Group requested that the Secretariat take on the responsibility of compiling the documentation of the yield model (paragraph 2.109). The Working Group further recommended that a subgroup should be formed which would coordinate analyses and tests to be carried out on the GYM in the future (see Table 3).

2.111 Dr Constable informed the Working Group that resources were available at the Australian Antarctic Division to help participants familiarise themselves with the use of the GYM. The Working Group thanked Dr Constable for the offer and also expressed gratitude to the Australian Antarctic Division for the considerable effort contributed to the development of the GYM.

2.112 The Working Group agreed that the same parameters in Table 1 would be used for a reassessment of γ for Division 58.4.1, except for details arising from the BROKE survey, including the CV (0.17) and the date of the survey (1 February). The results from the GYM were γ_1 = 0.123 and γ_2 = 0.091. The Working Group agreed that the γ = 0.091 would be applied to biomass estimates in Division 58.4.1 to determine precautionary catch limits in that region.

2.113 The new potential yield for krill in Division 58.4.1 is 0.44 million tonnes (γ = 0.091, B_0 = 4.83 million tonnes). The Working Group accepted this as the best estimate of potential yield available at the present time.

Subdivision of Potential Yield in Area 48

2.114 The Working Group reiterated the requirement to subdivide the potential yield in Area 48 as a method to distribute fishing effort and therefore to reduce the potential impact of commercial fishing on dependent species.

2.115 At the previous meeting of WG-EMM, a number of alternative approaches to the subdivision of potential yield for Area 48 had been proposed (SC-CAMLR-XVIII, Annex 4, paragraphs 8.55 and 8.61). Of these alternatives, the Working Group had considered that the most feasible in the short term were to subdivide the estimated krill yield from the survey based on (i) the proportion of survey in each statistical subarea, where proportions are estimated from the lengths of the survey tracks, and (ii) the area of krill distribution in each statistical subarea.

2.116 The Working Group noted that there had been insufficient time at the B_0 Workshop to determine the distribution range of krill from the CCAMLR-2000 Survey dataset. However, the importance of such an analysis was recognised and should be carried out as part of the future analyses to be coordinated by the CCAMLR-2000 Survey Steering Committee.

2.117 An estimation of the proportion of survey in each statistical subarea had been derived at the B_0 Workshop where the proportion was estimated from the lengths of the survey tracks in each subarea (Appendix G, Table 23). However, the Working Group noted that the lengths of survey tracks estimated in Table 23 contained both the large-scale and mesoscale transects and so was biased by the increased sampling intensity within the mesoscale survey areas.

2.118 The transect length within each statistical subarea, using the length of the large-scale transects plus the length of large-scale transects passing through mesoscale regions, was calculated using the information in Appendix G, Table 23. The results are given in Table 2.

2.119 The results of subdividing the potential yield of Area 48 between Subareas 48.1 to 48.4 on the basis of transect length are shown in Table 2.

Subdivision of Division 58.4.1

2.120 Division 58.4.1 is the second largest CCAMLR statistical reporting area. WG-EMM-00/30 presents evidence that this region is neither homogeneous in biological nor oceanographic characteristics. It is therefore suggested that Division 58.4.1 should be divided into two approximately equal subdivisions: 80–115°E and 115–150°E. Revised krill biomass estimates for the proposed west and east subdivisions are 3.04 million tonnes (CV 19%) and 1.79 million tonnes (CV 30%) respectively.

2.121 The Working Group noted that although a significantly greater biomass of krill was found in the western region, historically the commercial fishery had operated mainly in the eastern region of Division 58.4.1 for logistic reasons.

Future Work

2.122 The Working Group recognised the unique data resource that was now available from the CCAMLR-2000 Survey. A steering committee, comprising the principal scientists of the participating nations, the Convener of WG-EMM and a vice-chair of the CCAMLR Scientific Committee, was set up to coordinate the analyses of these datasets at future workshops and intersessionally. The draft terms of reference for this steering committee are given in Appendix F.

2.123 The Working Group recommended that the regional and local surveys in Area 48 during the same period as the CCAMLR-2000 Survey should be analysed to address questions such as when is the best time to sample the biomass and characteristics of the krill population.

2.124 The analysis of those surveys considered as ancillary surveys to the CCAMLR-2000 Survey could take place as part of the International Coordination Workshop. This workshop will be convened during the intersessional period by Dr Kim. The final aim of the workshop will be to construct a time series of krill abundance and distribution through the 1999/2000 season for Subarea 48.1.

2.125 The Working Group recognised that given the participation of several nations at the above workshop and need for ongoing analysis of the CCAMLR-2000 Survey results, some prioritisation of tasks was needed. For the moment the Working Group acknowledged that the CCAMLR-2000 Survey analyses should be given higher priority.

2.126 The DWBA model of scattering has the potential to describe TS more accurately and precisely than the presently used relationship of Greene et al. (1991). However the use of this model requires a much better understanding of the orientation of krill in nature. The Working Group encouraged the collection of such data.

2.127 The estimation of uncertainty and bias in acoustic survey estimates of biomass has been refined considerably (WG-EMM-00/49). However, further work on potential biases caused by presently-used krill delineation techniques are required.

2.128 The Working Group recommended that the proportion of krill occurring near the surface during daytime should be determined and its effect on acoustic surveys quantified.

2.129 Given the large number of papers submitted to the current meeting of WG-EMM, the Working Group requested that in future every paper should contain an abstract and two or three paragraphs after the abstract that highlighted the relevance of the paper to ecosystem analysis, assessment and management.

2.130 The Working Group requested future presentations on alternative methods to subdivide the precautionary catch limit.

2.131 The Working Group noted that several nations were involved in genetic population studies (Australia, Italy, Japan, Republic of Korea, Sweden and UK) for stock identification. Dr B. Bergström (Sweden) volunteered to coordinate an ad hoc Subgroup on Population Genetics to provide a forum to discuss progress and analyses.

2.132 The Working Group noted that myctophids are likely to form an important part of an alternative food web to the traditional krill food web. There is now the potential to estimate the biomass of myctophids acoustically and the Working Group encouraged further work on this topic (see paragraph 4.46).

DEPENDENT SPECIES

CEMP Indices

3.1 Dr Ramm presented a summary report on CEMP indices (WG-EMM-00/26).

3.2 The Working Group thanked Dr Ramm and his staff for the significant progress made in organising and summarising CEMP data. The Working Group noted that recommendations for improving the CEMP indices (SC-CAMLR-XVIII, Annex 4, paragraph 4.5) had been undertaken by the Data Manager including:

(i) summaries of anomalous trends presented in two ways: all variables by site and all sites within subareas by each variable;

(ii) providing electronic data forms (e-forms) for each of the standard methods;

(iii) notifying Members of data requirements and clarifications in submitted datasets; and

(iv) archiving inactive datasets.

3.3 It was pointed out that e-forms represent significant progress towards preventing transcription errors and improving the quality of the data.

3.4 It was suggested that a box be added to standard method data forms to indicate if data were collected according to the standard method protocol. Data providers should check the box if all data were collected as such. If not, providers should indicate the nature of, and reason for, any departure from the standard method.

3.5 Dr Ramm reported that 30 pages of the table listing CEMP data in the database were eliminated by archiving datasets which had only 1–2 years of data and which did not contain data for the immediate past season.

3.6 The Working Group reiterated its wish to have updated CEMP data available at WG-EMM each year. It also endorsed the value of the summaries and pointed out that work was underway to develop new methods (e.g. composite indices) for examining the data and focusing on specific questions of interest to CCAMLR.

CEMP Species – Seabirds

3.7 Dr Trivelpiece summarised a preliminary report of SCAR-BBS (WG-EMM-00/16). The final version of this report will be tabled at the SC-CAMLR meeting during October 2000. The report is the result of a workshop held in Bozeman, Montana, USA, from 17 to 21 May 1999. The group met in response to a request from SC-CAMLR for a statistical assessment of available population data on Southern Ocean seabirds. The criteria used for selection of data to be analysed were: continuous annual data of 10 years or more duration, discontinuous data of greater than 10 years duration with at least 50% coverage, and data of sufficient quality to be used as indicative of trends. The objective of the analysis was to determine whether there were statistically significant trends in the long-term seabird population data. Twenty-one seabird species were analysed. Five (four penguins and one albatross) were CEMP species. The preliminary results of the population trends are summarised below:

Adélie penguins –
Adélie penguin data were available from east Antarctica, the Antarctic Peninsula and the Ross Sea. In east Antarctica (Béchervaise Island, Syowa Station, Point Geologie and Casey Station), all populations increased significantly from the 1970s–1980s to the present at 3–4% per annum. At the Antarctic Peninsula (King George, Anvers and Signy Islands), populations were stable or declining slowly through the 1980s but all have declined significantly in the 1990s. There were significant non-linearities in the Ross Sea population data. Cape Royds exhibited a significant linear increase since 1959. Cape Crozier increased from the 1960s to 1987 and has decreased significantly since, while Cape Bird increased between the 1960s and 1987, declined between 1987 and 1994 and has increased significantly since.

Gentoo penguins –
Gentoo population data were available from three regions. In the Antarctic Peninsula region, the population at Port Lockroy has increased significantly, whereas the King George Island population has significant non-linearities in the data due to infrequent, strong cohorts that arise and dominate the population for 10+ years. This population is currently near its 25-year low. The gentoo population at Bird Island showed significant declines over 20 years. The Marion Island population increased significantly between 1975 and 1995, but this trend was based on only three counts. Since 1995, the population at Marion Island has declined significantly.

Chinstrap penguins –
The populations at King George and Signy Islands exhibited significant declines since the 1970s, with a greater rate of decline in the 1990s. The small population at Anvers Island increased significantly between its discovery in the 1970s, and the early 1990s, with indications that the population has stabilised during the 1990s.

Macaroni penguins –
Population data were available from Marion, Bird and Kerguelen Islands. The Marion Island population counts are from three small colonies, all of which exhibited significant declines. Total counts from Marion Island were not assessed as it was felt that the

counts had large error estimates associated with them; however, the Marion Island population as a whole was considered to be relatively stable. Bird Island populations increased by 20% between 1977 and 1986 but the population has declined by 48% since then. This represents a significant 5% per annum decline at Bird Island and the decline broadly reflects other colonies in the area, which have declined by up to 50% in the last 20 years. The population at Kerguelen Island was counted from aerial photographs three times between 1963 and 1999. The results indicate a stable population with a slight increase over the period.

Black-browed albatross –
Data were available from populations at Bird Island and the Kerguelen Islands. The Bird Island population declined significantly from 1976 to 1999, with the earlier period exhibiting the sharpest declines. The Kerguelen population did not show any significant trend, but the data suggested fluctuations in the population, with an apparent strong cohort every three to four years.

3.8 The Working Group recognised the thorough nature of this analysis and expressed its gratitude to SCAR-BBS for bringing it to the attention of WG-EMM. Recommendations arising from the workshop included:

(i) Counts need to be standardised, dates of counts need to be included in the historical database and methods used to obtain counts (e.g. aerial, ground, density etc.) must be clearly reported.

(ii) For the more complete and long-term datasets, investigation of potential interactions between population size and physical and biological environmental variables would be useful. Data holders were encouraged to undertake and collaborate in such work.

(iii) Comparison of population trends, and timings of population change, across populations and species on regional bases would be useful in future investigations.

3.9 The Working Group noted these recommendations. In order to assist SCAR-BBS with its future work, the Working Group made the following comments.

(i) It noted that, in some instances, shifts in distributions of a species or populations could complicate interpretations of declines. It is, therefore, important, whenever possible, to place local population counts in a regional context.

(ii) Where possible, it would be helpful if population data and trends of the same species among sites were presented at the same scales.

(iii) The Working Group recognised the utility of both statistical and demographic models to understand the significance of the status and trends in seabird populations. It may be possible to improve the current statistical models by developing a system by which each estimate of abundance could be weighted according to the SCAR Working Group's view of the reliability of the estimate.

(iv) Extending this approach, the Working Group suggested that it may be important to assess the possibility of apparently rapid changes in abundance from current understanding of the demographics of the species concerned. Therefore, it suggested that a compilation of demographic information alongside the data about trends in abundance would allow this type of assessment to be made.

3.10 Several other papers dealt with issues concerning CEMP status and trends of seabirds.

3.11 WG-EMM-00/40 examined chick provisioning and survival among Adélie penguins at Béchervaise Island. Breeding success and foraging behaviour were summarised for nine seasons including three poor years. Breeding success was negatively correlated with the distance of the sea-ice edge from the colony. Males foraged more inshore than females. Food availability during the guard stage of the breeding cycle was identified as the most important factor in distinguishing between years of varying food availability. The authors suggest that competition with fisheries for food, if it occurs during the early chick-rearing period, is likely to have the greatest impact on the penguin population at Béchervaise Island.

3.12 WG-EMM-00/41 reported length-frequency data from diet samples of Adélie, gentoo and chinstrap penguins and Antarctic fur seals during the 1999/2000 season at the NSF field camp in Admiralty Bay, King George Island. The mean length of krill in the penguin samples increased by 7 mm between the first and last sampling periods (15 December 1999 to 7 February 2000). This increase was consistent with growth of individual krill over the sampling period. Fur seal scat analyses of krill carapaces showed a mean krill size of 50–51 mm in the diets between 9 February and 3 March 2000. Both predators' diets were dominated by krill in the 46–50 mm size classes.

3.13 WG-EMM-00/62 summarised seabird research undertaken at the US AMLR field camp at Cape Shirreff during 1999/2000. Krill length-frequency data from diet samples also showed a dominant krill size group of between 46 and 50 mm. A three-year summary of krill sizes in stomach samples revealed an annually increasing mean size across the period, consistent with the hypothesis that the krill dominating the diets of the penguins at this site are largely from the strong 1995 cohort reported to previous meetings of the Working Group.

3.14 WG-EMM-00/13 reported on aspects of the CEMP monitoring program at Bouvetøya Island by Norwegian researchers in 1998/99. Macaroni penguin populations increased and chinstrap populations decreased relative to counts in the 1996/97 season. However, it was pointed out that a substantial portion of the chinstrap penguin colony washed away between the years, so the lower counts for that species may be due largely to a habitat change. The chinstrap penguins ate exclusively krill, while macaroni penguin diets were predominantly composed of fish with krill as an item of secondary importance.

CEMP Species – Pinniped Studies

3.15 Four papers presented information on Antarctic pinnipeds:

(i) WG-EMM-00/47 presented a general overview of pinniped research at Cape Shirreff by the US AMLR Program and gave a brief synopsis of conditions for fur seals at Cape Shirreff in the 1999/2000 season. It reported that indices of reproductive performance for adult females and for the growth of pups at Cape Shirreff in 1999/2000 were above average.

(ii) WG-EMM-00/48 used a comparative approach to examine how often three species of otariids exceeded their calculated aerobic dive limits. Such measures can be used in management of species because they define how close to their physiological limits individuals are working. Dive data collected for Antarctic fur seals at Cape Shirreff showed that, for that population, animals are working well within their physiological limits for diving. Therefore, it appears that fur seals from Cape Shirreff would be able to exploit prey deeper in the water column than is currently observed.

(iii) WG-EMM-00/13 presented an overview of fur seal research at Bouvetøya Island. This included the monitoring of adult female foraging/attendance cycles and pup growth rate using the CEMP standard methods.

(iv) WG-EMM-00/63 provided a report of the meeting of SCAR-GSS on the status and trends of Antarctic seal populations. This included Antarctic and sub-Antarctic fur seals, southern elephant seals and four species of ice seals. Both species of fur seal are increasing rapidly. In contrast, elephant seal populations are declining in the Indian Ocean but are probably stable or increasing slowly in the Atlantic. Less is known about current trends in ice seal population numbers. Results of the current APIS Program will be available in the near future and this will provide additional information about the status and trends of pack-ice seals. The report recommended removing Antarctic fur seal (*Arctocephalus gazella*) from the list of Specially Protected Species.

3.16 The Working Group thanked SCAR-GSS for providing the report. It was recognised that due to the short interval between the SCAR-GSS meeting and the current meeting, there were several outstanding issues involving the data presented in the text and tables as well as the clarification of the work conducted at the South Shetland Islands. Prof. Boyd was asked to liaise with the convener of SCAR-GSS to help ensure that an updated version of the report was made available for the Scientific Committee.

3.17 The Working Group noted that IUCN was invited to comment on the removal of Antarctic fur seal from the list of Specially Protected Species and to date no response had been received by the Secretariat. It is, therefore, too early for CCAMLR to form an opinion on this issue. It was also pointed out that a review of IUCN criteria for listing species was due to be published in October 2000 and this new information would be important to review the status of the Antarctic fur seal.

3.18 Dr R. Holt (USA) informed the Working Group that contrary to information presented in the text of the report, the US AMLR Program had conducted a census of all known fur seal pupping sites at the South Shetland Islands at approximately five-year intervals since 1987. He further indicated that it was US AMLR’s intention to conduct a fur seal census of the South Shetland Islands in the near future. The Working Group agreed that documenting population changes in Antarctic fur seals in the South Shetland Islands is a high priority.

Predator Abundance Surveys

3.19 Discussion continued concerning the importance of estimating predator abundance regionally, giving high priority to standardising methods. Surveys of predator populations are needed to anchor the observed small-scale population trends at research sites in a larger regional context. It was suggested that a workshop on methodology was needed to assess problems associated with conducting large-scale (regional) population counts. The Working Group endorsed the idea of such a workshop.

3.20 It was noted that predator surveys should not be confined to penguins and seals but should include whales. Input by the IWC would be required and the Working Group noted that CCAMLR should continue to request updates on whale population abundance and information relevant to estimating krill consumption from the IWC.

Non-CEMP Species

3.21 WG-EMM-00/16 summarised the population trends of several non-CEMP seabird monitoring species that are of interest to the Working Group. King penguin populations at Crozet and Heard Islands have all shown significant increases over the last 20 to 30 years. Albatross populations at three sub-Antarctic Islands (Marion, Kerguelen and Possession) have all shown population increases since the 1980s, after significant declines in the 1970s.

However, the wandering and grey-headed albatross populations at Bird Island have exhibited significant declines since the 1960s. Giant petrel populations decreased at Marion Island, Mawson Base, and at several northern Antarctic Peninsula sites, whereas increases were reported at Possession and Anvers Islands.

3.22 The significant declines in many of the giant petrel populations were thought to be due to disturbance from nearby bases. The largely undisturbed population on Anvers Island was reported to have increased significantly; however, this population exhibits large interannual variability in the breeding population size. The Working Group noted that this dataset was based on chick counts, not breeding pairs and, therefore, caution was advised in interpreting the population trend at this site.

3.23 The Working Group noted the lack of population data for many petrel species, particularly the white-chinned petrel, as it is the most commonly killed seabird in the longline fishery.

3.24 WG-EMM-00/8 and 00/9 presented information of the diets of shags from Laurie Island, South Orkney Islands and the Danco Coast of the western Antarctic Peninsula respectively. The authors examined regurgitate pellets over four years at Laurie Island and reported the diet consisted of benthic fishes, molluscs and polychaetes in order of importance. They found significant interannual differences in the size classes of fish in the diets. The data from the Danco Coast was confined to the 1997/98 season. Results showed significant intra-annual differences in the size classes of fish in the diets. The authors suggest that data from shag diets might provide valuable information on the status and recovery of exploited fish stocks.

3.25 WG-EMM-00/11 examined the diet of snow petrels at Laurie Island during the chick-rearing period of the 1997/98 austral summer. Fish (myctophids) dominated the diet and krill was of secondary importance.

3.26 WG-EMM-00/36 reported a southerly range extension for the greater shearwater to the vicinity of the South Sandwich Islands in 1999/2000 and suggested this may signal a southward shift in the location of the Polar Front.

Indices of Key Environmental Variables

3.27 The Working Group considered various aspects of the environment with regard to topics relevant to fishing operations, topics relevant to spatial and temporal variability, and topics relevant to 1999/2000, the year of the CCAMLR-2000 Survey.

Environmental Influences on Fishing Operations

3.28 Environmental data from the national observer on board the krill fish cannery supertrawler *Konstruktor Koshkin* are reported in WG-EMM-00/04. This report considered the period from May to July 1999 when fishing operations were centred around the South Orkney Islands. It contains a description of meteorological conditions, details of sea-surface temperature, information about sea-ice, and summaries on the presence of icebergs. The report noted that the presence of drifting sea-ice complicated fishing operations during the night, but did not interfere with operations during the day. It also noted that wind strength and sea state did not interfere with fishing operations until July, when storm force winds became more frequent.

3.29 The Working Group noted that environmental information related to fishing activities was extremely useful. It provides evidence that will help the Working Group understand spatial patterns in the distribution of fishing effort and understand temporal patterns in the partitioning of fishing operations. The Working Group encouraged the presentation of similar contributions at future meetings.

Spatial and Temporal Environmental Variability

3.30 Data about spatial structure in the environment for Division 58.4.1 are reported in WG-EMM-00/30. Much of the information derives from a combined physical–biological survey for krill that was carried out during 1996 by the RSV *Aurora Australis* (Australia) (BROKE) and which has been presented at previous meetings of the Working Group (e.g. WG-EMM-96/29). WG-EMM-00/30 provided an overview of the circulation in the BROKE region (80°–150°E; 63°–66°S) presenting information to support the existence of a cyclonic gyre in the west (80°–115°E) of the area. Data from drifting sea-ice and from satellite-derived measurements of primary production (chl*a*) indicate the quasi-permanent status of the gyre. The paper highlights physical and biological differences across the region and suggests that the west of the region (80°–115°E) supports higher levels of biological production than the east (115°–150°E). The paper noted that the ACC is further offshore in the area of the gyre and concluded that the structure in the environment is probably a reflection of average summer conditions.

3.31 The Working Group noted that partitioning Division 58.4.1 on the basis of the physical environment would produce approximately evenly sized subdivisions and that this would be appropriate (paragraphs 2.120 and 2.121).

3.32 The Working Group also considered information relating to temporal variability, including indices of thermohaline structure in Area 48. In this respect, WG-EMM-00/34 detailed variability at South Georgia, the South Orkney Islands and at the South Shetland Islands. Variability at each of these locations was represented by a single CTD station that had been occupied on a number of past occasions. At each location the thermohaline structure was observed to vary between years, with structure restricted to a limited number of thermohaline states.

3.33 Temporal variability in the environment and the measurement of aspects that could have a direct effect on dependent species was also considered. Specific measurements have been discussed at previous meetings (e.g. WG-EMM-98/06; WG-EMM-99/12) and have led to the development of new standard methods for indices of F1 (sea-ice viewed from a CEMP site), F3 (local weather) and F4 (snow cover). Earlier meetings of the Working Group have reviewed F1, F3 and F4 (SC-CAMLR-XVIII, Annex 4, paragraph 8.86) and have suggested that it is not necessary (or appropriate) for Members to submit data in support of F3 to the CCAMLR Data Centre. However, WG-EMM-00/27 concluded that, given longer time series of data, it would be possible to derive meaningful CEMP parameters from automated weather stations. In preparation for approval by the Subgroup on Methods, WG-EMM-00/27 presented data from Béchervaise Island and from Edmonson Point as examples of F1, F3 and F4. The paper also presented information from microwave satellite data from the US National Snow and Ice Data Center that could help provide meaningful indices about sea-ice cover adjacent to CEMP sites. The Working Group welcomed the new information and encouraged further developments.

3.34 Temporal variability in average monthly atmospheric conditions is considered in WG-EMM-00/35. The paper used principal components analysis to examine variability in atmospheric pressure between 1970 and 2000, making preliminary conclusions that cyclical patterns (2–3 years and 4–6 years) were present in the atmosphere and that both zonal and meridional variability were important. WG-EMM-00/35 noted the existence of anomalous atmospheric conditions in the late 1990s, and suggested that these could have an impact on the ACC.

The Environment in 1999/2000; the
Year of the CCAMLR-2000 Survey

3.35 Information about the environment during the year of the CCAMLR-2000 Survey was presented in a number of papers. Available information related to CEMP environmental indices, to satellite remote-sensing and to information from research vessels.

3.36 The CEMP environmental indices F2a (September sea-ice cover), F2b (proportion of year ice free), F2c (time sea-ice is within 100 km of a CEMP site) and F5 (sea-surface temperature) provide a standardised description of the environment. In considering the most recent index values presented in WG-EMM-00/26, the Working Group noted that virtually all were within normally observed ranges. Only the most recent value for F2b at Béchervaise Island deviated from the normally observed range. The Working Group also noted that the recent values for F2a were negative in Subareas 48.1, 48.2 and 48.3, but that the values were not sufficiently negative to be classed as deviates.

3.37 In considering the CEMP indices presented in WG-EMM-00/26, the Working Group noted that long-term baseline datasets were important, but that no current definitions were available that would help determine the minimum time period needed to provide adequate baselines. The Working Group also noted that recognition of trends away from baseline data could be difficult in certain circumstances.

3.38 Information derived from US NOAA satellites detailing sea-surface temperatures across the Scotia Sea was presented in WG-EMM-00/55. In addition sea-surface temperatures derived from GOES-E and MEOSAT-7 satellites were presented for the South Georgia region in WG-EMM-00/20. This paper presented information for the period 1999/2000 as well as for a limited number of previous years (1989/90 and 1990/91). After deriving monthly anomalies, the paper concluded that the area to the north of South Georgia was colder during the period of the CCAMLR-2000 Survey than it was during the comparable time of the historical data.

3.39 Information collected from research vessels participating in regional surveys undertaken in Area 48 (WG-EMM-00/51 and 00/52) and participating in the CCAMLR-2000 Survey (WG-EMM-00/21, 00/33 and 00/52) were considered by the Working Group.

3.40 In January 2000 the RV *Onnuri* (Republic of Korea) undertook a physical–biological survey in the vicinity of the South Shetland Islands (WG-EMM-00/52). This survey covered the South Shetland Island mesoscale strata of the CCAMLR-2000 Survey. CTD results from the survey showed a clear delineation in the hydrographic structure; this was manifested as distinct offshore and shelf/coastal regions. Offshore water showed a strongly defined temperature minimum near the surface, with the presence of warmer CDW at greater depths. Over the shelf, coastal water was cooler at depths with no evidence of CDW. Preliminary results from an ADCP were also discussed.

3.41 During January 2000 the RV *Atlantida* (Russia) undertook a mesoscale survey to the north of South Georgia; this is described in WG-EMM-00/51. The survey covered the same mesoscale areas previously occupied by the BAS Core Programme which has been reported to the Working Group in past years. The oceanographic environment during the occupation of the RV *Atlantida* showed considerable similarities with the structure previously described for the region; evidence of a strong shelf-break front and of mesoscale structure was evident in the data. Further analysis of the survey will be undertaken during a joint BAS–AtlantNIRO workshop in the near future.

3.42 Following the mesoscale survey at South Georgia, the RV *Atlantida* participated in the CAMLR-2000 Survey occupying the strata mainly located in Subarea 48.4 (WG-EMM-00/33). CTD data collected during the survey showed that conditions reflected the complex hydrographic structure determined during previous occupations of the area by Soviet Union and Russian survey vessels (1977, 1987 and 1990). Specifically, waters from the Weddell gyre (including waters of the Weddell Scotia Confluence) occupied much of the area surveyed. The warmer waters of the ACC occurred to the north and northeast of the survey area. The paper notes that the main concentrations of krill were associated with the colder Weddell-influenced waters.

3.43 CTD data from the RV *Atlantida* were not available during the CCAMLR-2000 Survey B_0 Workshop, however they have now been combined with the CTD data from the *Kaiyo Maru* (Japan), the RRS *James Clark Ross* (UK) and the *Yuzhmorgeologiya* (USA) in preparation for future analyses.

3.44 WG-EMM-00/21 described the CCAMLR-2000 Survey B_0 Workshop including details of the indices collected to describe the physical environment (Appendix G, Table 5). At the workshop the CTD dataset collected by the *Kaiyo Maru*, the RRS *James Clark Ross* and the *Yuzhmorgeologiya* was considered. When combined with the CTD data from the RV *Atlantida*, the dataset is the largest synoptic physical description of the Scotia Sea since FIBEX. The data were collected to previously agreed protocols using standard instrumentation and are of a very high quality. Though the station spacing was insufficient to resolve mesoscale features such as eddies, the data will allow large-scale environmental features to be mapped across the Scotia Sea (Appendix G, paragraphs 2.35 to 2.38).

Analytical Procedures and Combination of Indices

Combining Indices

3.45 Since the meeting of the Subgroup on Statistics in 1996, WG-EMM has been encouraging work to further develop CSIs aimed at combining the many predators indices determined in CEMP into a single index. At its 1998 meeting, WG-EMM requested that differences in approaches to estimate the CSI covariance be addressed (SC-CAMLR-XVII, Annex 4, paragraphs 7.1 to 7.4). Following results presented to WG-EMM's 1999 meeting, a number of key issues relevant to further consideration of the development and use of CSIs were identified (SC-CAMLR-XVIII, paragraphs 6.6 and 6.7).

3.46 WG-EMM-00/18 presented updated values for the CSIs of various land-based predators at Bird Island. The study focused on the indices which are most likely to reflect the food supply during the summer season. The results indicated that indices from land-based predators did not vary significantly from normal during 1999 or 2000. However, the low breeding population size of land-based predators in 2000 was not taken into account since this is more likely to be influenced by environmental conditions during the preceding winter. Consequently, the data presented only give an indication of food availability concurrent with the breeding season in each year.

3.47 WG-EMM noted that the information presented in WG-EMM-00/14 showed that 1984 and 1994 were years with particularly low predator performance followed by 1991 and 1978. This observation was consistent with previous analyses presented (e.g. WG-EMM-99/40) and future analyses along similar lines were encouraged.

3.48 WG-EMM-00/46 presented an algorithm to estimate the energy and carbon budgets for a variety of land-based predators. The algorithm provides a way to examine the overall consumption of prey by land-based predators and, using different input data, it would be possible to develop it further on a regional basis taking into account current knowledge on predator movement and distribution. The approach could also be adapted to other predator species such as fish or squid.

3.49 WG-EMM noted that the approach outlined in WG-EMM-00/46 was most sensitive to variability in predator demographic parameters. However, predator consumption rates can still be estimated with a reasonable level of confidence even when there is relatively high uncertainty associated with many demographic parameters. The Working Group encouraged further development of the algorithm, particularly as it may provide another index of the functional linkages between predators and prey.

3.50 WG-EMM-00/14 is a complete and revised version of work presented to the WG-EMM Subgroup on Statistics in 1997 and to WG-EMM in 1998. It presents a potential method for combining CEMP data into a single index for individual predator, prey and environmental parameters. Various criteria for including parameters in a single index were discussed. It was noted that the power of the procedure adopted by WG-EMM in 1996 to detect anomalies in CEMP data declines to low levels when more than a few anomalous levels are apparent in the data. The paper presented an iterative procedure using estimates of the mean and variance of the baseline data time-series. This approach was found to demonstrate consistently better statistical powers for combining CEMP data, regardless of the accumulation of anomalies.

3.51 In discussing the results presented in WG-EMM-00/14, the Working Group noted that an approach had been outlined for the further development of CEMP indices in their application by CCAMLR. It was agreed that further development of CEMP indices should be encouraged. Based on suggestions presented in WG-EMM-00/14, the Working Group endorsed the need to address the following issues in the further development of CEMP indices.

(i) Define the classes of index behaviour to be detected by the indices.

The obvious candidates are changing variability (range), trends, shifts and changes in the frequency of anomalies.

(ii) Select the normalising transformations required for various parameters.

(iii) Select a baseline dataset.

This dataset will be used to estimate the centering matrix for the multivariate data and the variances to be used in transforming the data into an approximately standard multinormal distribution. From these data, the covariance/correlation matrix can be estimated. As a stopgap, any missing correlation coefficients could be filled in from other data series if necessary. The parameters within an index should all be positively correlated. If they are not, their role in the formation of an index requires consideration. Examine the data for serial correlation.

(iv) Examine the statistical properties of the proposed index, including, for example:

(a) detecting anomalies;

(b) effects of missing data in various scenarios;

(c) effects on the index of the variability due to sampling versus that due to intrinsic variability;

(d) effects of serial correlation;

(e) effects of non-linear correlations between parameters;

(f) plotting the indices in the form of 'control charts' –

two types of charts could be examined:

- based on an index, with critical bounds (useful for displaying anomalies); and

- based on renormalised cumulative sum of the indices – a ‘cusum’ chart (useful for detecting the effects of a systematic shift in mean level). A randomisation procedure could be tested for the identification of drift.

(v) Examine the power of the indices to detect phenomena of interest, including, for example:

(a) consideration of the appropriate levels of the probability of making type I and type II errors – type II errors may have more important consequences than type I;

(b) the effect of the length and stability of baseline data;

(c) consideration of whether all parameters should have their normal range defined purely statistically, some parameters may have their anomalies defined on biological grounds;

(d) correlation between the three indices (predator–environment–prey);

(e) examination of possible improvements in the design of the CEMP Program to increase the power of the indices. This would include the exploration of experimental designs such as before-after-control-impact designs (Constable, 1992); and

(f) examination of how the indices could be included in the development of quantitative management advice (see Constable, 1992 for further discussion).

3.52 The Working Group recognised that the above represents a substantial program of work, but it should be feasible to make considerable progress over the next few years.

3.53 WG-EMM-00/60 addressed general questions relating to the ecosystem approach for managing CCAMLR fisheries, particularly for pelagic species such as krill. The paper focused on three general questions which included consideration of:

(i) How do pelagic fisheries impact incidentally on the ecosystem?
(ii) What are the conservation objectives for predators of fished species?
(iii) What approaches might be considered for achieving the conservation objectives?

3.54 In addressing conservation objectives for predators, WG-EMM-00/60 outlined general objectives as required by Article II of the CCAMLR Convention and indicated an approach for the development of operational objectives. To achieve conservation objectives, the paper suggested that estimates of total average production could be formulated as a basis for:

(i) assessment of precautionary yield using predator criterion;
(ii) monitoring ecosystem function; and
(iii) undertaking ecosystem assessments.

3.55 In carrying forward the approach outlined above, WG-EMM recognised that various operational objectives and performance criteria should be elaborated. Members encouraged the development of such aspects, taking particular note of how uncertainty could be taken into account in the formulation of decision rules for management purposes. In this regard, it was agreed that a review of CEMP parameters and their potential utility in management procedures is timely. Further discussion on this point is contained in paragraph 3.51.

Future Work

3.56 The Working Group discussed the need for additional information about predator populations. This was a high priority because of the need to:

(i) place the long-term monitoring of predator populations within a wider regional context;

(ii) provide information about the status and trends in abundance of key species together with appropriate confidence intervals on these estimates; and

(iii) as outlined in WG-EMM-00/46, provide accurate estimates of the total prey consumption by predators to better determine the level of competition between predators and the fishery.

3.57 The Working Group looked forward to receiving information on pack-ice seals from APIS, and also saw a need to update estimates of Antarctic fur seal abundance at the South Shetland Islands and to include pelagic predators such as whales by requesting input from the IWC.

3.58 The Working Group considered that the estimation of predator abundance was of sufficiently high priority that there should be a degree of coordination of survey effort and methodology throughout the CCAMLR community. There was a case for carrying out a synoptic survey of land-based predator populations, although it was also noted that several national programs were already planning regional surveys. The Working Group encouraged these initiatives and asked each program to submit a brief outline of their objectives to Dr Constable so that he can collate these and report to the Scientific Committee about the present level of activity. He will also consult with Working Group members and prepare a potential outline for the development and timing of a synoptic estimate of land-based predator populations.

3.59 The Working Group agreed that the following conditions would probably have to be met before such a survey could be seen as a practical option:

(i) all potential participants would have to participate in a workshop to decide on methodology;

(ii) a set of methods would probably have to be adopted to match the logistics and circumstances of each program or region;

(iii) there would have to be prior agreement such that estimates from different regional surveys could be combined and a standard procedure for calculating the error on estimates would have to be agreed; and

(iv) since many methods will rely on counts of the breeding population, there will be a requirement for demographic data to allow estimation of the size of portions of the populations that cannot be counted directly.

3.60 The Working Group agreed that monitoring of the key environmental variables identified in the CEMP standard methods should continue.

3.61 Future analysis of the CCAMLR-2000 Survey oceanographic results was encouraged particularly in respect of improving identification and definitions of key hydrographic features such as oceanic fronts.

3.62 The ground truthing of CEMP-derived indices of sea-ice distribution should continue using available satellite telemetry data on sea-ice.

3.63 Work on the issues identified in paragraph 3.51 is encouraged with a view to facilitating future consideration of the application of CSIs to CEMP data. In this respect, it is proposed that WG-EMM's next meeting will devote some time to a working session on the application of CSIs and Members' experience in their use.

3.64 Prof. Boyd will liaise with SCAR-GSS in order to convey the various views and queries expressed by WG-EMM in paragraph 3.16.

ECOSYSTEM ASSESSMENT

4.1 The Working Group considered the format of this item and agreed that there were four main components to the following discussion. The first component considered the krill-centred interactions that may be of interest to managing the krill fishery within the context of Article II of the Convention. The second involved fish and squid interactions and the third involved an assessment of the krill-centred ecosystem. The fourth involved further approaches to ecosystem assessment. In this connection, the Working Group also noted the request from the Scientific Committee (SC-CAMLR-XVIII, paragraphs 6.21 and 6.22) for guidance about status and trends of resources, dependent species, environmental variables, fisheries and also about the interactions between these components of the ecosystem. In the first three of these components of the discussion the Working Group addressed a series of key questions.

Krill-centred Interactions

Implications of Krill Distributions

4.2 The Working Group addressed the question 'What are the implications of geographical distribution for assessing which sections of the krill population are being exploited by the fishery and predators?'. In combination with this, the Working Group also addressed the question 'What is the interaction between krill distribution and oceanography?'.

4.3 The geographical stratification of the krill population is an important part of the ecosystem assessment of krill-centred interactions because a knowledge of which sections of the krill population are being exploited by both the fishery and predators has implications for management. Results from the CCAMLR-2000 Survey (WG-EMM-00/6) provided a comprehensive overview of the structure of krill populations in the Scotia Sea based on length-frequency distributions. It suggested, in particular, that krill to the south and east of South Georgia may be distinct from the populations in the remainder of the Scotia Sea, at least in terms of their length structure.

4.4 The CCAMLR-2000 Survey results (WG-EMM-00/6) also supported the view that, at the Antarctic Peninsula (Subarea 48.1), krill populations may be stratified according to the oceanography. Based on analyses of krill length frequencies from the fishery (WG-EMM-00/4), there was less certainty of congruence between krill distributions and oceanography to the east of the Antarctic Peninsula (Subarea 48.2). Although work relating the krill population structure to the oceanography from the CCAMLR-2000 Survey is still at an early stage, the Working Group welcomed and encouraged forthcoming analysis of the relationship between krill distributions and oceanography.

4.5 WG-EMM-00/6 also showed that there were few small krill in the region of the Antarctic Peninsula during the 1999/2000 season and this was supported by information about krill size from the diets of penguins in the region (WG-EMM-00/41). This is evidence of another year in which there has been poor krill recruitment in the region. Low levels of recruitment have now been recorded for the past three seasons.

4.6 The reasons for continued low recruitment are unclear, although variations in the extent of winter sea-ice are a possible cause. However, there was also a recognition that the spatial separation of age classes could lead to an impression of low recruitment at the Antarctic Peninsula. Smaller size classes of krill were present to the east of the Antarctic Peninsula (Subarea 48.2) (WG-EMM-00/6) and it is possible that there may be a relationship between these small krill and the large krill at the Antarctic Peninsula (Subarea 48.1).

4.7 Further information was available about the current status of the krill-centred ecosystem at South Georgia based on krill length-frequency information. Data from the CCAMLR-2000 Survey (WG-EMM-00/6) and also from the diets of fur seals (WG-EMM-00/19) showed that small krill were present in the region of South Georgia during summer. There was uncertainty about the origins of these small size classes, which were absent from the Antarctic Peninsula (Subarea 48.1) region. While it is possible that these krill may have originated from the Weddell Sea, the Working Group considered that further analysis of both the associated oceanography and the length-frequency distributions would be required before any conclusion could be reached.

4.8 WG-EMM-00/51 also noted that during January 2000, krill to the east of South Georgia were smaller than those to the west. This difference appears to be related to differences in origin in that smaller krill were associated with Weddell-influenced waters to the east, whilst larger krill were associated with ACC waters to the west.

4.9 The information from the diets and performance of fur seals at South Georgia suggested that there had been a transition from a domination by large krill during the early summer (October–December) to small krill during the middle to late summer (January–March), linked to changes in availability of krill over that period (WG-EMM-00/19). It was unlikely that this change had been caused by the fur seals shifting to new foraging locations so it was likely that it represented a progressive shift in the composition of the krill populations in the region through the summer. Further work is required to assess how the availability and size structure of krill in the predator foraging areas may be influenced by small-scale changes in oceanography of the region. This may affect the degree to which the predators have access to the earlier portion of the krill population which appears to have different properties than the west (WG-EMM-00/56).

Predator Responses to Changes in Krill Abundance

4.10 The Working Group addressed the question 'What are the implications of apparent lack of recruitment at the Antarctic Peninsula for predators and the fishery?'.

4.11 Although there was no evidence from the CEMP indices (WG-EMM-00/26), and from other papers placed before the Working Group (WG-EMM-00/41, 00/47 and 00/62), that the breeding performance of those populations were reduced in the current year, it was still possible that predators were exploiting a declining stock of krill at the Antarctic Peninsula. If this continued, it was likely that responses from the predator populations would be observed.

4.12 Since the response of krill predators to changes in krill populations was likely to be non-linear, there was a possibility that continuing lack of recruitment to the krill population will lead to declines in predator reproductive rates. However, the Working Group also recognised that occasional declines in reproductive rate were unlikely, of themselves, to lead to declines in the predator populations. Only if food continues to decline over a protracted period and there is a succession of years in which there is a low predator reproductive rate will there be a need to examine possible remedial measures.

4.13 There was a recognition that predator reproductive rates were most likely to respond to reductions in food before some other demographic variables, such as adult survival rate or recruitment. At present the Working Group has insufficient information to be able to distinguish between the effects of food shortages on reproduction as opposed to recruitment or adult survival.

Diet of Krill Predators

4.14 The Working Group considered the question 'Is there evidence of long- or short-term changes in the diets of krill predators that might suggest changes in the ecosystem or in krill availability?'.

4.15 WG-EMM-00/13 showed that, at Bouvetøya, Antarctic fur seals and chinstrap penguins fed predominantly on krill. Macaroni penguin diets also included krill as a major component. The Working Group welcomed these additional data from this site which is recognised as a krill-centred ecosystem that currently has no fishery. As such, the site provides an important comparison with other regions in which a krill fishery exists. These data provided further evidence of the importance of krill in the diets of predators at Bouvetøya.

4.16 WG-EMM-00/47 and 00/62 examined the diets of Antarctic fur seals and gentoo and chinstrap penguins at Cape Shirreff (Subarea 48.1). Krill was the dominant component of the diet although, amongst fur seals, there was more fish and squid in the diet than had been observed in the previous year.

4.17 With reference to WG-EMM-00/19 which showed a change in the diet of Antarctic fur seals at South Georgia from large to small krill through the breeding season, the Working Group considered that this was most likely to have been caused by changes in the availability of different size classes of krill through the summer. However, it is possible that these changes in the diet of fur seals could be due to changes in the selection of prey by the predator.

4.18 Predators have the potential to actively select prey of differing quality. At South Georgia, Antarctic fur seals often feed on myctophids later in the breeding season which could be explained by myctophids moving into the region. Consistency of foraging locations among individuals within a breeding season suggests that this may indeed be the case because there is no evidence that fur seals are travelling elsewhere to access myctophids. At Cape Shirreff, fur seals are observed to forage closer to shore when myctophids begin to appear in the diet.

4.19 Alternative components in the diet have important implications for understanding both how krill predators are likely to respond to reductions in prey and to our understanding of alternative energy pathways. These alternative pathways may have unforseen implications for the dynamics of the ecosystem.

4.20 It is, therefore, important to understand how predators select prey. Two alternatives were discussed. One involved predators switching foraging strategies to hunt for particular types of prey under each strategy. The alternative is that predators maintain a consistent foraging strategy involving hunting for specific size classes or patches of prey which are economical for the predator to exploit. This latter strategy does not imply that predators will forage for a particular species or type of prey. The importance of this distinction is that, in the former case, predator diet may not reflect the availability of prey because predators may switch foraging strategies for reasons other than to hunt the most abundant prey. In the latter case predator diets are more likely to reflect the natural density of prey in the foraging area. It was recognised that the balance between these alternatives may differ among predator species but there is currently too little data available to decide which of these possibilities was the most likely in each case. Several ongoing initiatives are likely to help to narrow down the answer to this problem.

4.21 The Working Group concluded that there was still insufficient knowledge of predator feeding tactics to be able to conclude that there was evidence of short-term changes in krill density from predator diets, although the evidence to date suggests that it may be possible to make progress in this field. There was more evidence that predator diet reflected changes in the gross structure of the available krill populations. In the long-term, the case of the declines of macaroni penguins at the west end of South Georgia in conjunction with a shift in diet away from krill may indicate a change in the feeding conditions for macaroni penguins that is detrimental to population growth.

4.22 In the past, most of the attention of the Working Group has been focused on the diets of land-based predators. There is a recognition that, whenever practical, the diets of pelagic predators of krill should also be included within ecosystem assessments. In particular, there may be opportunities in future to sample the diet of fish, such as the mackerel icefish, within the context of observer programs associated with fisheries or in association with scientific surveys. From the beginning, CCAMLR had sought to include the widest possible range of species within CEMP but there had been a need to narrow down to tractable species and circumstances. There was a recognition of the opportunities offered by monitoring fish and the Working Group encouraged the collection of data about fish diets when opportunities arise, although it also considered that the development of a regular monitoring procedure for this was not feasible at this stage.

Status and Trends of Krill Predator Populations

4.23 The Working Group addressed the question 'Is there evidence of long- or short-term changes in the populations of krill predators that suggest changes in the ecosystem?'.

4.24 In this regard, the Working Group noted information contained in the reports from SCAR-BBS and SCAR-GSS (WG-EMM-00/16 and 00/63).

4.25 Although, overall, the data about bird populations show that there are no consistent Antarctic-wide trends in the abundance of seabirds that are predators of krill, two features were noted. These were: (i) the general decline in the abundance of Adélie and chinstrap penguins at sites on the northern end of the Antarctic Peninsula, and (ii) that the main indicators for macaroni penguins show that this species may be in a long-term decline, especially at South Georgia. The Working Group recognised that these apparent changes in populations could be caused by the results of regional redistributions of animals or to local effects rather than region-wide effects. However, it is important to continue tracking these changes and to understand their implications in the context of the whole region.

4.26 Detecting changes in the abundance of predators is a high priority for the Working Group but there was a particular need to detect significant declines in abundance and to identify the probable causes of these declines. At its previous meeting the Working Group had expressed its interest in developing a system for assessing predator populations according to the IUCN criteria for threatened species (SC-CAMLR-XVIII, Annex 4, paragraphs 7.74 to 7.77). However, experience of the lack of recovery of long-lived fish populations that were heavily exploited in Area 48 during the 1970s has provided an example of population depletion that should be avoided in future (SC-CAMLR-XVIII, Annex 5, paragraph 3.137). This has shown that when long-lived predators, which also tend to have low rates of recruitment, are driven to very low levels, it is unlikely that recovery can be achieved within the 20–30-year time period specified in Article II of the Convention. Therefore, if krill predators are driven down to the levels at which the IUCN criteria for threatened species become relevant, then the management measures put in place to prevent such a process could be deemed to have failed.

4.27 Fur seal populations continue to increase at a very high rate within Area 48. The Working Group considered that it was inevitable that fur seals were having an effect on the krill-centred ecosystem and there was evidence from South Georgia that they were also affecting icefish (WG-EMM-00/22). The Working Group noted that past notions of there being a krill surplus following the reduction of whale populations in the region probably no longer apply and that we may expect to see evidence of competition amongst predators and between predators and the fishery for a limited supply of krill. An example of such a competitive interaction may be present at the west end of South Georgia (Subarea 48.3) which is at the centre of the fur seal expansion. Macaroni penguin populations in this area have been in long-term decline (WG-EMM-00/16) and there has been a shift in diet away from krill (WG-EMM-00/26). This may be evidence of a competitive interaction with fur seals.

4.28 The increasing number of Antarctic fur seals illustrates that populations of predators may not be in a stable state. Consequently, management objectives will need to take this into account.

Assessment of the Impacts of Predators on Krill

4.29 The Working Group addressed the question 'What are the impacts of predators on krill populations?'.

4.30 The assessment of the krill consumption by predators has been highlighted as an important area of research for this Working Group at most of its past meetings. WG-EMM-00/46 provided a potential way forward in this respect. The paper presented an algorithm for calculating the impacts of predators on their prey populations. The intention was to begin to apply this algorithm spatially and temporally to predators in order to build up a view of the spatial and temporal impacts of predators on krill, including impacts on krill population structure through the selection of specific size classes of krill by predators.

4.31 The algorithm emphasised the importance of gaining good data about predator population sizes and demography because the CV around the estimated prey consumption rate was most sensitive to uncertainties in these parameters. It also showed that uncertainty around the metabolic rate could lead to an upward bias in the estimated food consumption.

4.32 The Working Group reiterated its view that this was an important area of work and encouraged further development of this approach.

Distribution of Predators relative to Krill

4.33 Although the analysis in WG-EMM-00/46 concentrated on fur seals and macaroni penguins at South Georgia and was based on data for these species during 1991, the Working Group noted that potential krill predation at South Georgia was substantially greater than at the South Shetland Islands. Therefore, the impacts of predators are likely to be greater at South Georgia. There was also recognition of the relatively high level of predation pressure that probably exists at the western end of South Georgia (Subarea 48.3).

4.34 Dr Everson pointed out that, compared with the Bering Sea, the frequency of observations of predators at sea to the west of South Georgia did not suggest there were unusually high densities of avian predators in the region. However, both Prof. Boyd and Dr Trivelpiece considered that this observation did not take into consideration the substantial differences between the avifaunas of the Bering Sea and the Southern Ocean. Much of the food consumed by predators to the west of South Georgia was due to penguins which, due to diving, have a much lower visibility at sea than the auks found in the Bering Sea. This raised the issue of how best to use data from ship observations of predators. It was agreed that this was an important topic and the Working Group encouraged comparative analysis of ship- and satellite-based observations of predators at sea.

4.35 New data are becoming available from the satellite tracking of predators throughout their annual cycle. Dr Trivelpiece informed the Working Group about data showing chinstrap penguins that breed at the South Shetland Islands (Subarea 48.1) moving as far afield as the South Sandwich Islands (Subarea 48.3) during winter. Prof. Boyd also informed the Working Group of the results of tracking female fur seals in the winter which showed about half the animals tracked left the Southern Ocean and were observed over the Patagonian shelf in winter. Although these are only preliminary reports of ongoing studies, these data suggest that there is a substantial redistribution of foraging effort by krill predators in winter and that some krill predators are moving out of the Southern Ocean in winter.

4.36 The Working Group agreed that this information about the redistribution of krill predators in winter compared with the breeding season was important because it will improve information about the possibility of overlap between krill predators and the fishery.

4.37 The Working Group considered the question 'Can data from mackerel icefish be incorporated into the CEMP time series to be use in ecosystem assessments?'.

4.38 Discussion of ways in which it may be possible for ecosystem assessments of interactions between predators and krill to include spatial scales associated with pelagic predators, as well as those from land-based predators, was centred on information about variability in condition indices of icefish (WG-EMM-00/44 and 00/45). Even though it is recognised that the suite of land-based predators that is available can cover many different spatial and temporal scales, a pelagic predator like the icefish has the potential to integrate conditions across a region. The icefish, which moves up from the bottom to feed on krill rather than down from the surface as in the case of land-based predators, may also be exploiting a different part of the krill population from land-based predators. Although the movement patterns of icefish are imprecisely known, it is thought that there are different icefish populations associated with each region of continental shelf, such as at South Georgia, and they could be used to assess the krill-centred ecosystem at that spatial scale and across the whole of the year.

4.39 The icefish condition index appears to respond rapidly to changes in krill availability, which makes it a useful index to measure fluctuations in krill. The gonadal development is subject to considerable interannual variation. It is suggested that this may be because of the greater uncertainty surrounding the prey availability for this bentho-pelagic predator (WG-EMM-00/45). While the statistical properties of the condition index, like those of some other CEMP indices, remain to be fully investigated, a series of data from 1973 to the present showed that many of the fluctuations in the condition index were associated with similar changes in indices of performance from the land-based predators.

4.40 Therefore, the icefish condition index has potential to provide important information about the fluctuations in the krill available to icefish. However, it was noted by the Working Group that there were a number of questions remaining to be addressed. These were:

(i) What is the linkage between icefish and krill?
(ii) What density of krill is optimal for feeding icefish?
(iii) How can data be collected regularly from both icefish and krill to address the above questions using fish surveys and the fishery?

Functional Relationships between Predators and Krill

4.41 The Working Group considered the question 'How can empirical functional relationships between krill and predators be used to provide advice and what actions need to be taken with respect to the fishery?'.

4.42 WG-EMM-00/44 had shown a non-linear relationship between krill density and the mackerel icefish condition index. Since its initial meeting in Siena, Italy, in 1995, the Working Group has highlighted the need to understand the functional relationships between predators and krill and the relationship from the icefish adds to several that have been developed for CEMP parameters. These relationships can only be developed from continuous effort over many years, as in the case of CEMP, but also including independently derived estimates of krill density in the region of interest. Therefore, they are a highly valued product of the research effort being directed at understanding krill–fisheries–predator interactions.

4.43 The report of the Siena meeting (SC-CAMLR-XIV, Annex 4) laid out a mechanism for incorporating functional relationships into a strategic model of the ecosystem. Subsequent work by Prof. D. Butterworth (South Africa) had examined the relationships between krill density and predator populations and made assumptions about the form of these functional relationships. This concept has been extended at the present meeting by Dr Constable (WG-EMM-00/60). The Working Group welcomed the data about functional relationships. At present, they may be best applied in a qualitative sense in that the current data confirm the non-linearities of these relationships and they probably indicate the type of non-linearity. Of particular interest is that krill density needs to decline to relatively low levels before a predator response is detected. However, the Working Group also recognised the need to link the indices of predator performance used in these functional relationships to the demography of the predator populations.

4.44 The Working Group recognised that it eventually needs to move towards a predictive framework for its advice and that quantitative functional relationships between predators and krill are essential to make this possible. These functional relationships could have a certain amount of generality in that they may be phenotypically determined at the level of individuals although further work would be required in order to examine what effects population density might have on the functional relationship at a population level. Therefore, there is a need to understand the factors which determine the form of functional relationships.

Fish and Squid-centred Interactions

The Importance of Fish and Squid

4.45 During its discussions of krill-centred interactions, the Working Group returned to the issue that krill-centred interactions cannot be viewed in isolation from interactions with other components of the ecosystem. The issues raised about mackerel icefish as a predator of krill also raised the issue that icefish are themselves prey for land-based predators. This complexity needs to be reflected in the deliberations of the Working Group and it is important to develop a robust management structure for fisheries within the ecosystem that considers this complexity.

4.46 The role of myctophids as alternative prey to krill for some predators was a recurring issue and it was also recognised that myctophids may be predators of krill in some circumstances. The Working Group agreed that, with the recent completion of the CCAMLR-2000 Survey, there is an opportunity to analyse the acoustic data from the survey to examine the density of other targets, including myctophids. Although there are difficulties with net sampling myctophids because the nets used to sample krill are not effective for sampling myctophids, these samples are likely to be sufficient to examine species composition. The Working Group strongly encouraged the analysis of the CCAMLR-2000 Survey data to obtain additional information about myctophid biomass and distribution.

Diet of Fish and Squid Predators

4.47 The Working Group considered the question 'What are the implications of studies of the diet of squid and fish predators for ecosystem assessment?'.

4.48 WG-EMM-00/8 and 00/9 examined the fish prey of South Georgia and Antarctic shags from the South Orkney Islands for 1995–1998 and for the Antarctic Peninsula during 1998 respectively. The papers showed that this coastal species of predator had a wide range of fish prey in its diet. The prey species were those expected to be associated with a near-shore benthic forager. However, with the presence of *Gobionotothen gibberifrons* in diets at both sites, but particularly at the South Orkney Islands, where this species had been exploited heavily in the past, it was suggested that the shag could be used as a convenient coastal monitoring species for fish populations.

4.49 Dr Everson commented that *Notothenia rossii* occurred only sporadically in the diet which was not surprising since this was a more offshore species. In contrast, *G. gibberifrons* is known to be a coastal species so it was not surprising that it occurred in the diet. It was surprising, however, that at the South Orkney Islands, shags did not have mackerel icefish in their diets and, since icefish occurred in the regions concerned, Dr Everson considered that this was evidence that shags must have been ignoring icefish as a prey item. Mr Reid pointed out that shags at South Georgia have icefish in their diets.

4.50 These data from shags may be of importance to CCAMLR in that Article II of the Convention states that depleted populations should be rebuilt and there may be information from the diets of shags to assess the progress that is being made towards this objective. However, in the absence of a direct assessment of the resource concerned, it is difficult to determine the utility of this index. Nevertheless, the Working Group recommended continued submission of information about the diets of shags.

4.51 Dr E. Fanta (Brazil) suggested that it may be possible to use a region as a case study to examine the food-web interactions of all predators, including the land-based and fish predators. This would provide information to help interpret the relative importance of finding specific prey in the diet of some predators. It was recognised that this would require quite specific circumstances in which there were relatively few predators and a fish fauna that was comparatively well known and easy to study, but the Working Group recognised the need for such studies. In this case, there was perhaps a need to develop linkages with other programs operating in the region, such as the Palmer LTER and SCAR.

Status and Trends of Squid and Fish Predators

4.52 The report from SCAR-GSS (WG-EMM-00/63) showed continued declines in elephant seal populations in the Indian Ocean. This population is thought to be distinct from the population in the Atlantic which appears to be stable or increasing very slowly. The Working Group considered the question 'Are the declines in the elephant seal populations an issue that is of interest to CCAMLR?'.

4.53 Dr Constable amplified some of the points raised in WG-EMM-00/63 by pointing out that there was evidence that the elephant seal populations at Macquarie Island appeared to be stabilising after a long period of decline.

4.54 The Working Group recognised that elephant seal diets were not well documented but that the information available suggested they fed on fish and squid. In the case of elephant seals in the Indian Ocean, tracking studies indicate that they rely heavily on foraging south of the Antarctic Polar Front and that foraging extends further afield from the breeding colonies in older age classes.

4.55 The toothfish fishery in the Southern Ocean is the most likely fishery that would influence elephant seals at this stage. Current data indicate that toothfish are a relatively minor component of the diet of elephant seals and that toothfish in the diet are likely to be juveniles. At Heard Island, the current escapement of 80% for juvenile toothfish should be sufficient to maintain this item in the diet of elephant seals (SC-CAMLR-XVI, Annex 4, paragraph 6.89). However, the high level of illegal fishing for toothfish may mean that recruitment of juvenile toothfish may become impaired in the long term. If this occurs, then toothfish may become less important in the diet of elephant seals.

4.56 The decline in elephant seal numbers began before the toothfish fishery so this fishery is not the cause of the decline in elephant seals. The central question is whether the toothfish fishery may impede recovery of these seals. The Working Group agreed that consideration of the consequences of illegal fishing on the recruitment of toothfish would be worthwhile to help answer this question. Also, there are few quantitative data on the diet of elephant seals. More information on the relative importance of toothfish in the diet of elephant seals from different regions will help determine the potential effects of the toothfish fishery on this species.

4.57 The Working Group noted from the report of SCAR-BBS (WG-EMM-00/16) that king penguin populations have been showing a consistent increase in abundance among sites. Since king penguins mainly feed on myctophids, the Working Group addressed the question 'Does this change in abundance suggest the presence of a long-term change in the ecosystem?'.

4.58 Dr Trivelpiece informed the Working Group that recent increases in the numbers of South Polar skuas at the Antarctic Peninsula reported in WG-EMM-00/16 may be linked to an increasing occurrence of myctophids in their diet. In the 1970s and 1980s there were no myctophids in the diet when *Pleuragramma* was the dominant prey species. During this period there were several years when South Polar skuas failed to produce any chicks when *Pleuragramma* was absent from the diet. During the 1990s myctophids increased in the diet and this has been associated with increased reproductive success and a lack of any years of complete productive failure. It appears probable that this has occurred because of a greater availability of myctophids in recent years.

4.59 Dr V. Siegel (Germany) also informed the Working Group that net sample data from the Antarctic Peninsula and Elephant Island regions (Subarea 48.1) suggest that there was a change in the species composition of fish in the region during the late 1980s because, until then, *Pleuragramma* larvae were caught but none have been caught in surveys during the 1990s. Dr Hewitt also considered that, based on the US AMLR Program time series of hydroacoustic surveys of the region over the past 10 years, myctophids may have increased at the South Shetland Islands.

4.60 Although several indicators suggested that myctophids increased in abundance over the past 10 years, the Working Group agreed that there was too little information available to conclude that the abundance of myctophids had increased. Information from the CCAMLR-2000 Survey could make a very useful contribution to knowledge of myctophids as a resource in Area 48.

4.61 Dr Everson pointed out that WG-FSA provides annual summaries of the standing stock (with CV), mortality rate and growth coefficients of key species and that it may be useful if these were made available to WG-EMM because they would provide additional information about the status and trends of fish which could be related to information about dependent species.

Effects of Environment on Predator Distributions

4.62 Stimulated by WG-EMM-00/36, the Working Group addressed the question 'What is the interaction between physical oceanography and predator distributions and its relevance to possible changes in the distribution of predators in the future?'.

4.63 A meeting 'Interannual Variability in the Southern Ocean' was held in Cambridge, UK, during August 1999 and the proceedings will be published in the *Journal of Geophysical Research* which will develop the theme of linkages between the biotic and physical components of the Southern Ocean ecosystem.

4.64 WG-EMM-00/36 suggested that there had been a southerly shift in the Polar Front based on changes in the distribution of seabirds. Dr M. Naganobu (Japan) confirmed this and described changes in the position of the Polar Front from a data time series based on the WOCE transect across the Drake Passage. He hypothesised linkages between this variability and the El Niño / La Niña process in the Pacific Ocean.

4.65 Although, in some regions, the position of the Polar Front can be remarkably static between years, there is quite probably a linkage between ENSO and the Southern Ocean anomaly precession that has been recognised to exist in historical datasets. Since the early days of krill research it has been recognised that frontal variability could influence krill populations and, by implication, the foraging locations of krill predators.

4.66 The Working Group recognised the importance of these studies of the physical system and its interaction with the biology of the ocean and it encouraged further work. There are important opportunities to relate oceanography with biology, including the distribution of predators, through the analysis of recently collected datasets from research cruises that included observations of predators as well as the physical and biological oceanography.

Status of the Krill-centred Ecosystem

Development of Assessment Methods

4.67 The Working Group was reminded of paragraphs 8.5, 8.17 and 8.18 of the 1998 report of WG-EMM (SC-CAMLR-XVII, Annex 4). These outlined a process to develop a robust way of using CEMP parameters for carrying out an ecosystem assessment. Substantial progress has been made in some areas. As discussed under paragraphs 4.41 to 4.44 there has been progress in demonstrating the relationship between CSIs and prey (SC-CAMLR-XVII, paragraph 8.17(b)), although there is a continuing need to bring forward these data to WG-EMM for explicit consideration.

4.68 In addition, information from the tracking of predators at sea provides the spatial and temporal scale of relevance for each predator species. Data on this subject have been submitted to WG-EMM in past years and the Working Group encouraged continuation of this process.

4.69 Particular consideration needs to be given to the requirement to demonstrate how CSIs can be interpreted in relation to the demography and abundance of the indexed species. The Working Group recognised that this was a substantial task. Demographic information about long-lived predators is not easily obtained and is mainly rooted in long-term mark–recapture studies. These can take decades to produce useful results and only in the past few years have the datasets begun to yield the type of information that would be required in order to examine the relationships with CSIs.

4.70 There is a general recognition that the assessment of breeding population size in CEMP species needs to be set within the context of changes in the total population within a region of interest. This arises because it is not normally possible to measure total population size on a regular basis and, therefore, sub-sections of the whole population are monitored. Periodic regional surveys need to be carried out in order to validate the local population assessments. The Working Group recognised that several national programs now have plans in place to undertake the necessary work to undertake regional surveys of predator populations and the Working Group welcomed these initiatives.

Current Status

4.71 Further to its assessment of the current status of the krill-centred ecosystem, the Working Group examined the CEMP indices for evidence of changes in predator behaviour and reproductive success. Based on plots of anomalies in WG-EMM-00/26, it noted that:

(i) the number of Adélie penguins breeding at Signy and Laurie Islands (Subarea 48.2) was unusually low;

(ii) the number of breeding pairs of Adélie penguins declined significantly and is the second lowest count in the 21-year time series from Admiralty Bay (Subarea 48.1);

(iii) the highest fledging success of macaroni penguins occurred at Bird Island (Subarea 48.3) in a 24-year time series;

(iv) only four of 18 CEMP indices from Bird Island were negative;

(v) the largest occurrence of fish in the diet of macaroni penguins occurred at Bird Island in an 11-year time series;

(vi) the greatest fur seal pup growth rate occurred at Bird Island in an 11-year time series;

(vii) the September sea-ice index was generally lower than normal at most sites in a 21-year time series; and

(viii) recent data about overlap between the fishery and predators does not suggest that the overlap has increased.

4.72 This information, in addition to other information brought to the Working Group under this agenda item, suggests that the current year was not anomalous. On balance, the indicators from CEMP show that there was above-average conditions for reproduction during the summer. However, it is difficult to know what density-dependent processes may be operating. For example, if breeding population size declined, as appeared to be the case for penguins at the South Orkney Islands, then reduced competition for food in the local area might lead to relatively small changes in breeding success even though there could have been low krill density.

4.73 Nevertheless, based on comparisons between the results of the CCAMLR-2000 Survey and recent smaller-scale surveys, the krill densities during 1999/2000 were at the lower end of the normal range of variability.

4.74 The Working Group considered the continued lack of recruitment of krill in Subarea 48.1 and the potential responses of predators in the future. Declines in krill density in the region based on hydroacoustic surveys appear to be related to this apparent lack of recruitment. At present, there are no indicators that suggest any adverse effects of low krill density on predators.

4.75 WG-EMM-00/40 showed that penguins may be most sensitive to krill shortages during the early phases of chick rearing. While different species are likely to respond in different ways, this suggests that, in general, the CEMP monitoring would have detected reduced prey availability during the critical breeding phase of the annual cycle.

Historical Status of the Ecosystem

4.76 WG-EMM-00/18 presented an analysis of 14 CEMP parameters from Bird Island across a time period from 1977 to the present using Antarctic fur seals and macaroni and gentoo penguins. The analysis was based on the CSI approach outlined in WG-EMM-00/14. The analysis also suggested that the breeding performance of predators was not significantly different from normal in 1999/2000. However, it also showed that significant reductions in predator breeding performance had occurred during 1978, 1984, 1991 and 1994, but there was no indication of a trend in breeding performance or that the frequency of years of significantly reduced reproductive performance had changed through time.

4.77 Attention is drawn to paragraphs 4.56 to 4.59 for discussion of further indications of the historical status of the ecosystem.

4.78 The Working Group considered the results of the current estimate of B_0 in light of the past estimate based on the FIBEX survey carried out in 1980. In this connection, the Working Group drew attention to the reasons for wishing to replace the FIBEX estimate with a more reliable one (SC-CAMLR-XV, Annex 4, paragraph 4.61).

4.79 There were important differences between the current CCAMLR-2000 Survey and the FIBEX survey in the way in which they were carried out. These were:

(i) CCAMLR-2000 and FIBEX surveys covered substantially different areas. The coverage of the CCAMLR-2000 Survey (2 065 000 km^2) was aimed at encompassing both the regions where krill fisheries occur and regions of open ocean, thus covering five times more area than FIBEX (396 000 km^2) which coincided with the locations of the krill fishery.

(ii) Unlike the CCAMLR-2000 Survey, the different ships involved in FIBEX did not use identical hydroacoustics and sampling methods.

(iii) Since the time of FIBEX there have been many improvements in technology, statistical sampling methods and in our understanding of the use of hydroacoustics to carry out biological surveys. These were applied to the recent CCAMLR-2000 Survey but not the FIBEX survey.

4.80 The direct comparison of the total biomass estimated from the two surveys (B_0 = 44.3 million tonnes; FIBEX = 32.7 million tonnes) is confounded by the different total areas covered by the two surveys. Similarly the direct comparison of the mean density of krill in the two surveys (B_0 = 21.4 g/m^2; FIBEX = 77.6 g/m^2) is confounded by the concentration of the FIBEX survey on regions of known high krill density.

4.81 Comparison between the two estimates may also not be valid when the results are placed within the context of the variability observed in mesoscale surveys conducted in the years between FIBEX and B_0. Although it may be possible to use these intervening surveys to attempt to assess the overall change in the krill populations between the two surveys, the

Working Group recognised that this would require considerable additional work without any guarantee that the work would provide an answer to the original question. However, the Working Group noted that, based on the changes in krill density observed in the mesoscale survey box off Elephant Island, the CCAMLR-2000 Survey may have taken place during a period of relatively low krill abundance in what may be a long-term cycle of krill abundance. In this circumstance, the estimate of B_0 from the recent survey will be precautionary.

4.82 Beyond this, the Working Group agreed that it was not possible to make a comparison between the results of the two surveys. It was also agreed that the result of the recent CCAMLR-2000 Survey was the best available estimate of B_0.

4.83 Dr Azzali informed the Working Group of historical changes in krill abundance with a 20 000 n mile^2 survey box in the Ross Sea. During 1994/95, the krill biomass was approximately 3 million tonnes but this had declined to approximately 2 million tonnes in 1997/98. Data from more recent estimates remain to be analysed. In 1994/95 the krill biomass was centred on 75°S and 175°E; in 1997/98 it was centred on 72–73°S and 175°E and in 1999/2000 the centre of biomass was at 71°S. Dr Azzali considered that this change in distribution was caused by the change in the timing of the three surveys since the 1994/95 survey took place in November whereas the surveys in 1997/98 and 1999/2000 took place in December and January respectively.

4.84 It was suggested that the movement of krill spatial pattern from south to north could be in relation to front-ice that moves in the same direction from November to January. The decrease of krill biomass can be due to dispersion of the population into Pacific waters.

4.85 It was observed that it is necessary to acquire more information in this field, including environmental parameters.

Further Approaches to Ecosystem Assessment

4.86 At the WG-EMM 1999 meeting there was a debate about how to carry out ecosystem assessments. During the debate there was a discussion about the relative merits of the different types of data being collected and a broad discussion about the best ways to develop the ecosystem approach. The development of the ecosystem approach within CCAMLR was documented in the WG-EMM 1995 report, and during the 1999 meeting, the Working Group was reminded of the original objectives and the history of the development of the ecosystem approach.

4.87 At the 1999 meeting the Working Group participants were encouraged to undertake intersessional work to produce new frameworks for the development of the ecosystem approach. Participants were also encouraged to take account of approaches adopted elsewhere in the world (SC-CAMLR-XVIII, Annex 4, paragraphs 9.1 to 9.9).

4.88 Three papers were submitted to the WG-EMM 2000 meeting that addressed the general issues involved developing ecosystem assessments. These papers presented a range of discussions about the history of the ecosystem approach in CCAMLR. They also proposed a number of initiatives to develop the approach.

4.89 WG-EMM-00/43 presented a discussion of the way forward for ecosystem assessments and suggested a three-pronged approach to conservation questions associated with the Antarctic krill fishery. The three elements were:

(i) identification and monitoring of key processes governing krill recruitment and transport, and those controlling the viability of krill predator populations;

(ii) elaboration of resource management rules based on monitoring results; and

(iii) research activities designed to reduce uncertainty, monitor performance and improve the management scheme.

4.90 A number of questions were posed about the operation of the key elements of the system with the focus on identifying key processes. The paper emphasised the key objectives of maintaining the viability of the krill population and the viability of the predator populations. These objectives should be the basis for the system management with monitoring of the critical processes assessed through decision rules that dictate the management response.

4.91 On process monitoring, the paper discussed a range of aspects. The paper highlighted the need to review the CEMP monitoring program with a view to understanding the extent and adequacy of the existing program. This would also help to understand how to develop the program. The program development may require an increase in the spatial scale of monitoring, additional monitoring sites may need to be set up, pelagic predators may need to be included and the spatial extent and frequency of krill surveys may need to be extended. Consideration may also need to be given to further large-scale surveys of the form of the CCAMLR-2000 Survey.

4.92 A key issue that the paper highlighted was the potential value of an experimental approach, such as undertaking experimental fishing, to examine directly the effects of fishing on local prey and predator populations.

4.93 WG-EMM-00/60 developed the theme of achieving conservation objectives for predators of fished species (paragraphs 3.53 and 3.54). Consideration of the conservation literature indicated that such objectives had not yet been developed in relation to the predators. The objectives need to include a consideration of how the system is changing and how to maintain a system exposed to exploitation. In developing these objectives, it will be particularly important to consider non-linearities to take account of potential phase shifts in the system.

4.94 The paper highlighted that the fishery removed production in the form of the fished species that is then not available to the predators. This could be the focus of objectives centered on the question 'What is the target level for the production of predators?'. Once objectives are in place, decision rules can be specified, such as closing the fishery when krill abundance is below a critical level or altering fishing if an anomalous year in predator production is reported to avoid adverse effects of successive anomalies.

4.95 The decision rules could be set to develop along with the fishery. Hence, an expansion of the fishery could trigger the development of further monitoring and may require a modified management regime.

4.96 In WG-EMM-00/22 the historical basis for the development of the CCAMLR approach was described. The paper highlighted the original Article II principles of conservation and emphasised how these had been developed within CCAMLR leading to the development of the ecosystem approach described by WG-EMM in 1995 that has guided much of the work over the last five years.

4.97 The paper noted the problems of analysing local-scale system dynamics by highlighting the temporal and spatial changes in prey availability. The paper also discussed the merits of the CEMP program highlighting its strengths, but also noting issues that the program cannot address. The paper highlighted, through the use of the mackerel icefish example, how different scales of variation can be monitored using predator indices to examine the changing availability of krill.

4.98 To develop the ecosystem approach the paper suggested four simple questions that capture the essence of the problem:

(i) Is the availability of krill changing?
(ii) Are populations of dependent species in decline?
(iii) How much krill is required by the dependent species?
(iv) What is the extent of overlap between krill fishing and the foraging by dependent species?

4.99 The paper made the suggestion that adopting the icefish example (paragraph 4.97) more generally may allow the development of the use of predator monitoring of prey availability to match the scale of the variation. The paper also highlighted that the ratio of the predator demand to fishery demand would be an appropriate way to monitor fishing impact.

4.100 The paper presented a decision process as a conceptual figure that describes how local decisions could be included in the large-scale conservation framework. The figure highlighted that local-scale information needs to be integrated to address the large-scale krill fishery questions. The local-scale monitoring can then be used to trigger local management actions based on fishery and predator assessments.

4.101 The Working Group thanked the authors of the three papers for their efforts in developing the ecosystem approach. The Working Group noted that the papers were together an extremely useful contribution to the debate and that a number of similar points were emphasised. All three papers highlighted the need to consider what requires monitoring, how appropriate indices may be derived and how these should be used.

4.102 The Working Group favourably viewed the conceptual framework presented in Figure 8 of WG-EMM-00/22, included in this report as Figure 1. The figure highlighted some of the relationships that would need to be considered in any decision process and emphasised where our management intentions may break down. The Working Group noted that the scale on the right of the diagram could vary in relation to the scale of the predator issues being addressed, e.g. colony, island, regional and population.

4.103 Figure 1 also emphasises the need to develop knowledge of predator population dynamics. While a better understanding of the dynamics is being developed, the monitoring indices would need to be used to identify significant indications of a decline in predator performance. The key question here is ‘Are the current CEMP parameters good proxies that give an indication of any population changes?’.

4.104 The Working Group considered that in developing the ecosystem approach the emphasis should be on developing decision rules that are robust and maintain the objectives of conservation while allowing rational use. Development of Figure 1 would be a useful focus for this effort.

4.105 Developing such conservation objectives was addressed in WG-EMM-00/60 (paragraph 4.93) and the approach adopted in this paper of considering overall predator production was noted as being both novel and useful. The Working Group noted that it could provide a potentially powerful and cost-effective framework for developing an ecosystem approach.

4.106 The predator production assessment could be applied at a number of levels. The current CCAMLR approach focuses on detailed analyses of particular species. Another approach would be to assess the overall level of production and set in place only broad decision rules for the various species. The latter approach has a lot of potential in a system like the Southern Ocean where the interaction dynamics are uncertain. The Working Group encouraged the further development of the approach alongside the more traditional species-based views.

4.107 There was a broad discussion in the Working Group about the development of the theoretical approaches to ecosystem analyses and assessments for conservation. A key question in this regard is ‘How to characterise an ecosystem?’. This needs to include consideration of the expected dynamics of different populations so that bounds could be determined for the expected behaviour of different system components. Such a theoretical consideration would need to include aspects of biodiversity that included a focus on species. The key element will be to link aspects of food-web dynamics that are the focus of CCAMLR efforts to broader species-based views. The two views are linked because the loss of a species would be regarded as a failure under Article II of the Convention.

4.108 The Working Group felt that it would be useful to develop models of the system that allow the examination of different plausible scenarios of system behaviour and management procedures. These simulation models should be robust and include the current level of knowledge and uncertainty in the system. The analyses would have to take account particularly of the uncertainty in predator population size and demographics. Different management rules could then be examined given different levels of system monitoring. This would allow the decision rules to be evaluated. The decision process adopted should include subsidiary rules that account for unforseen but extreme changes in the system outside the boundaries of expected behaviour. This could be expressed as an 'exceptional circumstance rule' in the management regime.

4.109 Management measures may not only involve placing controls on the fishing activities, but may also involve enhanced monitoring to provide feedbacks. Generally, more information should lead to better management.

4.110 Development of the ecosystem dynamics was encouraged and this should include the effects of change and variability and the importance of alternative pathways in food webs.

4.111 The Working Group noted that the concept of permitted biological removals (PBRs) used in some marine systems within the USA is an example of the type of approach that could be explored in the CCAMLR region. It was also suggested that the potential for biological effects, such as disease, that could rapidly change the viability of predator populations could also be considered.

4.112 The suggestion of including the economics of the fishery was made (paragraphs 2.6 and 2.7). It was noted that although many of the key aspects of the krill fishery may not be economically based, including operational effects in a multinational fishery would be valuable. The economics also include the cost of managing the fishery, including monitoring. A successful management procedure is one that achieves the objectives while ensuring the costs of managing the fishery are commensurate with the value of the fishery.

4.113 The Working Group noted that the Southern Ocean ecosystem is highly variable in space and time and that this should be an important focus in any review of the value of particular monitoring datasets and in the development of any management strategies.

4.114 In response to the debate at WG-EMM-99 about the development of the ecosystem approach within CCAMLR, the Secretariat was asked to undertake a review of the status of various tasks initiated at WG-EMM-95 and later meetings. This review was prepared by Dr E. Sabourenkov (Science Officer) in WG-EMM-00/29.

4.115 The Working Group thanked the Secretariat for undertaking this task which had produced an extremely useful review that would help to focus the efforts of the group in developing the ecosystem analysis approach. This was a broad and useful summary and the Working Group requested it should be updated annually.

4.116 The paper helps to clarify the Working Group's progress in developing an ecosystem approach to managing krill fisheries.

Such a management procedure can be summarised in two statements. It requires:

(i) a predictive assessment of yield; and
(ii) the appropriate monitoring and decision process to provide the feedback to manage the harvesting.

4.117 The Working Group considered that it was currently in a much better position to judge the development of such procedures as a result of the success of the CCAMLR-2000 Survey and the now extensive basis of the CEMP time series. The Working Group considered that a realistic time scale for having a solid basis in place for the process was five years, and 5–10 years for the development of a full management procedure.

Future Work

4.118 A number of papers described aspects of future data collection, synthesis and the development of national and international science programs relevant to the generation of the CCAMLR ecosystem approach.

4.119 WG-EMM-00/61 presented a plan for developing a broad view of the status of ecosystems covering physical, chemical and biological variables across a range of trophic levels. This paper considered how to characterise an ecosystem that the Working Group emphasised as a key issue for ecosystem assessment. The Working Group noted that the inclusion of physical and chemical data and other variables relating to the broader operation of the ecosystem, covering other zooplankton and pelagic predators, will be a valuable development. This will help to address the importance of food-web pathways other than krill to land-based predators in the operation of the ecosystem.

4.120 WG-EMM-00/42 compared target strength from net sample and predator diet data and provided a potential way of calibrating rapid acoustic surveys with a reduced requirement for net-based sampling. The Working Group considered that extending the temporal and spatial scale of ship-based sampling using predator diet data was extremely valuable. The Working Group encouraged the further development of such techniques and the application that could extend the spatial and temporal coverage of sampling of the krill populations.

4.121 WG-EMM-00/53 detailed the development of the Southern Ocean GLOBEC Program. The paper highlighted the current status of the program cruise plans. The paper also gave details of the US Southern Ocean GLOBEC cruise plans. The Working Group thanked the authors for providing details of the Southern Ocean GLOBEC program and considered that it was important that there was active interaction between CCAMLR scientists and Southern Ocean GLOBEC scientists.

4.122 It was pointed out that a number of CCAMLR scientists are also active participants of the Southern Ocean GLOBEC Program. The Working Group noted that the interaction with Southern Ocean GLOBEC is likely to be extremely important as a number of the key science issues of interest to CCAMLR overlap with the goals of Southern Ocean GLOBEC. Southern Ocean GLOBEC is emphasising krill and land-based predators within the field program.

4.123 Aspects of overwintering and spring survival of different stages of krill, interactions in the plankton and impacts of predators are all being addressed within Southern Ocean GLOBEC and this relates to key CCAMLR issues of krill recruitment variation, links to environmental variation and quantifying the mortality rates of krill. The Working Group considered that the active interaction with Southern Ocean GLOBEC was important and the two-way process of communication of CCAMLR and GLOBEC goals and plans should be actively encouraged.

4.124 The Working Group discussed future interactions with other groups whose work may be of relevance to the questions being addressed by CCAMLR. It is important for the Working

Group to have access to, and synthesise all, the relevant information for making ecosystem assessments and for developing sound management based on the most up-to-date knowledge.

4.125 Two types of interactions were possible. One was on the personal level where individual members of the Working Group could represent CCAMLR at meetings they may be attending. The other is to send a formal representative to the meetings of other groups and to invite participation in the activities of the Working Group.

4.126 To a very great degree the second of these types of approach was in hand. The useful reports from SCAR-GSS and SCAR-BBS that had been considered at the current meeting were cited as successful formal connections and Dr Fanta was thanked for representing CCAMLR very successfully at the SCAR WG-Biology. There are also useful connections in place with the IWC.

4.127 However, the Working Group saw a need to alter the structure of its meetings to make it easier for participants with external expertise in particular fields to be able to attend the meetings without the need to become involved in the detailed business. It is essential that this was a two-way process so that these participants can benefit from their contacts with the Working Group and vice versa. In the past, one of the benefits of holding the Working Group meetings in different locations has been that it has provided an opportunity for locally-based scientists to contribute to the meeting.

4.128 The Working Group suggested that its meeting could include one or two short, 2–3 day, science thematic sessions each year. The Working Group also suggested that for such sessions, it was important to identify the key issues for discussion with external experts, develop an agenda and invite external experts. The Working Group suggested this should start next year with a focus on the review of monitoring data, identification of new monitoring requirements and methods for analysing and integrating the information.

4.129 Some concern was expressed as to whether the science profile of CCAMLR was sufficiently high in the international science community. The Working Group considered that it was extremely important that the science of CCAMLR was exposed to the broadest possible audience. This would be beneficial in terms of ensuring the correct direction of CCAMLR-based research through international feedback, but would also help to clarify where interactions with other groups would be valuable. Working Group members were encouraged to communicate the objectives and research of WG-EMM and CCAMLR generally to the broadest possible audience.

4.130 WG-EMM-00/31 presented a proposal by scientists from the University of British Columbia (UBC) (Canada) to undertake the development of an ECOPATH-based model of the Southern Ocean ecosystem. The UBC science proposal will be funded by a variety of academic, government and industry sources, including Biozyme Systems Inc. of Vancouver, BC, Canada. The proposal relates to earlier discussions by the Working Group on the development and application of such a modelling approach.

4.131 The Working Group reiterated its earlier interest in seeing the execution of such a feasibility study for ECOPATH applied to the Southern Ocean ecosystem. The Working Group noted that this technique could be a useful exercise for reviewing the available information and for highlighting important gaps in the data. The Working Group noted again that the key questions related to the examination of the effects of uncertainty or indeed gaps in the available data. Central to this was how such uncertainty affected the outcomes from the model and how this can be used to feed back into the development of management procedures. The UBC group has a lot of experience in the application of ECOPATH in areas such as the Bering Sea and clarification of the process in such areas would be useful for the group.

4.132 The Working Group has in place programs for the compilation or collection of data that will be important in such an analysis. Other data may require input of expertise and data that is beyond the scope of the coverage of CCAMLR scientists. However, the Working Group noted that participation in such an exercise could help to clarify issues of priority of data collection.

4.133 The Working Group considered it important that clarification was obtained on the current status of the proposal and how the feasibility study would address the issues of data quality and uncertainty and the development of management procedures. This would help to clarify the level of input required by CCAMLR scientists. Dr Miller was asked to communicate with the UBC group to address these questions. The Working Group considered that the proposed international workshop would be most valuable if it could be associated with a WG-EMM meeting.

4.134 On the question of the CCAMLR Data Manager attending an ECOPATH training course at UBC and undertaking the initial phase of model development, the Working Group considered that this would be useful. It would give the Secretariat, and hence the Working Group, the initial skills in developing an ECOPATH model analysis. The Working Group considered that this would be most useful if the questions described in paragraphs 4.131 to 4.133 formed a key part of the interaction with UBC. The Scientific Committee is the forum where any decision would be made about the overall work priorities for the Data Manager. The priorities for the future work of the Working Group are given in Table 3.

4.135 It was also acknowledged that many of the key questions of identifying appropriate parameter values and taking a proactive science role in the project might be better done by one or more of the Working Group participants. It was suggested that concentrating on specific areas of the Southern Ocean where a full range of appropriate data are available could be useful. This may be better pursued by direct UBC links with a single national group. Such a group would have better access to the relevant scientific expertise and data required to properly parameterise an ECOPATH model. Some form of collaboration within the project, possibly by a visit by UBC to a single national group such as BAS could be another useful way to proceed. Such an interaction would help to clarify the data requirements for a broader application in the CCAMLR region.

4.136 Dr Azzali emphasised that it was important that the Working Group maintained a broad view of the operation of the whole Antarctic marine ecosystem including areas such as the Ross Sea. The Working Group agreed that it was important that knowledge of the operation of the Southern Ocean ecosystems outside the main areas of fishing would give important insights into the dynamics of the ecosystem and the potential effects of exploitation.

4.137 WG-EMM advocated additional studies providing comparisons of water masses to krill taxa and demographics (e.g. WG-EMM-00/52).

METHODS AND DESIGNATION OF CEMP SITES

Harvested Species Methods

5.1 Twenty-two papers included methods to describe the abundance, dispersion, population structure, recruitment, growth and production of krill. Of these papers, seven could be categorised as methods for integrated or ecosystem investigations, five included methods to glean scientific information from krill fishery data, five were directly associated with the CCAMLR-2000 Survey, three described methods to indirectly derive information about krill from their predators, and two dealt specifically with acoustical measurement methods. New and noteworthy methods were highlighted.

5.2 In 1998 acoustical surveys were conducted using an unusual transmission frequency of 80 kHz in the areas around Coronation, Elephant and King George Islands (WG-EMM-00/5). WG-EMM encouraged an investigation of the advantages and disadvantages of using this frequency (relative to 38, 120 and 200 kHz) for acoustical surveys of krill or other taxa.

5.3 WG-EMM-00/21 detailed the methods used in the CCAMLR-2000 Survey. Most notably: (i) krill were identified and delineated from other sound scatterers using a delta mean volume backscattering strength (ΔMVBS) criteria of 2–16 dB (Sv120-Sv38); and (ii) target strengths (TS) were calculated using the TS-length model, adopted by SC-CAMLR in 1991, and krill lengths measured from RMT8 samples during the survey.

5.4 WG-EMM recognised great value in the standardisation of acoustical survey protocols. However, so as not to stifle advancement in acoustical surveying techniques, it was suggested that protocols for data collection be defined separately from data processing methods (to the extent that such a separation is possible).

5.5 A three-frequency method for identifying, delineating and assessing *E. superba* and *E. crystallorophias* was presented in WG-EMM-00/37. Volume backscattering strengths (Sv) were averaged in 2 m depth by 1 n mile distance bins. Three permutations of the differences in Sv (ΔMVBS; 120-38 kHz, 200-120 kHz and 200-38 kHz) were used to discriminate the two species. It was noted that the three ΔMVBS coefficients depended significantly on the length of species:

- if euphausiids with lengths greater than 30 mm, ΔMVBS120-38 was between 5 and 15 dB; ΔMVBS200-120 was less than 5 dB; and ΔMVBS200-38 was less than 20 dB;

- if *E. crystallorophias* with lengths less than 30 mm, ΔMVBS120-38 was greater than 15 dB; ΔMVBS200-38 was greater than 20 dB; and ΔMVBS200-120 was greater than 5 dB;

- if *E. superba* with lengths less than 30 mm, ΔMVBS120-38 was between 5 and 15 dB; ΔMVBS200-38 was less than 20 dB; and ΔMVBS200-120 was greater than 5 dB; and

- if nekton, ΔMVBS120-38 was less than 5 dB.

The authors also noted that aggregation densities and thresholding may limit the detectability of scatterers at all three frequencies. If the aggregation is detectable only at 120 and 200 kHz, then ΔMVBS 200-120 greater than 5 dB indicates *E. crystallorophias* and ΔMVBS 200-120 less than or equal to 5 dB indicates *E. superba*.

5.6 Application of this multifrequency method for delineating taxa in a 1997/98 survey of krill in the Ross Sea yielded 8.87% less krill than one obtained using results of net samplings.

5.7 As the length classes of *E. superba* and *E. crystallorophias* were generally different in this study, there was a discussion about the effectiveness of the method for discriminating these two species when length-classes overlap. The authors noted that other factors (e.g. physiological condition, shape, or animal orientation) probably provide enough variation in the three-frequency descriptors to enable discrimination for these two species, even when they have similar length classes (less than 30 mm). WG-EMM agreed that this and other multifrequency methods for taxa delineation have great merit and encouraged their continued development and application.

5.8 In WG-EMM-00/39, the acoustical estimation of mean krill lengths, based on the fluid sphere scattering model (assuming length equals 12.07 times the equivalent spherical radius), were 9% less than the mean lengths determined from net catches. Three size classes were calculated using the three-frequency measurements within each layer. It was noted that the high accuracy of the acoustical length estimation suggests that nearly all of the variability in ΔMVBS coefficients is due to animal length. In that view, the effectiveness of the three-frequency method to discriminate two euphausiid species with overlapping length-frequency distributions was questioned. The numerical abundance of krill estimated using the fluid sphere model was 20 to 100 times greater than estimated from the catch. The Working Group noted that much more work is required before these biases can be understood.

5.9 In WG-EMM-00/49, a method was offered to estimate the total variance (measurement and sampling variance) for the CCAMLR-2000 estimate of B_0. Assuming each of the three frequencies (38, 120 and 200 kHz) provided independent estimates of B_0, average densities were randomly selected for each interval from one of the three frequencies and probability density functions of B_0 and CVs were simulated using the sampling methods of Jolly and Hampton, 1990.

5.10 The paper noted that the total CV does not account for possible biases. Multiple sources of potential bias were outlined for future investigations. WG-EMM encouraged such investigations and advocated quantification and reporting of bias and imprecision in all measurements relevant to WG-EMM's work.

5.11 WG-EMM-00/42 described a method to estimate TS using a TS versus krill length relationship and krill lengths sampled by Antarctic fur seals. These TS estimates can be used to accurately convert integrated volume backscattering areas, sampled with concurrent and proximate shipboard acoustical surveys, to krill biomass. A correction factor has been developed to compensate TS for the proportion of krill in the diet smaller than 40 mm. It was noted that this method does not replace the need for net sampling, rather it is a tool for sampling krill lengths when net sampling concomitant with acoustical surveys is not possible.

CEMP Methods

5.12 WG-EMM 00/27 described environmental data collected in accordance with draft CEMP Standard Methods F1, F3 and F4 at Edmonson Point and Béchervaise Island. The data indicated a relationship between the CEMP indices F1 (sea-ice extent viewed from the CEMP site) and A6 (breeding success) for Adélie penguin.

5.13 It was recognised that the report of WG-EMM from 1999 recommended that Standard Methods F1 and F4 be accepted at this meeting, after consideration by the Subgroup on Methods. Membership and the role of this subgroup was discussed. It was agreed that the membership and relevant expertise of the subgroup be as follows: Prof. Boyd (predator methods – seals), Dr Constable (statistics), Dr Murphy (environment), Mr Reid (Convener), Dr Siegel (prey), Dr Trivelpiece (predator methods – birds).

5.14 The subgroup recommended the acceptance of Standard Methods F1 and F4 as tabled in WG-EMM 99/12. By means of clarification, the subgroup recommended that where Members wish to collect data on sea-ice extent or snow cover at a CEMP site, they should follow Standard Methods F1 and F4 respectively. However, submission of these data were not obligatory and Members were encouraged to report any observations of unusual environmental conditions that may have undue influence on other CEMP indices.

5.15 WG-EMM-00/32 presented information on the size of individual colonies of Adélie penguins at Béchervaise Island. These data indicated that the overall breeding population had increased by 5% between 1991 and 1999. However, the subset of colonies used for the CEMP parameter A3 indicated a 24% increase over the same period. Dr Constable indicated that the construction of a database of the Béchervaise Island Adélie penguin study was nearing completion and that this would be used to address issues relating to inter-colony dynamics within the study area.

5.16 WG-EMM-00/35 reported the initial findings of a long-term study of atmospheric data from the South Georgia region which showed a number of fluctuations over a range of time scales. The subgroup recognised the potential importance of this approach and encouraged further work.

Designation and Protection of CEMP Sites

5.17 The Subgroup on Designation and Protection of CEMP sites was charged with the following tasks during the intersessional period:

(i) undertake minor technical revisions of the management plans for Cape Shirreff and Seal Islands CEMP sites;

(ii) consider further development of a methodology for the assessment of proposals for marine protected areas put forward by the ATCM;

(iii) consider details of the proposal put forward by New Zealand on Balleny Islands SPA; and

(iv) consider and evaluate CEMP site maps.

5.18 The intersessional group was chaired by Dr Penhale and coordinated by Dr Sabourenkov. Members included Drs Constable, Fanta, K. Kerry (Australia), Naganobu, D. Torres (Chile), K. Shust (Russia) and Wilson. Drs M. Gambi and S. Kawaguchi joined the subgroup in Taormina.

5.19 In addition to its designated tasks, the subgroup also considered a proposal to reorganise the conservation measures related to CEMP Conservation Measures 18/XIII, 62/XI and 82/XIII. At the meeting of WG-EMM, the group considered WG-EMM-00/23 Rev. 1, a proposal for an SSSI at Terra Nova Bay.

5.20 The Working Group recommended that the Scientific Committee approve the revision of the Seal Islands Management Plan (Conservation Measure 18/XIII, Annex 18/B). The Working Group also recommended that WG-EMM approve the revision of the Cape Shirreff Management Plan (Conservation Measure 18/XIII, Annex 18/B), pending minor technical revisions.

5.21 The Working Group discussed a proposal by Dr Penhale to reorganise the current conservation measures related to CEMP sites. The current organisation is as follows:

(i) Conservation Measure 18/XIII includes the procedure for according protection to CEMP sites, information to be included in management plans for CEMP sites (Annex 18/A) and the management plans, codes of conduct and background and history for both Seal Islands and Cape Shirreff CEMP sites (Annex 18/B plus appendices).

(ii) Conservation Measure 62/XI includes the designation of protection of the Seal Islands CEMP site.

(iii) Conservation Measure 82/XIII presents the designation of protection of the Cape Shirreff CEMP site.

5.22 The intent of a reorganisation of the conservation measures was to separate the procedures for according protection of CEMP sites (including guidance to writing management plans and the Code of Conduct, which apply to all plans) from the designation of individual sites with associated management plans.

5.23 Thus, one measure would include the procedure of according protection to CEMP sites, the information to be included in management plans for CEMP sites and the Code of Conduct. A second measure would include the Protection of the Seal Islands CEMP site, with annexes to include the management plan and the background information. A third would include the Protection of the Cape Shirreff CEMP site, with annexes to include the management plan, the background information and the history of protection.

5.24 The Working Group approved this reorganisation and requested that the Secretariat draft these changes prior the meeting of the Scientific Committee for consideration at that time.

5.25 The Working Group reviewed the CEMP site maps provided in response to a request by the Secretariat on behalf of the Scientific Committee (SC-CAMLR-XVIII, paragraph 4.24) for improved site maps. Deficiencies such as general poor quality, inadequate information on the location of colonies monitored at present and in the past, and information on the history of colonies had been noted. Maps were requested from 11 Member countries and were received from Australia, Japan, New Zealand, Norway and the UK. Maps were not received from Argentina, Brazil, Chile, Italy, South Africa and the USA.

5.26 The maps provided by New Zealand were viewed as meeting the criteria and should provide an excellent example for others to follow. The maps from Norway and the UK were also considered as meeting the criteria. The maps provided by Australia, which provided excellent information when viewed as the colour originals on the CCAMLR website, were difficult to assess when printed in black and white. The map from Japan would benefit from minor technical improvements.

5.27 The Working Group recommended that the subgroup review the criteria provided in the ATCM system for the production of maps of protected areas and in Conservation Measure 18/XIII, Annex 18/A, part A, as background to develop guidance for CCAMLR Members who plan to produce maps of CEMP sites. The importance of readability in black and white was noted.

5.28 The Working Group noted that WG-EMM-00/32, which described the Australian CEMP site at Béchervaise Island, provides a good example of the type of detailed colony information which would assist the interpretation of monitoring data submitted to the CEMP database.

5.29 Dr Kerry proposed that additional information on sites where monitoring is being undertaken at present or has been reported in the past would be of value. Such information could include maps, possibly in GIS format, which allow for fine-scale resolution of individual colonies; a description of individual colonies outlining their history with respect to human interference and research undertaken; annual updates on each of the study colonies outlining activities undertaken, problems encountered, unusual events etc.; and photographs of each colony with regular updates.

5.30 The Working Group agreed that such additional information could be useful and encouraged Members to provide such ancillary information, if practical, on an individual country website.

5.31 A link from the CEMP map section of the CCAMLR website could facilitate interested parties in finding any ancillary information provided.

5.32 Dr Gambi made a presentation on the Italian management plan for the Terra Nova Bay site (WG-EMM-00/23 Rev. 1). The presentation focused on the values to be protected (the unique marine benthic community located near Terra Bay Station and an Adélie penguin colony), the description of the area and the long-term research program that had been established in the area.

5.33 It was noted that this plan had been simultaneously submitted to both the SCAR WG-Biology and WG-EMM. At its 10 to 14 July 2000 meeting in Tokyo, Japan, WG-Biology welcomed the concept of the plan, but referred it to the next meeting of GOSEAC for consideration.

5.34 The Working Group recognised that it was premature to make recommendations to the Scientific Committee with regard to approval of the plan in the absence of comments from GOSEAC. Although some members felt that the plan should not be discussed at this time, others felt that it was appropriate to provide scientific advice to the originators of the plan.

5.35 Drs Naganobu and Kawaguchi noted that the Terra Nova Bay plan had been submitted directly from Italy to the Secretariat for transmission to WG-EMM rather than the plan being submitted from the ATCM directly to the Commission. Thus, in the absence of a charge from the Commission to WG-EMM to review the plan, he felt that the plan should not be discussed at this time.

5.36 Dr Miller stated that WG-EMM should be able to formulate scientific advice based on submissions from Members to the Working Group; thus, he concluded that such a scientific review of the Terra Nova Bay marine protected area would fall within the rules of procedure. He also noted policy matters should be referred to the Commission. In order to facilitate the work of the Commission, he suggested that an examination of marine protected areas in other parts of the world might prove of value.

5.37 Those who commented on the scientific aspects of the Terra Nova Bay plan noted the strong scientific basis for protection and the productive research that had been conducted at the site. Recommendations for improvement to the plan included: a clearer identification of the marine and terrestrial boundaries of the plan, the addition of the Adélie penguin colony in the management plan, the inclusion of more detailed management discussion (e.g. helicopter landing sites) and other minor technical improvements.

5.38 The Working Group considered the Balleny Islands management plan (WG-EMM-00/7) at the request of the Commission (CCAMLR-XVIII, paragraph 4.9). Dr Wilson introduced the scientific justification and the details of the Balleny Islands plan. Although some members felt that the subgroup should be prepared to make a recommendation regarding approval to WG-EMM, others felt that this was premature.

5.39 In terms of the details of the plan, it was noted that the plan had been modified based on advice from GOSEAC in 1999 and that the modified plan had been recommended for approval by SCAR by WG-Biology during its 10 to 14 July 2000 meeting.

5.40 Those who viewed the plan positively agreed that the values described in the plan were justified on the basis of available data. These values included the outstanding biodiversity of both the terrestrial and marine fauna and flora. The area was viewed as an excellent representative of a unique marine and terrestrial ecosystem. It was noted the area, which has been predominantly undisturbed, includes important breeding sites, as well as foraging habitat, for birds and seals. The reduced marine area was viewed as more scientifically justifiable than that in the previous version of the plan and it was noted that detailed maps had been provided. It was noted that the proposed boundary bisected the Balleny Seamount. A recommendation was made to adjust the boundary to include this seamount, as it is expected to be a significant habitat for fish species.

5.41 Dr Shust felt that the scientific basis for the protection of the Balleny Islands was not sufficiently described and that the threats to the Balleny Islands ecosystem had not been adequately detailed. The suggestion was made that additional scientific research would be required prior to presenting the plan for approval. He recommended that the area to be managed be reduced in size to one or two of the islands containing major wildlife concentrations.

5.42 Dr Y. Lee (Republic of Korea) felt that the scientific rationale for the plan was not strong. He noted that there has been very little research conducted in the area. In particular, the lack of information on foraging areas for marine birds and seals and the lack of recent penguin surveys were considered important deficiencies. Compared to the limited area (approximately 6 x 10 km) of the Terra Nova Bay plan, the large area (approximately 200 x 350 km) of the Balleny Islands plan does not seem justifiable.

5.43 Drs Naganobu and Kawaguchi expressed reservations on the discussion of the Balleny Islands plan at this time. Concerns raised included the issue that the subgroup has just begun to consider further development of a methodology for the assessment of proposals which include marine protected areas. They felt that these methods should be agreed on prior to consideration of plans. Secondly, CCAMLR Members have been securing the practical coordination between rational use of marine resources and their protection through surveys, analyses and discussions. The Balleny Islands plan does not consider the field approaches of CCAMLR. Thirdly, the protection of marine sites is a serious issue for CCAMLR's approach to fishing regulation and needs to be considered carefully prior to the accordance of protection.

5.44 Dr Shust also felt that the Balleny Islands plan did not consider the field approaches of CCAMLR and that the protection of marine sites is a serious issue for consideration with regard to CCAMLR's approach to fishery regulation.

5.45 Dr Naganobu felt that progress could be made in the Commission through a philosophical discussion which would focus on the principle of protection in the ATCM and the principle of rational use in CCAMLR.

5.46 Dr Miller drew the Working Group's attention to Article II of the Convention, which strives to balance rational use with conservation of resources.

5.47 Dr Penhale referred the Working Group to the underlying principles related to CCAMLR's review of management plans for marine protected areas proposed by the ATCM (Articles 4 and 5 of the Protocol and Article 6 of Annex V, paragraph 2). CCAMLR's interest would thus focus on whether the proposed plans are consistent with the achievement of the objectives and principles of CCAMLR.

5.48 The Working Group noted that marine areas in both the Terra Nova Bay and the Balleny Islands management plans are not located near sites of current commercial fishing interests. Dr Fanta felt that protection of marine areas of high biodiversity is of value for the objectives of CCAMLR.

5.49 Dr Wilson suggested that WG-EMM does at least approve the Balleny Islands proposal, in principle, pending consideration by the Commission of the arguments concerning rational use of resources. The importance of this proposal was also recognised by the recent SCAR WG-Biology meeting which recommended the plan be approved by SCAR. He suggested that rational use does not mean the whole of the ocean should be open to fishing activity. The Balleny Islands proposed SPA will make a significant contribution to representative biodiversity protected areas which will provide valuable non-treatment or control areas against which rational use can be measured. Furthermore, the Balleny Islands proposal does not create a precedent; there are other marine protected areas in the ATCM area.

5.50 Most members of the subgroup and WG-EMM felt that the focus should be on whether the values in these proposals were scientifically defensible rather than on the policy concerning the maintenance of those values and that the assessment of the amount of data required to assess the proposal is a matter for the ATCM. Policy was viewed as the responsibility of the Commission and the ATCM. In that case, the Commission may ask the Scientific Committee to clarify whether such proposals would prejudice or enhance the work of the Commission. Such information may help the Commission provide advice to the ATCM on these proposals. These

Members noted that the Commission has used Article IX of the Convention to close areas, which are of importance to some fishing activities, indicating that the Commission recognises the value of closed areas for achieving its objectives.

5.51 Most members supported the scientific validity of creating the Balleny Islands SPA which includes a marine component for the protection of high biodiversity values. However, some members did not agree (paragraphs 5.41 to 5.45); therefore the Working Group could not recommend to the Scientific Committee that the plan be approved.

5.52 The Working Group considered further development of a methodology for the assessment of proposals for marine protected areas put forward by the ATCM. Using guidance from CCAMLR-XIII (paragraphs 11.16 to 11.18), experience from past reviews, and a consideration of the interests of CCAMLR, the Working Group discussed the development of a methodology.

5.53 Some members noted that management plans transmitted by the ATCM were written to further the objectives of the ATCM; thus, such plans may not necessarily further the aims of CCAMLR. This should not be viewed as a negative aspect of the plan. The main focus of the overall CCAMLR review process should be on whether the plan would prejudice the objectives of CCAMLR.

5.54 Nevertheless, the review of management plans presents the opportunity for CCAMLR to review the scientific questions to be addressed, to review any plans for proposed scientific research or monitoring to be conducted in the area, to evaluate whether the closure of a marine area could be of value to CCAMLR, and to evaluate the positive and negative aspects of the plan with respect to fisheries.

5.55 In evaluating the application of marine protected areas by CCAMLR for its own purposes, the Working Group suggested that an examination of marine protected area development in other parts of the world may be useful.

5.56 While there was not sufficient time available for a complete review of the topic, some progress was made in the development of a methodology for the assessment of marine protected areas put forward by the ATCM.

5.57 As a starting point, the Working Group agreed that future reviews should include an assessment of the information relevant to the attributes to the area, including *inter alia*:

(i) information on the values for which protection is required; and
(ii) sufficient details in the text, maps and figures for a scientific review.

5.58 The review should also include an assessment of available information relevant to CCAMLR and its objectives, including *inter alia*:

(i) the location of breeding seabirds and seals in the area;

(ii) the location of any known foraging areas of seabirds and seals that may breed in, or are associated with, the proposed management area;

(iii) a description of known marine fauna;

(iv) a description of current or potential fisheries in the area; and

(v) the location and details of research directly relevant to CEMP.

5.59 Additionally, the review should draw to the attention of CCAMLR any other matters which may be relevant to the implementation of Article II of the Convention.

5.60 The value of transmitting to the ATCM the scientific interests and concerns of CCAMLR with respect to the review of marine protected areas was recognised as a means to improve the process and thus further the aims of both bodies.

5.61 The Working Group recognised the need for further work on the development of a methodology for the review of management plans for marine areas put forward by the ATCM and recommended that its deliberations on this topic be transmitted to the Scientific Committee.

5.62 Membership of the subgroup was reviewed and it was agreed that Dr Lee be included in the subgroup (paragraph 5.18).

5.63 The Working Group wished to convey its thanks to the subgroup for its work and to Dr Sabourenkov for his valuable contributions, particularly for coordinating the tasks and providing the required background documents.

Future Work

5.64 WG-EMM encouraged further investigations of biases associated with the CV for the CCAMLR-2000 Survey. It also advocated quantification and reporting of bias and imprecision in all measurements relevant to WG-EMM's work.

5.65 WG-EMM recommended the continued development of other multifrequency methods for delineation between *E. superba* and *E. crystallorophias*, and encouraged their application.

5.66 The Subgroup on Methods was re-established (paragraph 5.13) and will be convened by Mr Reid.

5.67 The Working Group recommended that the Subgroup on Designation and Protection of CEMP Sites develop criteria as guidance for the production of CEMP site maps.

5.68 The subgroup was requested to continue its work on the development of a methodology for the assessment of marine protected areas put forward by the ATCM, pending comment on the topic from the Scientific Committee and CCAMLR.

ADVICE TO THE SCIENTIFIC COMMITTEE

Precautionary Catch Limits for Area 48

6.1 Following the CCAMLR-2000 Survey, the Working Group agreed that the current estimate of biomass of krill is 44.29 million tonnes (CV 11.38%) (paragraph 2.87). The Working Group also endorsed the new estimate of γ of 0.091. According to the calculation where yield is the product of these two estimates, the Working Group recommended that the potential yield for krill in Area 48 be set at 4 million tonnes.

6.2 The Working Group reiterated the requirement to subdivide the potential yield in Area 48 as a precautionary method to distribute fishing effort (paragraph 2.114) and agreed that such a subdivision, at this stage, should be based on the percentage of the survey undertaken in each subarea (paragraph 2.119, Table 2). The recommended precautionary catch limits for each subarea are:

48.1 1.010 million tonnes
48.2 1.100 million tonnes
48.3 1.060 million tonnes
48.4 0.830 million tonnes.

6.3 The Working Group noted that the precautionary catch limit for krill had not been adjusted since the first calculation of 1.5 million tonnes pending the undertaking of the CCAMLR-2000 Survey. The current recommendation is consistent with revised estimates of the potential yield considered in this Working Group in previous years (e.g. SC-CAMLR-XIII, Annex 5). The Working Group emphasised that the current estimate of yield is based on a well-planned survey to obtain a reliable estimate of biomass in Area 48 (SC-CAMLR-XVIII, Annex 4, Appendix D; Appendix G to this report) coupled with agreed protocols for the analysis of the data and the method for subdividing the yield between subareas. As such, the Working Group had confidence in its recommendations.

6.4 The Working Group recognised that these recommendations may be revised from time to time in the future as new analyses and estimates of parameters come to hand, as is the usual practice in WG-FSA. The Working Group reiterated that the current recommendations are based on the best scientific evidence available.

Regulatory Framework for CCAMLR Fisheries

6.5 The Working Group noted the general points for consideration by the Scientific Committee contained in its earlier discussion in paragraphs 2.32 to 2.35.

Consideration of other Management Measures

6.6 The Working Group agreed that the new estimate of biomass of krill for Division 58.4.1 of 4.83 million tonnes (CV 17%) (paragraphs 2.79 and 2.80) was now the best scientific evidence available. Combined with the estimate of γ for this division (paragraph 2.112) of 0.091, the precautionary yield would be 440 000 tonnes (paragraph 2.113). The Working Group recommended that this yield be considered by the Scientific Committee to be the best scientific estimate available at this time.

6.7 Dr Naganobu indicated that the basis of the new estimate for Division 58.4.1 will need to be reviewed by Japanese experts prior to consideration by the Scientific Committee.

6.8 The Working Group agreed that the precautionary yield for Division 58.4.1 should be subdivided to account for the size of the area and the need to distribute catches across the area, as for Area 48. It was noted that this division was 4.68 million km^2 compared to the combined area for Subareas 48.1, 48.2, 48.3 and 48.4 of 3.42 million km^2. The Working Group agreed that, unlike Area 48 which is subdivided on the basis of bathymetry and island groups, Division 58.4.1 would best be subdivided based on oceanographic features that are likely to separate ecological units. It agreed that the best scientific evidence available for such a subdivision is based on the difference in characteristics of the east and west parts of the division separated approximately at the longitude 115°E (paragraph 2.120).

6.9 Given the available evidence, the Working Group agreed that a subdivision at longitude 115°E would result in a subdivision of the biomass of krill in Division 58.4.1 into 3.04 million tonnes in the western section and 1.79 million tonnes in the east (paragraph 2.120). A subdivision of the yield based on the relative proportion of the krill biomass in each of these sections would result in precautionary yields of 277 000 tonnes and 163 000 tonnes in the western and eastern sections respectively. The Working Group recommended that the Scientific Committee consider this subdivision as the best method currently available.

6.10 Dr Naganobu indicated that he does not have difficulty with a subdivision in principle. However, he was unable to accept the subdivision of Division 58.4.1 at this stage without further consideration, for the following reasons:

(i) oceanographic data have not been used previously to subdivide areas;

(ii) the proposed line of subdivision at 115°E may not be a fixed feature but may vary from one year to the next according to oscillations such as those that might arise from variation in the Antarctic low pressure trough; and

(iii) there is no krill fishing in this area at this stage and such fishing is unlikely in the near future.

6.11 The Working Group recommended that, in general, the Scientific Committee should consider further the overall issue of subdividing large statistical units into management units based on ecological knowledge. This would help focus survey, monitoring and management requirements as well as ensuring that large catches are not taken from within small-scale areas.

6.12 The Working Group also recommended an examination of how useful small management units with local conservation measures would be for helping the Commission achieve the objectives in Article II of the Convention.

6.13 The Working Group recommended that the Scientific Committee request that nations provide prior notification to the Secretariat of their intention to fish for krill (including new entries to the fishery). These notifications should be received well in advance of the annual meeting of WG-EMM so that the Working Group could consider the total potential fishing pressure in the coming seasons (paragraph 2.3).

6.14 The Working Group wished to inform the Scientific Committee that quantitative information on conversion rates for krill products from the fishery was still lacking and this was impeding understanding of the development of the krill fishery (paragraph 2.8).

6.15 The Working Group drew the Scientific Committee's attention to the continued absence of detailed economic information from the krill fishery. This information would allow the Working Group to better predict future trends in the fishery (paragraph 2.7).

6.16 The Working Group recommended a greater level of implementation of the CCAMLR Scheme of International Scientific Observation in the krill fishery (paragraph 2.27).

6.17 The Working Group recommended that the Scientific Committee approve the revision of the Seal Islands Management Plan and the Cape Shirreff Management Plan (Conservation Measure 18/XIII, Annex 18/B) (paragraph 5.20).

6.18 The Working Group recommended that the Scientific Committee endorse the reorganisation of the conservation measures related to CEMP sites (paragraphs 5.21 to 5.24). A draft will be prepared by the Secretariat prior to the next meeting of the Scientific Committee.

6.19 The Working Group drew the attention of the Scientific Committee to the discussions of the Working Group and issues for consideration regarding:

(i) a proposal to the ATCM regarding protection of a marine area at Terra Nova Bay (paragraphs 5.32 to 5.37);

(ii) the proposal to the ATCM regarding protection of a marine area around the Balleny Islands (paragraphs 5.38 to 5.51); and

(iii) methods for the assessment of proposals made to the ATCM on the protection of marine areas (paragraphs 5.52 to 5.62).

Future Work

6.20 The Working Group encouraged members to further test the GYM and to submit these tests to the Secretariat for archiving (paragraphs 2.96 and 2.97) and to use the GYM to undertake future work examining the sensitivity of estimates of krill yield to changes in parameter values (paragraph 2.108).

6.21 The Working Group discussed the now extensive nature of the CEMP database and other datasets and recommended that these data be used to review the types of data that could be used in short- and longer-term management approaches. The Working Group noted that paragraphs 3.51 and 3.55 provide a guide to this work.

6.22 The Working Group noted that interpretation and assessment of changes in CEMP indices may require information on the region-wide characteristics of the populations of monitored species (paragraph 3.56). To this end, the Working Group considered whether it would be feasible to undertake a large-scale assessment of land-based predator populations (paragraphs 3.58 and 3.59). The Working Group recommended that the Scientific Committee consider whether such surveys could be undertaken over the next few years following the intersessional communication on this issue amongst members of the Working Group (paragraph 3.58).

6.23 The Working Group noted that precautionary catch limits have only been adopted for Area 48 and Divisions 58.4.1 and 58.4.2. It discussed the need to undertake surveys of krill biomass in areas for which CCAMLR has no survey data following the advanced protocols used in the survey of Division 58.4.1 or the recent CCAMLR-2000 Survey. The Working Group endorsed the need to carry out these surveys as soon as is practicable, particularly in areas where fishing has occurred in the past, such as Subarea 88.1 in the Ross Sea, and in Division 58.4.2, and looks forward to receiving proposals for review. In addition, the Working Group recommended surveys to be undertaken in other areas that may be important in ecosystem monitoring, such as adjacent to Bouvet Island (Subarea 48.6).

6.24 The Working Group discussed its future role and the manner in which it would undertake its work. These discussions are reflected in paragraphs 4.128, 4.129 and 7.10 to 7.17.

6.25 The Working Group noted that increased interaction with other research groups and international bodies might be of benefit to the Working Group and CCAMLR, particularly regarding specific questions considered at its meetings (paragraphs 4.51 and 4.122 to 4.129).

6.26 The Working Group wished to bring to the attention of the Scientific Committee a request by scientists from UBC to undertake development of an ECOPATH-based model of the Southern Ocean ecosystem in Area 48. This was discussed and actions detailed in paragraphs 4.130 to 4.135. The Working Group requested that the Scientific Committee consider the role of the Data Manager in this program of work, given the priorities of the Working Group detailed in Table 3 and the overall requirements of the Secretariat for the coming year.

6.27 The Working Group noted that the proposal to develop an ECOPATH model was submitted by authors from a non-Member nation. The Working Group advised the Scientific Committee that proper discussion of issues raised by such papers was best achieved with full national representation and participation in the Working Group's scientific activities. This is best achieved when the nation is a full Member of the Commission.

FUTURE WORK

Future Intersessional Work of WG-EMM

7.1 Future work identified by the Working Group is detailed in the relevant sections of this report. This work is summarised in Table 3, together with the persons identified to take the work forward, and the references to paragraphs where the tasks are described. High priority items for the Secretariat are shown in the table.

7.2 Outstanding tasks identified by WG-EMM from 1995 to 1999 were reviewed in WG-EMM-00/29 prepared by Dr Sabourenkov. The Working Group's discussions are reflected in paragraphs 4.114 to 4.117.

Future Meetings of WG-EMM

7.3 Dr Miller introduced WG-EMM-00/64 which outlined the costs and implications of holding meetings of WG-EMM in various locations worldwide. This paper was prepared in response to the Commission's request that the Scientific Committee consider the possibility of holding future meetings of WG-EMM in Hobart (SC-CAMLR-XVIII, paragraphs 13.7 to 13.10). This request was made following consideration by SCAF of measures to reduce the overall operational costs of CCAMLR.

7.4 The Working Group considered two key aspects of holding meetings in Hobart:

- the financial implications; and
- the impact on the work of WG-EMM and the Scientific Committee.

7.5 Budget implications and the impact on the work were evaluated with reference to past meetings of Working Groups held in Hobart (WG-FSA) and elsewhere (WG-CEMP, WG-Krill and WG-EMM).

Financial Implications

7.6 Based on financial information provided by the Secretariat, Dr Miller concluded that the holding of the meetings of WG-EMM in Hobart, Australia, would reduce the travel costs of the Commission (Secretariat) budget by approximately A$30 100–36 200 per meeting (i.e. no travel required for staff). However, at the same time, meeting support activities (e.g. document production, hire of equipment etc.) would incur a cost of approximately A$5 000 per meeting to the Commission budget. The net savings to the Commission budget would be in the order of A$25 100–34 300 per meeting, or a maximum net saving of about A$1 491 per Member per meeting.

7.7 The Working Group noted that the relatively remote location of Hobart for most Member countries would also increase the travel costs of participating countries by approximately A$1 700 per participant per meeting. As an example, Dr Holt advised that it would have cost the delegation from the USA an extra A$10 200 (6 x A$1 700) to attend WG-EMM-2000 had that meeting been held in Hobart rather than in Taormina.

7.8 Dr Miller indicated that the overall net savings to Members if the meetings of WG-EMM were held in Hobart would be in the order of A$347–613 per Member per meeting (see WG-EMM-00/64).

7.9 The Working Group noted that an additional cost incurred by meetings held at the CCAMLR Headquarters in Hobart, and not included in WG-EMM-00/64, was the general disruption to the Secretariat's work resulting from hosting large, two-week, meetings. The Secretariat already hosts one such meeting each year (WG-FSA) which inevitability involves all staff, either directly with the meeting, or indirectly through work-related interactions (e.g. requests for data and analyses, publications etc.) and the sharing of office space and facilities. Meetings of WG-EMM held at the Headquarters would add to this type of disruption.

Impact on the Work

7.10 In considering the impact that Hobart-based meetings would have on the work of WG-EMM, the Working Group discussed, in broad terms, the future direction of its work. It was agreed that key aspects of this work included, or will include, *inter alia*:

- the development of an integrated management scheme for krill fisheries;
- the involvement of experts from within, and outside, CCAMLR to help in this development;
- the involvement of new scientists, including new perceptives on research and the problems under consideration;
- the involvement of other national scientists, managers and industry representatives; and
- the promotion of the work of CCAMLR and its role in managing the marine resources in the Southern Ocean.

7.11 The development of an integrated management scheme for krill fisheries was a long-term goal of WG-EMM, and this may require another 5–10 years to establish (paragraph 4.117). This timing is similar to other major developments in resource management, such as the Revised Management Plan for Whales developed by the IWC over a period of approximately 10 years. The implementation of a management scheme for the krill fisheries would lead to regular fishery assessments, similar to those conducted by WG-FSA, and further long-term developments.

7.12 The Working Group discussed the ways in which its meetings could be used to facilitate future work. It was agreed that it was essential to hold meetings in various parts of the world so that:

- the work of CCAMLR could be promoted in the host countries;
- young scientists in each of the Member countries would have the opportunities to participate in the work of WG-EMM; and
- WG-EMM could visit laboratories with expertise relevant to its work.

7.13 Examples of some of the advantages of this process are evident from previous meetings of WG-EMM. For example, a large number of national scientists and students participated in the meetings of the working groups (see WG-EMM-00/64, Figure 1). Dr Kawaguchi informed the group that, even though many of these scientists may only attend one meeting, their exposure to the work of WG-EMM is valuable. It was also noted that meetings in the USA had allowed the introduction of valuable expertise. Such opportunities provide the impetus for some national scientists to remain in contact with WG-EMM and make further contributions by presenting papers at future meetings.

7.14 The Working Group also agreed that the development and the promotion of its work would be improved by changing the format of the meetings (paragraphs 4.127 and 4.128). Options for future meetings would include, for example:

- 1-day or 2-day symposium where key papers could be presented and discussed – this would allow scientists not involved in the work of CCAMLR to attend part of the meeting and contribute expertise and ideas in areas of interest, such as fisheries management (e.g. ICES);

- a 3-day thematic workshop where specific work could be developed, such as the development of CEMP indices, assessments of populations and models of their dynamics, or the GYM – this focus would allow invited experts to contribute to the work of WG-EMM over a short period of time; and

- plenary sessions where the core work of WG-EMM would be developed.

7.15 Dr Miller examined the potential impact on the work of WG-EMM and the Scientific Committee if the meetings were to be held in Hobart (WG-EMM-00/64). WG-EMM currently has the highest level of participation of any CCAMLR working group, past and present, and this was attributed directly to the roving location of meeting venues.

7.16 In contrast, meetings in Hobart would provide limited opportunities for participation by national scientists and students. The cost of reaching Australia, and Hobart in particular, from Europe, the Americas and Asia would be prohibitive to most junior scientists and students. These costs may also be prohibitive to some key scientists. Prof. Boyd advised that the level of participation in WG-EMM by the UK would be diminished if the Working Group meetings were held in Hobart because of the increased costs involved with reaching this venue. This echoed comments from Dr Holt about the cost of participation of delegates from the US AMLR Program (paragraph 7.7).

Recommendation

7.17 The Working Group agreed that a key element of its work was the ability to hold its meetings where it was deemed most beneficial to its current work; this was unlikely to include Hobart on a regular basis. It was agreed that Dr Hewitt would develop a paper on the format for undertaking the work of WG-EMM at future meetings for consideration by the Scientific Committee. Dr Miller agreed to update the analyses in WG-EMM-00/64 and append this information to the paper to be prepared by Dr Hewitt.

CCAMLR WEBSITE

8.1 Dr Ramm presented an update of the developments of the CCAMLR website (www.ccamlr.org), as these related to the work and recommendations of WG-EMM (WG-EMM-00/28). Many sections of the website are now available in the four official languages of CCAMLR. However, the webpages of WG-EMM, and other working groups, will remain in English only as this is the working language. WG-EMM documents can be accessed from the MAIN INDEX, by selecting MEMBERS under the Scientific Committee heading. The MEMBERS button leads to an entry screen where the user name and password are required to proceed.

8.2 The responsibility for issuing user names and passwords to persons has been devolved to each Member country. The Secretariat provides each Scientific Committee contact (nominated by the Commission contact) with the user names and passwords required to access the secure webpages of the Scientific Committee, and it is the responsibility of each Scientific Committee contact to issue this information to those members of their scientific team they consider appropriate. Scientific Committee contacts were listed in Appendix 1 of WG-EMM-00/28.

8.3 Recent additions to the website arising from the recommendations of WG-EMM-99 included:

- documents for WG-EMM-2000;
- CCAMLR bibliography related to the work of WG-EMM;
- *CCAMLR Scientific Abstracts*;
- *Statistical Bulletin*, Volume 12;
- CEMP site maps; and
- monitoring of hits and visit rates.

8.4 In addition, guidelines for submitting material for the website were reiterated in WG-EMM-00/28.

8.5 The Working Group congratulated the Secretariat, and in particular Ms R. Marazas, Webmaster, for the continued high-quality development of the CCAMLR website. Those who had used the site had found it to be a very useful tool in providing information about CCAMLR, including access to meeting documents. Information on hit and visit rates indicated that others had also made use of the site, with a total of 13 168 visits from 56 countries over the period 1 January to 6 July 2000 (mean visit rate: 492 visits per week).

8.6 The Working Group encouraged the Secretariat to consider the website as a living document, which would require frequent, small changes so that it remained attractive to repeat users. For example, the appearance of the homepage could be varied by changing the background graphics. The structure of the website could also be tuned to visitor usage. Some participants had also found the MEMBERS button, used to access secure webpages, cryptic; an explicit description of this button, such as MEMBERS AREA, was suggested.

8.7 The Working Group discussed the approach used this year by the Secretariat to distribute meetings papers via the website. Meeting documents submitted by the pre-meeting distribution deadline (16 June) had been made available via the website in portable document format (pdf). This format allowed most participants to access and print all/any of the available papers in advance of the meeting, thus providing early access to the information, as well as some savings in Secretariat resources. The Secretariat had also offered to airmail hard copies of available WG-EMM documents to participants; no request had been received. Papers submitted after 16 June were distributed in the document bundle issued on the first day of the meeting. Finally, papers in the pre-meeting distribution were made available on request on the first day of the meeting.

8.8 The Working Group noted that a small number participants had experienced difficulties accessing the secure webpages or printing documents, or had encountered lengthy download times. It was believed that these sorts of problems would be resolved with further technological advances. Many participants had brought hard copies of the early papers to the meeting, and this had saved considerable photocopying at the meeting. Overall, the Working Group supported the approach taken this year, and agreed that this approach should apply to the distribution of papers for WG-EMM-2001; a copy of the agenda should be included in the bundle of papers issued on the first day.

8.9 The process of archiving electronic copies of meeting documents was also discussed. The Working Group recommended that all WG-EMM-2000 documents should remain on the secure webpages for a period of 3–12 months following the meeting. To achieve this, participants were requested to provide electronic copies of papers submitted in paper format, including those submitted at the start of the meeting.

8.10 In the longer term, the Working Group proposed that meeting documents should be removed from the website, and archived on CD-ROM for distribution to interested parties. This may eventually lead to an electronic reference library for use by WG-EMM. Removing archived papers from the website would also remove the need to maintain these documents on secure webpages.

8.11 Dr Constable advised that he had scanned a considerable amount of CCAMLR material into a personal electronic library, and that he would be prepared to provide this material to the Secretariat if this was thought useful. Other participants may also have other material available, and the Working Group encouraged the Secretariat to make use of this scanned material where suitable.

OTHER BUSINESS

Future Meetings

9.1 The Working Group received indications that three initiatives were under way for hosting future meetings of WG-EMM. Dr Bergström advised that he is looking into the feasibility of hosting the 2001 meeting of WG-EMM at the Kristineberg Marine Research Station, Sweden. Dr Wilson advised that New Zealand was interested in hosting the 2002 meeting in Christchurch. Prof. Boyd informed the Working Group that the UK was looking into the feasibility of hosting a meeting of WG-EMM within two to three years. The Working Group welcomed this news, and noted that this tentative plan fitted well within the structure discussed for future meetings (see section 7).

9.2 Concern was expressed about the timing of recent meetings, and WG-EMM agreed that the best time for its meetings was from early June (the end of the field seasons) until early August. The early August cut-off was necessary so that the Secretariat could edit and translate the report of WG-EMM prior to the annual meeting of the Scientific Committee. The Working Group also urged local organisers to avoid time conflicts, when possible, with other major Antarctic meetings.

9.3 The Working Group agreed that Dr Hewitt should endeavour to develop the agenda and format of the 2001 meeting by January–February 2001, pending the outcome of SC-CAMLR-XIX in reference to paragraph 7.17, so that participants could focus their intersessional work and meeting papers (see also paragraph 7.14). The Working Group agreed that certain agenda items may not need to be addressed at each meeting. For example, detailed consideration of CEMP indices may be given once every two to three years. This type of schedule would allow WG-EMM to afford detailed consideration of key elements of its work on a rotational basis.

Meeting Papers

9.4 Once again the Working Group expressed concern at the large number of meeting papers submitted on the first day of the meeting. At this meeting, as in recent other meetings of WG-EMM, only approximately 30% of the meeting papers had been submitted by the pre-meeting distribution deadline (16 June, one month prior to the meeting). The majority of the papers were submitted in the last few days prior to the meeting, or on the first day of the meeting. This practice places a large burden on all participants.

9.5 In a move to alleviate this burden, the Working Group agreed that full papers (including the synopsis; see next paragraph) must be submitted electronically to the Secretariat at least two weeks prior to the start of the meeting. The Working Group agreed that papers for WG-EMM-2001 which did not comply with this principle would not be accepted at the 2001 meeting. The Working Group agreed to review this process at future meetings.

9.6 The Working Group agreed that each paper submitted at future meetings should include a synopsis which would consist of an abstract of the paper and a summary of the findings, as these relate to the nominated agenda items (see also paragraph 2.129). The Working Group also agreed that each synopsis should be no longer than one page, and be submitted on an electronic pro-forma to be developed by the Secretariat.

9.7 The Working Group also agreed that the Secretariat's paper (WG-EMM-00/29), which documents the development and completion of tasks put forward by WG-EMM, should be updated each year, and distributed to WG-EMM with the preliminary agenda. This would serve to remind participants of the tasks at hand, and help focus work at the meetings.

ADOPTION OF THE REPORT

10.1 The report of the sixth meeting of WG-EMM was adopted.

CLOSE OF THE MEETING

11.1 In drawing the meeting to a close, Dr Hewitt thanked all participants for working so hard over the past two weeks, and for contributing to the detailed discussions on ecosystem monitoring and management. He also thanked Prof. Guglielmo for hosting the meeting in Taormina, and Prof. J. Rydzy (Italy) for proposing this venue at the last meeting of WG-EMM. Dr Hewitt also thanked the two Secretariat staff supporting the meeting, Ms G. Tanner and Dr Ramm, for their dedicated efforts under trying circumstances.

11.2 Prof. Boyd, on behalf of the Working Group, thanked Dr Hewitt for leading the group through the meeting. The meeting had been highly profitable, and Dr Hewitt had done a fantastic job. Prof. Boyd also thanked Dr Constable for his intellectual input in so many of the issues discussed, and for his deep knowledge of the workings of CCAMLR.

11.3 Earlier, Dr Miller, prior to leaving the meeting, had also congratulated Dr Hewitt on his excellent convenership of his first meeting of WG-EMM. Dr Miller had thanked all participants and the rapporteurs, for their enthusiastic contributions during the meeting.

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Table 1: Parameters input to the GYM for evaluating γ_1 and γ_2 for krill in Area 48 based on the CV and timing of the CCAMLR-2000 Survey. Parameters are based on the assessment undertaken at WG-Krill-94 (SC-CAMLR-XIII, Annex 5, paragraphs 4.51 to 4.110).

Category	Parameter	Estimate
Age structure	Recruitment age	0
	Plus class accumulation	7
	Oldest age in initial structure	7
Recruitment (R) and natural mortality (M)	M and R dependent on proportion of recruits in stock where:	
	Proportion of recruits	0.557
	Standard deviation of proportion	0.126
	Age of recruitment class in proportion	2
	Data points to estimate proportion	17
von Bertalanffy growth	Time 0	0
	L_∞	60.8 mm
	k	0.45
	Proportion of year from beginning in which growth occurs	0.25
Weight at age	Weight–length parameter – A	1.0
	Weight–length parameter – B	3.0
Maturity	L_{m50}	32.0–37.0 mm
	Range: 0 to full maturity	6 mm
Spawning season		1 December–28 February
Estimate of B_0	Survey time	1 February
	CV	0.114
Simulation characteristics	Number of runs in simulation	1 001
	Depletion level	0.2
	Seed for random number generator	-24189
Characteristics of a trial	Years to remove initial age structure	1
	Observations to use in median SB_0	1 001
	Year prior to projection	1
	Reference start date in year	1 November
	Increments in year	365
	Years to project stock in simulation	20
	Reasonable upper bound for annual F	5.0
	Tolerance for finding F in each year	0.0001
Fishing mortality	Length, 50% recruited	30–39 mm
	Range over which recruitment occurs	9 mm
	Fishing selectivity with age	
Fishing season		1 December–1 March

Table 2: Transect length (large-scale transects including sections passing through mesoscale regions), percentage of total transect length, and subdivision of potential yield within statistical subareas in Area 48.

Subarea	Transect Length (km)	% of Total Transect in each Subarea	Subdivision of Potential Yield (million tonnes)
48.1	4 218	25.2	1.008
48.2	4 613	27.6	1.104
48.3	4 419	26.4	1.056
48.4	3 493	20.8	0.832

Table 3: List of tasks identified by WG-EMM as future work. The paragraph numbers (Ref.) refer to this report unless stated otherwise. √√ – high priority items for the Secretariat.

Ref.	Topic and Task	Actioners	
		Secretariat	WG-EMM
	HARVESTED SPECIES		
	Trends in the krill fishery		
2.7	Complete and submit an economic analysis of the fishery.		General request
2.8	Provide detailed information on conversion rates for krill products (see also paragraph 2.14).		Members involved in krill fisheries
2.9	Analyse published information on conversion rates for krill products.		Drs Everson and Nicol
2.12	Develop the model used to analyse the fishing positions in relation to salp density and krill density (see WG-EMM-00/58).		Dr Kawaguchi
2.13	Notify the Secretariat, well in advance of the meeting of WG-EMM, of intentions to conduct krill fishing in the following season.		Members intending to fish for krill
App. D	Assess changes in fishing patterns.	√√	General request
	Observer scheme for the krill fishery		
2.20	Obtain information on methods used by Flag States to determine the total removals.	√	
2.21	Re-distribute the draft questionnaire seeking information on krill fishing strategies, and provide feedback and ideas.	√	Members involved in krill fisheries and Members designating national and international observers
2.22	Provide facilities on board so that observers may directly estimate conversion rates for krill products.		Members involved in krill fisheries
2.26	Develop a proposal to improve the sampling protocols described in the *Scientific Observer Manual*.		Mr Jones
2.31	Develop a stratified sampling strategy for finfish by-catch which takes account of the anticipated density of juvenile fish.		General request
	Regulatory framework for fisheries		
2.35	Develop a framework to guide fishery development.		Ad hoc task group convened by Dr Miller
	Estimation of potential yield		
2.97	Develop a pro-forma for the submission and archiving of GYM tests.	√√	Dr Constable and others
2.108	Understand the sensitivity and performance of the GYM to changing parameter values.		General request
2.110	Evaluate the GYM and submit results to the Secretariat.	√	Dr Constable and others
2.110	Compile the documentation on the KYM, including its historical development.	√√	

(continued)

Table 3 (continued)

Ref.	Topic and Task	Actioners	
		Secretariat	WG-EMM
	CCAMLR-2000 Survey		
2.122	Coordinate the analyses of the data at future workshops and intersessionally.		Drs Hewitt, Naganobu, Nicol, Sushin,Watkins
2.123	Analyse regional and local surveys in Area 48 during the same period as the CCAMLR-2000 Survey to complement the synoptic information.		Scientists involved with these surveys
2.124	Analyse data from ancillary surveys during an International Coordination Workshop.		Dr Kim (workshop convener)
2.126	Develop a better understanding of the orientation of krill.		General request
2.127	Investigate the potential biases caused by the currently used krill delineation techniques.		General request
2.128	Determine the proportion of krill occurring near the surface during daytime and its effect on acoustic survey estimates.		General request
2.130	Consider alternative methods to subdivide the precautionary catch limit.		General request
2.131	Coordinate an ad hoc subgroup on population genetics of krill and provide a forum to discuss progress and analyses.		Dr Bergström (subgroup coordinator)
2.132	Estimate the biomass of myctophids from acoustic data.		General request
3.61	Analyse oceanographic data with the aim of improving the identification and definition of key hydrographic features.		General request
	DEPENDENT SPECIES AND THE ENVIRONMENT		
	CEMP Indices		
3.4	Add a box to the CEMP eforms to indicate if data were collected according to the standard methods.	√	
3.5	Update information on CEMP indices and report to WG-EMM-2001.	√√	
3.47, 3.63	Further develop the application of CSIs intersessionally and during a working session at WG-EMM-2001.	√	General request
3.49	Further develop the algorithm to estimate the energy and carbon budgets of land-based predators.		General request
3.51	Further develop the CEMP indices along the points identified at the meeting.		General request
3.55	Review CEMP parameters and their potential utility in management procedures.		General request
3.55	Review the historical development of CEMP indices and the ecosystem assessments.	√	
3.55	Make available the CEMP database at WG-EMM-2001.	√√	
3.60	Continue monitoring CEMP environmental indices.	√	CEMP data providers

(continued)

Table 3 (continued)

Ref.	Topic and Task	Actioners	
		Secretariat	WG-EMM
	CEMP Species		
3.8, 3.9	Convey the appreciation of WG-EMM, and comments arising from the meeting, to SCAR-BBS for submitting WG-EMM-00/16.	√	
3.16	Liaise with the SCAR-GSS to clarify issues raised by WG-EMM, and help ensure that the updated report is submitted to SC-CAMLR.		Prof. Boyd
3.18	Document population changes in Antarctic fur seals in the South Shetland Islands.		US AMLR
3.19, 3.59	Convene a workshop to assess problems associated with conducting large-scale population counts.		General request
3.20	Request updates on whale population abundance and information relevant to estimating krill consumption.	√	
3.56	Estimate the large-scale abundance of land-based predator populations.		General request
3.58	Collate program outlines for collaborating in a synoptic survey of land-based predator populations, and present at SC-CAMLR-XIX.		Dr Constable (coordinator) and Program Leaders
	APIS		
3.57	Request information on pack-ice seals.	√	
	Environment		
3.29	Present environmental information related to fishing activities at future meetings.		General request
3.33, 3.62	Further develop indices on the extent of sea-ice adjacent to CEMP sites.		General request
	ECOSYSTEM ANALYSIS		
4.4	Further develop the ecosystem approach.		General request
4.120	Further develop techniques for extending the spatial and temporal coverage of sampling krill populations.		General request
4.123	Interact with SO-GLOBEC.		General request
4.129	Promote the work of CCAMLR outside the CCAMLR community and seek input on issues of interest to WG-EMM.	√√	General request
4.133	Communicate with UBC regarding questions concerning ECOPATH.		Dr Miller
4.134	Acquire the initial skills in developing an ECOPATH model analysis, subject to approval by SC-CAMLR.	√	
4.137	Conduct further studies to compare water masses to krill taxa and demographics.		General request

(continued)

Table 3 (continued)

Ref.	Topic and Task	Actioners	
		Secretariat	WG-EMM
	METHODS AND DESIGNATION OF CEMP SITES		
5.64	Further investigate biases associated with the CV for the CCAMLR-2000 Survey.		Dr Demer and others
5.65	Further develop the application of multi-frequency methods for delineation between *E. superba* and *E. crystallorophias.*		Dr Azzali and others
5.66	Reconvene the Subgroup on Methods and address issues raised by WG-EMM.		Mr Reid
5.67	Develop criteria to guide the production of CEMP site maps.		Subgroup on the Designation and Protection of CEMP sites
5.68	Develop a method to assess marine protected areas put forward by the ATCM .		Subgroup on the Designation and Protection of CEMP sites
6.18	Redraft CEMP conservation measures.	√√	
	FUTURE MEETINGS OF WG-EMM		
4.127	Structure future meetings to make it easier for participants with external expertise.		Dr Hewitt
7.17	Update the analyses in WG-EMM-00/64.		Dr Miller
7.17	Develop a paper to present the views of WG-EMM to SC-CAMLR.		Dr Hewitt
	CCAMLR WEBSITE		
8.6	Consider the website as a living document which would require frequent, small changes so that it remained attractive to repeat users.	√	
8.8	Apply the approach used to distribute WG-EMM-2000 documents at WG-EMM-2001; a copy of the agenda should be included in the bundle of papers issued on the first day.	√√	
8.9	Leave all available WG-EMM-2000 documents on the secure webpages for a period of 3–12 months following the meeting (participants were requested to provide electronic copies of papers submitted in paper format, including those submitted at the start of the meeting).	√√	General request

(continued)

Table 3 (continued)

Ref.	Topic and Task	Actioners	
		Secretariat	WG-EMM
	OTHER BUSINESS		
9.2	Avoid time conflicts, when possible, with other major Antarctic meetings when organising future meetings of WG-EMM.	√	Dr Hewitt and hosts
9.3	Develop the agenda and format of the 2001 meeting by January–February 2001, and distribute together with an updated version of WG-EMM-00/29.	√√	Dr Hewitt
9.5	Submit advance notifications of papers, or a synopsis, or full papers (including the synopsis) electronically to the Secretariat at least one month prior to the start of the meeting.		General request

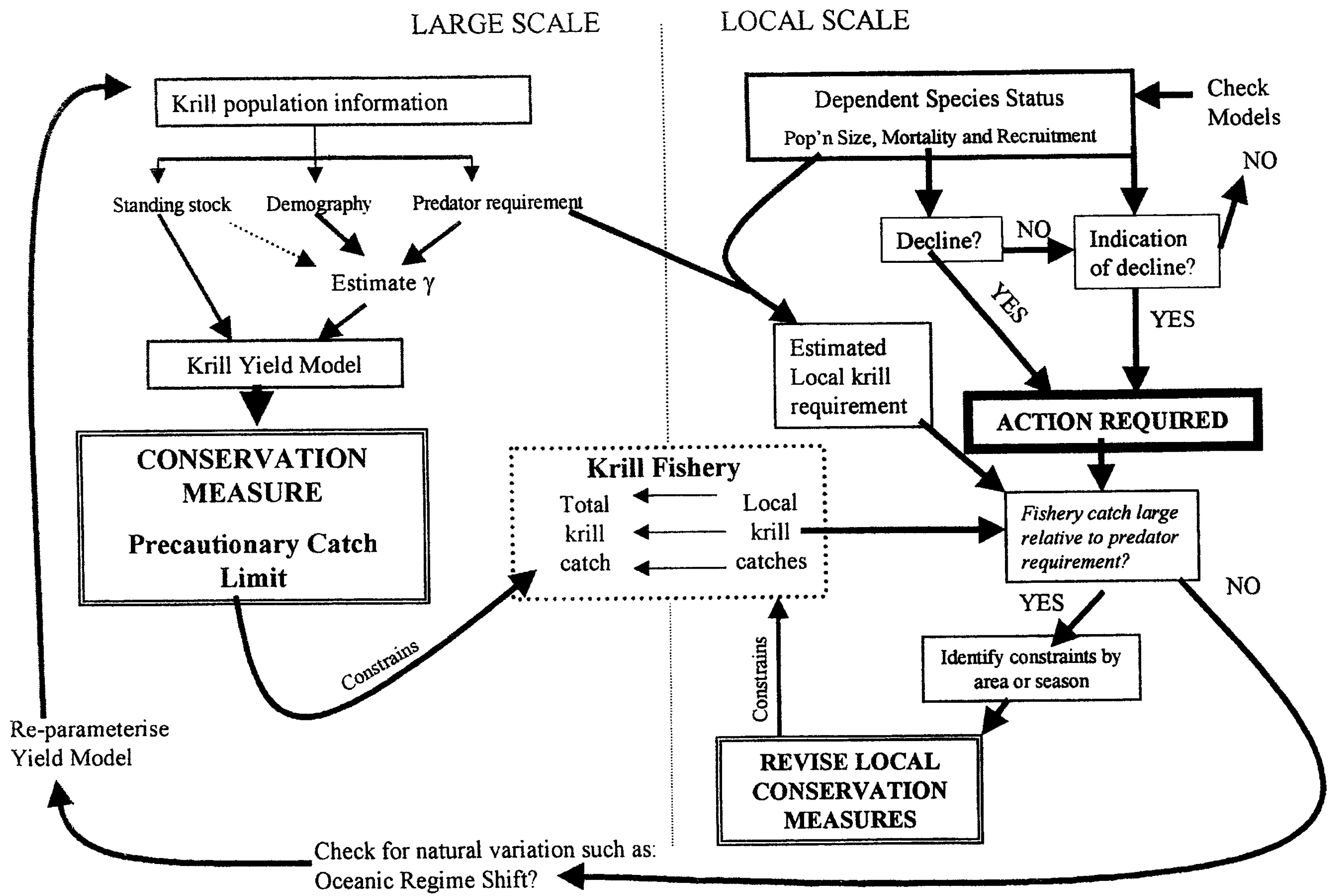

Figure 1: Decision processes incorporating information from dependent species into a mechanism to provide advice for management of a krill fishery.

APPENDIX A

AGENDA

Working Group on Ecosystem Monitoring and Management
(Taormina, Sicily, Italy, 17 to 28 July 2000)

1. Introduction

    1.1 Opening of the Meeting
    1.2 Organisation of the Meeting and Adoption of the Agenda

2. Harvested Species

    2.1 Fisheries Information
        (i) Catches Status and Trends
        (ii) Trends in Fishery Development
        (iii) Observer Scheme
        (iv) Regulatory Framework for CCAMLR Fisheries
    2.2 Regional and Local Surveys
    2.3 B_0 Workshop (results from the CCAMLR-2000 Survey in Area 48)
        (i) Data
        (ii) Methodology
        (iii) Estimate of Krill Biomass for Area 48
        (iv) Variance Associated with Estimate of Krill Biomass
    2.4 Estimation of Potential Yield
    2.5 Future Work

3. Dependent Species and the Environment

    3.1 CEMP Indices
    3.2 Status and Trends of other Species
    3.3 Indices of Key Environmental Variables
    3.4 Analytical Procedures and Combination of Indices
    3.5 Future Work

4. Ecosystem Analysis

    4.1 Krill-centred Interactions
    4.2 Fish and Squid-centred Interactions
    4.3 Status of the Krill-centred Ecosystem
    4.4 Further Approaches to Ecosystem Assessment
    4.5 Future Work

5. Methods and Designation of CEMP Sites

    5.1 Harvested Species Methods
    5.2 CEMP Methods
    5.3 Designation and Protection of CEMP Sites
    5.4 Future Work

6. Advice to the Scientific Committee

    6.1 Precautionary Catch Limits for Area 48
    6.2 Regulatory Framework for CCAMLR Fisheries
    6.3 Consideration of Possible Management Measures
    6.4 Future Work

7. Future Work

    7.1 Outstanding Tasks from 1995 to 1999
    7.2 Review of Future Work under Agenda Items 2.5, 3.5, 4.5, 5.4 and 6.3
    7.3 Future Meetings of WG-EMM

8. CCAMLR Website

9. Other Business

10. Adoption of the Report

11. Close of the Meeting.

APPENDIX B

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(Taormina, Sicily, Italy, 17 to 28 July 2000)

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APPENDIX C

LIST OF DOCUMENTS

Working Group on Ecosystem Monitoring and Management
(Taormina, Sicily, Italy, 17 to 28 July 2000)

WG-EMM-00/1	Provisional Agenda and Provisional Annotated Agenda for the 2000 Meeting of the Working Group on Ecosystem Monitoring and Management (WG-EMM)
WG-EMM-00/2	List of participants
WG-EMM-00/3	List of documents
WG-EMM-00/4	Report of national observer on the work carried out aboard the vessel *Konstruktor Koshkin* in Subarea 48.2 in May–June 1999 V. Bibik (Ukraine)
WG-EMM-00/5	Ecosystem studies carried out during the second Ukrainian Marine Antarctic Expedition in Subareas 48.2 and 48.1 in 1998 V. Bibik and P. Gozhik (Ukraine)
WG-EMM-00/6 Rev. 1	Krill distribution patterns in the Atlantic sector of the Antarctic during the CCAMLR-2000 Survey V. Siegel (Germany), S. Kawaguchi (Japan), F. Litvinov (Russia), V. Loeb (USA) and J. Watkins (United Kingdom)
WG-EMM-00/7	Draft management plan for Specially Protected Area (SPA) No. 4 – Balleny Islands, northern Ross Sea, Antarctica New Zealand
WG-EMM-00/8	Changes in the diet of the South Georgia shag *Phalacrocorax georgianus* at the South Orkney Islands along four consecutive years R. Casaux and A. Ramón (Argentina)
WG-EMM-00/9	Fish in the diet of breeding Antarctic shags *Phalacrocorax bransfieldensis* at four colonies in the Danco Coast, Antarctic Peninsula R. Casaux, A. Baroni and E. Barrera-Oro (Argentina)
WG-EMM-00/10	Second report on distribution, abundance and biological aspects of krill (*Euphausia superba*) north of South Shetland Islands (Survey 0001 RV *Humboldt* – 23 to 28 January 2000 – XI Peruvian Antarctic Expedition) M. Gutiérrez, N. Herrera and J. Quiñones (Peru), X. Chalen (Ecuador) and A. Antony (India)
WG-EMM-00/11	Preliminary results on the diet of the snow petrel *Pagodroma nivea* at Laurie Island, Antarctica, during the 1997/98 breeding season G. Soave, V. Ferretti, N. Coria and R. Casaux (Argentina)

WG-EMM-00/12	Final report of scientific observations of commercial krill harvest aboard the Japanese stern trawler *Chiyo Maru No. 5*, 31 January to 1 March 2000 W. Rain (CCAMLR Observer)
WG-EMM-00/13	Studies of seabirds and seals at Bouvetøya 1998/99 K. Isaksen (Norway), O. Huyser, S. Kirkman, R. Wanless and W. Wilson (South Africa)
WG-EMM-00/14 Rev. 1	Utilising data from ecosystem monitoring for managing fisheries: development of statistical summaries of indices arising from the CCAMLR Ecosystem Monitoring Program W. de la Mare and A. Constable (Australia) (*CCAMLR Science*, 7: 101–117)
WG-EMM-00/15	Notes on the commercial krill harvest of the Japanese stern trawler *Chiyo Maru No. 5* in Subarea 48.1 C. Jones (USA)
WG-EMM-00/16	A statistical assessment of the status and trends of Antarctic and sub-Antarctic seabirds (prepared for the SCAR Bird Biology Subcommittee and SC-CAMLR) Working draft as of June 2000 E.J. Woehler (Australia), J. Cooper (South Africa), J.P. Croxall (United Kingdom), W.R. Fraser (USA), G.L. Kooyman (USA), D.G. Miller (South Africa), D.C. Nel (South Africa), D.L Patterson (USA), H.-U. Peter (Germany), C.A. Ribic (USA), K. Salwicka (USA), W.Z. Trivelpiece (USA) and H. Weimerskirch (France)
WG-EMM-00/17	Haul data analysis from the Polish krill fishery in 1997–1999 E. Jackowksi (Poland)
WG-EMM-00/18	Combined standardised indices of predator performance from Bird Island, summer 1977–2000 I. Boyd (United Kingdom)
WG-EMM-00/19	A description of the ecosystem status at South Georgia during winter 1999–summer 2000 K. Reid (United Kingdom)
WG-EMM-00/20	Status of the South Georgia subarea (48.3) on satellite monitoring of the sea surface temperature, December 1999–January 2000 G. Vanyushin and A. Korobochka (Russia)
WG-EMM-00/21 Rev. 1	Report of the B_0 Workshop (La Jolla, USA, 30 May to 9 June 2000)
WG-EMM-00/22	Ecosystem management I. Everson (United Kingdom) (*CCAMLR Science*, 8: submitted)
WG-EMM-00/23 Rev. 1	Management plan for a new Site of Special Scientific Interest (SSSI) Terra Nova Bay, Victoria Land, Ross Sea Italy

WG-EMM-00/24	Secretariat work in support of WG-EMM Secretariat
WG-EMM-00/25	Krill fishery information Secretariat
WG-EMM-00/26	CEMP indices 2000: analysis of anomalies and trends Secretariat
WG-EMM-00/27	Development of environmental indices F1, F3 and F4 S. Olmastroni and S. Corsolini (Italy), K. Kerry and J. Clarke (Australia) and D. Ramm (CCAMLR Secretariat)
WG-EMM-00/28	Update on the CCAMLR website Secretariat
WG-EMM-00/29	History of development and completion of tasks put forward by WG-EMM (1995–1999) Secretariat
WG-EMM-00/30	A proposal to subdivide CCAMLR Statistical Division 58.4.1 using environmental data S. Nicol and T. Pauly (Australia)
WG-EMM-00/31	Evaluating the ecosystem impact of harvesting krill in the Southern Ocean: an ECOPATH with ECOSIM feasibility study Prof. T. Pitcher (University of British Columbia)
WG-EMM-00/32	Béchervaise Island, MacRobertson Land, Antarctica – CCAMLR Ecosystem Monitoring Program (CEMP) Monitoring Site: description, maps and colony photographs K. Kerry, L. Meyer, W. Papps, J. Clarke and L. Irvine (Australia)
WG-EMM-00/33	Krill distribution pattern due to water structure and dynamics near the South Sandwich Islands in January–February 2000 (Krill Synoptic Survey 2000) V. Sushin, P. Chernyshkov, V. Shnar, F. Litvinov and K. Shulgovskiy (Russia)
WG-EMM-00/34	Interannual variations of water thermochaline structure on South Georgia Island, South Orkney Islands and Shetland Islands shelves P. Chernyshkov, V. Shnar, O. Berezhinsky and I. Polischuk (Russia)
WG-EMM-00/35	Interannual hydroclimate fluctuations of the Atlantic part of the Antarctic since 1970 to 2000 G. Chernega, I. Polischuk and P. Chernyshkov (Russia)
WG-EMM-00/36	Some changes observed in Antarctic seabird distribution and behaviour F. Litvinov (Russia)

WG-EMM-00/37	A multiple-frequency method for identifying and assessing the Antarctic krill stock in the Ross Sea (1989/90, 1997/98 and 1999/2000) M. Azzali, J. Kalinowski and G. Lanciani (Italy) (*CCAMLR Science*, 8: submitted)
WG-EMM-00/38	Summer distribution, abundance and structure of krill populations (*Euphausiasuperba* and *Euphausia crystallorophias*) sampled by plankton net in the western Ross Sea (January–February 2000) M. Azzali, A. Sala and G. Brancato (Italy) (*CCAMLR Science*, 8: submitted)
WG-EMM-00/39	Comparative studies on the biological and acoustical properties of krill aggregations (*Euphausiasuperba* Dana) samples during the XIII Italian Expedition to the Ross Sea (December 1997–January 1998) M. Azzali, J. Kalinoswki, G. Lanciani and I. Leonori (Italy) (*CCAMLR Science*, 8: submitted)
WG-EMM-00/40	Chick provisioning and chick survival to fledging J. Clarke, K. Kerry, L. Irvine and B. Philips (Australia)
WG-EMM-00/41	The length-frequency distribution of krill in the diets of predators at Admiralty Bay, King George Island, Antarctica in the austral summer of 1999–2000 W.Z. Trivelpiece, K. Salwicka, L. Shill and S. Trivelpiece (USA)
WG-EMM-00/42	The use of predator-derived krill length-frequency distributions to calculate krill target strength K. Reid and A.S. Brierley (United Kingdom) (*CCAMLR Science*, 8: submitted)
WG-EMM-00/43	Contribution to a discussion of the ecosystem approach to management of the krill fishery. R.P. Hewitt and E.H. Linen Low (USA) Extract from *The fishery on Amtarctic krill: defining an ecosystem approach to management*. In: *Reviews in Fishery Science*, 8 (3), 2000.
WG-EMM-00/44	Variations in condition indices of mackerel icefish at South Georgia from 1972 to 1997 I. Everson (United Kingdom) and K.-H. Kock (Germany) (*CCAMLR Science*, 8: submitted)
WG-EMM-00/45	Interannual variation to the gonad cycle of the mackerel icefish I. Everson (United Kingdom), K.-H. Kock (Germany) and J. Ellison (United Kingdom)
WG-EMM-00/46	A generalised algorithm for estimating energy and carbon budgets in marine predators I.L. Boyd (United Kingdom)

WG-EMM-00/47	Pinniped research at Cape Shirreff, Livingston Island, Antarctica, 1999/2000. M.E. Goebel (USA) (Extract from: *US AMLR 1999/2000 Field Season Report*)
WG-EMM-00/48	Aerobic dive limit: how often does it occur in nature? D.P. Costa, N.J. Gales and M.E. Goebel (USA) (In: P. Pongonis (Ed.), *Proceedings of the Kooyman Symposium 2000*)
WG-EMM-00/49	Some components of uncertainty in the CCAMLR 2000 acoustical survey of krill D.A. Demer (USA)
WG-EMM-00/50	Distribution of krill as a fraction of Antarctic zooplankton within the South Sandwich Islands area in summer 2000 S.M. Kasatkina and A.P. Malyshko (Russia)
WG-EMM-00/51	Krill distribution related to water structure and dynamics on the South Georgia shelf in January 2000 (AtlantNIRO-BAS Core Programme 1999/2000) V.A. Sushin (Russia), P.P. Chernyshkov (Russia), F.F. Litvinov (Russia), J.L. Watkins (United Kingdom) and A.S. Brierley (United Kingdom)
WG-EMM-00/52	Hydrography and acoustic biomass estimates of Antarctic krill (*Euphausia superba*) near the South Shetland Islands, Antarctica, during January 2000: preliminary results D. Kang, Y. Lee, H.-C. Shin, W. Lee and S. Kim (Republic of Korea)
WG-EMM-00/53	Collection of informative manuscripts regarding SO-GLOBEC activities on Antarctic krill S. Kim (Republic of Korea) and E. Hofmann (USA)
WG-EMM-00/54	Some notes on by-catch of fishes and salps caught by the fishery vessel *Niitaka Maru* in the vicinity of the South Shetland Islands (January to February 1999) T. Iwami, S. Kawaguchi and M. Naganobu (Japan)
WG-EMM-00/55	Notes on the eighth Antarctic survey by the RV *Kaiyo Maru*, Japan in 1999/2000 M. Naganobu, S. Kawaguchi, T. Kameda, Y. Takao and N. Iguchi (Japan)
WG-EMM-00/56	Scales of interannual variability in Antarctic krill biomass at South Georgia A.W. Murray, A.S. Brierley and J.L. Watkins (United Kingdom)
WG-EMM-00/57	CPUEs and body lengths of Antarctic krill during the 1998/99 season in Area 48 S. Kawaguchi (Japan)

WG-EMM-00/58	Analysis of krill trawling positions in the area north of the South Shetland Islands (Antarctic Peninsula area) from 1980/81 to 1998/99 S. Kawaguchi (Japan) (*CCAMLR Science*, 8: submitted)
WG-EMM-00/59	Krill length distribution in fur seal diet at Cape Shirreff, Livingston Island, 1999/2000 M.E. Goebel (USA)
WG-EMM-00/60	The ecosystem approach to managing fisheries: achieving conservation objectives for predators of fished species A.J. Constable (Australia) (*CCAMLR Science*, 8: submitted)
WG-EMM-00/61	Towards an ecosystem status assessment for South Georgia 'Variability of Southern Ocean Ecosystems' Project Team
WG-EMM-00/62	Seabird research at Cape Shirreff, Livingston Island, Antarctica, 1999–2000 T.M. Carten, W.Z. Trivelpiece, M.R. Taft and R.S. Holt (USA)
WG-EMM-00/63	Excerpts from the Report of the Meeting of the SCAR Group of Specialists on Seals Report to CCAMLR WG-EMM, July 2000
WG-EMM-00/64	Report to WG-EMM on implications of meeting schedules Chairman of the Scientific Committee

APPENDIX D

AN EXAMPLE OF AN EXAMINATION OF TRENDS IN KRILL CATCHES IN AREA 48 USING NON-METRIC MULTIDIMENSIONAL SCALING (nMDS)

by Dr A. Constable (Australia)

A preliminary examination of this approach was undertaken by Drs Constable and Ramm and presented to the Working Group in Figures 1(a)–(c). Total catches from each fine-scale area in Area 48 (368 areas in all) were pooled for each three-month period in a split-year – winter (July–September), spring (October–December), summer (January–March) and autumn (April–June). The pattern of catches across all fine-scale areas was then compared for every season between 1980/81 and 1998/99 split-years using nMDS in the Primer statistical package (Clarke and Warwick, 1994). In this procedure, similarities between fishing patterns are determined for all pairwise comparisons of seasons using the Bray-Curtis similarity index. A fourth-root transformation was used to facilitate comparisons between the distribution of catches with only a small weight on that distribution by the total catch in the season. These similarities are then compared using the nMDS routine to provide X-Y coordinates for comparing the overall similarities of seasons (see Clarke, 1993 for discussion of the technique). The distance between points on the graph indicates the similarity between those points, such that close points are more similar in their fishing pattern than distant points. The axes in this context provide a relative measure of distance but do not imply the role of particular factors.

2. The overall results are decomposed to show the similarity of points from the same seasons across years (Figures 1(a) and (b)). The respective split-years are indicated by the last two digits of the year and the lines help indicate the general movement of the fishery from one year to the next. Close points indicate little change in fishing pattern while more distant points show a substantial change in fishing pattern across Area 48. Figure 1(a) shows the segregation of autumn and winter fishing patterns with the latter being concentrated to the north around South Georgia. For autumn, the higher catches of the 1980s are evident as well as the fishing pattern being similar throughout the 1990s. Figure 1(b) shows that the fishing patterns in spring and summer were similar in the 1980s but became segregated in the 1990s. The spring pattern has been much more variable than the tighter pattern in summer.

3. The results are pooled into one figure, Figure 1(c), for the years from 1991 to the present, which is the period when the fishing pattern is expected to have been more stable. These results show a basic separation of seasons, with fishing in winter being reasonably tightly constrained around South Georgia, the spring pattern likely to be near to the retreating ice edge, the summer pattern concentrating near the Antarctic Peninsula and the autumn pattern moving northwards. The shift in fishing pattern in the winter of 1999 probably arises from increased fishing around the South Orkneys.

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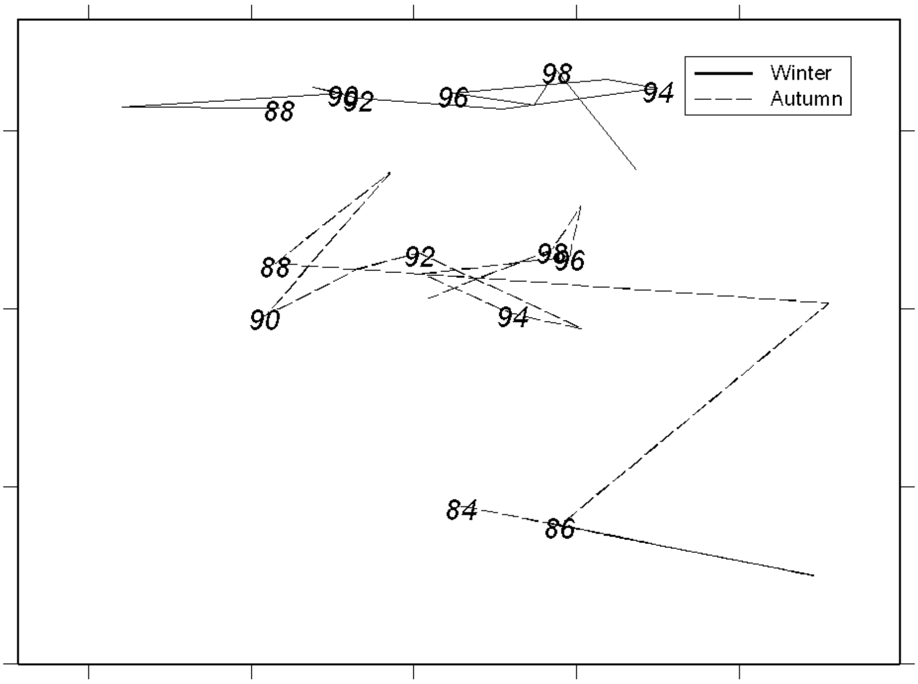
Clarke, K.R. 1993. Non-parametric multivariate analyses of changes in community structure. *Austalian Journal of Ecology*, 18: 117–143.

Clarke, K.R. and R.M.Warwick. 1994. *Change in Marine Communities: An Approach to Statistical Analysis and Interpretation.* Natural Environment Research Council, Plymouth Marine Laboratory, Plymouth, UK.



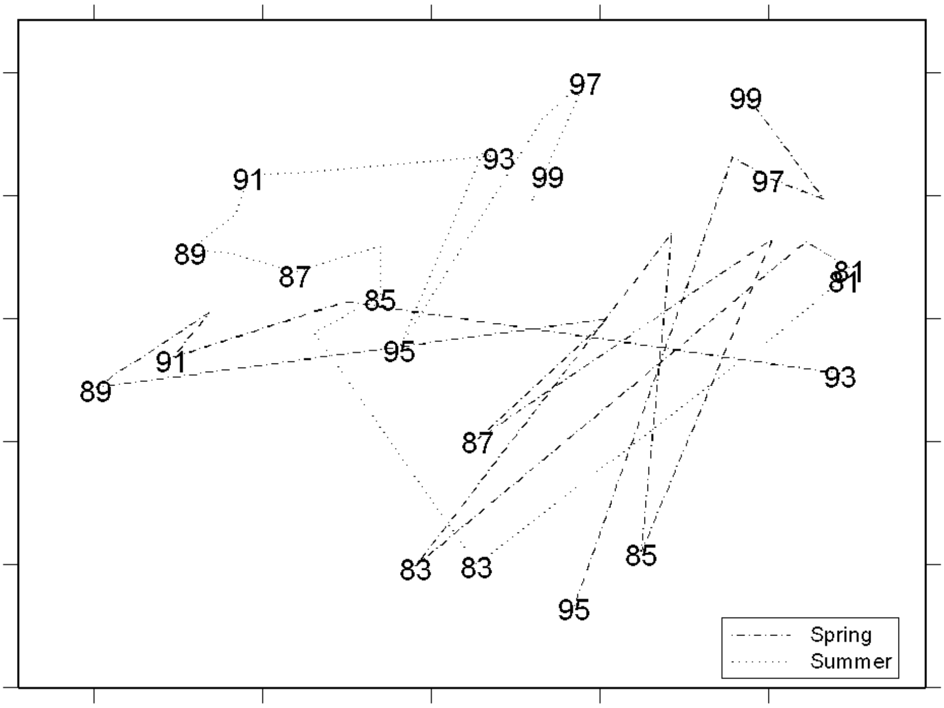


Figure 1: Comparisons of the pattern of krill fishing in Area 48 for each of four seasons since 1980/81 to 1998/99 (see text for details) (Stress = 0.22): (a) winter and autumn fishing patterns; (b) spring and summer fishing patterns; and (c) combined fishing patterns across nine fishing seasons between 1990/91 and 1998/99.

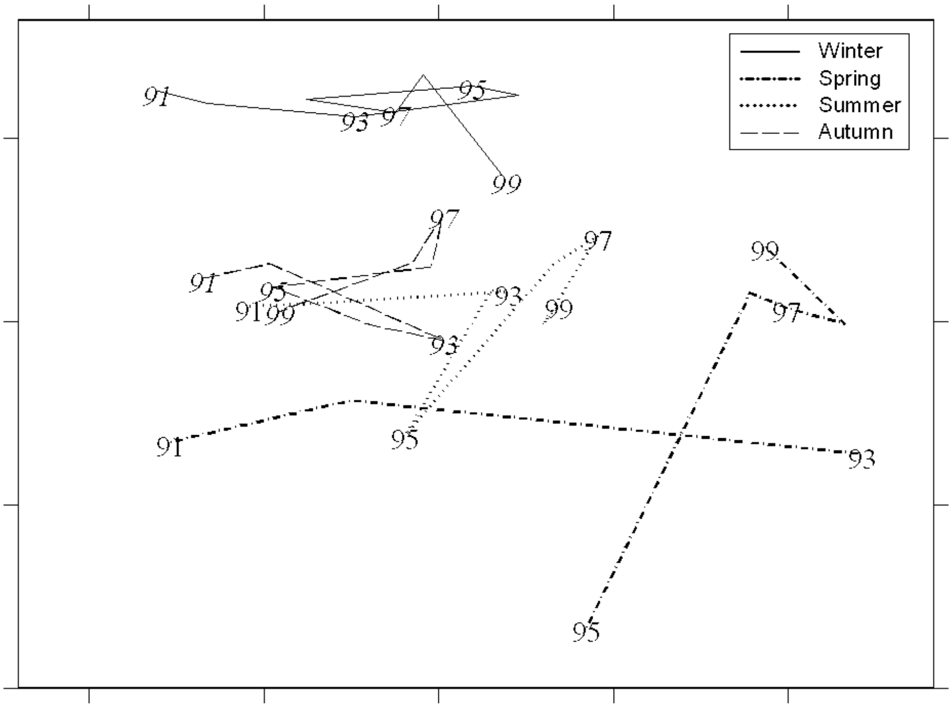


Figure 1 (continued)

APPENDIX E

EXAMINATION OF POTENTIAL CHANGES IN γ ARISING FROM THE YIELD CALCULATIONS AS A RESULT OF SURVEYING BIOMASS AFTER DIFFERENT FRACTIONS OF THE YEAR

Dr A. Constable (Australia)

The aim of the yield calculations for krill is to determine γ such that the long-term precautionary yield satisfies the agreed decision rules:

(i) recruitment criterion – 'that the probability that the spawning biomass falls below 20% of the median pre-exploitation spawning biomass after 20 years should not exceed 10%' –

$\gamma_1 = 0.118$;

(ii) predator criterion – 'that the median spawning biomass should not fall below 75% of the pre-exploitation spawning biomass after 20 years' –

$\gamma_2 = 0.091$; and

(iii) choose the lower γ of the two.

2. This γ is used to estimate yield, Y, according to the equation

$$Y = \gamma B_0 \tag{1}$$

where B_0 is the estimate of pre-exploitation biomass.

3. The expectation from a survey at a different time is that the same yield would arise from the calculation. Thus, it is expected that

$$\gamma_{s2} B_{s2} = \gamma_{s1} B_{s1} \tag{2}$$

4. Rearranging this equation to determine the new γ gives

$$\gamma_{s2} = \frac{\gamma_{s1} B_{s1}}{B_{s2}} \tag{3}$$

5. A simple deterministic formulation of the population model can be used to illustrate the relationship between the two γs, such that biomass at a given time, t, in the year is governed by the weight, w, at age, a, and mortality, M,

$$B_{s1} = R \sum_a e^{-M(a+t)} w_{a+t} \tag{4}$$

where R is an estimate of recruitment at age 0. Biomass at another time, f, in the year is given relative to the first biomass according to the equation

$$B_{s2} = e^{-M(f-t)} R \sum_a e^{-M(a+t)} w_{a+f-t} \tag{5}$$

6. This shows that the second γ will be influenced by the combination of mortality and growth.

7. The relationship between the two γs for a deterministic application of the parameters in Table 1 (main Text) is given in Figure 1 with M = 0.8 and R = 1. The ratios are relative to the first survey being undertaken one month after the beginning of the year.

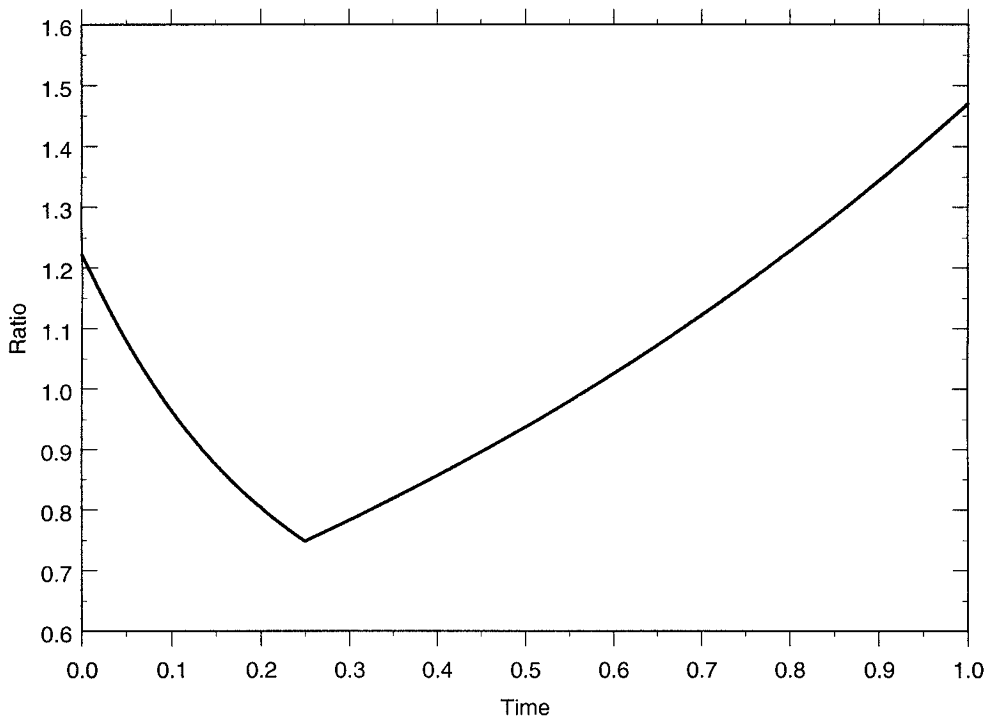


Figure 1: The ratio of the two γs for a deterministic application of the parameters in Table 1 (main text) with M = 0.8 and R = 1. The ratios are relative to the first survey being undertaken one month after the beginning of the nominal growth period (1 November). Time is the fraction of the year.

APPENDIX F

DRAFT TERMS OF REFERENCE FOR THE CCAMLR-2000 SURVEY ANALYSIS STEERING COMMITTEE

The Steering Committee shall comprise the principal scientist form each ship participating in the CCAMLR-2000 Survey (Japan, Russia, UK and USA) plus a vice-chair of the Scientific Committee. The present composition is therefore Drs R. Hewitt (USA), M. Naganobu (Japan), S. Nicol (Vice-chair, Scientific Committee), V. Sushin (Russia) and J. Watkins (UK).

2. The Steering Committee should act in a proactive way to promote and coordinate the analyses and publication of results relating to the CCAMLR-2000 Survey.

3. Specifically the Steering Committee should:

(i) Science Tasks –

(a) Define analyses to be undertaken collaboratively.

(b) Define analyses to be conducted unilaterally.

(ii) Analysis –

(c) Ensure that all analyses are coordinated and agreed by the Steering Committee prior to commencing work.

(c) Define, coordinate and promote analysis workshop(s).

(e) Coordinate analyses of data not undertaken at workshops.

(f) Act as a two-way information conduit such that Steering Committee members are made aware of individual analyses being conducted in each member's country, and that individual scientists are made aware of this information.

(iii) Publication –

(g) Oversee production of a special issue in a peer-reviewed international journal.

(h) Establish an Editorial Board for this issue.

(i) Produce a proposed publication list for the special issue.

(j) Act as arbitrators/mediators for conflicts in all publication authorships.

(k) Ensure that all manuscripts are brought to the attention of the Steering Committee prior to submission.

(l) Maintain a register of all publications relating to the CCAMLR-2000 Survey.

APPENDIX G

REPORT OF THE B_0 WORKSHOP
(La Jolla, USA, 30 May to 9 June 2000)

REPORT OF THE B_0 WORKSHOP
(La Jolla, USA, 30 May to 9 June 2000)

INTRODUCTION

1.1 A workshop to analyse data from the CCAMLR-sponsored multinational, multiship acoustic survey for krill biomass in Area 48 undertaken in January and February 2000 was held at the Southwest Fisheries Science Center, La Jolla, California, from 30 May to 9 June 2000. The workshop was convened by Dr R. Hewitt (USA). A List of Participants is included in this report as Attachment A.

1.2 Dr R. Neal, Deputy Director, Southwest Fisheries Science Center, welcomed participants to the workshop and wished them a profitable meeting.

1.3 A Provisional Agenda had been prepared by the Convener and this was adopted. The Agenda is included as Attachment B.

1.4 This report was prepared by Dr I. Everson (UK) in consultation with workshop participants.

Aims

1.5 The primary aims of the workshop had been agreed by WG-EMM at its 1999 meeting as the estimation of B_0 of Antarctic krill (*Euphausia superba*) and its associated variance in CCAMLR Statistical Area 48 (SC-CAMLR-XVIII, Annex 4, paragraph 8.37). It had been agreed that a key step in this estimation would comprise a multiship acoustic survey of Area 48 (CCAMLR-2000 Survey) to be undertaken in early 2000 (SC-CAMLR-XVIII, paragraph 6.36).

1.6 The workshop noted that the term 'B_0' denotes a krill standing stock being estimated (SC-CAMLR-XII, paragraphs 2.39, 2.41 to 2.47). It is used as a proxy for krill pre-exploitation biomass in the CCAMLR Generalised Yield Model (GYM) used to estimate krill sustainable yield, and to scale the krill biomass probability distribution over time in the estimation of γ with the GYM. In this report 'B_0' and 'standing stock' are used interchangeably.

1.7 WG-EMM would use the estimate of B_0 produced by the workshop to estimate potential yield using the GYM. This would be used to advise on a precautionary catch limit for Area 48, and this precautionary catch limit would be subdivided for smaller management areas as appropriate (SC-CAMLR-XVIII, Annex 4, paragraph 8.50).

1.8 WG-EMM had considered several methods by which catch limits might be subdivided and had agreed that the most tractable were likely to be by proration by:

(i) the proportion of the survey in each statistical subarea where the proportions are estimated from the lengths of survey tracks (SC-CAMLR-XVIII, Annex 4, paragraphs 8.55(iii) and 8.61); and

(ii) the area of krill distribution in each statistical subarea (SC-CAMLR-XVIII, Annex 4, paragraphs 8.55(iv)(b) and 8.61).

1.9 The workshop had been requested to provide estimates of the relative proportions of the survey track length within each statistical subarea (SC-CAMLR-XVIII, Annex 4, paragraph 8.61).

Preparation

1.10 Plans for the CCAMLR-2000 Survey had been set in motion during the 1996 WG-EMM meeting. The underlying theme was that since the krill biomass estimate from the 1981 FIBEX survey, on which the current CCAMLR precautionary catch limit for krill is based, had been made 15 years previously, a new estimate of this limit was a high priority. While a standing stock estimate remained the primary aim, it was recognised that additional oceanographic sampling during the CCAMLR-2000 Survey could provide much new information of value to ecosystem assessments undertaken by WG-EMM. The scope of the overall study had as a result been broadened whilst still retaining the same primary objective as outlined in paragraph 1.5.

1.11 Plans for the CCAMLR-2000 Survey had been finalised at a meeting in Cambridge, UK, in 1999 (SC-CAMLR-XVIII, Annex 4, Appendix D). At that meeting the main survey transects were delineated, methods for krill sampling agreed and the scope of ancillary sampling discussed.

1.12 The following computing facilities were available at the workshop: five computers were running Windows 2000 and had the acoustic data analysis software Echoview, Versions 1.51.38 and 2.00.62 installed. All computers had the package Microsoft Office and two had the numerical analysis packages Surfer, Transform and MatLab installed. All computers were networked to a central file server, colour and black and white printers and a video projector. Additional computers were made available on the network as needed.

INFORMATION AVAILABLE AT THE WORKSHOP

Survey Design

2.1 The CCAMLR-2000 Survey design had been agreed by WG-EMM in 1999 and consisted of a large-scale survey to cover much of Subareas 48.1, 48.2, 48.3 and 48.4 with randomly spaced transects. This large-scale survey was divided into three strata. Within the large-scale area there are four mesoscale regions that are considered to have a high abundance of krill and therefore to be of importance to commercial fishing fleets. These regions lie to the north of South Georgia, north of the South Orkney Islands, and north of the South Shetland Islands, and around the South Sandwich Islands. Additional mesoscale strata were designated for these regions. In some instances the large-scale survey transects crossed the mesoscale survey boxes. The sections of large-scale survey transects which went through these are indicated in Table 1. These were excluded from the analyses.

Definition of Strata

2.2 The area surveyed within each stratum was calculated from the nominal transect lengths and the 125 km wide zone within which each transect was placed (see Figure 1a, b, c). The land and mesoscale survey areas were excluded from the estimated areas for the large-scale survey.

2.3 The estimated strata areas were as follows:

Large-scale strata:

Antarctic Peninsula	473 318 km^2
Scotia Sea	1 109 789 km^2
East Scotia Sea	321 800 km^2

Mesoscale strata:

South Shetland Islands	48 654 km^2
South Orkney Islands	24 409 km^2
South Georgia	25 000 km^2
South Sandwich Islands	62 274 km^2

2.4 At WG-EMM-99 it had been agreed that sampling according to the design outlined above would be used for the estimation of standing stock in Area 48. However, it was recognised that additional sampling programs would be in progress within Area 48 at approximately the same time as the CCAMLR-2000 Survey. It had also been agreed that data arising from such surveys should not be included in the analyses leading to the estimation of B_0, but would provide useful information to support the Area 48 B_0 analysis.

Sampling Program

B_0 Sampling

2.5 Vessels from Japan (*Kaiyo Maru*, Scientist-in-Charge (SIC) Dr M. Naganobu), Russia (*Atlantida*, SIC of Acoustic Program, Dr S. Kasatkina), UK (*James Clark Ross*, SIC Dr J. Watkins) and USA (*Yuzhmorgeologiya*, SIC Dr Hewitt) had participated in the CCAMLR-2000 Survey. The survey tracks of all participating vessels are shown in Figure 2.

2.6 All participating vessels were equipped with Simrad EK500 echosounders operating at 38, 120 and 200 kHz (Tables 2 and 3). Echosounders were set according to protocols agreed at the planning meeting (paragraph 1.11 above; SC-CAMLR-XVIII, Annex 4, Appendix D). On each vessel, acoustic data were logged using the SonarData echolog_EK Version 1.50 software.

Survey Activities

2.7 SICs on each vessel gave a brief presentation outlining key results from their respective research cruises. Summary information on the cruises of direct relevance to the workshop aims is set out in Table 4. All vessels undertook a sampling program more extensive than the requirements of the CCAMLR-2000 Survey protocol. Details of this additional sampling are set out in Table 5.

2.8 Dr Watkins noted that the *James Clark Ross* had encountered a large number of icebergs in the vicinity of Shag Rocks and the southern side of South Georgia (Subarea 48.3). This caused the vessel to divert from the planned survey transect (SS07). It was noted that this may be a more general problem with other transects (see also paragraph 3.51).

2.9 Due to adverse weather conditions causing the vessel to fall behind schedule, the fifth transect (AP13) allotted to the *James Clark Ross* had been sampled from north to south, (the reverse direction to that of the original plan). Time constraints meant that the last 100 km of the final transect (AP19) had not been sampled by the *James Clark Ross*.

2.10 Dr Kasatkina reported that the *Atlantida* had undertaken a large-scale and mesoscale survey in the vicinity of the South Sandwich Islands (Subarea 48.4) according to a plan designed to fit into the overall CCAMLR-2000 Survey plan agreed by WG-EMM (SC-CAMLR-XVIII, Annex 4, paragraphs 8.4 to 8.6). All transects on the survey had been sampled.

2.11 Dr Kasatkina reported that an acoustic calibration of the *Atlantida* had been undertaken in Horten, Norway, prior to the vessel heading south to participate in the CCAMLR-2000 Survey. The second acoustic calibration, (the first calibration for the CCAMLR-2000 Survey), had been made at Stromness Harbour, South Georgia. High winds had made this calibration very difficult. The second calibration for the survey was undertaken under much more favourable weather conditions at the end of the survey.

2.12 In Subarea 48.4 (South Sandwich Islands) the interaction of two Antarctic water masses was observed: cold water of the Weddell Sea and warmer water of the southern flow of Antarctic Circumpolar Current. The boundary between the two water masses represented the Weddell Gyre frontal zone. Northward transport of cold Weddell Sea waters along the South Sandwich Islands arc was observed up to 54°S. In general, species composition of catches was mixed (krill, other euphausiids, juvenile fish, jellyfish, myctophids, salps). Krill ranging from 21–60 mm total length were caught. The highest krill catches were observed in the Weddell Sea Water.

2.13 Dr Naganobu noted that during Leg 1 of their cruise, the *Kaiyo Maru* had undertaken a mesoscale survey as part of the International Coordination Study in the vicinity of the South Shetland Islands (Subarea 48.1), before commencing the CCAMLR-2000 Survey (SC-CAMLR-XVIII, paragraph 5.10). Leg 2 of the cruise was the CCAMLR-2000 Survey and this had been undertaken without difficulty. Also during Leg 2 a second mesoscale survey was conducted in the vicinity of the South Shetland Islands that was part of the CCAMLR-2000 Survey.

2.14 Dr Hewitt noted that the *Yuzhmorgeologiya* had undertaken the CCAMLR-2000 Survey as planned although due to time constraints the final part of the last transect (AP17) had been curtailed. He also noted that since relatively few large acoustic targets had been encountered, only a small number of targeted net hauls had been undertaken. Surface chlorophyll measurements in Subarea 48.1 confirmed the observations from SeaWIFS satellite data that there is tongue of oligotrophic water offshore of the South Shetland Islands.

2.15 In general discussion it was noted that target net hauls had indicated that myctophids were present in deep water (>300 m). It was therefore likely that they might be the cause of most of the acoustic backscatter in deep water attributable to biological targets.

2.16 Two shallower target tows, that had been aimed at scatterers which were assumed to have been krill, caught *Themisto gaudichaudii* (Amphipoda) and *Thysanoessa*.

2.17 All vessels had encountered large numbers of icebergs in the vicinity of South Georgia. These were thought to have been due to the breakup of two large icebergs – A10 which had come from the Weddell Sea and B10 from the Bellingshausen Sea.

National Surveys

Korean Survey

2.18 Dr D. Kang (Republic of Korea) described a cruise to estimate the abundance and distribution of krill in the vicinity of the South Shetland Islands where a hydroacoustic survey was conducted by the RV *Onnuri* as a part of the Korea Antarctic Research Program. The survey was conducted from 9 to 19 January 2000 using a Simrad EK500 echosounder operating at 38, 120 and 200 kHz. The acoustic data were obtained from the eight transects comprising the South Shetland Islands mesoscale box (total transect length = 459 n miles, area = 38 802 km^2). Krill were collected using Bongo nets (mesh size: 0.333 mm, 0.505 mm) to determine their size composition and stage of development. In addition, a Conductivity Temperature Depth probe (CTD) and on-station Acoustic Doppler Current Profiler (ADCP) were used to understand the physical structure of the water column at 11 stations.

2.19 The length–weight relationship of krill sampled during the survey was $w = 0.0035\ L^{3.2108}$ where w was the mass (mg) and L was the total length (mm); the median length was 50 mm. The conversion factor for integrated volume backscattering to areal krill biomass density at 120 kHz was 0.1556. The mean density of krill in the area surveyed was 12 g/m^2 with a coefficient of variance of 14.5%. Krill swarms with relatively higher densities appeared to the north of Smith Island, north and east of King George Island, and north and south of Elephant Island. The mean density of krill observed during the survey was much lower than that observed during a similar survey in 1998 (151 g/m^2).

US AMLR Survey

2.20 Mesoscale sampling in the vicinity of Elephant Island, undertaken by the *Yuzhmorgeologiya* as part of the US AMLR Program, was described by Dr Hewitt. The design consisted of three survey boxes: one to the north of the South Shetland Islands, one north of Elephant Island and the third south of the eastern end of the South Shetland Islands. As in previous years, a sharp frontal zone was noted north of the South Shetland Islands shelf break and this became more diffuse towards Elephant Island. Mean densities of krill were 28 g/m^2 in the northern South Shetland box, 26 g/m^2 in the Elephant Island box and 17 g/m^2 in the southern South Shetland box.

2.21 The variations in the krill density estimates over the past eight years in the Elephant Island area were described by a cyclical function (Hewitt and Demer, in press). The relatively low standing stock observed during the survey was considered to be indicative of poor recruitment over recent seasons; 1994/95 producing the last strong year class.

Japanese Survey

2.22 A survey along the northern side of the South Shetland Islands undertaken by *Kaiyo Maru* was described by Dr Naganobu. The survey was carried out by sampling closely spaced stations in and around the krill fishing grounds. Data on seasonal krill flux during the 1999/2000 season were collected during a series of repeat surveys. The first survey was undertaken in December 1999 and the second in January and February 2000. Large-scale oceanographic transects were sampled using CTD along two longitudinal sections: one in the Drake Passage (WOCE Line SR1) and the other in the Indian Ocean sector. A series of 12 laboratory experiments was undertaken aboard the vessel to estimate the instantaneous growth rate of krill. A further 500 individual krill were transported alive to Japan for further biological experiments.

Russian Survey

2.23 A small-scale survey at South Georgia that had been planned as part of the BAS Core Program could not be undertaken by *James Clark Ross* due to unforeseen circumstances. That survey was undertaken by the *Atlantida* and the results will be analysed at a joint workshop between scientists from Russia and the UK.

Krill Length Frequencies

2.24 Krill length-frequency data from the station hauls sampled by all vessels participating in the CCAMLR-2000 Survey had been analysed by Dr V. Siegel (Germany). The analysis had been undertaken in two parts: an agglomarative hierarchical cluster analysis to determine whether there were recognisable groupings of krill length-frequency distributions over the survey area, and a geographical consideration of the distribution of such clusters.

2.25 Four types of linkage method were used to compare the results from the different fusion methods on the station groupings:

(i) single linkage;
(ii) complete linkage;
(iii) unweighted Pair Group Average (UPGA); and
(iv) Ward's Method.

2.26 In the first step, each object (station) represents a cluster of its own and the distance between objects is determined by the distance measure (e.g. Euclidean Distance). In principal, objects which have a minimal distance value (single linkage) are fused. Another approach is to group objects (stations) into different (dissimilar) clusters by identifying the maximum distance (furthest neighbour, complete linkage). The latter method is usually recommended for data which naturally form groupings of objects.

2.27 The results of the single linkage method showed no separation of stations into distinct clusters, but the dendrogram formed a 'chain' of stations. This often occurs if few objects have similar distance values. Results from all other three linkage methods clearly indicated a separation of stations into at least three distinct clusters.

2.28 Interpretation of the results using Ward's method caused some difficulty since, from the dendrogram, Cluster 2 appeared to be more similar to Cluster 1 than to Cluster 3, although the resulting overall length-frequency distribution of Cluster 1 was distinctly different from those of Clusters 2 and 3 (see below).

2.29 The UPGA method uses the average distance between all pairs of objects (stations). The dendrogram of this linkage showed a greater similarity between Clusters 2 and 3 and a greater dissimilarity of these two to Cluster 1. This was in concordance with the resulting composite length-frequency distributions of the relevant clusters.

2.30 The complete linkage method (using the greatest instead of the average distance) provided a dendrogram very similar to the UPGA method, and the three clusters were even more distinct than for the previous method. Therefore, the result of the complete linkage method was thought to be the most appropriate to describe the geographical distribution of the various clusters and the related composite length-frequency distributions (Figure 3). Grouping the length-frequency distributions, weighted by catch rates, indicated that each of the clusters had a reasonably tight length-frequency distribution. The aggregated length-frequency distributions are shown in Figure 4.

2.31 The locations of hauls on which these clusters were based fitted into a pattern which appeared similar to the water circulation pattern in the region (paragraphs 2.33 to 2.38). Cluster 1 was composed of small krill of median length 26 mm and occurred from the northern sector of the Weddell Sea and extended across to the north of South Georgia. The distribution of Cluster 2, with a median length of 48 mm, extended from the Bransfield Strait eastwards to the east of the South Orkney Islands, then across the Scotia Sea to the north of South Georgia and the northern part of the South Sandwich Islands. The distribution of Cluster 3, median length 52 mm, extended from the Drake Passage eastwards to include Elephant Island and the South Orkney Islands. The distribution of the clusters is shown in Figure 5 and the latitudinal positions of the cluster boundaries along the transects are indicated in Table 6.

2.32 A small subgroup discussed the future analysis of zooplankton samples. Its report is included as Attachment C.

Physical Oceanography

2.33 A summary of physical oceanographic information was provided by Dr M. Brandon (UK). Routine collection of physical oceanographic data formed an integral part of the CCAMLR-2000 Survey. Data from 157 oceanographic stations sampled by the *Kaiyo Maru*, *James Clark Ross* and *Yuzhmorgeologiya* were available in advance of the workshop. Together with data from the remaining stations sampled from the *Atlantida*, these data represent the largest synoptic dataset since FIBEX in 1981. In comparison with the FIBEX study the CCAMLR-2000 Survey covered a greater area.

2.34 All sampling was undertaken according to predetermined protocols and the submitted data had been combined into an overall database. Plots of potential temperature against salinity indicated very good consistency between sampling vessels. This enabled mapping of key water masses across the region.

2.35 Considering the transects from west to east, the main direction of flow of the Antarctic Circumpolar Current, the constraining effect of the Drake Passage was clearly evident in the proximity of the Southern Antarctic Circumpolar Current Front and the Continental Water Boundary. Both these fronts were close to the Antarctic Peninsula. Similarly the Sub-Antarctic Front and Antarctic Polar Front were close together at the central section of the Drake Passage.

2.36 As the Antarctic Circumpolar Current enters the Scotia Sea it becomes less topographically constrained and spreads out. Although a large dataset was collected during the CCAMLR-2000 Survey, it was not sufficient to resolve individual eddies.

2.37 All of the transects were south of the Polar Front. The Weddell Scotia Confluence is observed extending from the Antarctic Peninsula to the vicinity of the South Orkney Islands. Proceeding further east, and particularly in the region east of the South Orkney Islands, Weddell Sea Water becomes the dominant water mass.

2.38 The general distribution of water masses over the region during the CCAMLR-2000 Survey is shown in Figure 6.

METHODS

Acoustic Data Preparation

3.1 The steps required to produce an estimate of B_0 from acoustic data as agreed at WG-EMM-99 (SC-CAMLR-XVIII, Annex 4, paragraphs 8.41 to 8.49) were reviewed. The steps are:

(i) Delineate volume backscattering attributed to krill from all other volume backscattering. Two methods were proposed to accomplish this step: one based on the difference between mean volume backscattering strength (MVBS) at 120 and 38 kHz, the other based on an algorithm that makes use of volume backscattering at three frequencies. Once volume backscattering attributed to krill was delineated, it would be summed over a depth range and averaged over a time/distance interval (integrated).

(ii) Convert integrated backscattering area attributed to krill to areal krill biomass density. Two methods were proposed to accomplish this step: one using length-frequency data to estimate a distribution of target strengths (TS) based on the TS-length model adopted by SC-CAMLR in 1991, and the other using *in situ* TS measurements. The workshop agreed to make initial assessments using published TS to size relationships and, if time permitted, to extend the assessments using *in situ* TS results.

(iii) S areal krill biomass densities over the survey area. Two methods were proposed to accomplish this step: one is an application of the method of Jolly and Hampton (1990), which assumes that the mean density for each transect within a stratum is a representative sample of the stratum mean, and the other uses an approach based on geostatistical methods. The workshop agreed to use the Jolly and Hampton method.

(iv) Estimate the uncertainty associated with an estimate of B_0. It was agreed that the estimate of uncertainty should include both sampling errors (transect to transect variance) and measurement errors.

3.2 The workshop agreed that the 120 kHz data should be used for the estimation of krill standing stock. Data at 38 and 200 kHz would be used along with those at 120 kHz to aid with target delineation and also provide information to incorporate into the estimate of uncertainty of the standing stock estimate.

3.3 Acoustic datasets from all participating vessels were available for analysis at the workshop. These included raw data (EK5 files), annotations including positional data (EV files), calibration data, transect start and stop times, and noise measurements.

3.4 Recent developments had been made with the Echoview software and these were described to the workshop by Mr I. Higginbottom (SonarData, the Echoview developer). The main advances from Version 1.51 to Version 2.00 had been to permit the simultaneous analysis of data from multiple frequencies and echosounders.

3.5 Version 1.51 EV files had been submitted prior to the workshop by SICs for each participating survey vessel. These were converted to Version 2.00 EV files for use at the workshop. However, several questions remained to be resolved before the EV files could be used to address the steps outlined in paragraph 3.1.

3.6 After some discussion it was agreed that prior to integrating and analysing the acoustic data, consideration needed to be given to the following: draft correction, allowance for noise, surface layer exclusion, calibration, sound velocity, absorption coefficient, wavelength, bottom detection algorithm, transect sections to be excluded and equivalent two-way beam angle.

Draft Correction

3.7 The workshop considered that no changes were needed to the draft correction for any of the vessels. A draft correction for the *James Clark Ross* had to be removed.

Allowance for Noise

3.8 Two general methods were considered:

(i) setting a threshold (either fixed or time-varied) and accepting all integrated values greater than the threshold (termed the thresholding approach); and

(ii) estimating a time-varied volume backscattering strength due to noise and subtracting this from integrated values (termed the subtraction approach). In the case of negative values being derived these were reset to -999 dB.

3.9 The workshop concluded that the subtraction approach would provide better estimates of volume backscattering strength (S_v). Initial estimates of noise at each frequency on each transect as provided by SICs were used. During subsequent inspection of echograms several noise levels were modified. The final values used are listed in Table 7.

Calibration

3.10 Calibration was an integral part of the overall CCAMLR-2000 Survey plan with two calibration periods scheduled for each vessel. Calibrations were undertaken prior to the start of the survey at Stromness Harbour, South Georgia, by all vessels. The second calibration was undertaken on completion of the survey at Stromness by the *Atlantida* and at Admiralty Bay, King George Island by the other three vessels.

3.11 All calibrations were undertaken using the standard sphere method. Dr D. Demer (USA) had obtained a set of 38.1 mm diameter Tungsten Carbide spheres from the same manufacturing lot. He had arranged for these spheres to be bored and fitted with monofilament loops. These spheres had been distributed to the SIC on each vessel. Standard copper spheres 60, 23 and 13.7 mm diameter, provided by each vessel, were also used for calibration.

3.12 Temperature and salinity at the calibration sites were similar and within the range of a large part of the CCAMLR-2000 Survey area. In a few instances inclement weather had slightly prejudiced the quality of the results, but in spite of this all calibrations were within or close to the specification for the equipment. For the *Yuzhmorgeologiya* and the *James Clark Ross* the mean values of the two calibrations were used. For the *Atlantida* the second calibration and for the *Kaiyo Maru* the first calibration were considered to be the better of the two. The measured values of S_v gain and TS gain along with those selected for application to the acoustic analyses are shown in Tables 8 and 9. Summary calibration data from each survey vessel are set out in Table 10 and details of the calibration parameters are set out in Table 11.

Sound Velocity (c)

3.13 In advance of the CCAMLR-2000 Survey a default value for the velocity of sound in water (c), derived from CTD analyses in previous seasons, of 1 449 m/s had been agreed. Physical oceanographic sampling during the survey indicated that a better estimate for c would be 1 456 m/s. Although only a slight modification, the workshop agreed that data should be analysed using this value.

Absorption Coefficient (α)

3.14 The absorption coefficient (α) is dependent on sound velocity, temperature and salinity. Default values of α had been agreed in advance of the CCAMLR-2000 Survey; these were 0.010 dB/m at 38 kHz, 0.026 dB/m at 120 kHz and 0.040 dB/m at 200 kHz. Using the equations of Francois and Garrrison (1982), the following revised values, appropriate to the actual survey conditions, were agreed: 0.010 dB/m at 38kHz, 0.028 dB/m at 120 kHz and 0.041 dB/m at 200 kHz.

Wavelength (λ)

3.15 The slight change in the accepted value of sound velocity required a recalculation of the wavelength. Using the nominal resonant frequency of the transducers the following values were determined for wavelength (λ):

200 kHz:	1 456/200 000	=	0.00728 m
120 kHz:	1 456/119 050	=	0.01223 m
38 kHz:	1 456/37 880	=	0.03844 m

Bottom Detection Algorithm

3.16 Bottom as detected by the EK500 was visually verified from the echograms and adjusted, if necessary, to ensure that bottom echoes were excluded from the integrated layers.

Equivalent Two-way Beam Angle

3.17 This parameter, provided by the manufacturer for a nominal sound speed of 1 473 m/s, was adjusted for a sound velocity of 1 449 m/s by the *James Clark Ross* and the *Atlantida* and set in the EK500 prior to the CCAMLR-2000 Survey. No such adjustments were made for the *Kaiyo Maru* and the *Yuzhmorgeologiya* prior to the survey. The workshop accepted that no additional change was necessary (see Table 12).

Surface Exclusion Layer

3.18 A surface layer exclusion depth of 15 m had been applied to data from the *Yuzhmorgeologiya* and the *Atlantida*, and 20 m for data from the *James Clark Ross* and the *Kaiyo Maru*. These values had been set by the various operators based on previous experience. Whilst there might be some merit in standardising the depth for analysis, it was agreed that given that krill may occur near the surface, it was important to review the data files and make adjustments to include any near-surface targets or exclude any intensive surface noise spikes. This was carried out by a combination of changing the overall depth of the surface exclusion layer or editing small fragments of the surface exclusion layer around individual targets (see Table 7 for details).

3.19 The foregoing decisions on values for draft correction, noise, calibration, sound velocity, absorption coefficient, wave length, bottom detection and two-way beam angle were incorporated into revised EV files for each transect (Table 10).

3.20 Each participating group had provided a complete set of data at the three frequencies. Consequently the datasets included data collected during the following types of activity:

(i) large-scale synoptic survey transects;
(ii) mesoscale survey transects;
(iii) net hauls;
(iv) CTD stations;
(v) calibrations; and
(vi) vessel ‘down time’ due to bad weather or other causes.

3.21 All of these data are indexed by date, time and position. The date and time for the start and end of each transect are set out in Tables 13 to 19. The EV files were further annotated to include only valid acoustic transect periods after the start time, between station periods and down time along the transects, and before the end time.

Delineation of Volume Backscatter Attributed to Krill

3.22 Two options were considered for the identification of krill targets on echocharts. In the past several workers had applied a subjective visual classification to echograms with moderate success. It was accepted that that method was very much dependent on operator skill and experience and was subject to considerable individual variation even between workers at the same institute. The workshop agreed that a processing algorithm would offer a better approach by providing a formalised and objective method for analysing the data.

3.23 Dr Watkins provided an overview of a method that he and his colleagues had developed (Watkins and Brierley, 2000). The method relies on the frequency dependence of the echostrength of acoustic targets. In the acoustic domain, the ratio of the echostrengths is given as the difference between the mean volume backscattering strength (ΔMVBS) at two frequencies. The chosen frequencies were 120 and 38 kHz and the method had been developed during studies over several seasons at South Georgia (Subarea 48.3).

3.24 Applying the method of Watkins and Brierley (2000), the ΔMVBS for krill fell within the general range 2–12 dB. Although other scatterers were present in the water these generally fell outside the ΔMVBS range for krill. It was accepted that some, such as other euphausiids (*Thysanoessa* and *Euphausia frigida*) and amphipods (*T. gaudichaudii*), might be included within the krill ΔMVBS. The ΔMVBS values determined from field studies fitted reasonably closely to those from theoretical models of krill TS and size.

3.25 This approach relies on the mean density averaged over the integration depth range and distance. Providing transducers are situated close together and the echosounders are synchronised, then a ping-by-ping comparison might provide a source of information for target delineation.

3.26 Dr Demer described an approach which sought to exploit the frequency dependence allied to differences in variance between individual pixels to address this problem. He had found that one component of the variance provided a good indication as to whether the echoes arose from biological scatterers or were due to noise, the seabed or some other non-biological source. Extending this analysis to include data from the three frequencies 38, 120 and 200 kHz provided a more rigorous approach to target identification. Modelling results had supported these conclusions from field observations and the frequency dependence at 38 and 120 kHz were in agreement with the Watkins and Brierley method outlined above.

3.27 The means to implement this procedure were still under development and at the time of the workshop the processing algorithms still required some development. The workshop felt that the approach had considerable merit and should be developed, however, it was felt that with the limited time available it would be appropriate to use the Watkins and Brierley method until such time as alternatives were available. Development of such methods was considered a high priority by the group.

Implementation of Echoview 2.00.62

3.28 The workshop discussed a stepwise approach to analysing the CCAMLR-2000 Survey data. It was agreed that the first group of processing activities should lead to the production of intermediate echogram datafiles which contained only those data deemed appropriate for echointegration.

3.29 The first step in this process involved the definition of the upper and lower depth ranges. Nominal surface layer exclusion depths to define the upper depth limit had been defined for each vessel. These are included in Table 7. The lower level was set according to one of two criteria. Where the bottom depth was <500 m, the lower level of integration was set as the bottom depth less 5 m. Where the bottom depth was >500 m, the lower level for integration was set to 500 m.

3.30 The second step involved the averaging of S_v into integration bins of 5 m depth by 100 s in time. These approximate to a horizontal distance of 0.5 km when the vessel is proceeding at 10 knots.

3.31 The third step was to calculate a time-varied noise S_v for each frequency on each vessel. Using the subtraction process, revised datasets of resampled 'noise-free' S_v values at each operating frequency were generated. The noise measurement results are set out in Table 7.

3.32 The fourth step was to generate a matrix of ΔMVBS values by subtracting the resampled noise-free 38kHz values from the resampled noise-free 120kHz values.

3.33 Although krill have previously been delineated by using a general ΔMVBS window of 2–12 dB, Watkins and Brierley (2000) showed that a substantial proportion of small krill sampled in a field study around South Georgia in 1996 and 1997 were not detected using this general window, but would be detected using a range of 2–16 dB. Given that krill in the eastern area of the Scotia Sea were relatively small, it was agreed that a ΔMVBS range of 2–16 dB should be used in the present analysis.

3.34 These steps were implemented as set out in Table 20.

Methods for Converting Integrated Krill Backscattering Area to Areal Krill Biomass Density

3.35 A factor for converting integrated backscattering area to areal krill biomass density can take the form:

$$\rho = S_A\, w/\sigma \qquad (1)$$

where ρ = areal krill biomass density
S_A = integrated backscattering area
w = krill mass
σ = acoustic cross-sectional area

where $$\sigma = 4\,\pi\, r_0^2\, 10^{TS/10} \qquad (2)$$

and $r_0 = 1$ m.

3.36 This factor can be considered as two components, the relationship of krill acoustic cross-sectional area to length and krill mass to length. These two can then be combined to provide a factor to convert S_A to areal krill biomass density.

3.37 The workshop used the generalised formula

$$w = aL^b \quad (3)$$

where w = total mass (mg) and L = total length (mm).

3.38 It was agreed that ideally the length to mass relationship to be used to analyse the CCAMLR-2000 Survey data should come from data collected during the survey. Length and mass data had been collected by the *Kaiyo Maru* when working in Subarea 48.3. No other length mass data from the survey were available to the workshop.

3.39 These data from the CCAMLR-2000 Survey were examined in relation to other published krill length to mass data from Area 48 which were thought to be compatible in terms of the season and krill maturity stage composition. The following length to mass relationships were considered.

a	b	L (mm)	Source
0.000925	3.550	-	FIBEX 1
0.00180	3.383	-	FIBEX 2
0.002236	3.314	30–48	This survey *Kaiyo Maru*
0.00385	3.20	26–59	Morris et al. (1988)
0.00205	3.325	23–60	Siegel (1992)

3.40 SC-CAMLR (SC-CAMLR-X, paragraph 3.34) adopted the following krill TS to length relationship at 120 kHz:

$$TS_{120} = -127.45 + 34.85 \log (L) \quad (4)$$

3.41 Applying the frequency dependent formula given by Greene et al. (1991) the following formulae for 38 and 200 kHz are obtained:

$$TS_{38} = -132.44 + 34.85 \log (L) \quad (5)$$

$$TS_{200} = -125.23 + 34.85 \log (L) \quad (6)$$

3.42 The workshop did not have sufficient time to examine *in situ* TS data from the survey. Consequently equations 4, 5 and 6 had been used to estimate the TS of the krill in the survey area. The workshop encouraged further work to compare the *in situ* results from the survey with those from the equations (see paragraph 6.7).

3.43 Substituting equation 3 along with equation 4, 5 and 6 as appropriate into equation 2, conversion factors were calculated to convert S_A (m^2/n $mile^2$) to areal biomass krill density (g/m^2).

3.44 The workshop agreed to use the conversion factor derived from the length and mass data obtained aboard the *Kaiyo Maru* because these data were collected during the CCAMLR-2000 Survey. The values fall within the range of the other estimates in Table 21.

Depth of Integration

3.45 The workshop had no prior reason for selecting any specific depth to set the lower level of integration. After some discussion it was agreed to integrate down to the deepest sampling depth and to describe the detection thresholds which will be a function of krill density and noise level (signal to noise ratios) for each frequency.

Examination of Echograms

3.46 The workshop considered ways by which the filtered resampled noise-free echograms (see paragraph 3.32) might be examined to identify outlying and erroneous values. This was tasked to four subgroups, one for each vessel. Noise subtraction was checked by inspection of raw echograms and filtered resampled noise-free echograms. Outlying and erroneous values were checked by integrating and inspecting the output by cell in Microsoft Excel.

3.47 In order to ensure consistency in the integration analysis a cross-checking process was included as follows:

Dataset	Analysed by
Kaiyo Maru	Drs S. Kasatkina and A. Malyshko (Russia)
Atlantida	Dr S. Kawaguchi and Mr Y. Takao (Japan)
James Clark Ross	Mrs J. Emery (USA)
Yuzhmorgeologiya	Drs J. Watkins and A. Brierley and Ms C. Goss (UK)

3.48 The integration analysis was undertaken according to the following schedule:

Step One: The 120 kHz echogram was examined and edited to ensure that near-surface swarms were included and bubbles arising from surface turbulence excluded. For this process the display threshold was set to -70 dB and depth grid turned 'off'. The resulting edited surface layer definition was saved.

Step Two: The S_v threshold was set to -100 dB and with this setting the noise level on NOISE 120 file was adjusted until the 'rainbow' was removed. The adjusted noise level was increased by 3 dB and the file resaved. All changes were recorded (Table 7).

Step Three: In the EV file menu properties the following variables were selected: S_v mean, S_A mean, S_v max, C height, C depth, Date M, Time M, Lat S, Lon S, Lat E, Lon E, Lat M, Lon M and EV file name. (The naming convention for these variables is M = mean, S = start, E = end). The filtered resampled noise-free echogram at 120 kHz was opened and the grid changed to a GPS distance of 1 n mile and 5 m depth. The echogram was then integrated by cell and the resultant integrated file saved according to the following filename convention: 'transect name' 'freq.' (eg SS03_120.csv). These files were saved to a folder for each ship.

Step Four: Each file was sorted by S_v max. This allowed the highest values to be identified by date, time and depth bin. These high values were then examined on the echogram to determine whether they were likely to have been due to biological scatterers such as krill or else due to noise, bottom integration or some other extraneous scattering. Scatterers thought not to be krill were labelled as 'bad data'. The corrected echogram was then re-integrated and saved as described in Step Three above.

3.49 The 38 and 200 kHz echograms were then analysed using the same process for noise subtraction and integration but excluding the 'bad data' regions and including near surface swarms identified at 120 kHz.

3.50 Conversion factors, CCAMLR-2000 from Table 21, were used to convert S_A along each transect to biomass using the appropriate clusters as indicated in Table 6.

3.51 For several reasons ships deviated from the planned transects. Such deviations included random effects caused by strong winds and ocean currents, and larger systematic deviations caused by avoidance of icebergs. To correct for these larger deviations, an expected change in latitude per nautical mile of transect, Δlat was calculated from the waypoints derived in WG-EMM-99/7. These values are listed in Table 22. Although the transects, on great circle courses, did not have a constant heading, using a constant Δlat as shown in Table 22 introduces a possible error of only 9 m in a N–S transect, and a possible error of only 25 m in a NE–SW transects. These errors are within the expected accuracy of the available navigation. An actual latitude made good, $\Delta l\hat{a}t$, was derived by differencing the latitudes of the 1 n mile Echoview output. An interval weighting W_I was calculated as:

$$W_{\mathrm{I}} = \frac{|\Delta lat| - |(\Delta lat - \Delta l\hat{a}t)|}{|\Delta lat|} \tag{7}$$

If the deviation from the standard track line for a particular interval was greater than 10% (i.e. if $W_I < 0.9$), then the 1 n mile integral was scaled by W_I, otherwise $W_I = 1$.

3.52 The sum of the interval weightings along each transect was used to weight the transect means to provide a stratum biomass.

3.53 The planned transect lengths within each subarea are set out in Table 23 and it was agreed that these should be used to estimate the proportion of survey effort in each subarea.

RESULTS

Estimated Standing Stock

4.1 Mean krill biomass densities along each transect and at each acoustic frequency were calculated according to the schedule set out in paragraphs 3.48 to 3.52. Biomass estimates were made according to the method of Jolly and Hampton (1990) as agreed in paragraph 3.1. The results are set out in Tables 24 to 26 and Figure 7.

4.2 With the results to hand, a series of checks was made to determine as far as possible that the analyses had been undertaken in the prescribed way.

4.3 In theory there should be the same number of distance intervals at each frequency for each transect. In some instances, however, there were differences, and in these instances files were checked and corrected.

4.4 As a first step to investigate the possibility of bias between ships, an analysis of variance was used to test whether there were significant differences between vessels. A rigorous test could only be undertaken for the Scotia Sea and Antarctic Peninsula regions where the survey tracks of the individual vessels, *James Clark Ross*, *Kaiyo Maru* and *Yuzhmorgeologiya*, were interleaved. The results from this analysis are set out in Table 27 and indicate there to be no significant difference between vessels. A second ANOVA which included the results from the *Atlantida*, the only vessel to sample in the South Sandwich Islands area, also indicated that there was no significant difference between any of the vessels (Table 28).

4.5 The distribution of the W_I (paragraph 3.51) was plotted on a map of the surveyed area to indicate whether any bias might exist in the sampling intensity. Although statistical analyses were not possible in the time available, a visual examination of the results suggested that the distribution was not likely to affect the estimates of krill density.

4.6. The distribution of the conversion factors along the transects of the krill length-frequency clusters was checked against the nominal distribution in Table 6. The distribution was confirmed to be correct over nearly all transects except within the region of the South Shetland Islands mesoscale survey on transects AP15 and AP16 where short portions of these two transects were assigned to Cluster 2 instead of Cluster 3. The workshop noted that the potential error to the standing stock estimate arising from this was likely to negligible. It was agreed that no further action was necessary at the workshop.

4.7 The krill standing stock, estimated using 120 kHz as agreed by the workshop, was 44.29 million tonnes (CV 11.38%). The standing stock estimates at the other two frequencies were 29.41 million tonnes (CV 9.25%) at 38 kHz and 44.82 million tonnes (CV 15.76%) at 200 kHz (see Tables 24 to 26; Figure 7).

4.8 The workshop accepted the estimate of krill standing stock at 120 kHz (44.29 million tonnes) as the best available for the CCAMLR-2000 Survey.

Considerations of Uncertainty

4.9 The workshop noted that the estimation of standing stock by the Jolly and Hampton method gave an associated sampling variance for the survey. This sampling variance provides an important component of the uncertainty. There are however other components of uncertainty which need to be identified so that they can be incorporated into the estimation of γ for the GYM.

4.10 During the meeting Dr Demer had undertaken a series of analyses to quantify the following components of uncertainty which might make a significant contribution to the overall uncertainty:

(i) TS: dependence on acoustic frequency and krill size and orientation;
(ii) detection probability: background noise, distribution of TS, krill by depth; and
(iii) efficiency of krill detection and delineation.

4.11 The following topics were thought to have a minimal effect on the overall uncertainty: variation in α and sound speed over the survey area in comparison to the agreed default values.

4.12 In order to provide an estimate of combined measurement and sampling uncertainty, it is necessary to undertake further analyses of the data and undertake simulation studies to determine the extent and relative importance of the key components. There was insufficient time at the workshop to undertake these studies. Dr Demer offered to develop this analysis and provide a paper for consideration at WG-EMM-2000.

ARCHIVE AND STORAGE OF DATA ANALYSED AT THE WORKSHOP

5.1 The analyses by the workshop were based on the three core datasets collected during the CCAMLR-2000 Survey (SC-CAMLR-XVIII, Annex 4, Appendix D, paragraph 19): acoustic data, micronekton net data, and CTD profiles. These data are to be transferred, together with documentation, to a new CCAMLR database for archiving. Dr D. Ramm (Data Manager) will present a report on the archiving process to WG EMM-2000.

5.2 Four types of acoustic data files were used: raw ping-by-ping data (EK5 files); Echoview data annotation files (EV files); S_A by transect and frequency, and total S_A by frequency (CSV files); and biomass by stratum (Excel files).

5.3 The raw ping-by-ping data files consist of EK500 telegrams, and these files are in a format specified by SonarData. Raw data were available from the *Atlantida* (3 414 files, 4.40 Gb); *James Clark Ross* (1 499 files, 5.88 Gb); *Kaiyo Maru* (936 files; 4.17 Gb); *Yuzhmorgeologiya* (1 445 files, 6.54 Gb). Dr Hewitt agreed to submit the EK500 data on CD-ROM (approximately 40 disks) to the Secretariat by the end of August 2000, together with a copy of the relevant documentation describing the data format used in these files.

5.4 The EV files specify the EK5 data, transect regions and acoustic parameters used in the analyses done in Echoview. These files are in Echoview format, and there is one EV file for each transect. The values of parameters are summarised in the tables of this report. The specifications held in each file are presently only accessible using Echoview, and the Secretariat does not have this software. Dr Hewitt agreed to submit the EV files to the Secretariat by the end of August 2000. In addition, the group agreed that a detailed listing of the data held in the EV files be developed by the Secretariat in consultation with Dr Hewitt and Mr Higginbottom.

5.5 The S_A files, in CSV format, and the biomass by stratum files, in Microsoft Excel, were developed at the workshop. Dr Hewitt agreed to submit the CSV files, Excel files and their descriptions to the Secretariat by the end of August 2000.

5.6 The micronekton net data were derived from samples collected using the RMT8. Raw data had been collated and analysed by Dr Siegel prior to the workshop (WG-EMM-00/6). Dr Siegel advised that these data required some further validation, and he agreed to do this shortly after the workshop. Once validated, Dr Siegel agreed to submit the micronekton net data, together with data documentation, to the Secretariat by early July 2000.

5.7 The CTD data were collected by all four ships. Data from the *James Clark Ross, Kaiyo Maru* and *Yuzhmorgeologiya* had been collated and analysed by Dr Brandon prior to the workshop. The data from the *Kaiyo Maru* required minor re-calibration, and Dr Naganobu agreed to undertake this task, and resubmit the data to Dr Brandon as soon as possible. In addition, Dr Kasatkina agreed to submit the CTD data from the *Atlantida* to Dr Brandon by early July 2000. Dr Brandon would then collate the CTD data, and submit these data, together with relevant documentation, to the Secretariat.

5.8 All acoustic data submitted to the Secretariat will initially be stored on CD-ROM. A catalogue of these data, together with the RMT8 and CTD data will be held in a Microsoft Access database. Once the structure of the new CCAMLR-2000 Survey database is established, data will be transferred to SQL Server format, in line with other data held by the Secretariat. Resources should be provided to the Secretariat so that the acoustic data can be transferred from CD-ROM to hard disk within the next 12 months. This will ensure that these data are backed up to magnetic tape regularly, and can be transferred, along with all other CCAMLR data, to any new, future system. All survey data submitted to CCAMLR will be subject to the rules of access and use of CCAMLR data.

FUTURE WORK

Archiving of Data and Access to Samples

6.1 All data considered by the workshop, together with detailed documentation of all data fields, are to be submitted to the CCAMLR Data Centre for archiving as specified in paragraphs 5.3 (EK5 files); 5.4 (EV files); 5.5 (S_A files), 5.6 (RMT8 data) and 5.7 (CTD data). A report on the archiving process will be presented to WG-EMM-2000 (paragraph 5.1).

6.2 The group noted that the archiving of the CCAMLR-2000 Survey data has a budgetary consideration: additional hard disk space and back-up capacity within the Secretariat will be required to ensure that all EK5 files can be transferred from CD-ROM format within the next 12 months (paragraph 5.8). To ensure complete archiving of the workshop data and analysis results, the Secretariat should hold a copy of Echoview 2.00.

6.3 All survey data submitted to CCAMLR will be subject to the rules of access and use of CCAMLR data (paragraph 5.8).

6.4 The group identified the need to develop a protocol and process for scientists wishing to access zooplankton and nekton samples collected using the RMT1 and RMT8 nets (Attachment C).

Publications and Future Symposia and Workshops

6.5 Much of the CCAMLR-2000 Survey data collected is yet to be analysed. It is expected that each major set of data would form the focus of future CCAMLR workshops. Data analysed at such workshops will need to be transferred to the CCAMLR Data Centre for archiving. All data submitted to the CCAMLR Data Centre for archiving should be fully documented with specific data formats being defined.

6.6 The following possibilities were identified for the future publication of the CCAMLR-2000 Survey results:

(i) prepare a short communication (in the order of 1 000 words) to a scientific journal with broad readership under the following conditions:

   (a) such communication will describe the survey, the participants, the methods of data collection and analysis and the estimate of B_0, but not necessarily the implications;

   (b) such communication will be authored by a team name such as 'CCAMLR-2000 Survey Team' with team members listed in alphabetical order in a footnote;

   (c) an initial draft will be prepared within the next four months by Dr Hewitt and circulated for comments via email.

(ii) develop a series of papers to describe the results of, and the protocols developed by, the workshop. This could include the development of a special issue of *CCAMLR Science*.

(iii) consolidate the protocols of the CCAMLR-2000 Survey into a CCAMLR manual on the execution of acoustic surveys of krill.

6.7 The CCAMLR-2000 Survey has produced a unique multinational dataset. It was agreed that to maximise the potential of these data, their collaborative analyses should be encouraged. Such analyses could be undertaken by future CCAMLR workshops, and/or through collaboration between individual data providers as well as between individual scientists. This requires that the intellectual property rights attached to the data are recognised and balanced with the need to maximise data use. Again, all data analysed at CCAMLR workshops will be subject to the CCAMLR data access rules. In responding to requests for other data, the SICs (or their alternates) should serve as a first contact point to manage data access and as a conduit to promote collaborative analyses. WG-EMM and the Scientific Committee were requested to consider this matter further.

6.8 Future analyses identified by the workshop include, *inter alia*:

(i) Sampling techniques:

(a) apply alternative analyses to the current survey data (e.g. using geostatistical techniques to estimate mean krill biomass density and its variance over the survey area);

(b) refine krill density and biomass estimates using conversion factors derived from data collected by all ships during the survey;

(c) develop refined methods for acoustic target delineation;

(d) identify targets larger than krill, especially myctophids;

(e) compare *in situ* TS estimates with those from SC-CAMLR equations;

(f) investigate *in situ* TS measurements with respect to the biological condition of krill;

(g) determine the pattern of ambient noise from 38 kHz in relation to water depth and weather;

(h) investigate net sampling survey design, net selection, catchability and selectivity with respect to krill; and

(i) develop protocols for the application of optimal temporal and spatial designs for future acoustic surveys of krill.

(ii) Multidisciplinary analyses:

(a) investigate the distribution of krill density and classification (length and maturity) in respect to water masses and in relation to the cluster boundaries identified by the workshop;

(b) investigate the distribution of acoustic scatterers and zooplankton other than krill;

(c) investigate the spatial distribution of krill biomass with respect to latitude, water masses and bathymetry;

(d) analyse combined oceanographic datasets;

(e) determine flow fields across the Scotia Sea and then calculate krill flux;

(f) compare acoustic data from mesoscale survey boxes with acoustic survey results from similar boxes over time;

(g) compare krill standing stock estimate to validate land-based dependent species population estimates; and

(h) integrate CCAMLR-2000 Survey data collected by CCAMLR and the IWC.

CLOSE OF WORKSHOP

7.1 The report of the workshop was adopted.

7.2 The Chairman of the Scientific Committee, Dr D. Miller, thanked Dr Hewitt for convening a very successful workshop and the US Government for facilitating the process. The workshop joined Dr Everson in thanking Mrs L. Bleathman and Dr Ramm for their participation and support. Dr Hewitt then thanked Dr Everson for his major input as rapporteur, and thanked contributors for their valued input to discussions and the report, and for working long hours to ensure the success of the workshop.

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Siegel, V. 1992. Review of length–weight relationships for Antarctic krill. In: *Selected Scientific Papers, 1992 (SC-CAMLR-SSP/9)*. CCAMLR, Hobart, Australia: 145–155.

Watkins, J.L. and A.S. Brierley. 2000. Verification of acoustic techniques used to identify Antarctic krill. *ICES J. Mar. Sci.*, (in press).

LIST OF DOCUMENTS

WG-EMM-00/06	Krill distribution patterns in the Atlantic sector of the Antarctic during the CCAMLR-2000 Survey V. Siegel, S. Kawaguchi, F. Litvinov, V. Loeb and J. Watkins

Table 1: Transect section from CCAMLR-2000 Survey large-scale transects which lie within mesoscale survey boxes. (See Table 4 for transect abbreviations).

Transect	From		To	
	Latitude (°S)	Longitude (°W)	Latitude (°S)	Longitude (°W)
South Georgia				
SS03	53.7099	35.2440	54.6058	35.1363
SS04	53.1002	37.1962	53.9972	37.1336
South Orkneys				
SS07	59.8292	43.4326	60.7249	43.5246
SS08	59.7697	45.2811	60.6639	45.4222
South Shetlands				
AP13	60.4858	55.4738	61.2918	54.6604
AP14	61.0372	57.9057	61.8577	57.1422
AP15	61.4720	60.2064	62.3050	59.4948
AP16	61.6936	61.8532	62.5341	61.0074
South Sandwich				
SSb	59.7557	25.3475	55.3544	27.0268
Overlap between AP and SS*				
SS10	61.9923	50.0037	discard data to the south	

* This portion of SS10 was discarded because of an overlap between AP and SS.

Table 2: System-specific echosounder settings by ship.

Transceiver	Menu	*Atlantida*	*James Clark Ross*	*Kaiyo Maru*	*Yuzhmorgeologiya*
1	Transducer type	ES38B	ES38B	ES38B	ES38-12
	Transducer depth (m)	5.0	5.70	5.8	7.0
	Two-way beam angle (dB)	-21.2	-20.8	-20.9	-15.9
	S_v transducer gain (dB)	23.32	25.49	27.06	22.95
	TS transducer gain (dB)	23.50	25.60	27.32	22.51
	Angle sens. along	21.9	21.9	21.9	12.5
	Angle sens. athw.	21.9	21.9	21.9	12.5
	3 dB beamw. along (°)	7.1	7.0	6.8	12.2
	3 dB beamw. athw. (°)	7.1	7.1	6.9	12.2
2	Transducer type	ES120-7	ES120	ES120-7	ES120-7
	Transducer depth (m)	5.0	5.70	5.8	7.0
	Two-way beam angle (dB)	-20.9	-18.4	-20.6	-20.4
	S_v transducer gain (dB)	24.49	2026	24.74	24.52
	TS transducer gain (dB)	24.66	20.26	24.83	24.13
	Angle sens. along	15.7	15.7	21.0	21.0
	Angle sens. athw.	15.7	15.7	21.0	21.0
	3 dB beamw. along (°)	7.3	9.3	7.1	7.3
	3 dB beamw. athw. (°)	7.3	9.3	7.1	7.3
3	Transducer type	200_28	200_28	200_28	200_28
	Transducer depth (m)	5.0	5.70	5.8	7.0
	Two-way beam angle (dB)	-20.3	-20.8	-20.5	-20.5
	S_v transducer gain (dB)	23.26	22.78	25.76	26.30
	TS transducer gain (dB)	23.47	23.07	25.78	26.30
	3 dB beamw. along (°)	7.1	6.9	7.1	7.1
	3 dB beamw. athw. (°)	7.1	7.1	7.1	7.1

Table 3: Survey echosounder settings defined in protocol.

Operation menu		Ping mode	Normal
		Ping auto start	Off
		Ping interval	2.0 Sec
		Transmit power	Normal
		Noise margin	0 dB
Transceiver menu	Transceiver-1 menu	Mode	Active
		Transd. Sequence	Off
		Absorption coef.	10 dB/km
		Pulse length	Medium
		Bandwidth	Wide
		Max. Power	2000 W
		Alongship offset	0.00°
		Athw.ship offset	0.00°
	Transceiver-2 menu	Mode	Active
		Transd. sequence	Off
		Absorption coef.	26 dB/km
		Pulse length	Long
		Bandwidth	Narrow
		Max. power	1000 W
		Alongship offset	0.00°
		Athw.ship offset	0.00°
	Transceiver-3 menu	Mode	Active
		Transd. sequence	Off
		Absorption coef.	40 dB/km
		Pulse length	Long
		Bandwidth	Narrow
		Max. power	1000 W
		Alongship offset	0.00°
		Athw.ship offset	0.00°
Bottom detection menu*	Bottom detection-1 menu	Min. depth	10.0 m
		Max. depth	500 m
		Min. depth alarm	0.0 m
		Max. depth alarm	0.0 m
		Bottom lost al.	0.0 m
		Min. level	-50 dB
	Bottom detection-2 menu	Min. depth	10.0 m
		Max. depth	500 m
		Min. depth alarm	0.0 m
		Max. depth alarm	0.0 m
		Bottom lost al.	0.0 m
		Min. level	-50 dB
	Bottom detection-3 menu	Min. depth	10.0 m
		Max. depth	500 m
		Min. depth alarm	0.0 m
		Max. depth alarm	0.0 m
		Bottom lost al.	0.0 m
		Min. level	-50 dB
Log menu		Mode	Speed
		Ping interval	20
		Time interval	20 s
		Dist. interval	1.0 n mile
		Pulse rate per n mile	200

* Initial settings, changed according to conditions.

continued

Table 3 (continued)

Layer menu		Super layer	Ship specific
	Layer-1 menu	Type	Ship specific
	Layer-2 menu	Type	Ship specific
	Layer-3 menu	Type	Ship specific
	Layer-4 menu	Type	Ship specific
	Layer-5 menu	Type	Ship specific
	Layer-6 menu	Type	Ship specific
	Layer-7 menu	Type	Ship specific
	Layer-8 menu	Type	Ship specific
	Layer-9 menu	Type	Ship specific
	Layer-10 menu	Type	Ship specific
TS detection menu	TS Detection-1 menu	Min. value	-90 dB
		Min. echo length	0.8
		Max. echo length	2.5
		Max. gain comp.	4.0 dB
		Max. phase dev.	2.0
	TS Detection-2 menu	Min. value	-90 dB
		Min. echo length	0.8
		Max. echo length	2.5
		Max. gain comp.	4.0 dB
		Max. phase dev.	2.0
	TS Detection-3 menu	Min. value	-90 dB
		Min. echo length	0.8
		Max. echo length	2.5
		Max. gain comp.	4.0 dB
		Max. phase dev.	2.0
Ethernet com. menu	Telegram menu	Remote control	On
		Sample range	0 m
		Status	On
		Parameter	On
		Annotation	Off
		Sound velocity	Off
		Navigation	On
		Motion sensor	Off
		Depth	1
		Depth nmea	Off
		Echogram	1&2&3
		Echo-trace	1&2&3
		S_v	Off
		Sample angle	Off
		Sample power	Off
		Sample S_v	Off
		Sample TS	Off
		Vessel-log	On
		Layer	On
		Integrator	Off
		Ts distribution	Off
		Towed fish	Off
	UDP port menu	Status	Ship specific
		Parameter	Ship specific
		Annotation	Ship specific
		Sound velocity	Ship specific
		Navigation	Ship specific
		Motion sensor	Ship specific

continued

Table 3 (continued)

Ethernet com. menu (continued)	UDP port menu	Depth	Ship specific
		Echogram	Ship specific
		Echo-trace	Ship specific
		S_v	Ship specific
		Sample angle	Ship specific
		Sample power	Ship specific
		Sample S_v	Ship specific
		Sample TS	Ship specific
		Vessel-log	Ship specific
		Layer	Ship specific
		Integrator	Ship specific
		TS distribution	Ship specific
		Towed fish	Ship specific
	Echogram-1 menu	Range	500 m
		Range start	0 m
		Auto range	Off
		Bottom range	0 m
		Botttom range start	10 m
		No. of main val.	700
		No. of bot. val.	0
		TVG	20 log r
	Echogram-2 menu	Range	500 m
		Range start	0 m
		Auto range	Off
		Bottom range	0 m
		Bottom range start	10 m
		No. of main val.	700
		No. of bot. val.	0
		TVG	20 log r
	Echogram-3 menu	Range	500 m
		Range start	0 m
		Auto range	Off
		Bottom range	0 m
		Bottom range start	10 m
		No. of main val.	700
		No. of bot. val.	0
		TVG	20 log r
Serial com. menu	Telegram menu	Format	ASCII
		Modem control	Off
		Remote control	On
		Status	Off
		Parameter	Off / on
		Annotation	Off / on
		Navigation	Off
		Sound velocity	Off
		Motion sensor	Off
		Depth	Off
		Depth nmea	Off
		Echogram	Off
		Echo-trace	Off
		S_v	Off
		Vessel-log	Off
		Layer	Off
		Integrator	Off

continued

Table 3 (continued)

Serial com. menu (continued)	Telegram menu	TS distribution	Off
		Towed fish	Off
	USART menu	Baudrate	9600
		Bits per char.	8
		Stop bits	1
		Parity	None
Motion sensor menu		Heave	Off
		Roll	Off
		Pitch	Off
Utility menu		Beeper	Off / On
		Status messages	On
		Rd display	Off
		Fifo output	Off
		External clock	Off
		Default setting	No
		Language	English

Table 4: Summary of activities undertaken by vessels during the CCAMLR-2000 Survey (January–February 2000), and data submitted to the B_0 Workshop. AP – Antarctic Peninsula; Sand – South Sandwich Islands; SG – South Georgia; SOI – South Orkney Islands; SS – Scotia Sea; SSI – South Shetland Islands.

	Vessel			
	Atlantida	*Kaiyo Maru*	*James Clark Ross*	*Yuzhmorgeologiya*
Synoptic survey				
Survey area	SS	AP SS	AP SS	AP SS
CCAMLR subareas	48.4	48.1 48.2 48.3	48.1 48.2 48.3	48.1 48.2 48.3
Start date	17 January	11 January	18 January	13 January
End date	1 February	2 February	10 February	4 February
Large-scale transects				
Number	3	6	7	6
Transect names	SSa SSb SSc	SS03 SS06 SS09 AP12 AP15 AP18	AP13 AP16 AP19 SS01 SS04 SS07 SS10	AP11 AP14 AP17 SS02 SS05 SS08
Mesoscale transects				
Number	10	8	0	8
Transect names	Sand01-10	SSI01-08		SG01-04 SOI01-04
Calibration				
Pre-survey				
Date	14 January	9 January	16 January	12 January
Location	Stromness Bay	Stromness Bay	Stromness Bay	Stromness Bay
Post-survey				
Date	5 February	4 February	11 February	7 March
Location	Stromness Bay	Admiralty Bay	Admiralty Bay	Admiralty Bay
Data submitted				
Acoustic data	√	√	√	√
Net data	√	√	√	√
CTD data		√	√	√

Table 5: Summary of data collected by vessels during the CCAMLR-2000 Survey. ADCP – acoustic Doppler current profiler; CPR – continuous plankton recorder; CTD – conductivity temperature depth probe; EPCS – electronic plankton counting system; EK500 – Simrad EK-500 echosounder (38, 120, 200 kHz) with SonarData Echoview software; IWC – IWC Observers; JNCC – Joint Nature Conservancy Council Seabirds-at-Sea; LADCP – lowered ADCP; MAPT – meteorological automatic picture transmission; NORPAC – North Pacific standard net; RMT1 – rectangular midwater trawl 1 m^2; RMT8 – rectangular midwatertrawl 8 m^2; SeaWIFS – sea-viewing wide field-of-view sensor; XBT – expendable bathythermograph; XCTD – expendable CTD.

Type of Data	Vessel			
	Atlantida	*Kaiyo Maru*	*James Clark Ross*	*Yuzhmorgeologiya*
Under-way Observations:				
Acoustic survey				
Acoustic profiles*	EK500	EK500	EK500	EK500
Bathymetry			EA500 (12kHz)	
Physical oceanography				
Meteorological data	Instruments	MAPT	Instruments	Instruments
Satellite images		NOAA		SeaWIFS
Current velocity and direction	ADCP		ADCP	
Water temperature and salinity		EPCS, XBT, XCTD	@6m	Thermosalinograph
Biological sampling				
Chlorophyll and zooplankton		EPCS		Flurometer
Chlorophyll calibration	Water samples	Water samples	Water samples	Water samples
Predator observations				
Seabirds and marine mammals	Observers	IWC, Observers	IWC, JNCC	IWC
On-Station Sampling:				
Physical oceanography				
Temperature and conductivity*	CTD	CTD	CTD	CTD
Dissolved oxygen	CTD	CTD		CTD
Current velocity and direction		LADCP	ADCP	
Water samples	to 1 000 m	to 1 000 m		to 1 000 m
Biological sampling				
Krill and other micronekton*	RMT8	RMT8	RMT8	RMT8
Zooplankton	RMT1	RMT1, NORPAC, CPR	RMT1, Bongo	RMT1
Chlorophyll-*a*		√		√
Nutrients		√		

* Core datasets

Table 6: Latitudinal position at which krill size clusters change along acoustic transects. (See Table 4 for transect abbreviations and Figure 4 for a description of the clusters).

Transect	Cluster	Position (latitude S) between Clusters
SS01	2	North of 54°30’
SS01	1	South of 54°30’
SS02	2	North of 52°54’
SS02	1	52°54’ to 58°18’
SS02	2	58°18’ to 60°
SS02	1	South of 60°
SS03	2	North of 53°
SS03	1	53° to 57°30’
SS03	2	57°30’ to 59°21’
SS03	1	South of 59°21’
SS04 to SS06	2	Entire transect
SS07	2	North of 60°
SS07	3	South of 60°
SS08	2	North of 60°
SS08	3	60° to 61°
SS08	2	South of 61°
SS09	2	South of 62°15’
SS09	3	North of 62°15’
SS10	2	South of 61°15’
SS10	3	North of 61°15’
AP11 to AP16*	2	South of 61°15’
AP11 to AP16*	3	North of 61°15’
AP17 to AP19	3	Entire transect
All SOI	3	Entire transect
SSI01	3	North of 61°20’
SSI01	2	South of 61°20’
SSI02 and 03	3	North of 61°30’
SSI02 and 03	2	South of 61°30’
SSI04 and 05	3	North of 61°45’
SSI04 and 05	2	South of 61°45’
SSI06 and 07	3	North of 62°
SSI06 and 07	2	South of 62°
SSI08	3	Entire transect
SG01 to 03	1	Entire transect
SG04	2	Entire transect
SSa 48.4 east	2	North of 58°45’
SSa 48.4 east	1	South of 58°45’
SSb 48.4 middle	2	North of 58°
SSb 48.4 middle	1	South of 58°
SSc 48.4 west	2	North of 56°33’
SSc 48.4 west	1	56°33’ to 58°
SSc 48.4 West	2	58° to 59°05’
SSc 48.4 West	1	South of 59°05’
Sand 01,02,03,06,07	2	Entire transect
Sand 04,05,08,09,10	1	Entire transect

* During the error checking phase (paragraph 4.6) it was noted that portions of AP15 and AP16 north of the mesoscale box in the SSI were incorrectly assigned to Cluster 2 and should have been assigned to Cluster 3.

Table 7: CCAMLR-2000 Survey noise measurements (dB) and surface exclusion. Atl – *Atlantida;* JCR – *James Clark Ross*; KyM – *Kaiyo Maru*; Yuz – *Yuzhmorgeologiya*. (See Table 4 for transect abbreviations).

Ship	Transect	Surface Layer (m)	Noise (S_v re 1 m)		
			38 kHz	120 kHz	200 kHz
Yuz	SG01	20	-123.00	-123.00	-123.00
Yuz	SG02	20	-124.00	-120.00	-121.00
Yuz	SG03	20	-125.00	-124.00	-124.00
Yuz	SG04	15	-137.00	-129.00	-124.00
Yuz	SS02	20	-137.00	-123.00	-124.00
Yuz	SS05	15	-135.00	-125.00	-123.00
Yuz	SS08	15	-131.00	-125.00	-123.00
Yuz	SOI01	15	-126.00	-120.00	-119.00
Yuz	SOI02	15	-126.00	-122.00	-123.00
Yuz	SOI03	15	-129.00	-122.00	-122.00
Yuz	SOI04	20	-135.00	-127.00	-122.00
Yuz	AP11	20	-129.00	-120.00	-123.00
Yuz	AP14	15	-129.00	-120.00	-125.00
Yuz	AP17	20	-121.00	-120.00	-117.00
Atl	Sand01	15	-127.00	-136.50	-135.00
Atl	Sand02	15	-127.00	-136.50	-135.00
Atl	Sand03	15	-127.00	-136.50	-135.00
Atl	Sand04	15	-127.00	-136.50	-135.00
Atl	Sand05	15	-127.00	-136.50	-135.00
Atl	Sand06	15	-127.00	-136.50	-135.00
Atl	Sand07	15	-127.00	-136.50	-135.00
Atl	Sand08	15	-127.00	-136.50	-135.00
Atl	Sand09	15	-127.00	-136.50	-135.00
Atl	Sand10	15	-127.00	-136.50	-135.00
Atl	SSa	15	-127.00	-136.50	-135.00
Atl	SSb	15	-127.00	-136.50	-135.00
Atl	SSc	15	-127.00	-136.50	-135.00
JCR	SS01	20	-150.00	-124.00	-110.00
JCR	SS04	15	-150.00	-124.00	-112.00
JCR	SS07	20	-150.00	-124.00	-112.00
JCR	SS10	20	-150.00	-124.00	-110.00
JCR	AP13	20	-150.00	-124.00	-110.00
JCR	AP16	20	-150.00	-124.00	-110.00
JCR	AP19	20	-152.00	-124.00	-110.00
KyM	SS03	20	-136.40	-136.40	-134.40
KyM	SS06	20	-147.40	-136.40	-138.10
KyM	SS09	20	-141.90	-136.80	-138.40
KyM	AP12	20	-147.00	-135.70	-135.10
KyM	AP15	20	-148.10	-136.20	-136.10
KyM	AP18	20	-147.40	-136.60	-136.80
KyM	SSI01	20	-140.90	-136.60	-134.40
KyM	SSI02	20	-138.90	-136.60	-133.40
KyM	SSI03	20	-144.90	-136.60	-133.40
KyM	SSI04	20	-141.90	-136.60	-135.40
KyM	SSI05	20	-144.90	-136.60	-134.40
KyM	SSI06	20	-146.90	-136.60	-135.40
KyM	SSI07	20	-149.90	-136.60	-135.40
KyM	SSI08	20	-152.90	-136.60	-135.40

Table 8: Calibration constants S_v gain (dB).

Frequency	Vessel	First Calibration	Second Calibration	Chosen Value
38 kHz	*Atlantida*	23.42	23.32	23.32
	James Clark Ross	25.49	25.53	25.51
	Kaiyo Maru	27.06	27.09	27.06
	Yuzhmorgeologiya	22.43	22.29	22.36
120 kHz	*Atlantida*	23.23	24.49	24.49
	James Clark Ross	20.26	20.15	20.20
	Kaiyo Maru	24.74	24.30	24.74
	Yuzhmorgeologiya	25.37	25.16	25.26
200 kHz	*Atlantida*	24.83	23.26	23.26
	James Clark Ross	22.78	23.04	22.91
	Kaiyo Maru	25.76	25.74	25.76
	Yuzhmorgeologiya	26.12	25.80	25.96

Table 9: Calibration constants TS gain (dB).

Frequency	Vessel	First Calibration	Second Calibration	Chosen Value
38 kHz	*Atlantida*	23.76	23.50	23.50
	James Clark Ross	25.60	25.60	25.60
	Kaiyo Maru	27.32	27.35	27.32
	Yuzhmorgeologiya	22.64	22.37	22.51
120 kHz	*Atlantida*	23.29	24.66	24.66
	James Clark Ross	20.26	20.09	20.18
	Kaiyo Maru	24.83	24.55	24.83
	Yuzhmorgeologiya	25.56	25.17	25.37
200 kHz	*Atlantida*	24.50	23.47	23.47
	James Clark Ross	23.07	23.16	23.12
	Kaiyo Maru	25.78	25.77	25.78
	Yuzhmorgeologiya	26.12	25.80	25.96

Table 10: CCAMLR-2000 Survey calibration settings.

Atlantida	38 kHz		120 kHz		200 kHz	
	Logging	Processing	Logging	Processing	Logging	Processing
Absorption coef. (dB/m)	0.010000	0.010000	0.026000	0.028000	0.040000	0.041000
Sound speed (m/s)	1449.00	1456.00	1449.00	1456.00	1449.00	1456.00
Transmitted power (W)	2000.00	2000.00	1000.00	1000.00	1000.00	1000.00
2-way beam angle (dB)	-21.30	-21.30	-21.00	-21.00	-20.30	-20.30
S_V gain (dB)	23.43	23.32	23.23	24.49	24.83	23.26
Wavelength (m)	0.03868	0.03844	0.01225	0.01223	0.00735	0.00728
Trans. pulse length (ms)	1.000	1.000	1.000	1.000	1.000	1.000
Frequency (kHz)		38.00		120.00		200.00
Draft correction (m)		0.00		0.00		0.00
Nominal angle (°)		7.10		7.30		7.10

James Clark Ross	38 kHz		120 kHz		200 kHz	
	Logging	Processing	Logging	Processing	Logging	Processing
Absorption coef. (dB/m)	0.010000	0.010000	0.026000	0.028000	0.040000	0.041000
Sound speed (m/s)	1449.00	1456.00	1449.00	1456.00	1449.00	1456.00
Transmitted power (W)	2000.00	2000.00	1000.00	1000.00	1000.00	1000.00
2-way beam angle (dB)	-20.80	-20.80	-18.40	-18.40	-20.80	-20.80
S_V gain (dB)	25.49	25.51	20.26	20.20	22.78	22.91
Wavelength (m)	0.03868	0.03844	0.01225	0.01223	0.00735	0.00728
Trans. pulse length (ms)	1.000	1.000	1.000	1.000	1.000	1.000
Frequency (kHz)		38.00		120.00		200.00
Draft correction (m)		0.00		0.00		0.00
Nominal angle (°)		7.10		9.30		7.10

Yuzhmorgeologiya	38 kHz		120 kHz		200 kHz	
	Logging	Processing	Logging	Processing	Logging	Processing
Absorption coef. (dB/m)	0.010000	0.010000	0.026000	0.028000	0.040000	0.041000
Sound speed (m/s)	1485.00	1456.00	1485.00	1456.00	1485.00	1456.00
Transmitted power (W)	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00
2-way beam angle (dB)	-15.90	-15.90	-20.40	-20.40	-20.50	-20.50
S_V gain (dB)	22.43	22.36	25.37	25.26	26.12	25.96
Wavelength (m)	0.03868	0.03844	0.01225	0.01223	0.00735	0.00728
Trans. pulse length (ms)	1.000	1.000	1.000	1.000	1.000	1.000
Frequency (kHz)		37.88		119.05		200.00
Draft correction (m)		0.00		0.00		0.00
Nominal angle (°)		12.20		7.10		7.10

Kaiyo Maru	38 kHz		120 kHz		200 kHz	
	Logging	Processing	Logging	Processing	Logging	Processing
Absorption coef. (dB/m)	0.010000	0.010000	0.026000	0.028000	0.040000	0.041000
Sound speed (m/s)	1449.00	1456.00	1449.00	1456.00	1449.00	1456.00
Transmitted power (W)	2000.00	2000.00	1000.00	1000.00	1000.00	1000.00
2-way beam angle (dB)	-20.90	-20.90	-20.60	-20.60	-20.50	-20.50
S_V gain (dB)	27.06	27.06	24.74	24.74	25.76	25.76
Wavelength (m)	0.03868	0.03844	0.01225	0.01223	0.00735	0.00728
Trans. pulse length (ms)		1.000		1.000		1.000
Frequency (kHz)		38.00		119.00		200.00
Draft correction (m)		0.00		0.00		0.00
Nominal angle (°)		7.10		7.10		7.10

Table 11: Calibration parameters for the *Atlantida*, *James Clark Ross*, *Kaiyo Maru* and *Yuzhmorgeologiya*.

Atlantida						
Date	13-Jan-00	05-Feb-00	13-Jan-00	05-Feb-00	13-Jan-00	05-Feb-00
Location	Stromness Bay	Stromness Bay	Stromness Bay	Stromness Bay	Stromness Bay	Stromness Bay
Transducer	ES38B	ES38B	ES120-7	ES120-7	200_28	200_28
Water depth (m)	56	53	54	53	54	53
Sound speed (m/s)	1 457	1 460	1 457	1 460	1 457	1 460
Alpha (dB/km)	10	10	28	28	41	41
Transmit power (watts)	2 000	2 000	1 000	1 000	1 000	1 000
Pulse duration (m/s)	1	1	1	1	1	1
Bandwidth (kHz)	3.8 (10%)	3.8 (10%)	1.2 (1%)	1.2 (1%)	2.0 (1%)	2.0 (1%)
2-way beam angle (dB)	-21.2	-21.2	-20.9	-20.9	-20.3	-20.3
Sphere type	60.0 mm CU	38.1 mm WC	23.0 mm CU	38.1 mm WC	13.7 mm CU	38.1 mm WC
Range to sphere (m)	17.1	14.5	15.0	15.9	14.7	15.5
Calibrated TS gain (dB)	23.76	23.50	23.29	24.66	24.50	23.47
Calibrated S_v gain (dB)	23.43	23.32	23.23	24.49	24.83	23.26
James Clark Ross						
Date	16-Jan-00	12-Feb-00	16-Jan-00	12-Feb-00	16-Jan-00	12-Feb-00
Location	Stromness Bay	Admiralty Bay	Stromness Bay	Admiralty Bay	Stromness Bay	Admiralty Bay
Transducer	ES38B	ES38B	ES120	ES120	200_28	200_28
Water depth (m)	54	264	54	264	54	264
Sound speed (m/s)	1 458	1 455	1 458	1 455	1 458	1 455
Alpha (dB/km)	10	10	27	27	41	41
Transmit power (watts)	2 000	2 000	1 000	1 000	1 000	1 000
Pulse duration (m/s)	1	1	1	1	1	1
Bandwidth (kHz)	3.8 (10%)	3.8 (10%)	1.2 (1%)	1.2 (1%)	2.0 (1%)	2.0 (1%)
2-way beam angle (dB)	-20.8	-20.8	-18.4	-18.4	-20.8	-20.8
Sphere type	38.1 mm WC	38.1 mm WC	38.1 mm WC	38.1 mm WC	38.1 mm WC	38.1 mm WC
Range to sphere (m)	27.7	29.9	28.2	29.73	28.2	28.7
Calibrated TS gain (dB)	25.60	25.60	20.26	20.15	23.07	23.16
Calibrated S_v gain (dB)	25.49	25.53	20.26	20.09	22.78	23.04
Kaiyo Maru						
Date	09-Jan-00	04-Feb-00	09-Jan-00	04-Feb-00	09-Jan-00	04-Feb-00
Location	Stromness Bay	Admiralty Bay	Stromness Bay	Admiralty Bay	Stromness Bay	Admiralty Bay
Transducer	ES38B	ES38B	ES120-7	ES120-7	200_28	200_28
Water depth (m)	80	58	80	58	80	58
Sound speed (m/s)	1 453	1 453	1 453	1 453	1 453	1 453
Alpha (dB/km)	10	10	28	27	41	40.5
Transmit power (watts)	2 000	2 000	1 000	1 000	1 000	1 000
Pulse duration (m/s)	1	1	1	1	1	1
Bandwidth (kHz)	3.8 (10%)	3.8 (10%)	1.2 (1%)	1.2 (1%)	2.0 (1%)	2.0 (1%)
2-way beam angle (dB)	-20.9	-20.9	-20.6	-20.6	-20.5	-20.5
Sphere type	38.1 mm WC	38.1 mm WC	38.1 mm WC	38.1 mm WC	38.1 mm WC	38.1 mm WC
Range to sphere (m)	30.6	30.0	30.0	29.9	30.5	30.1
Calibrated TS gain (dB)	27.32	27.35	24.83	24.55	25.78	25.77
Calibrated S_v gain (dB)	27.06	27.09	24.74	24.30	25.76	25.74
Yuzhmorgeologiya						
Date	12-Jan-00	07-Mar-00	12-Jan-00	07-Mar-00	12-Jan-00	07-Mar-00
Location	Stromness Bay	Admiralty Bay	Stromness Bay	Admiralty Bay	Stromness Bay	Admiralty Bay
Transducer	ES38-12	ES38-12	ES120-7	ES120-7	200_28	200_28
Water depth (m)	88	75	88	75	88	75
Sound speed (m/s)	1 450	1 450	1 450	1 450	1 450	1 450
Alpha (dB/km)	10	10	26	26	40	40
Transmit power (watts)	1 000	1 000	1 000	1 000	1 000	1 000
Pulse duration (m/s)	1	1	1	1	1	1
Bandwidth (kHz)	3.8 (10%)	3.8 (10%)	1.2 (1%)	1.2 (1%)	2.0 (1%)	2.0 (1%)
2-way beam angle (dB)	-15.9	-15.9	-20.4	-20.4	-20.5	-20.5
Sphere type	38.1 mm WC	38.1 mm WC	38.1 mm WC	38.1 mm WC	38.1 mm WC	38.1 mm WC
Range to sphere (m)	30.0	38.0	29.2	37.6	29.0	37.6
Calibrated TS gain (dB)	22.64	22.37	25.56	25.17	26.12	25.80
Calibrated S_v gain (dB)	22.36	22.29	25.37	25.16	22.78	25.80

Table 12: Equivalent two-way beam angle correction for sound speed for the four vessels.

Sound speed during Simrad calibration:	1 473 m/s
Sound speed during survey:	1 449 m/s
Sound speed ratio:	0.9837
Ratio squared:	0.9676
Ratio dB:	-0.1426

Transducer Frequency	Transducer Type	Simrad Specified Beam Angle (dB)	Corrected Beam Angle dB (= specified + dB ratio)
James Clark Ross			
38	ES38B	-20.7	-20.8
120	ES120	-18.3	-18.4
200	200_28	-20.7	-20.8
Kaiyo Maru			
38	ES38B	-20.9	*
120	ES120-7	-20.6	*
200	200_28	-20.5	*
Atlantida			
38	ES38B	-21.2	-21.3
120	ES120-7	-20.9	-21.0
200	200_28	-20.2	-20.3
Yuzhmorgeologiya			
38	ES38-12	-15.9	*
120	ES120-7	-20.4	*
200	200_28	-20.5	*

* Default values supplied by Simrad were used during the survey.

Table 13: *James Clark Ross* CCAMLR-2000 Survey transect times. (See Table 4 for transect abbreviations).

Transect	Begin		End		BAS ID	Comments
	Date	Time	Date	Time		
SS01	18-Jan	1737	18-Jan	2300	T10	
	19-Jan	0527	19-Jan	1359	T11	
	19-Jan	1637	19-Jan	2320	T12	
	20-Jan	0501	20-Jan	1204	T13	
	20-Jan	1505	20-Jan	2345	T14	
	21-Jan	0430	21-Jan	1400	T15	
	21-Jan	1624	21-Jan	1855	T16	
SS04						T17 transit from SS01 to SS04
	22-Jan	1324	22-Jan	1435	T18	
	22-Jan	1702	23-Jan	0015	T19	
	23-Jan	0505	23-Jan	0842	T20	
	23-Jan	0944	24-Jan	1430	T21	
	23-Jan	1611	23-Jan	2345	T22	
	24-Jan	0530	24-Jan	1432	T23	
	24-Jan	1658	24-Jan	2320	T24	
	25-Jan	1546	25-Jan	2321	T25	
SS07						T26 transit from SS04 to SS07
	26-Jan	2231	26-Jan	2320	T27	
	27-Jan	0634	27-Jan	1002	T28	
	27-Jan	1107	27-Jan	1451	T29	
	27-Jan	1609	27-Jan	2340	T30	
	28-Jan	0620	28-Jan	1433	T31	
	28-Jan	1716	29-Jan	0000	T32	
	29-Jan	0600	29-Jan	1356	T33	
	29-Jan	1629	30-Jan	0030	T34	
	30-Jan	0807	30-Jan	1116	T35	
	30-Jan	1214	30-Jan	1505	T36	
	30-Jan	1610	30-Jan	2020	T37	
SS10						T38 transit from SS07 to SS10
	2-Feb	0718	2-Feb	1225	T40	
	2-Feb	1541	3-Feb	0045	T41	
	3-Feb	0620	3-Feb	1524	T42	
AP13						T43 transit from SS10 to AP13
	4-Feb	0606	04-Feb	0748	T44	
	4-Feb	0854	4-Feb	1542	T45	
	4-Feb	1707	4-Feb	2127	T46	
	5-Feb	0635	5-Feb	1418	T48	
AP16						T49 transit from AP13 to AP16
	6-Feb	0900	6-Feb	1613	T50	
	6-Feb	1821	6-Feb	0055	T51	
AP19						T52 transit from AP16 to AP19
	8-Feb	0025	8-Feb	0153	T53	
	8-Feb	0756	8-Feb	1621	T54	
	8-Feb	1900	9-Feb	0205	T55	
	9-Feb	0722	9-Feb	1433	T56	
	9-Feb	1709	9-Feb	2020	T57	
AP16						T58 transit from AP19 back to AP16
	10-Feb	2308	11-Feb	0054	T59	Inner end AP16

Table 14: *Kaiyo Maru* CCAMLR-2000 Survey transect times. (See Table 4 for transect abbreviations).

Transect	Begin		End		Comments
	Date	Time	Date	Time	
SS03	10-Jan	2123	10-Jan	2325	
	11-Jan	0538	11-Jan	1321	
	11-Jan	1547	11-Jan	2345	
	12-Jan	0518	12-Jan	1323	
	12-Jan	1600	13-Jan	0015	
	13-Jan	0449	13-Jan	1323	
	13-Jan	1539	14-Jan	0056	
	14-Jan	0405	14-Jan	0600	
SS06	14-Jan	1830	15-Jan	0056	
	15-Jan	0449	15-Jan	1346	
	15-Jan	1555	16-Jan	0020	
	16-Jan	0527	16-Jan	1347	
	16-Jan	1554	16-Jan	2355	
	17-Jan	0549	17-Jan	1455	
	17-Jan	1710	17-Jan	2141	
SS09	19-Jan	0624	19-Jan	1414	
	19-Jan	1633	20-Jan	0043	
	20-Jan	0603	20-Jan	1415	
	20-Jan	1630	21-Jan	0122	
	21-Jan	0526	21-Jan	1428	
	21-Jan	1646	21-Jan	2024	
AP12	22-Jan	0018	22-Jan	0158	
	22-Jan	0524	22-Jan	1438	
	22-Jan	1655	23-Jan	0015	
	23-Jan	0553	23-Jan	1802	
AP15	24-Jan	1010	24-Jan	1511	
	24-Jan	1815	25-Jan	0215	
	25-Jan	0631	25-Jan	1340	
AP18	26-Jan	0910	26-Jan	1530	
	26-Jan	1751	27-Jan	0238	
	27-Jan	0643	27-Jan	1538	
	27-Jan	1755	28-Jan	0219	

Table 15: *Kaiyo Maru* CCAMLR-2000 Survey mesoscale transects. (See Table 4 for transect abbreviations).

Transect	Begin		End		Comments
	Date	Time	Date	Time	
SSI01	29-Jan	0703	29-Jan	1429	
	29-Jan	1646	29-Jan	1703	
SSI02	29-Jan	1910	29-Jan	2350	
SSI03	30-Jan	0701	30-Jan	1210	
SSI04	30-Jan	1552	30-Jan	1614	
	30-Jan	1805	30-Jan	2131	
SSI05	31-Jan	0701	31-Jan	1118	
SSI06	31-Jan	1614	31-Jan	1626	
	31-Jan	1803	31-Jan	2212	
SSI07	1-Feb	0723	1-Feb	1203	
SSI08	1-Feb	1956	2-Feb	0101	

Table 16: *Atlantida* CCAMLR-2000 Survey transect times. (See Table 4 for transect abbreviations).

Transect	Begin		End		Comments
	Date	Time	Date	Time	
SSa	22-Jan	0500	22-Jan	1322	
	22-Jan	1518	22-Jan	2235	
	23-Jan	0442	23-Jan	1330	
	23-Jan	1628	23-Jan	2301	
	24-Jan	0405	24-Jan	1239	
SSb	25-Jan	0413	25-Jan	1154	
	25-Jan	1458	25-Jan	2207	
	26-Jan	0455	26-Jan	1332	
	26-Jan	1842	26-Jan	2253	
	27-Jan	0513	27-Jan	1206	
	27-Jan	1454	27-Jan	2228	
	28-Jan	0528	28-Jan	1316	
SSc	29-Jan	0527	29-Jan	1314	
	29-Jan	1539	29-Jan	2211	
	30-Jan	0514	30-Jan	1238	
	30-Jan	1359	30-Jan	2246	
	31-Jan	0443	31-Jan	1235	
	31-Jan	1508	31-Jan	2253	
	1-Feb	0432	1-Feb	0822	

Table 17: *Atlantida* CCAMLR-2000 Survey mesoscale transects. (See Table 4 for transect abbreviations).

Transect	Begin		End		Comments
	Date	Time	Date	Time	
Sand01	17-Jan	1000	17-Jan	1324	
	17-Jan	1502	17-Jan	1752	
Sand02	17-Jan	1908	17-Jan	2146	
	18-Jan	0412	18-Jan	0544	
Sand03	18-Jan	0551	18-Jan	1104	
Sand04	18-Jan	1149	18-Jan	1255	
	18-Jan	1630	18-Jan	1742	
Sand05	18-Jan	1805	18-Jan	2323	
Sand06	19-Jan	0641	19-Jan	1119	
Sand07	19-Jan	1220	19-Jan	1321	
	19-Jan	1503	19-Jan	1731	
Sand08	19-Jan	1906	20-Jan	0017	
Sand09	20-Jan	0513	20-Jan	1118	
Sand10	20-Jan	1147	20-Jan	1302	
	20-Jan	1559	20-Jan	1833	

Table 18: *Yuzhmorgeologiya* CCAMLR-2000 Survey transects times. (See Table 4 for transect abbreviations).

Transect	Begin		End		Comments
	Date	Time	Date	Time	
SS02	16-Jan	0535	16-Jan	0809	
	16-Jan	1002	16-Jan	1417	
	16-Jan	1510	16-Jan	2323	
	17-Jan	0525	17-Jan	1243	
	17-Jan	1555	17-Jan	2046	
	18-Jan	0502	18-Jan	1420	
	18-Jan	1635	19-Jan	0019	
	19-Jan	0502	19-Jan	1420	
	19-Jan	1754	19-Jan	2042	
					Transit to SS05
SS05	20-Jan	1148	20-Jan	1442	
	20-Jan	1632	21-Jan	0035	
	21-Jan	0522	21-Jan	1148	
	21-Jan	1358	22-Jan	0003	
	22-Jan	0528	22-Jan	1445	
	22-Jan	1907	22-Jan	2352	
	23-Jan	0537	23-Jan	1438	
	23-Jan	1546	23-Jan	2335	
					Transit to SS08
SS08	25-Jan	1721	26-Jan	0013	
	26-Jan	0609	26-Jan	1324	
	26-Jan	1549	26-Jan	2139	
	27-Jan	0551	27-Jan	1520	
	28-Jan	0520	28-Jan	1503	
					Transit to AP11
AP11	31-Jan	0056	1-Feb	0052	
					Transit to AP14
AP14	1-Feb	2008	2-Feb	0134	
	2-Feb	0638	2-Feb	1610	
					Transit to AP17
AP17	3-Feb	0837	4-Feb	0208	
	4-Feb	0730	4-Feb	1642	
	4-Feb	1850	4-Feb	2019	

Table 19: *Yuzhmorgeologiya* CCAMLR-2000 Survey mesoscale transects. (See Table 4 for transect abbreviations).

Transect	Begin		End		Comments
	Date	Time	Date	Time	
SG04	13-Jan	1052	13-Jan	1437	
	13-Jan	1910	13-Jan	1936	
					Transit to SG03
SG03	13-Jan	2238	13-Jan	2339	
	14-Jan	0651	14-Jan	1105	
					Transit to SG02
SG02	14-Jan	1726	14-Jan	2255	
					Transit to SG01
SG01	15-Jan	0542	15-Jan	1044	
					Transit to SOI01
SOI01	29-Jan	0812	29-Jan	1315	
					Transit to SOI02
SOI02	29-Jan	1841	29-Jan	2255	
					Transit to SOI03
SOI03	30-Jan	0549	30-Jan	0957	
					Transit to SOI04
SOI04	30-Jan	1504	30-Jan	1830	

Table 20: Steps implemented in Echoview 2.00. Raw variables: Q1 – 38 kHz raw data; Q2 – 120 kHz raw data; Q3 – 200 kHz raw data.

Steps	Virtual Variables				
	Name	Operator	Operand1	Operand2	Other Settings Required
Define inclusions	Surf-bott	Line bitmap	Q1		Surface exclusion to integration stop line
	Good data	Region bitmap	Q1		Bad data regions, INVERT output
	Include	AND	Surf-bott	Good data	
Mask echograms	38-E	Mask	Q1	Include	DO check zero is no data
	120-E	Mask	Q2	Include	DO check zero is no data
	200-E	Mask	Q3	Include	DO check zero is no data
Resample masked echograms	38-S	Resample by time	38-E		100 seconds, 0–500 m, 100 samples
	120-S	Resample by time	120-E		100 seconds, 0–500 m, 100 samples
	200-S	Resample by time	200-E		100 seconds, 0–500 m, 100 samples
Generate noise	Noise 38	Data generator	38-S		Use noise(s_v)1 m from table; set α = 0.010
	Noise 120	Data generator	120-S		Use noise(s_v)1 m from table; set α = 0.028
	Noise 200	Data generator	200-S		Use noise(s_v)1 m from table; set α = 0.041
Subtract noise from resampled echograms	38-S-C	Linear minus	38-S	Noise 38	
	120-S-C	Linear minus	120-S	Noise 120	
	200-S-C	Linear minus	200-S	Noise 200	
Subtract (120-38)	Dif-S 120-38	Minus	120-S-C	38-S-C	Set display min s_v to 0
Define dB range	Range Dif-S	Range	Dif-S 120-38		Range 2–16
Mask resampled noise-free echograms	Mask 38-S-C	Mask	38-S-C	Range Dif-S	Do NOT check zero is no data, add grid
	Mask 120-S-C	Mask	120-S-C	Range Dif-S	Do NOT check zero is no data, add grid
	Mask 200-S-C	Mask	200-S-C	Range Dif-S	Do NOT check zero is no data, add grid
					Process tab: exclude above = surface exclusion; exclude below = integration stop.

Table 21: Conversion factor, integrated volume backscattering (S_A, m^2/n miles^2) to areal krill biomass density (g/m^2).

	Cluster 1	Cluster 2	Cluster 3	Clusters 2+3	Clusters 1+2+3
120 kHZ					
FIBEX 1	0.1481	0.1523	0.1536	0.1526	0.1508
FIBEX 2	0.1656	0.1583	0.1557	0.1576	0.1609
CCAMLR-2000	0.1636	0.1517	0.1477	0.1506	0.1560
Morris et al. (1988)	0.1931	0.1703	0.1630	0.1684	0.1785
Siegel (1992)	0.1556	0.1449	0.1414	0.1440	0.1487
38 kHz					
FIBEX 1	0.4672	0.4805	0.4847	0.4815	0.4757
FIBEX 2	0.5224	0.4993	0.4913	0.4971	0.5075
CCAMLR-2000	0.5163	0.4786	0.4661	0.4753	0.4921
Morris et al. (1988)	0.6092	0.5372	0.5142	0.5311	0.5630
Siegel (1992)	0.4909	0.4573	0.4461	0.4543	0.4693
200 kHz					
FIBEX 1	0.0888	0.0914	0.0921	0.0915	0.0904
FIBEX 2	0.0993	0.0949	0.0934	0.0945	0.0964
CCAMLR-2000	0.0982	0.0910	0.0886	0.0904	0.0936
Morris et al. (1988)	0.1158	0.1021	0.0977	0.1010	0.1070
Siegel (1992)	0.0933	0.0869	0.0848	0.0864	0.0892

Table 22: Expected change in latitude (Δlat) per nautical mile of transect. (See Table 4 for transect abbreviations).

Transect	Δlat	Transect	Δlat	Transect	Δlat
SS01	0.01649	SSI01	0.01496	Sand01	0.01635
SS02	0.01657	SSI02	0.01507	Sand02	0.01632
SS03	0.01662	SSI03	0.01519	Sand03	0.01630
SS04	0.01665	SSI04	0.01532	Sand04	0.01629
SS05	0.01666	SSI05	0.01539	Sand05	0.01628
SS06	0.01667	SSI06	0.01554	Sand06	0.01639
SS07	0.01665	SSI07	0.01559	Sand07	0.01637
SS08	0.01662	SSI08	0.01574	Sand08	0.01637
SS09	0.01656	S0I1	0.01665	Sand09	0.01635
SS10	0.01650	S0I2	0.01664	Sand10	0.01632
SSa	0.01625	S0I3	0.01662		
SSb	0.01635	S0I4	0.01660		
SSc	0.01643	SG01	0.01662		
AP11	0.01451	SG02	0.01663		
AP12	0.01463	SG03	0.01665		
AP13	0.01487	SG04	0.01666		
AP14	0.01521				
AP15	0.01546				
AP16	0.01561				
AP17	0.01590				
AP18	0.01599				
AP19	0.01613				

Table 23: Planned transect length (km) sampled within each subarea.

Subarea	Large-scale	Mesoscale	Total	% in each Subarea
48.1	3 818	800	4 618	25.6
48.2	4 413	400	4 813	26.6
48.3	4 219	400	4 619	25.6
48.4	2 993	1 000	3 993	22.1

Table 24a: Mean krill density and associated variance by transect and stratum estimated from acoustic data collected at 38 kHz. (See Table 4 for transect abbreviations and Attachment D for description of calculations).

Transect						Stratum Krill Density		
Name	Length (n miles)	Weighting Factor	Krill Density Measured (g/m^2)	Krill Density Weighted (g/m^2)	Variance Component	Mean (g/m^2)	Variance	CV (%)
AP11	95.99	0.67	5.02	3.36	13.10	10.42	6.46	24.38
AP12	194.66	1.36	18.18	24.70	111.15			
AP13	133.00	0.93	10.30	9.56	0.01			
AP14	76.59	0.53	13.77	7.36	3.20			
AP15	108.14	0.75	25.29	19.09	125.96			
AP16	90.29	0.63	13.41	8.45	3.55			
AP17	156.60	1.09	8.77	9.59	3.26			
AP18	228.75	1.60	5.33	8.51	66.08			
AP19	205.40	1.43	2.22	3.18	138.48			
SS01	431.22	1.23	9.29	11.46	42.77	14.60	2.68	11.21
SS02	416.33	1.19	15.16	18.06	0.46			
SS03	364.24	1.04	14.33	14.92	0.08			
SS04	312.13	0.89	18.44	16.46	11.78			
SS05	397.78	1.14	14.07	16.00	0.36			
SS06	402.61	1.15	11.25	12.95	14.87			
SS07	379.43	1.09	25.92	28.13	150.99			
SS08	271.53	0.78	15.85	12.31	0.94			
SS09	346.36	0.99	11.19	11.09	11.37			
SS10	175.13	0.50	9.18	4.60	7.36			
SSa	327.02	1.07	5.66	6.06	7.95	8.29	13.38	44.13
SSb	199.88	0.66	1.51	0.99	19.70			
SSc	388.56	1.27	13.99	17.81	52.67			
SSI01	37.87	1.09	58.10	63.39	15.53	54.49	105.20	18.82
SSI02	35.11	1.01	28.57	28.90	687.32			
SSI03	38.34	1.10	78.25	86.44	688.95			
SSI04	28.67	0.83	45.71	37.75	52.63			
SSI05	31.56	0.91	30.65	27.86	469.78			
SSI06	32.88	0.95	42.78	40.52	122.99			
SSI07	35.14	1.01	111.84	113.21	3 369.89			
SSI08	38.13	1.10	34.46	37.85	484.16			
SOI01	38.71	1.22	6.52	7.98	7 222.60	75.93	1678.90	53.96
SOI02	32.65	1.03	100.27	103.54	631.75			
SOI03	29.61	0.94	185.27	173.50	10 483.16			
SOI04	25.51	0.81	23.20	18.71	1 809.31			
SG01	38.47	1.03	17.68	18.23	53.02	10.62	9.78	29.45
SG02	39.48	1.06	3.38	3.57	58.60			
SG03	39.07	1.05	12.40	12.98	3.48			
SG04	32.26	0.86	8.89	7.69	2.22			
Sand01	42.27	1.13	23.32	26.32	125.01	13.41	4.49	15.79
Sand02	38.89	1.04	16.77	17.41	12.15			
Sand03	38.35	1.02	15.56	15.94	4.85			
Sand04	36.60	0.98	11.10	10.84	5.13			
Sand05	39.33	1.05	7.13	7.49	43.55			
Sand06	36.28	0.97	21.71	21.03	64.64			
Sand07	27.21	0.73	15.12	10.99	1.54			
Sand08	37.09	0.99	5.06	5.01	68.41			
Sand09	39.57	1.06	5.02	5.30	78.64			
Sand10	38.96	1.04	13.27	13.80	0.02			

Table 24b: Mean krill density and standing stock, and associated variances, by stratum and for the entire survey, estimated from acoustic data collected at 38 kHz. (See Table 4 for transect abbreviations and Attachment D for description of calculations).

Stratum	Nominal Area (km^2)	Mean Density (g/m^2)	Area*Density (million tonnes)	Variance Component
AP (11–19)	473 318	10.42	4 933 506.55	1 446 231 977 393.93
SS (01–10)	1 109 789	14.60	16 199 493.48	3 297 868 733 235.00
SS (a–c)	321 800	8.29	2 667 686.01	1 386 065 333 392.42
SSI (01–08)	48 654	54.49	2 651 158.06	249 033 424 971.57
SOI (01–04)	24 409	75.93	1 853 439.54	1 000 288 115 684.75
SG (01–04)	25 000	10.62	265 399.27	6 110 386 467.47
Sand (01–10)	62 274	13.41	835 277.60	17 405 436 721.73
Total	206 5244		29 405 960.52	7 403 003 407 866.88
Survey				
Mean density	14.24	g/m^2		
Variance	1.74	$(g/m^2)^2$		
CV	9.25	%		
Krill standing stock	29.41	million tonnes		
Variance	7 403 003.41	million tonnes^2		
CV	9.25	%		

Table 25a: Mean krill density and associated variance by transect and stratum estimated from acoustic data collected at 120 kHz. (See Table 4 for transect abbreviations and Attachment D for description of calculations).

Transect						Stratum Krill Density		
Name	Length (n miles)	Weighting Factor	Krill Density Measured (g/m^2)	Krill Density Weighted (g/m^2)	Variance Component	Mean (g/m^2)	Variance	CV (%)
AP11	95.99	0.67	12.83	8.59	1.13	11.24	4.70	19.29
AP12	194.66	1.36	15.58	21.17	34.79			
AP13	133.00	0.93	11.79	10.94	0.26			
AP14	76.59	0.53	18.06	9.65	13.29			
AP15	108.14	0.75	22.88	17.27	77.18			
AP16	90.29	0.63	13.22	8.33	1.56			
AP17	156.60	1.09	10.57	11.55	0.54			
AP18	228.75	1.60	5.30	8.46	89.92			
AP19	205.40	1.43	3.61	5.18	119.59			
SS01	431.22	1.23	20.38	25.14	26.28	24.54	14.07	15.28
SS02	416.33	1.19	47.53	56.60	749.40			
SS03	364.24	1.04	26.11	27.19	2.66			
SS04	312.13	0.89	30.94	27.62	32.67			
SS05	397.78	1.14	25.49	29.00	1.17			
SS06	402.48	1.15	13.93	16.03	149.20			
SS07	379.43	1.09	30.16	32.73	37.17			
SS08	271.53	0.78	21.40	16.62	5.96			
SS09	346.36	0.99	10.43	10.33	195.34			
SS10	175.13	0.50	8.29	4.15	66.27			
SSa	326.60	1.07	8.18	8.75	11.29	11.32	23.10	42.46
SSb	199.88	0.65	1.97	1.29	37.44			
SSc	389.24	1.28	18.75	23.91	89.85			
SSI01	37.87	1.09	17.73	19.35	476.09	37.73	97.94	26.23
SSI02	35.11	1.01	27.65	27.96	103.96			
SSI03	38.34	1.10	61.30	67.71	677.62			
SSI04	28.67	0.83	14.48	11.96	368.57			
SSI05	31.56	0.91	25.83	23.48	117.00			
SSI06	32.88	0.95	29.89	28.32	55.08			
SSI07	35.14	1.01	95.76	96.94	3 451.40			
SSI08	38.13	1.10	23.78	26.12	234.93			
SOI01	38.71	1.22	12.20	14.93	28 615.52	150.37	6966.86	55.51
SOI02	32.65	1.03	221.61	228.84	5 412.21			
SOI03	29.61	0.94	361.59	338.62	39 127.21			
SOI04	25.51	0.81	23.65	19.08	10 447.39			
SG01	38.47	1.03	70.75	72.94	1 051.46	39.30	146.24	30.77
SG02	39.48	1.06	17.34	18.34	539.47			
SG03	39.07	1.05	42.35	44.34	10.24			
SG04	32.26	0.86	24.95	21.57	153.74			
Sand01	42.27	1.13	27.69	31.25	4.77	25.76	46.15	26.37
Sand02	38.89	1.04	20.88	21.69	25.60			
Sand03	38.35	1.02	20.89	21.39	24.83			
Sand04	36.60	0.98	22.11	21.60	12.72			
Sand05	39.33	1.05	18.09	19.00	64.81			
Sand06	36.28	0.97	85.63	82.94	3 363.21			
Sand07	27.21	0.73	28.11	20.42	2.93			
Sand08	37.09	0.99	10.47	10.37	229.21			
Sand09	39.57	1.06	6.86	7.24	398.80			
Sand10	38.96	1.04	20.83	21.67	26.23			

Table 25b: Mean krill density and standing stock, and associated variances, by stratum and for the entire survey, estimated from acoustic data collected at 120 kHz. (See Table 4 for transect abbreviations and Attachment D for description of calculations).

Stratum	Nominal Area (km^2)	Mean Density (g/m^2)	Area*Density (million tonnes)	Variance Component
AP (11–19)	473 318	11.24	5 319 647.98	1 052 496 388 913.78
SS (01–10)	1 109 789	24.54	27 234 964.55	17 326 537 058 061.60
SS (a–c)	321 800	11.32	3 642 035.01	2 391 655 734 991.07
SSI (01–08)	48 654	37.73	1 835 720.49	231 845 632 004.71
SOI (01–04)	24 409	150.37	3 670 294.56	4 150 849 848 119.59
SG (01–04)	25 000	39.30	982 423.23	91 401 915 350.65
Sand (01–10)	62 274	25.76	1 603 985.17	178 954 989 453.98
Total	2 065 244		44 289 070.99	25 423 741 566 895.40

Survey		
Mean density	21.44	g/m^2
Variance	5.96	$(g/m^2)^2$
CV	11.38	%
Krill standing stock	44.29	million tonnes
Variance	25 423 741.57	million $tonnes^2$
CV	11.38	%

Table 26a: Mean krill density and associated variance by transect and stratum estimated from acoustic data collected at 200 kHz. (See Table 4 for transect abbreviations and Attachment D for description of calculations).

Transect						Stratum Krill Density		
Name	Length (n miles)	Weighting Factor	Krill Density Measured (g/m^2)	Krill Density Weighted (g/m^2)	Variance Component	Mean (g/m^2)	Variance	CV (%)
AP11	95.99	0.67	19.81	13.27	67.62	7.54	3.03	23.09
AP12	194.66	1.36	10.18	13.83	12.88			
AP13	133.00	0.93	7.15	6.63	0.13			
AP14	76.59	0.53	12.56	6.71	7.20			
AP15	108.14	0.75	12.01	9.07	11.42			
AP16	90.29	0.63	7.87	4.96	0.04			
AP17	156.60	1.09	4.83	5.28	8.77			
AP18	228.75	1.60	3.38	5.40	43.97			
AP19	205.40	1.43	1.87	2.68	66.03			
SS01	431.22	1.23	26.39	32.54	46.99	20.83	22.83	22.94
SS02	416.33	1.19	52.90	62.98	1 457.89			
SS03	364.24	1.04	15.56	16.21	30.11			
SS04	312.13	0.89	26.90	24.02	29.43			
SS05	397.78	1.14	18.49	21.04	7.04			
SS06	402.61	1.15	8.05	9.27	216.26			
SS07	379.43	1.09	18.65	20.23	5.59			
SS08	271.53	0.78	14.85	11.53	21.57			
SS09	346.36	0.99	6.68	6.62	196.38			
SS10	175.13	0.50	7.66	3.84	43.46			
SSa	327.04	1.07	23.00	24.65	112.13	32.88	182.73	41.11
SSb	199.88	0.65	8.08	5.29	264.00			
SSc	388.56	1.27	53.96	68.71	720.24			
SSI01	37.87	1.09	24.11	26.31	0.10	23.82	16.84	17.23
SSI02	35.11	1.01	13.91	14.07	100.53			
SSI03	38.34	1.10	32.50	35.90	91.92			
SSI04	28.67	0.83	26.64	22.00	5.42			
SSI05	31.56	0.91	14.51	13.19	71.76			
SSI06	32.88	0.95	18.76	17.77	23.04			
SSI07	35.14	1.01	46.24	46.81	515.18			
SSI08	38.13	1.10	13.24	14.54	135.24			
SOI01	38.71	1.22	10.23	12.52	11 072.17	96.17	2612.93	53.15
SOI02	32.65	1.03	154.86	159.91	3 672.22			
SOI03	29.61	0.94	214.35	200.73	12 248.51			
SOI04	25.51	0.81	14.29	11.53	4 362.27			
SG01	38.47	1.03	94.32	97.25	2 694.41	43.98	307.82	39.90
SG02	39.48	1.06	22.44	23.74	518.79			
SG03	39.07	1.05	35.13	36.78	85.76			
SG04	32.26	0.86	20.99	18.14	394.82			
Sand01	42.27	1.15	51.73	59.49	25.54	47.34	105.62	21.71
Sand02	38.89	1.06	39.51	41.81	68.58			
Sand03	38.35	1.04	52.34	54.61	27.22			
Sand04	36.60	1.00	2.17	2.16	2 022.03			
Sand05	32.33	0.88	60.97	53.62	143.73			
Sand06	36.28	0.99	65.19	64.35	310.63			
Sand07	27.21	0.74	136.64	101.15	4 370.60			
Sand08	37.09	1.01	61.26	61.82	197.45			
Sand09	39.57	1.08	23.18	24.96	676.45			
Sand10	38.96	1.06	8.85	9.38	1 663.85			

Table 26b: Mean krill density and standing stock, and associated variances, by stratum and for the entire survey, estimated from acoustic data collected at 200 kHz. (See Table 4 for transect abbreviations and Attachment D for description of calculations).

Stratum	Nominal Area (km^2)	Mean Density (g/m^2)	Area*Density (million tonnes)	Variance Component
AP (11–19)	473 318	7.54	3 567 466.33	678 506 608 166.80
SS (01–10)	1 109 789	20.83	23 113 322.60	28 118 640 024 444.60
SS (a–c)	321 800	32.88	10 581 899.97	18 922 484 846 099.70
SSI (01–08)	48 654	23.82	1 159 090.11	39 869 126 927.20
SOI (01–04)	24 409	96.17	2 347 454.90	1 556 782 525 132.16
SG (01–04)	25 000	43.98	1 099 399.53	192 384 609 178.69
Sand (01–10)	62 274	47.34	2 947 763.77	409 612 070 977.53
Total	2 065 244		44 816 397.21	49 918 279 810 926.70
Survey				
Mean density	21.70	g/m^2		
Variance	11.70	$(g/m^2)^2$		
CV	15.76	%		
Krill standing stock	44.82	million tonnes		
Variance	49 918 279.81	million tonnes^2		
CV	15.76	%		

Table 27: Results of a single-factor ANOVA testing for differences in krill densities (g/m^2 at 120 kHz) measured by the *James Clark Ross*, *Kaiyo Maru* and *Yuzhmorgeologiya* running interleaved transects in the Scotia Sea (SS) and Antarctic Peninsula (AP) regions. Minor changes to transect means resulting from error checking (paragraph 4.3) are not included. The inclusion of these changes is not expected to alter the conclusions drawn from this table.

Krill density (g/m^2)						
Ship/transect means	SS01,02,03	SS04,05,06	SS07,08,09	AP13,12,11	AP16,15,14	AP19,18,17
James Clark Ross	20.38	30.94	30.16	11.74	13.22	3.61
Kaiyo Maru	26.11	13.93	10.43	15.58	22.88	5.30
Yuhzmorgeologiya	47.53	25.49	21.40	12.83	18.06	10.57
Summary						
Groups	Count	Sum	Average	Variance		
James Clark Ross	6	110.05	18.34	117.90		
Kaiyo Maru	6	94.22	15.70	59.77		
Yuhzmorgeologiya	6	135.87	22.65	178.46		
ANOVA						
Source of variation	SS	df	MS	F	P-value	F crit
Between groups	147.34	2	73.67	0.62	0.55	3.68
Within groups	1 780.66	15	118.71			
Total	1 927.99	17				

Table 28: Results of a single-factor ANOVA testing for differences in krill densities (g/m^2 at 120 kHz) measured by all four research vessels in the Scotia Sea (SS) and Antarctic Peninsula (AP) regions. Minor changes to transect means resulting from error checking (paragraph 4.3) are not included. The inclusion of these changes is not expected to alter the conclusions drawn from this table.

Krill density (g/m^2)							
Ship/transect means	SS01,02,03	SS04,05,06	SS07,08,09	AP13,12,11	AP16,15,14	AP19,18,17	SS10
James Clark Ross	20.38	30.94	30.16	11.74	13.22	3.61	7.39
Kaiyo Maru	26.11	13.93	10.43	15.58	22.88	5.30	
Yuhzmorgeologiya	47.53	25.49	21.40	12.83	18.06	10.57	
Atlantida	8.18	1.97	18.75				
Summary							
Groups	Count	Sum	Average	Variance			
James Clark Ross	7	117.45	16.78	115.38			
Kaiyo Maru	6	94.22	15.70	59.77			
Yuhzmorgeologiya	6	135.87	22.65	178.46			
Atlantida	3	28.90	9.63	71.96			
ANOVA							
Source of variation	SS	df	MS	F	P-value	F crit	
Between groups	364.17	3	121.39	1.08	0.38	3.16	
Within groups	2 027.34	18	112.63				
Total	2 391.51	21					

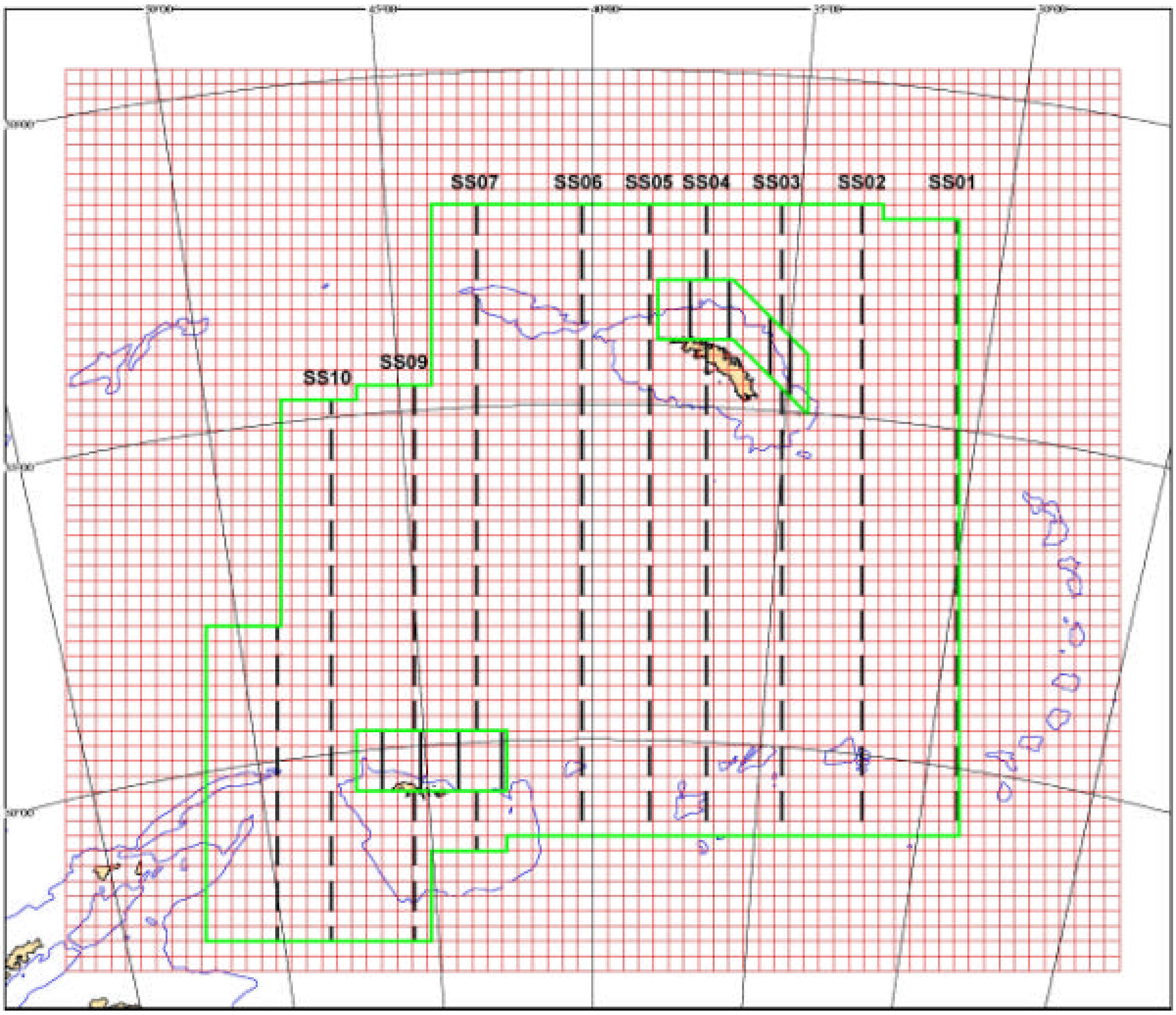

Figure 1a: CCAMLR-2000 Survey strata in the Scotia Sea. The large-scale stratum extends across the region, and two mesoscale survey boxes were located adjacent to South Georgia and the South Orkney Islands. Large-scale transects (SS01-SS10, dashed lines) and mesoscale transects (SG01-SG04 and SOI01-SOI04, solid lines) are shown. The grid squares are 25 x 25 km.

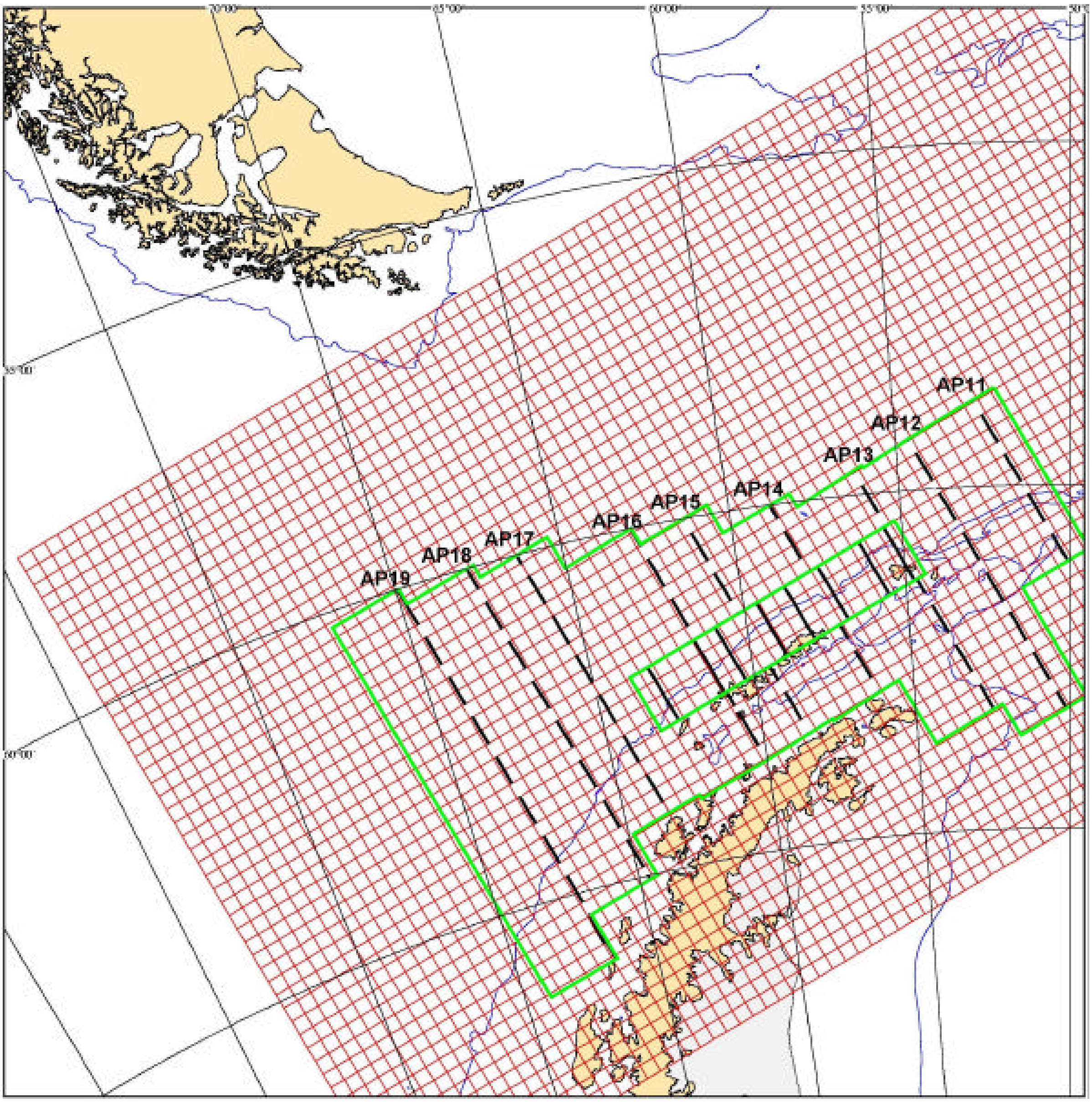

Figure 1b: CCAMLR-2000 Survey strata in the Antarctic Peninsula region. The large-scale stratum extends across the region, and the mesoscale survey box was located adjacent to the South Shetland Islands. Large-scale transects (AP11-AP19, dashed lines) and mesoscale transects (SSI01-08, solid lines) are shown. The grid squares are 25 x 25 km.

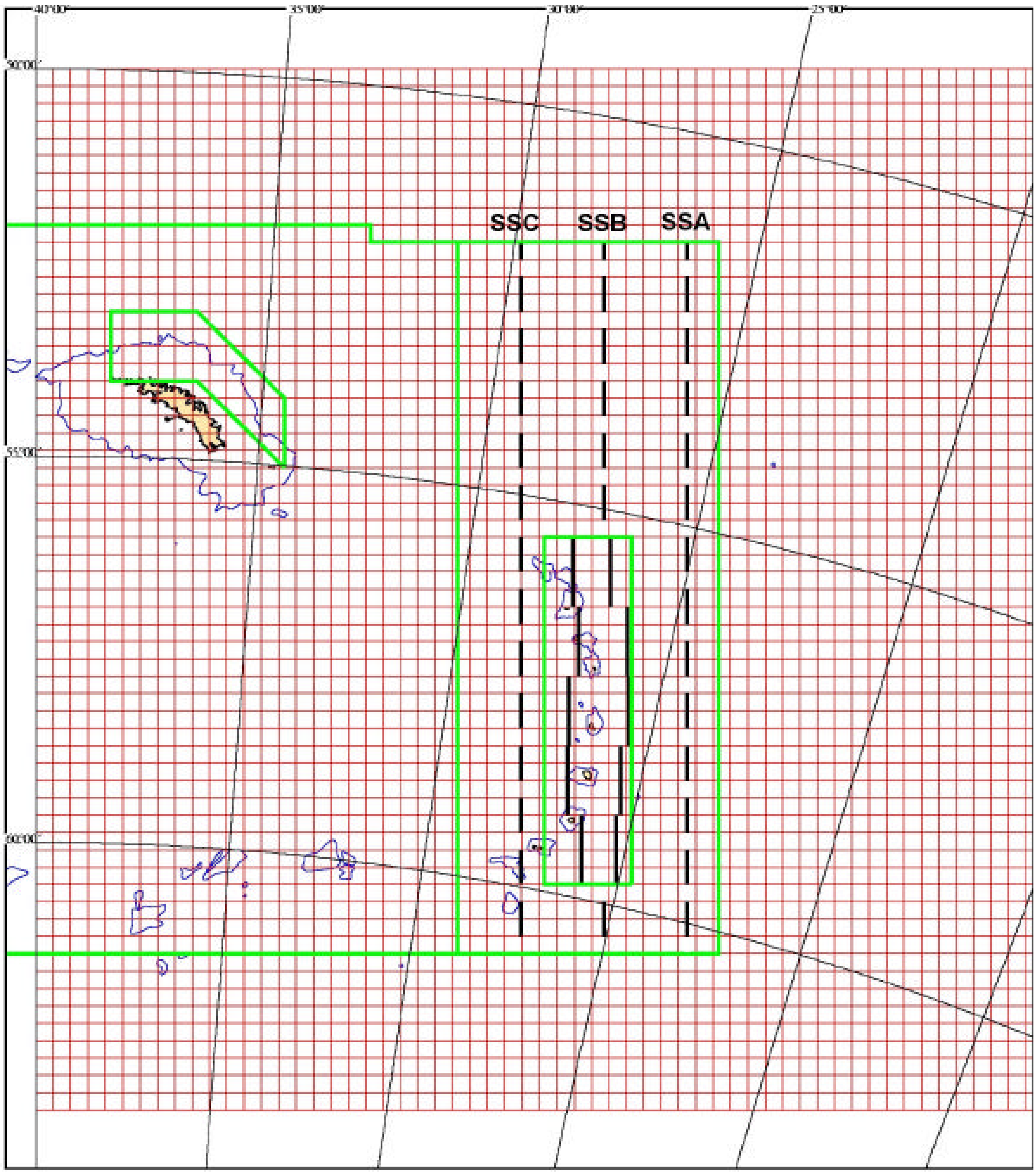

Figure 1c: CCAMLR-2000 Survey strata in the East Scotia Sea. The large-scale stratum extends across the region, and the mesoscale survey box was located adjacent to the South Sandwich Islands. Large-scale transects (SSA-SSC, dashed lines) and mesoscale transects (Sand01-10, solid lines) are shown. The grid squares are 25 x 25 km.

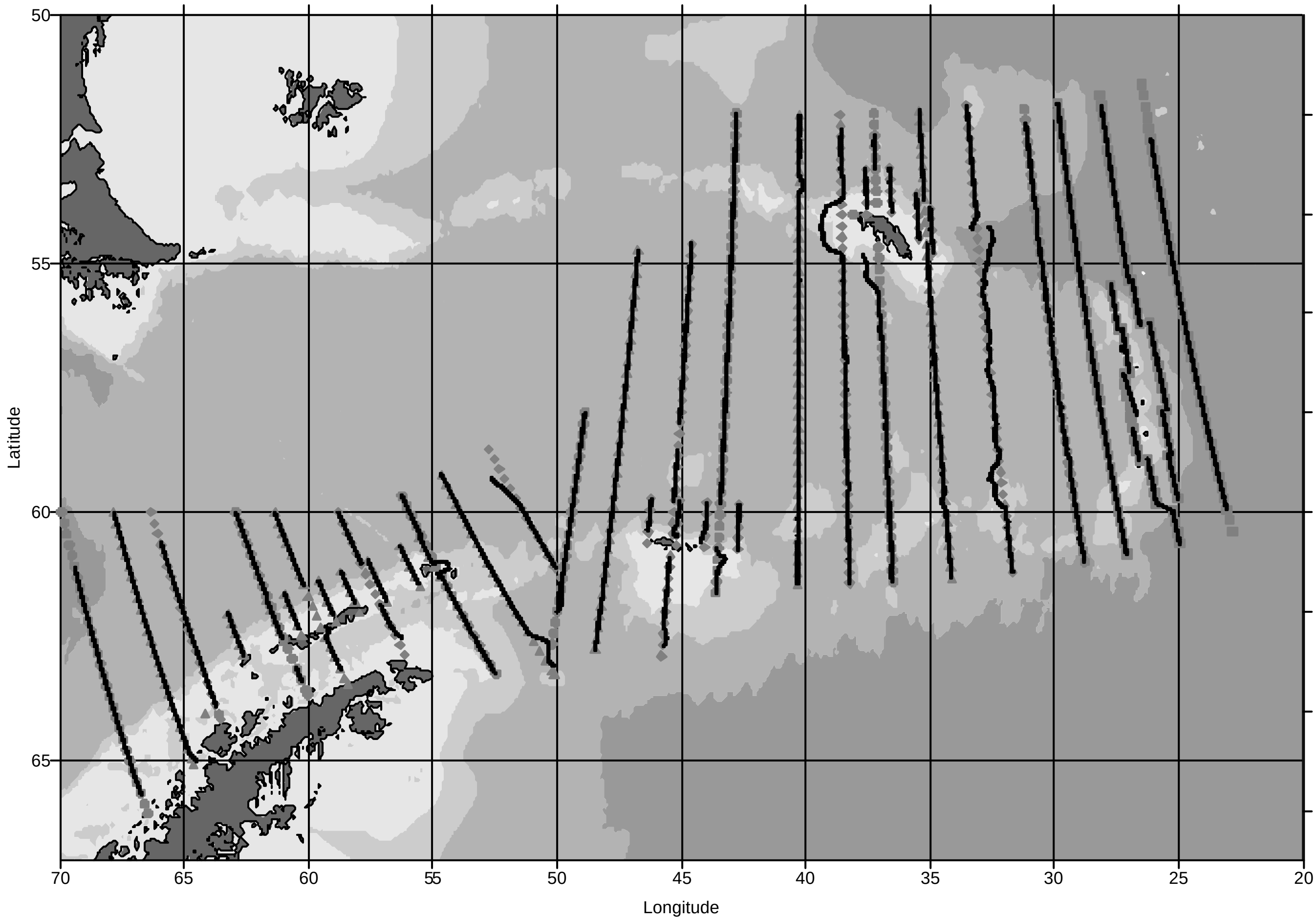

Figure 2: Planned way points for the *Atlantida* (¦), *Kaiyo Maru* (?), *James Clark Ross* (?) and *Yuzhmorgeologiya* (?) and actual transects (solid lines) conducted during the CCAMLR-2000 Survey.

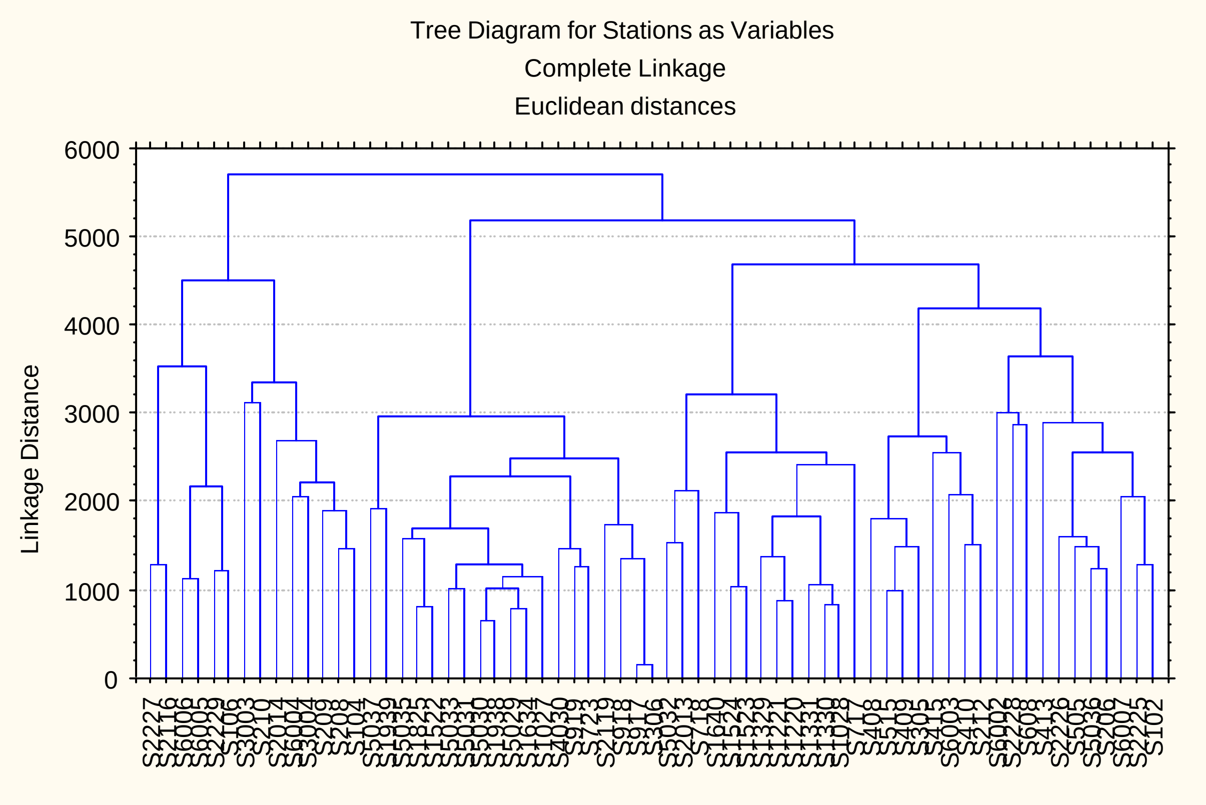

Figure 3: Dendrogram showing the clustering of length-frequency distributions of krill, from RMT8 samples, using the Complete Linkage Method.

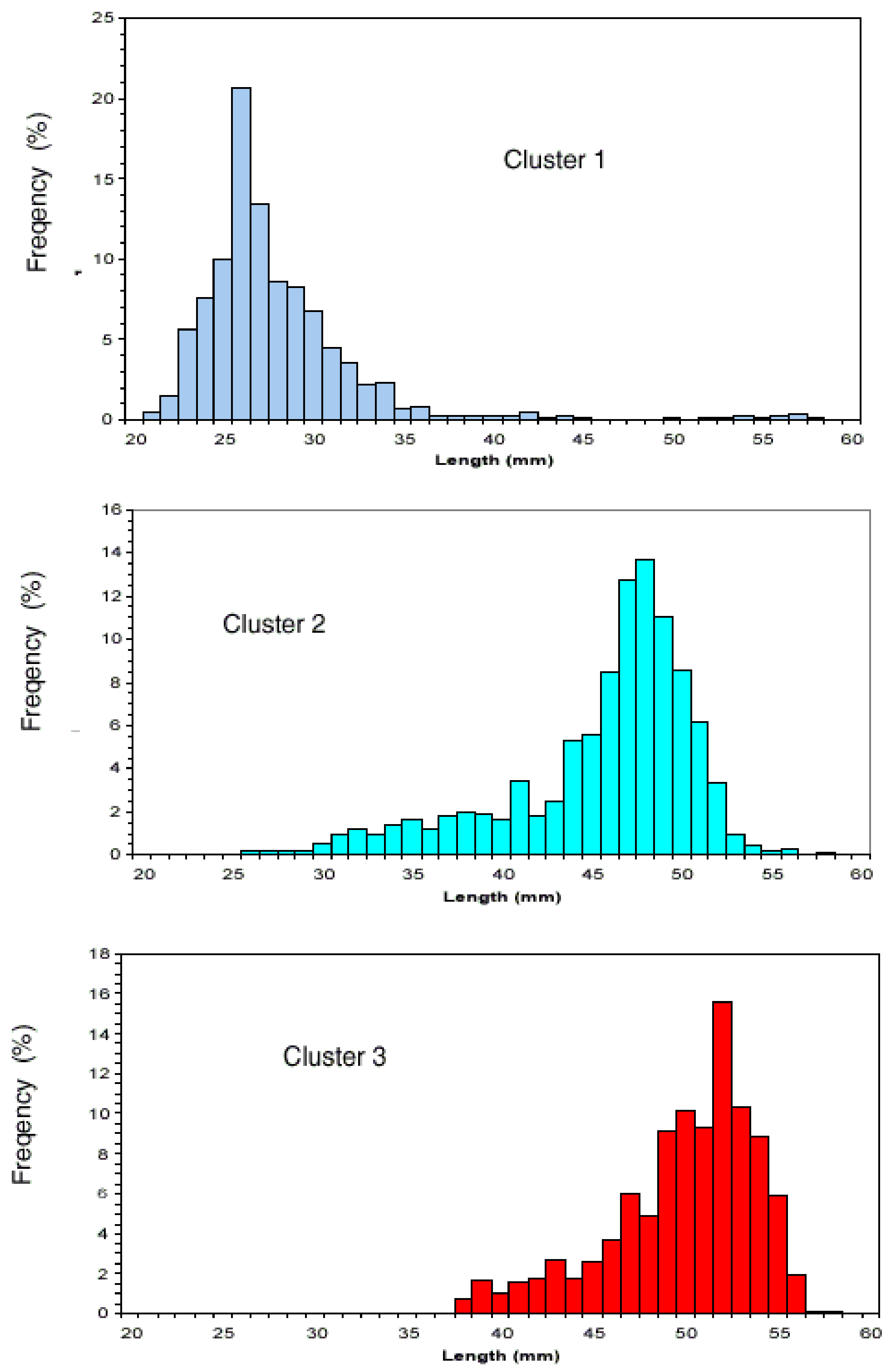

Figure 4: Aggregated length-frequency distributions of krill, from RMT8 samples, for the three clusters shown in Figure 3.

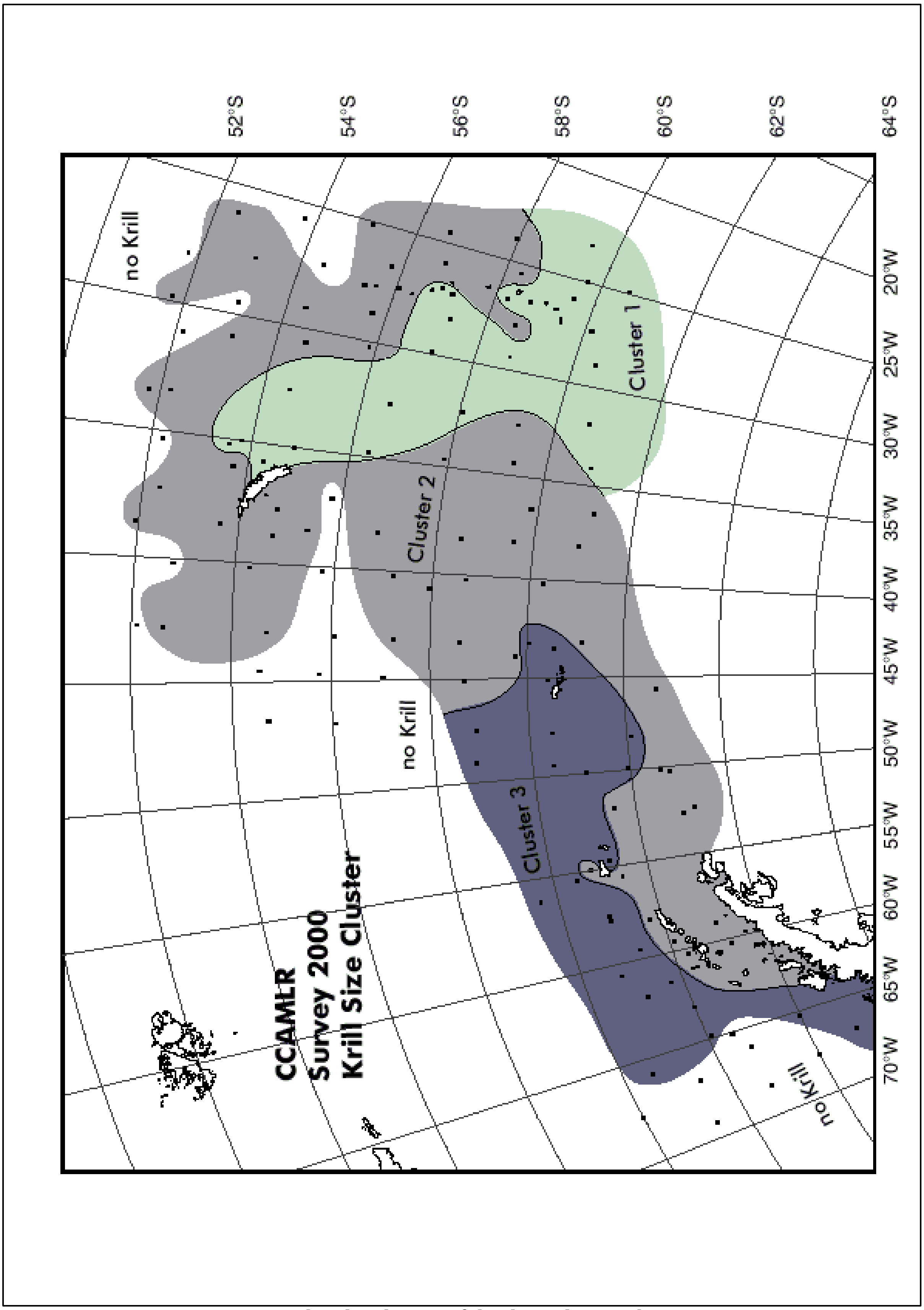

Figure 5: Geographic distribution of the three clusters shown in Figure 3.

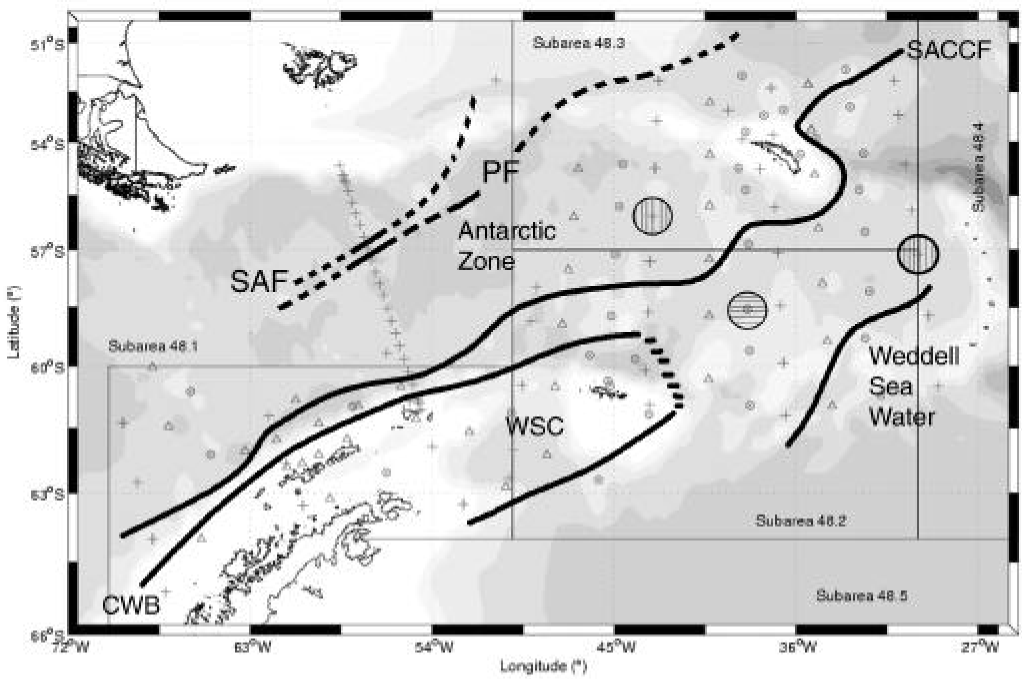

Figure 6: General distribution of water masses in the Scotia Sea and Antarctic Peninsula region during the CCAMLR-2000 Survey, based on CTD data collected by the *James Clark Ross* (+), *Yuzhmorgeologiya* (?) and *Kaiyo Maru* (?). Circles with vertical hatching represent eddies of warm water, horizontal hatched circles eddies of cold water. CWB: Continental Water Boundary; PF: Antarctic Polar Front; SACCF: Southern Antarctic Circumpolar Current Front; SAF: Sub-Antarctic Front; WSC: Weddell-Scotia Confluence.

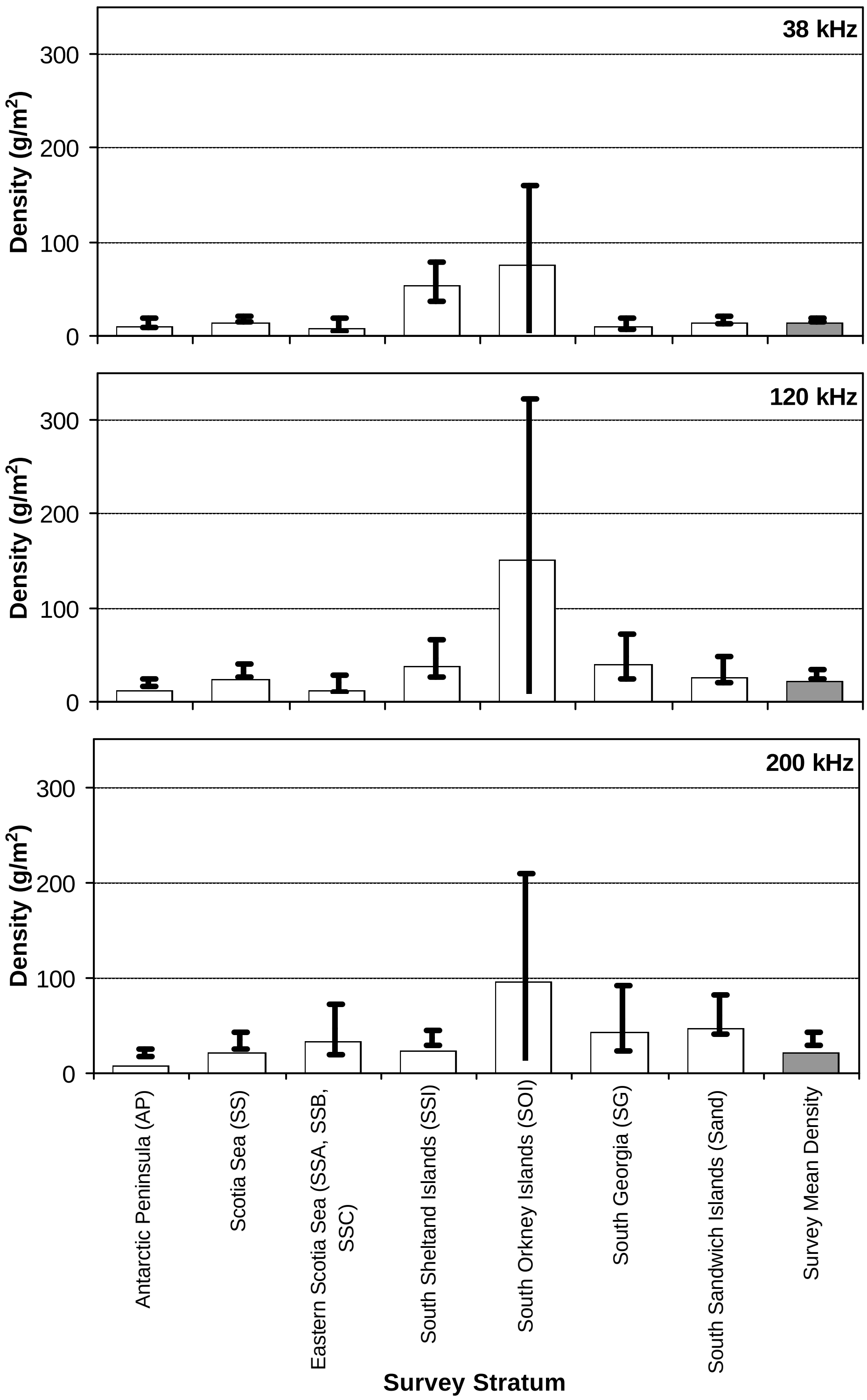

Figure 7: Mean krill density (g/m^2) by stratum, and for the entire survey area, estimated from acoustic data collected at 38, 120 and 200 kHz. Error bars represent the 95% confidence intervals.

LIST OF PARTICIPANTS

B_0 Workshop
(La Jolla, USA, 30 May to 9 June 2000)

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ATTACHMENT B

AGENDA

B_0 Workshop
(La Jolla, USA, 30 May to 9 June 2000)

1. Introduction (Day 1)

   1.1 Discussion of, and agreement to, the terms of reference, the specific tasks to be conducted, timetable, and output of workshop.
   1.2 Description of local facilities and infrastructure for accessing datasets and using analytical tools.
   1.3 Description of data preparations.

2. Abstracts of Survey Results (Day 1)

   2.1 Overviews of CCAMLR-2000 Survey by coordinators from Japan, UK, Russia and USA.
   2.2 Brief overviews of national surveys conducted in 1999/2000 over portions of the CCAMLR-2000 Survey area.
   2.3 Overviews of krill length frequency and water mass boundaries observed during CCAMLR-2000 Survey.

3. Methodology (Day 2)

   3.1 Presentation and discussion of methods for delineating krill volume backscattering from all other.
   3.2 Presentation and discussion of methods for converting krill volume backscattering to krill biomass density.
   3.3 Presentation and discussion of methods for estimating krill biomass over entire survey area.
   3.4 Presentation and discussion of methods for estimating variance of krill biomass estimate.
   3.5 Overview of Echoview 2.00.

4. Work Organisation (Day 2)

   4.1 List of specific tasks, designation of subgroups and assignment of responsibilities.
   4.2 Appointment of subgroup coordinators and rapporteurs.
   4.3 Outline format and content of report.
   4.4 Delegate work for writing sections and generating graphs.

5. Periodic Presentation and Discussion of Results from the Subgroups (Day 3 to Day 7).

6. Assemble Report (Day 8)

   6.1 Outline format and content of report.
   6.2 Delegate work for writing sections and generating graphs.
   6.3 Write report.

7. Adopt Report (Day 9).

ATTACHMENT C

CCAMLR B_0 ANALYSIS WORKSHOP SUBGROUP ON NET SAMPLING

Drs S. Kawaguchi (Japan), V. Siegel (Germany) and J. Watkins (UK) met to discuss the planned analysis of the RMT samples collected during the CCAMLR-2000 Survey.

2. Dr Watkins reported that all the RMT8+1 samples collected on board the *Yuzhmorgeologiya*, *James Clark Ross*, *Atlantida* and *Kaiyo Maru* had just returned to Cambridge, UK, on British Antarctic Survey ships. Basic sorting of RMT1 samples had been carried out on board the *Yuzhmorgeologiya*, but only sample volume had been determined on board the other ships. However, there had been no time to inspect the sample boxes prior to this workshop. Mr P. Ward (UK) will start the basic analysis of the unsorted RMT1 samples this summer and he estimates that this task will take around nine months. The data will then be made available to the CCAMLR participants, possibly through a future data analysis workshop.

3. It was re-emphasised that the zooplankton and krill samples collected during the CCAMLR-2000 Survey were extremely valuable, representing the largest single set of samples collected since the days of the Discovery Expeditions (1920–1930). It was therefore very important that the integrity of this dataset should be maintained while at the same time maximising the research that could be carried out on such samples.

4. It was recognised that the basic sorting of the RMT1 samples would separate the main species or groups of zooplankton but that there would be scope for more detailed analyses of individual taxa. Therefore it was likely that experts either within or outside the CCAMLR community will request access to the actual samples to undertake such work. For instance, interest in krill larvae (Dr Siegel) and salps (Dr Kawaguchi) had already been expressed. While such work should be welcomed it was important that this should take place within an agreed framework that protected the integrity of the samples and also the rights of the data originators. The latter was probably taken care of with the rules for access and use of CCAMLR data but the integrity of samples should be addressed through a set of 'conditions of access'.

5. A draft set of conditions of access was produced:

(i) Samples would only be released for further analysis if data originators from each country agreed.

(ii) Priority for analysis should be given to data originators, then other members of the CCAMLR community and finally requests originating outside of CCAMLR.

(iii) Persons requesting samples would have to guarantee return of entire samples to the archive within the agreed time.

(iv) All data from such analysis would have to be copied to the CCAMLR Data Centre and each data originator.

(v) All further analyses and publications would need approval of data originators.

6. In respect of the above, a general condition of access to samples should be to the account of the party wishing such access. As a consequence all costs associated with accessing the samples, processing the samples, and ensuring that their safety or integrity is not compromised will be borne by the accessing party. This will require that CCAMLR formalise the status of the samples and delineate a process for their use.

7. It was recognised that at present there were no firm plans to analyse the RMT8 samples further. However, a request had already been received from outside the CCAMLR community to look at the taxonomy and feeding ecology of myctophid fish. Any requests would need to take into account the stipulations of the draft conditions of access.

8. The particular case of samples of krill collected for genetic analyses was discussed. The collection of such samples had been agreed as part of the zooplankton sampling protocols. It was therefore thought appropriate that the idea of holding such samples centrally and sending subsamples for analysis to various groups should be considered. In the light of this discussion it was thought appropriate that clarification should be sought from the data originator (Dr B. Bergström, Sweden) about the status of genetic samples collected by the *Yuzhmorgeologiya.*

ATTACHMENT D

DESCRIPTORS FOR SUMMARY TABLES CONTAINING BIOMASS ESTIMATES

The following descriptors relate to labels contained in Tables 24 to 26. It should be noted that the various descriptor functions are based on those given in Jolly and Hampton (1990). In the formulae below *i* is used to index intervals along a transect, *j* is used to index transects within a stratum, and *k* is used to index strata.

Transect Label	Formula /Descriptor
Length	Transect length defined as the sum of all interval weightings (as defined in paragraph 3.51) $L_j = \sum_{i=1}^{N_j} (W_I)_i$ where L_j is the length of the *j*th transect, $(W_I)_i$ is the interval weighting of the *i*th interval, and N_j is the number of intervals in the *j*th transect.
Weighting factor	Normalised transect length $w_j = \frac{L_j}{\frac{1}{N_k}\sum_{j=1}^{N_k} L_j}$ such that $\sum_{j=1}^{N_k} w_j = N_k$ where w_j is the weighting factor for the *j*th transect, and N_k is the number of transects in a stratum.
Krill density measured	Mean areal krill biomass density over all intervals on each transect $\bar{\rho}_j = \frac{1}{L_j}\sum_{i=1}^{N_j} S_{Ai} f_i (W_I)_i$ where $\bar{\rho}_j$ is the mean areal krill biomass density on the *j*th transect, S_{Ai} is the integrated backscattering area for the *i*th interval and f_i is the conversion factor for the *i*th interval (see paragraphs 3.28 to 3.52).
Krill density weighted	Mean areal krill biomass density times the weighting factor $\bar{\rho}_{wj} = w_j \bar{\rho}_j$ where $\bar{\rho}_{wj}$ is the mean weighted areal krill biomass density on the *j*th transect.
Variance component	$VarComp_j = w_j^2 \left(\bar{\rho}_j - \bar{\rho}_k\right)^2$ where $VarComp_j$ is the weighted contribution of the *j*th transect to the stratum variance.

Stratum Label	Formula/Descriptor
Mean	Stratum mean areal krill biomass density $\bar{\rho}_k = \frac{1}{N_k}\sum_{j=1}^{N_k} w_j \bar{\rho}_j$ where $\bar{\rho}_k$ is the mean areal krill biomass density in the *k*th stratum (after equation 1, Jolly and Hampton, 1990).
Variance	Stratum variance $Var(\bar{\rho}_k) = \frac{N_k}{N_k - 1} \frac{\sum_{j=1}^{N_k} w_j^2 (\bar{\rho}_j - \bar{\rho}_k)^2}{\left(\sum_{j=1}^{N_k} w_j\right)^2} = \frac{\sum_{j=1}^{N_k} w_j^2 (\bar{\rho}_j - \bar{\rho}_k)^2}{N_k (N_k - 1)}$ where $Var(\bar{\rho}_k)$ is the variance of the mean areal krill biomass density in the *k*th stratum.
CV (%)	Coefficient of variation $CV_k = 100 \frac{\left(Var(\bar{\rho}_k)\right)^{0.5}}{\bar{\rho}_k}$ where CV_k is the coefficient of variation for the *k*th stratum.

Survey Label	Formula/Descriptor
Nominal area	Area of *k*th stratum (A_k) estimated at the time of survey design (see paragraphs 2.2 and 2.3).
Mean density	Mean areal krill biomass density of the *k*th stratum, $\bar{\rho}_k$.
Area*density	$A_k \bar{\rho}_k$
Variance component	$VarComp_k = A_K^2 Var(\bar{\rho}_k)$ where $VarComp_k$ is the contribution of the *k*th stratum to the overall survey variance of B_0.
Mean density	Overall survey mean areal krill biomass density $\bar{\rho} = \frac{\sum_{k=1}^{N} A_k \bar{\rho}_k}{\sum_{k=1}^{N} A_k}$ where N is the number of survey strata (after equation 2, Jolly and Hampton, 1990).

Survey Label (continued)	Formula/Descriptor
Variance	Overall survey variance of the mean areal krill biomass density $Var(\bar{\rho}) = \frac{\sum_{k=1}^{N} A_k^2 Var(\bar{\rho}_k)}{\left(\sum_{k=1}^{N} A_k\right)^2} = \frac{\sum_{k=1}^{N} VarComp_k}{\left(\sum_{k=1}^{N} A_k\right)^2}$ (after equation 3, Jolly and Hampton, 1990).
CV	Overall coefficient of variation of the mean areal krill biomass density $CV_{\bar{\rho}} = 100 \frac{(Var(\bar{\rho}))^{0.5}}{\bar{\rho}}$
Krill standing stock	$B_0 = \sum_{k=1}^{N} A_k \bar{\rho}_k$
Variance	Overall survey variance of B_0 $Var(B_0) = \sum_{k=1}^{N} VarComp_k$
CV	Overall coefficient of variation of B_0 $CV_{B_0} = 100 \frac{(Var(B_0))^{0.5}}{B_0}$

ANNEX 5

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 9 to 19 October 2000)

CONTENTS

Page

INTRODUCTION 283

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA 283

REVIEW OF AVAILABLE INFORMATION 283
Data Requirements Endorsed by the Commission in 1999 283
Data Inventory and Developments in the CCAMLR Database 283
Database Data Entry and Validation 284
Other 285
Fisheries Information 285
Catch, Effort, Length and Age Data Reported to CCAMLR 285
Estimates of Catch and Effort from IUU Fishing 286
Landings by all Countries 286
Estimated Trade in *Dissostichus* spp. in the 1999/2000 Split-year 286
Overall Estimates of IUU Catch 287
Indian Ocean Sector 287
IUU Catches in Assessments 288
IUU and the CDS 288
Catch and Effort Data for Fisheries for *Dissostichus* spp. in Waters adjacent to the Convention Area 288
Scientific Observer Information 288
Research Survey Data 291
Mesh/Hook Selectivity and related Experiments affecting Catchability 292
Conversion Factors 292
Advice to the Scientific Committee 293
Fish and Squid Biology/Demography/Ecology 293
Dissostichus spp. 293
Age Determination Methods 293
Length to Mass and Natural Mortality Coefficient (*D. mawsoni*) 294
Stock Structure 294
Gonad Maturity 294
Stomach Contents 295
Tagging Studies 295
Champsocephalus gunnari 295
Distribution 295
Reproduction 296
Feeding 297
Ectoparasites 297
Crabs 297
Sizes 297
Skates 298
Fish Identification 299
Other Species 301
Developments in Assessment Methods 301

ASSESSMENTS AND MANAGEMENT ADVICE 303
New and Exploratory Fisheries 303
New and Exploratory Fisheries in 1999/2000 303
New and Exploratory Fisheries Notified for 2000/01 308
General Issues 308
Review of Individual Notifications 309
Advice to the Scientific Committee 312

Assessed Fisheries 315
Dissostichus eleginoides 315
South Georgia (Subarea 48.3) 316
Standardisation of CPUE 316
Determination of Long-term Annual Yields using the GYM 318
Growth, Mortality and Fishing Selectivity 318
Trends in Selectivity 319
Recruitment and Natural Mortality 320
Assessment 322
Integration of CPUE into Assessment 323
Management Advice for *D. eleginoides* (Subarea 48.3) 323
South Sandwich Islands (Subarea 48.4) 323
Management Advice for *D. eleginoides* and *D. mawsoni* (Subarea 48.4) 324
Ob and Lena Banks (Division 58.4.4) 324
Kerguelen Islands (Division 58.5.1) 324
Standardisation of CPUE in the Longline Fishery 324
Standardisation of CPUE in the Trawl Fishery 325
Management Advice for *D. eleginoides* (Division 58.5.1) 325
Heard and McDonald Islands (Division 58.5.2) 325
Length Frequency 326
Determination of Long-term Annual Yields using the GYM 326
Assessment 326
Management Advice for *D. eleginoides* (Division 58.5.2) 327
General Advice 327
Champsocephalus gunnari 327
South Georgia (Subarea 48.3) 327
Past Assessment 328
New Information Available in 2000 328
Commercial Fishing 328
Research Surveys 329
Assessment at this Year's Meeting 329
Closed Season 332
Management Advice for *C. gunnari* (Subarea 48.3) 332
Kerguelen Islands (Division 58.5.1) 333
Management Advice for *C. gunnari* (Division 58.5.1) 333
Heard and McDonald Islands (Division 58.5.2) 333
Commercial Catch 333
Management Advice for *C. gunnari* (Division 58.5.2) 334
Other Fisheries 334
Other Finfish Fisheries 334
Antarctic Peninsula (Subarea 48.1) and South Orkney Islands (Subarea 48.2) 334
Management Advice 334
South Sandwich Islands (Subarea 48.4) 335
Management Advice 335
Antarctic Coastal Areas of Divisions 58.4.1 and 58.4.2 335
Pacific Ocean Sector (Subareas 88.2 and 88.3) 335
Management Advice 335
Crabs 335
Management Advice 336
Squid 336
Management Advice 336
General By-catch Provisions 337
Advice to the Scientific Committee 339
Regulatory Framework 339

CONSIDERATION OF ECOSYSTEM MANAGEMENT ... 340
Interaction with WG-EMM ... 340
By-catch of Young Fish in the Krill Fishery ... 340
Other Information arising from WG-EMM's Deliberations of relevance to WG-FSA ... 340
Ecosystem Assessment ... 341
Marine Protected Areas ... 341
Ecological Interactions ... 341
Interactions between Marine Mammals and Fishing Operations ... 341
Effects of Bottom Trawling ... 341

RESEARCH SURVEYS ... 342
Simulation Studies ... 342
Recent and Proposed Surveys ... 342
Proposed Surveys ... 342

INCIDENTAL MORTALITY ARISING FROM LONGLINE FISHING ... 342
Intersessional Work of Ad Hoc WG-IMALF ... 342
Research into the Status of Seabirds at Risk ... 343
Incidental Mortality of Seabirds during Regulated Longline Fishing in the Convention Area ... 346
2000 Data ... 346
Subarea 48.3 ... 347
Subareas 58.6 and 58.7 ... 347
Division 58.5.1 ... 349
Subarea 88.1 ... 349
General ... 349
Compliance with Conservation Measure 29/XVI ... 349
Streamer Lines ... 349
Offal Discharge ... 350
Night Setting ... 350
Line Weighting ... 350
Thawed Bait ... 350
General ... 351
Fishing Seasons ... 351
Incidental Mortality of Seabirds during Unregulated Longline Fishing in the Convention Area ... 351
Unregulated Seabird By-catch ... 351
Unregulated Effort ... 352
Results ... 352
Summary Conclusion ... 353
Incidental Mortality of Seabirds in relation to New and Exploratory Fisheries ... 354
New and Exploratory Longline Fisheries Proposed in 2000 ... 354
New and Exploratory Longline Fisheries Operational in 1999/2000 ... 356
New and Exploratory Longline Fisheries for 2000/01 ... 356
New Zealand Proposal in respect of Subarea 88.1 ... 356
Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area ... 357
Research into and Experience with Mitigating Measures ... 358
Offal Discharge ... 358
Underwater Funnel ... 359
Streamer Lines ... 360
Line Shooter ... 360
Artificial Bait ... 360
Line Weighting ... 360
Toothfish Pots ... 360
Other Measures ... 361

General ... 361
Policy Considerations in relation to Mitigating Measures and Conservation Measure 29/XVI ... 361
Offal Discharge ... 362
Streamer Lines ... 362
Night Setting ... 362
Line Weighting – Spanish System ... 363
Line Weighting – Autoline System ... 363
General Observations ... 363
Vessel Accreditation ... 364
International and National Initiatives relating to Incidental Mortality of Seabirds in relation to Longline Fishing ... 364
Workshop on Albatross and Petrel Mortality from Longline Fishing ... 364
FAO International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries (IPOA–Seabirds) ... 365
Convention on the Conservation of Migratory Species ... 366
Regional Agreement for the Conservation of Albatrosses ... 366
International Fishers' Forum ... 367
Commission for the Conservation of Southern Bluefin Tuna (CCSBT) ... 368
Indian Ocean Tuna Commission (IOTC) ... 368
General ... 368
Advice to the Scientific Committee ... 369
Research into the Status of Seabirds at Risk ... 369
Incidental Mortality of Seabirds during Regulated Longline Fishing in the Convention Area in 2000 ... 369
Compliance with Conservation Measure 29/XVI ... 370
Fishing Seasons ... 371
Assessment of Incidental Mortality of Seabirds during Unregulated Longline Fishing in the Convention Area ... 371
Incidental Mortality of Seabirds in relation to New and Exploratory Fisheries ... 371
Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area ... 372
Research into and Experience with Mitigating Measures ... 372
Policy Considerations in relation to Mitigating Measures and Conservation Measure 29/XVI ... 373
International and National Initiatives relating to Incidental Mortality of Seabirds in relation to Longline Fishing ... 374

OTHER INCIDENTAL MORTALITY ... 375
Longline Vessels – Marine Mammals ... 375
Trawl Fishing ... 375

CCAMLR WEBSITE ... 375

FUTURE WORK ... 376
Workshop on Approaches for the Management of Icefish ... 376
Intersessional Work of Subgroups ... 377
Other Intersessional Work ... 379
Secretariat Support at Future Meetings ... 380

OTHER BUSINESS ... 381
CCAMLR Science and the *Science Citation Index* ... 381
Fishery Data Manual ... 381
Deadline for the Submission of Meeting Papers ... 382
IUCN Criteria for Globally Threatened Species ... 382
Fish and Fish Resources of Antarctica ... 383
Bibliography on Antarctic Fish ... 383

ADOPTION OF THE REPORT 383

CLOSE OF THE MEETING 383

REFERENCES 384

TABLES 386

FIGURES 447

APPENDIX A: Agenda 475

APPENDIX B: List of Participants 478

APPENDIX C: List of Documents 483

APPENDIX D: Intersessional Work Plan for ad hoc WG-IMALF 491

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 9 to 19 October 2000)

INTRODUCTION

1.1 The meeting of WG-FSA was held at CCAMLR Headquarters, Hobart, Australia, from 9 to 19 October 2000. The Convener, Mr R. Williams (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. Following discussions, it was agreed that the following subitems be added:

(i) Subitem 10.3 'Impact of Budgetary Restraints; and
(ii) Subitem 11.4 'IUCN Criteria for Endangered Species'.

With these changes 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 Mr B. Baker (Australia), Dr E. Barrera-Oro (Argentina), Dr A. Constable (Australia), Prof. J. Croxall (UK), Dr I. Everson (UK), Dr R. Gales (Australia), Dr S. Hanchet (New Zealand), Dr R. Holt (USA), Mr C. Jones (USA), Dr G. Kirkwood (UK), Dr K.-H. Kock (Germany), Dr E. Marschoff (Argentina), Dr D. Miller (Chairman, Scientific Committee), Dr G. Parkes (UK), Dr G. Robertson (Australia), Mr N. Smith (New Zealand), Mr B. Watkins (South Africa) and the Secretariat.

REVIEW OF AVAILABLE INFORMATION

Data Requirements Endorsed by the Commission in 1999

Data Inventory and Developments in the CCAMLR Database

3.1 Dr D. Ramm (Data Manager) reported on the availability of data at the meeting and major developments within the CCAMLR Data Centre during the intersessional period.

3.2 Reconciliation of catch and effort reports with fine-scale data from CCAMLR fisheries in the 1999/2000 season was undertaken regularly during the year to assess the completeness of the fishery datasets. The majority of the fishery and observer data from the 1999/2000 season was available at the meeting, and details were reported in WG-FSA-00/6, 00/18 and 00/37.

3.3 At the start of the meeting, most of the fine-scale data from finfish fishing in the 1999/2000 season had been submitted. The submission of data from two longliners targeting *Dissostichus eleginoides* in Subarea 48.3 (*Lyn, Ibsa Quinto*) and one in Division 58.4.4 (*Isla Alegranza*) was overdue (data from the *Lyn* and *Isla Alegranza* were submitted and processed during the meeting). In addition, fine-scale data from the krill fishery in Area 48 in 1999/2000 had not yet been submitted.

3.4 STATLANT data from the Convention Area in the 1999/2000 split-year (1 July 1999 to 30 June 2000) were summarised in SC-CAMLR-XIX/BG/1. This paper provided an opportunity for Member countries to check their STATLANT data prior to publication in the CCAMLR *Statistical Bulletin*: four STATLANT datasets (Chile, Japan, Russia and Spain) were outstanding at the start of the meeting (data from Chile were submitted during the meeting).

3.5 Over the past two years, Data Centre staff had undertaken a major overhaul of the research survey database and the routines used for length-density analyses. This overhaul was necessary because of the increasing quantity and diversity of survey data and their importance in the assessments of WG-FSA.

3.6 As reported last year (WG-FSA-99/14), trawl survey data and commercial trawl data had been initially managed as a single dataset. While appropriate in earlier years, this procedure constrained the type of survey data that could be stored in the CCAMLR database and placed limitations on their interpretation. The overhaul of the survey database has resolved these historical difficulties. WG-FSA-00/11 described the work done during the intersessional period, the structure of the new survey database and the procedure for deriving data for the length-density analysis.

3.7 Another major task during 2000 was the implementation of the new Catch Documentation Scheme for *Dissostichus* spp. (CDS). This involved the development of a database, data-processing routine and a confidential web-based reporting system. A subset of the CDS data (landings by month and area) was made available to the Working Group, and these data were used to estimate catches of *Dissostichus* spp. taken outside the Convention Area (WG-FSA-00/6).

3.8 The implementation of the CDS and the significant budgetary constraints in 2000 had impacted on the work of the Data Centre, its computing facilities and the level of support at the meeting (see Section 10, Future Work).

Database Data Entry and Validation

3.9 Most of the data from the 1999/2000 fishing season had been submitted during August to October, and had been entered by the start of the meeting. These data would be validated by early 2001. Due mostly to the backlog of data submitted immediately prior to the meeting of WG-FSA, but also other work priorities (see above), eight submitted datasets were yet to be processed:

- *D. eleginoides* pot data from the experimental fishing in Subarea 48.3 (July–August 1999);
- *D. eleginoides* catch and effort data from Uruguay (*Isla Gorriti*) in Subarea 48.3 (May–July 2000);

- *Champsocephalus gunnari* length data from the national observer on board *Zakhar Sorokin* in Subarea 48.3 (December 1999–January 2000);

- krill biological data from Argentina (*Kasuga Maru*) in Area 48 (February–April 1999);

- krill catch and effort data from Ukraine (*Konstruktor Koshkin*) in Area 48 (May–July 1999);

- historical longline catch and effort data submitted by Russia and Ukraine (1986–1996);

- *D. eleginoides* catch and effort data from France in Division 58.5.1 and Subarea 58.6 (2000 season); and

- trawl survey data submitted from Russia (*Atlantida*, 2000).

3.10 With the exception of the data from the krill fishery and the experimental pot fishing, these datasets were processed during the first week of the meeting, and were made available to WG-FSA. In addition, Dr V. Herasymchuk (Ukraine) submitted historical data from seven trawl surveys carried out on four cruises on Ob and Lena Banks in Division 58.4.4 in 1980, 1982, 1986 and 1989; data from three other surveys would be submitted very soon. The Working Group thanked Dr Herasymchuk for these data, which will be entered into the new CCAMLR survey database.

3.11 Routine validation of the fine-scale data in 2000 detected two datasets where processed weights, rather than whole weights, may have been reported for *Dissostichus* spp. (WG-FSA-00/6); a similar situation was reported in 1999 (WG-FSA-99/9). Clarification had been sought from the data originators (Uruguay and South Africa) on 26 September 2000. In both cases, the retained weight of *Dissostichus* spp. was believed to be correctly reported as whole weight, however the discarded weight was believed to include offal and frames. If this interpretation is correct, then the weight of offal and frames will need to be subtracted from the weight of whole fish that have been discarded and that have been reported in these fine-scale datasets.

Other

3.12 The data section on the CCAMLR website has been updated, and now includes detailed information on the CCAMLR data requirements and the submission of data. Information on how to collect, record and submit data is available in portable document format (pdf), including the *Scientific Observers Manual* and the unpublished *Fishery Data Manual*.

3.13 Electronic data forms (eforms) are available for submitting catch and effort reports, fine-scale data, observer data and CEMP data. These forms are in Microsoft Excel format, and may be downloaded from the website, copied, completed and submitted to the Secretariat via email. Alternatively, the original data forms in Microsoft Word format may be downloaded, printed, completed and submitted via facsimile or airmail.

3.14 Eforms are now used by many of the Member countries to submit fishery and observer data, as well as other types of data. The amount of time required to process these eforms varies greatly and most datasets still require a significant amount of reformatting to overcome variations in formats (e.g. reporting time as 12.35 rather than 12:35) and data type (e.g. reporting lengths in mm rather than cm); some eforms take as long to process as data submitted in paper format. However, the amount of reformatting required is being reduced as the quality of the electronic submissions continues to improve, and the eforms and data extraction routines undergo further development.

Fisheries Information

Catch, Effort, Length and Age Data Reported to CCAMLR

3.15 Fisheries prosecuted under the conservation measures in force during the 1999/2000 fishing season were reported in CCAMLR-XIX/BG/5. With the exception of the krill fisheries (1 July 1999 to 30 June 2000), all fishing seasons in 1999/2000 fell between 1 December 1999 and 30 November 2000. Catches of target species reported by the start of the meeting are summarised in Table 1.

3.16 Catches reported from the Convention Area during the 1999/2000 split-year (1 July 1999 to 30 June 2000) are summarised in Table 2 (see also paragraph 3.4). These catches, reported in STATLANT data, included catches taken within South Africa's EEZ in Subareas 58.6 and 58.7, and within France's EEZ in Subarea 58.6 and Division 58.5.1.

3.17 Most of the length-frequency data submitted during 1999/2000 were collected by scientific observers, and submitted in their logbooks and reports. Some length-frequency data were submitted as fine-scale biological data. Catch-weighted length frequencies for *D. eleginoides* caught by longline in Subarea 48.3 during the 1998/99 and 1999/2000 seasons were reported in WG-FSA-00/6. This analysis required four sets of data: length-frequency data collected by scientific observers; fine-scale length-frequency data; fine-scale catch data; and STATLANT data. Data from four longliner fleets fishing in Subarea 48.3, and from the longliners which had fished in Subarea 88.1, were available for this analysis at the start of the meeting. Data processed during the meeting allowed further analysis of catch-weighted length-frequency data, including Divisions 58.4.4 and 58.5.2.

3.18 No data on ages were submitted to the Working Group.

Estimates of Catch and Effort from IUU Fishing

Landings by all Countries

3.19 The total green-weight landings of *Dissostichus* spp. for the 1999/2000 split-year from the licensed fishery was estimated as 14 441 tonnes. The Working Group noted that this was a decrease compared to the previous split-year (17 558 tonnes). Reported catches from waters outside the Convention Area are given in Table 3 and totalled 11 553 tonnes. This gave a reported grand catch total of 25 994 tonnes.

3.20 The Working Group estimated landings of IUU-caught *D. eleginoides* by all countries (CCAMLR Members and non-Members) in Durban (South Africa), Walvis Bay (Namibia), Port Louis (Mauritius), Montevideo (Uruguay) and Vigo (Spain) for the 1999/2000 split-year and the period July to August 2000 (Table 4). Mauritius remains the primary site for the landing of IUU-caught fish, in particular after May 2000 when the CDS came into force and landings in all ports other than Port Louis ceased.

3.21 WG-FSA used the approach adopted at its 1998 meeting (SC-CAMLR-XVII, Annex 5, paragraph 3.24) to estimate the magnitude of IUU fishing effort and catches in various subareas and divisions during the 1999/2000 split-year. The results of this analysis are presented in Tables 5 and 6. The estimated total catch for all subareas and divisions in the Convention Area in the 1999/2000 split-year was 20 987 tonnes, comprising 14 441 tonnes of reported catch and 6 546 tonnes of estimated unreported catch (Table 5). The total estimated landings of catches in Walvis Bay and Mauritius (7 942 tonnes) in 1999/2000 accounted for some 52% of the estimated 15 146 tonnes total catch in the Indian Ocean.

Estimated Trade in *Dissostichus* spp. in the 1999/2000 Split-year

3.22 Trade statistics for *D. eleginoides* in 1999/2000 were received from FAO, Japan and the USA (Table 7; WG-FSA-00/6, Tables E2 to E9) and by other countries (WG-FSA-00/6, Table E1). Product imports into Japan and the USA totalled an estimated 39 949 tonnes of whole and filleted *D. eleginoides* during the 1999 calendar year, with Argentina, Chile and Uruguay being the major sources of supply. In the first half of 2000, imports into Japan and the USA totalled 21 405 tonnes equivalent whole weight with Mauritius being a major supplier to Japan. The equivalent estimate of imports in the 1998 calendar year was 42 796 tonnes (SC-CAMLR-XVIII, Annex 5, Table 9).

3.23 The conversion factor (CF) for product to whole weight remains a problem for products other than fillets and headed and gutted, e.g. collars, in converting product weight to green weight. There is also some potential for double estimation of catch for split products as green weight is determined from product trunk weight only. The CDS reports all landed product weights per vessel and exports can be reconciled against reported landed weights (Table 8).

3.24 Although there was a decrease in the volume of imports into Japan and the USA, the price of headed and gutted product on the US market nearly trebled between July 1998 and July 1999 from US$3.80 to US$11.00 (SC-CAMLR-XVIII, Annex 5, Figure 1). From July 1999 to July 2000 this increasing trend was not evident (source from industry).

3.25 As in previous years, trade statistics should be treated with considerable caution since the export sources of a product are not necessarily responsible for the catching of fish.

Overall Estimates of IUU Catch

3.26 Table 5 provides overall estimates of the catch from IUU fishing operations. The total estimate for the 1999/2000 split-year was 6 546 tonnes. This compares to 4 913 tonnes in the 1998/99 split-year and 22 415 tonnes in 1997/98. It should be noted that estimating IUU catches has become increasingly more difficult, primarily due to transhipments on the high seas which are very difficult to track through the sources available to the Working Group (see Table 3). Consequently, estimates of IUU catches are likely to be underestimates of the true catches to an unknown extent. The Working Group agreed that estimates of IUU catches of *Dissostichus* spp. are only minimum estimates and that the proportion of these estimates is one-third that of regulated catches. The values for 1999/2000 should be compared with previous years only with caution (see Figure 1).

Indian Ocean Sector

3.27 There is some indication that there has been a drop in illegal activity in the Prince Edward Islands EEZ. This is in part due to lower catch rates generally, and the presence of toothed cetaceans particularly in the eastern sector. Illegal activity has a year-round presence with a higher concentration of vessels during the summer months. In waters adjacent to the Crozet and Kerguelen Islands illegal fishers are also present year-round from information presented to the intersessional subgroup on IUU fisheries. During August 2000, illegal vessels moved westwards into the Prince Edward Islands EEZ from French waters during a French naval surveillance.

3.28 In summary, the IUU fishery appears to be concentrated in Area 58 (although up to four Argentinian vessels were known to fish illegally around South Georgia (Subarea 48.3)). In Area 58 the IUU fishery targets known plateaux or topographic features, in particular the Kerguelen Plateau (Kerguelen and Heard Islands) or the area around Crozet. The oceanic banks (Ob and Lena, Division 58.4.4 and Africana/Del Cano, Subarea 58.6) are also subject to IUU fishing, probably due to the isolation of these fishing grounds.

IUU Catches in Assessments

3.29 The IUU input assessments for *D. eleginoides* fisheries used the estimated unreported catches of 300 tonnes for Subarea 48.3 (South Georgia) and 800 tonnes for Division 58.5.2 (Heard Island).

IUU and the CDS

3.30 Taken with the persistence and relatively high levels of IUU fishing, it is uncertain where removals of *Dissostichus* spp. are being landed. Landed weights of *Dissostichus* product reported to the CDS by 5 October 2000 are presented in Table 8. Two clear markets are now emerging: one market for landings with a *Dissostichus* catch document (DCD) and another, cheaper market for landings without the DCD. The market for fish without the DCD is apparently very unpredictable. In August 2000 it was estimated that in excess of 1 000 tonnes was being offered for sale with non-DCD fish fetching prices US$3.00/kg lower than DCD fish, then trading at around US$8.40/kg. There is also evidence that buyers in Mauritius are willing to pay cash for their purchases.

3.31 The Secretariat, intersessionally, was tasked with reconciling estimated IUU catches with reported catches. This will serve as a preliminary assessment aimed at assisting WG-FSA in developing further analyses of CDS data to track total *Dissostichus* spp. removals and possibly IUU catches. In the interests of efficiency, the Working Group suggested that a single Secretariat staff member should be tasked with compiling IUU and comparable CDS data intersessionally, and reporting this information annually.

3.32 The Working Group noted that FAO is currently developing an International Plan of Action (IPOA) to combat IUU fishing. The Working Group agreed that the FAO–IPOA development should be kept under review, especially in relation to data and information exchange (SC-CAMLR-XIX/BG/13). It also anticipated that the IPOA is likely to impact positively on CCAMLR's efforts to address IUU fishing.

3.33 WG-FSA discussed the requirements for scientific observers to record and report sightings of vessels. It was suggested that a standard form of recordings be developed and that the Scientific Committee would prepare advice for the Commission (paragraph 3.52).

Catch and Effort Data for Fisheries for *Dissostichus* spp. in Waters adjacent to the Convention Area

3.34 Information on catches taken in fisheries operating outside the Convention Area was obtained intersessionally from WG-FSA members, FAO, and the new CDS (WG-FSA-00/6). This information indicated that the recent annual catches of *D. eleginoides* in waters outside the Convention Area were in the order of 18 000–23 000 tonnes. Details are reported in paragraphs 3.19 to 3.33.

Scientific Observer Information

3.35 Information collected by scientific observers was summarised in WG-FSA-00/18, 00/37 and 00/38. Scientific observers were deployed on all fishing vessels targeting *Dissostichus* spp. or *C. gunnari* in the Convention Area during 1999/2000. Reports and logbook data were submitted from 35 longline and 8 trawl cruises. Details are in Table 9.

3.36 The Working Group noted that on the basis of information available, the two French observers deployed in Subarea 58.6 appeared to be national observers and not CCAMLR international observers. Technically, this was inconsistent with the requirement of paragraph 7 of Conservation Measure 182/XVIII that each vessel participating in exploratory fisheries for *D. eleginoides* during the 1999/2000 season shall have at least one observer, appointed in accordance with the CCAMLR Scheme of International Observation, on board throughout all fishing activities. In the absence of a French representative, the Working Group was unable to comment further on this situation.

3.37 All but four of the logbooks and all the observer cruise reports were submitted before the start of the meeting. The quality of these reports has been good, with all logbooks presented in CCAMLR format. Seven of the 31 longline logbooks and seven of the nine trawl logbooks received were submitted using CCAMLR electronic logbooks forms (Excel spreadsheet format). This format has been highly successful, allowing faster entry into the CCAMLR database. Likewise, the standard of cruise reports submitted was high, with all the reports following the guidelines laid out in Part 1, Section 5 of the *Scientific Observers Manual*.

3.38 In relation to the work of technical coordinators, the Working Group recommended that scientific observers should be requested to use standard electronic logbooks developed in Excel format by CCAMLR for recording data.

3.39 The observer reports contain detailed information on vessel characteristics, cruise itinerary, fishing gear and fishing operations, meteorological conditions and on biological observations carried out on fish. Information on seabird incidental mortality and marine mammal observations is also fairly comprehensive (see summary in Tables 10 and 11).

3.40 A waste disposal form used by observers this year is a revised form which increased the type of information to be recorded on disposal of fishing gear, oil, organic and inorganic galley waste and plastic packaging bands (Table 11). It was reported that 85% of vessels retained or incinerated all plastic packaging bands in accordance with Conservation Measure 63/XV. Unfortunately four vessels (*Isla Sofía*, *Magallanes III*, *Aquatic Pioneer*, *Eldfisk*) used and/or disposed of packaging bands in contravention of this conservation measure.

3.41 Collection of biological fish samples by observers continued to be done in accordance with research priorities identified by the Scientific Committee in previous years (by-catch, length frequency, weight at length, maturity, CF, otolith/scales) (Tables 10 and 12). However, the Working Group felt that it could be necessary to revise a list of priorities. The Secretariat was requested to consult intersessionally with technical coordinators and to collect their comments and proposals for consideration at the next meeting of the Working Group.

3.42 In general, the CFs have been calculated in the reports according to the standard methodology established by WG-FSA and endorsed by the Scientific Committee. The CF used by vessels (1.6, N = 16) was lower than the value estimated by the observers (mean 1.66, SD = 0.41, N = 1 598) (paragraphs 3.60 to 3.65).

3.43 As a consequence of WG-FSA deliberations and comments received from scientific observers (SC-CAMLR-XVIII, Annex 5, paragraphs 3.53 to 3.70), the Secretariat updated the *Scientific Observers Manual* and distributed it to Members before the start of the 1999/2000 season. The revised manual included new and improved forms for the recording of data.

3.44 Distribution of the revised manual has resulted in significant improvement on the following matters/points:

(i) collection of information by scientific observers on garbage disposal (i.e. an increase from 50% in 1999 to 70% in 2000) and loss of fishing gear at sea (from 37% to 72%) (Table 11);

(ii) awareness of fishing crews of CCAMLR conservation measures and on the availability and utility of the booklet *Fish the Sea Not the Sky*.

(iii) description of longline system design. Diagrams of Spanish and autoline systems were included in Form L2(i) with data fields for recording line dimensions, weighting regimes and weighting methods;

(iv) provision for random weighting of at least 30 weights and recording distance between weights (Form L2(i));

(v) recording of offal discharge during hauling to allow accurate analysis of compliance with Conservation Measure 29/XVI;

(vi) the use of a simplified version of Form L4(vii) which facilitates recording of information required;

(vii) updated nautical dawn/dusk table which included additional areas south of 72° in Subarea 88.1;

(viii) inclusion in the section 'Summary of fishing operations' in the scientific observer report, of an item on garbage and plastic disposal, snoods, hooks in discards, bands, oil/fuel discharge;

(ix) clarification that Form L3 should be completed at the discretion of observers for a limited number of days during the cruise;

(x) clarification that Form L4 may not be completed in full at night or under low visibility conditions;

(xi) increased number of cruises with two observers on board: 8 longliners and 6 trawlers from a total of 43 cruises (Tables 9 and 13); and

(xii) inclusion of a provision for reporting fish by-catch. During the current season all observers collected and reported data on by-catch.

3.45 Information on fish identification by observers in trawl and longline fisheries are provided in Tables 14 and 15. It was recommended that fish taken as by-catch in the longline fishery in Subarea 48.3 should be identified to the level of species. It is expected that with 100% observer coverage of longline vessels, the quality of collected by-catch data would improve considerably. Reference materials which are required by observers in their work on the identification of by-catch species are defined in paragraphs 3.110 to 3.118.

3.46 There were no significant problems reported by observers on the use of the S*cientific Observers Manual* this year. Despite the required clarification to the forms made last year, some observers continued to report problems with the completion of form L3 'Daily Work Schedule of Observers' and L4(vi/vii) estimating seabird and marine mammal abundance. However, last year it was stated that the completion of these forms is not compulsory (see paragraphs 3.44(ix) and (x)). Technical coordinators should continue to bring these changes to the attention of observers.

3.47 Some observers still continued to experience difficulties with the following matters:

(i) recording the number of hooks observed during hauling, swell/height and also moon phases in the presence of cloud cover;

(ii) an absence of visual materials in the *Scientific Observers Manual* to assist identification of maturity stages of *Dissostichus* spp., e.g. colour photographs or drawings of gonads at various stages of maturity; and

(iii) determining loss of *Dissostichus* spp. to toothed cetaceans.

The Secretariat, in consultation with technical coordinators, should consult intersessionally in order to find solutions for these matters.

3.48 At the last meeting it was noted that many observers failed to apply the longline random-sampling design originally proposed by the Working Group. In general, it relates to practical aspects of collecting samples on vessels as required by the method. It was recommended that technical coordinators be encouraged to correspond intersessionally in order to identify problems and find their solutions.

3.49 The Working Group revised the number of fish per haul which need to be collected during longline exploratory fishing (Conservation Measure 182/XVIII, Annex B, paragraph 3(v)). It was recommended that while length-frequency and sex data should continue to be recorded for at least 100 fish, samples for biological studies (otoliths, scales, stomach contents) should be taken and gonad stages recorded for at least 30 fish.

3.50 In general, the Working Group felt that the size of samples and methods for their collection in other fisheries should also be reviewed and, if required, clarified at next year's meeting.

3.51 The Working Group also recognised that, particularly for vessels with only one scientific observer, the number of currently specified tasks is such that urgent attention is needed to the prioritisation of duties (see SC-CAMLR-XVIII, Annex 5, paragraph 3.76) and to reassessment of sampling requirements (see also paragraph 7.30).

3.52 The Working Group discussed the requirement for scientific observers to record and report sightings of fishing vessels in the Convention Area (CCAMLR-XVIII, paragraph 8.22). It was suggested that a standard form for recording sightings be developed. The form should provide for recording of the following information: name of the vessel; time and date of sighting, position (including CCAMLR area, subarea, division and coordinates); flag of the vessel and mode of observation/record (i.e. radar image, radio traffic, visual sighting, photographic/video). This matter will be further discussed at the upcoming meetings of the Scientific Committee and advice on the matter be prepared for the Commission.

3.53 The Working Group thanked all scientific observers for their work during the 1999/2000 fishing season and for the great deal of very useful information collected. It was noted with satisfaction that for first time an international observer was deployed on board a krill fishing vessel in Area 48 (*Chiyo Maru No. 5*). The Working Group highlighted the potential use of observers simultaneously in longline, trawl and krill fisheries under the CCAMLR Scheme of International Scientific Observation.

3.54 The Working Group congratulated the Secretariat for the excellent job they had carried out during the intersessional period on processing and analysis of information related to scientific observation programs. This assisted considerably the work of the Working Group at the meeting.

Research Survey Data

3.55 Australia conducted a random stratified survey in the Heard and McDonald Islands region (Division 58.5.2) in May 2000 to assess the abundance of *C. gunnari* and juvenile pre-recruit *D. eleginoides* (WG-FSA-00/40). A total of seven surveys have now been conducted in this region. The 2000 survey enabled a revision of the yield for managing the fishery for *C. gunnari* (WG-FSA-00/41). The data also provided an update to the recruitment series for *D. eleginoides* (WG-FSA-00/42).

3.56 The UK conducted a random stratified survey in Subarea 48.3 in January 2000 that was reported in WG-FSA-00/21. The main aims of the study were to estimate the standing stock of *C. gunnari* and also determine the population structure of *D. eleginoides* around South Georgia and Shag Rocks. Data from these studies had been reported to CCAMLR. Additional studies involved tagging of *D. eleginoides*, reported in WG-FSA-00/26, and assessments of crab density using the Aberdeen University Deep Ocean Submersible (AUDOS).

3.57 Russia conducted a random stratified survey in Subarea 48.3 in February 2000 to assess the abundance of *C. gunnari* and other species in that area (WG-FSA-00/47). Data from this survey had been submitted to the Secretariat, and were entered in the new CCAMLR survey database during the meeting. The survey adds to the existing time series of survey data collected by Russia in this area. Data from the 2000 survey provided an assessment of the *C. gunnari* stock in that region, and a review of the methods of assessment (WG-FSA-00/45, WG-FSA-00/51). A revised assessment of the *D. eleginoides* stock was also provided (WG-FSA-00/46).

3.58 The UK conducted experimental fishing for *D. eleginoides* using pots in Subarea 48.3 during March–May 2000 (WG-FSA-00/23). The major aim of this work was to develop a viable method for catching *Dissostichus* spp. which eliminates incidental catches of seabirds. During the 53 days spent fishing, a total of 38.9 tonnes of *D. eleginoides* was caught (note that the total catch reported in the catch and effort reports was 17.4 tonnes (Table 1); during the meeting it was discovered that the 17.4 tonnes referred to the processed weight). Observations indicated that the interactions of seabirds during setting and hauling of the pots was minimal, and the possibility of birds becoming entangled in the fishing gear was also very low. As a result, no bird mortality was witnessed during the trial. The experiment also provided by-catch information on crabs (WG-FSA-00/24), and data on the gut contents of *D. eleginoides* (WG-FSA-00/25).

Mesh/Hook Selectivity and related Experiments affecting Catchability

3.59 There was no information on mesh and hook selectivity presented at the meeting.

Conversion Factors

3.60 Observers continued to collect information on CFs using the methods described in the *Scientific Observer Manual* for *D. eleginoides* and *D. mawsoni*. Green and processed weights are reported in sampling units comprising various numbers of fish. The data available at the meeting are summarised in Table 16.

3.61 CFs determined on individual fish processed into headed, gutted and tailed were analysed using the same nested ANOVA applied at last year's meeting (SC-CAMLR-XVIII, Annex 5, paragraph 3.86). No replications were available for cruises. Variance components were similar to those calculated at last year's meeting (0.01312 for vessels; 0.00386 for hauls and 0.01379 for individual fish).

3.62 At its last meeting, the Scientific Committee recommended that vessel masters adopt the procedure set out in the *Scientific Observers Manual* to calculate CFs at the beginning of the season (SC-CAMLR-XVIII, Annex 5, paragraphs 5.50 and 5.51).

3.63 In Table 17 the CFs used by vessels in reporting their catches is compared with CFs obtained by observers. The differences noted in last year's report (SC-CAMLR-XVIII, Annex 5, paragraphs 3.89 and 3.90) have been largely reconciled with the exception of headed and gutted fish for which not enough observer information was available this year.

3.64 The Working Group recommended the continuation of the program using the current format and concentrating efforts on the product constituting the largest fraction of the fish being processed.

Advice to the Scientific Committee

3.65 The Working Group advised that CF data should be reported by scientific observers on a fish-by-fish basis.

Fish and Squid Biology/Demography/Ecology

3.66 A subgroup, led by Dr Everson, had been tasked with collating information on fish and squid biology/demography/ecology. Key tasks were to: review methods for age determination in *Dissostichus* spp.; review gonad maturity stages of *Dissostichus* spp.; and review the biological components of value in developing a long-term management plan for *C. gunnari*. A request for information had been circulated in April. No direct responses had been received but papers had been tabled at WG-FSA. Discussion of these topics is reported along with that on other related topics in the following paragraphs.

Dissostichus spp.

Age Determination Methods

3.67 A comparison of the effectiveness of otoliths and scales was reported in WG-FSA-00/28. Otoliths and scales from 177 individual *D. eleginoides* from South Georgia, which measured up to 180 cm total length, had been analysed. Each otolith and scale preparation was read twice in random order by two independent readers. The authors noted that:

- ages determined from scales were significantly less than those estimated using otoliths;
- for scales, bias occurred for both readers between readings; and
- for otoliths, only one reader showed a bias between readings.

3.68 The Working Group accepted the findings of the study and agreed that otoliths provided a better estimation of age and should be used for future studies on *Dissostichus* spp.

3.69 Further discussion of age determination of *D. eleginoides* is found in paragraphs 4.119 to 4.123.

3.70 Following on from the study reported in 1999 (WG-FSA-99/43), further progress in estimating the age of *D. mawsoni* was reported in WG-FSA-00/55. Otoliths had been baked at 275°C for 12 minutes prior to being sectioned. A relatively dark zone was present at age 4 (range 3–6); in some instances there was a second distinct zone. Juvenile zones with multiple banding structure were also common. Zones outside the dark growth zone were generally narrow and regular. Work was still in progress to validate age determination of this species.

3.71 It was noted that there were very few fish in the samples thus far analysed. Dr Kock noted that samples of small *D. mawsoni* had been collected in the Elephant Island/South Shetland Islands region in March 1999 and had been sent to New Zealand for further analysis. Further information on the distribution of early juveniles was contained in Russian, and possibly Polish, publications from the 1970s and 1980s. Additional information may exist in Ukraine. The Working Group recommended that if further samples were available they should be analysed as soon as possible.

Length to Mass and Natural Mortality Coefficient (*D. mawsoni*)

3.72 Parameter values to convert length to mass and estimate natural mortality were presented in WG-FSA-00/55. These were considered by the subgroup assessing *Dissostichus* spp. and revised values determined (paragraphs 4.130 to 4.142).

3.73 Estimates of growth parameters for *D. eleginoides* were provided in WG-FSA-00/44 from samples collected at South Georgia (longline fishery), Kerguelen (trawl and longline fisheries), Heard Island (trawl fishery) and the Falkland/Malvinas Islands (longline fishery). Statistical analyses (ANOVA) indicated significant differences between samples from the Kerguelen trawl and longline fisheries. At Kerguelen, South Georgia and the Falkland/ Malvinas Islands the growth parameters for females were different to those for male fish. There was no significant difference in growth rates between South Georgia and Kerguelen for either sex, although both populations were significantly different for both sexes from the population caught by longline off the Falkland/Malvinas Islands. These results were discussed further in section 4.2.

Stock Structure

3.74 Following on from the molecular study on *Dissostichus* spp. reported in 1999 as WG-FSA-99/46, further work was reported in WG-FSA-00/53. In samples from *D. eleginoides* it was noted that three regions of the mitochondrial (mt) DNA show a distinct genetic break in samples from the South American shelf as compared to the Southern Ocean. The mtDNA control region further revealed two distinct groups in the Southern Ocean. One such group includes the Ross Dependency and Macquarie Island (FAO Areas 81 and 88); the other group includes Heard and McDonald Islands, Kerguelen Islands, Prince Edward Island (Area 58) and South Georgia (Subarea 48.3).

3.75 In the same study it was noted that fillets of *D. eleginoides* and *D. mawsoni* are readily distinguished by isoelectric focusing of muscle proteins. It is also noted that the protein profiles distinguish *Dissostichus* spp. from other fillets marketed under common trade names, such as bass and hake. Three regions of mtDNA also provide diagnostic species markers.

3.76 The study on growth rates reported in WG-FSA-00/44 provided supporting evidence of a separation between *D. eleginoides* from South Georgia and the Falklands/Malvinas region.

Gonad Maturity

3.77 Further work was reported on studies on gonad maturation in *D. mawsoni* in WG-FSA-00/54. Histological preparations have been made from ovaries collected during the most recent season. Macroscopic assessments of maturity stages had been made on these samples. As in previous years (SC-CAMLR-XVIII, Annex 4, paragraph 3.111), observers had encountered difficulty in objectively assessing maturity stages. Maturity stages 1 and 2 were difficult to distinguish as gonads were in resting stage at the time when fishing took place. Staging based on a macroscopic examination of the ovary alone is at this stage unreliable. Estimates of attaining length at sexual/spawning maturity were thus biased to an unknown extent. For the time being, the Working Group used L_{m50} = 100 cm as last year.

3.78 The Working Group agreed that a histological examination of ovarian samples covering the full size range of fish taken in the fishery would provide the best indication of size at maturity. At the same time, and in the course of taking the samples, observers should be encouraged to make their own assessments of ovarian status with a view to developing a macroscopic maturity stage scale in the future.

Stomach Contents

3.79 Stomach content samples collected from longline catches are known to be biased because the fish tend to regurgitate their stomach contents between being caught and landed. The experimental pot fishery for *D. eleginoides* at South Georgia afforded an opportunity to obtain samples unaffected by this bias. The results from that study were presented in WG-FSA-00/25. The most common prey was Decapod prawns which were present in 1 116 (41%) of all stomachs. It was noted that the amounts were localised by area and depth and also that prawns were not present in stomachs of fish taken on longlines from the same location. The next most common item was fish, present in 930 (34.4%) stomachs. *Patagonotothen guntheri*, a species thought to be confined to waters of less than 350 m depth, occurred in 33 stomachs (0.8%). The third most important component was Cephalopoda present in 226 (8.3%) stomachs. Arising from these observations the authors considered *D. eleginoides* to be an opportunistic carnivore.

Tagging Studies

3.80 Information on tagging studies on *Dissostichus* spp. was provided in two papers. A UK study, described in WG-FSA-00/26, was aimed at determining:

(i) whether juvenile fish in the vicinity of Shag Rocks recruited to the South Georgia fishery;

(ii) movements of fish within the South Georgia fishery area; and

(iii) growth of individual fish.

3.81 It was noted that the fish had not been injected with tetracycline as a growth marker.

Champsocephalus gunnari

Distribution

3.82 The mesoscale distribution around South Georgia was described in WG-FSA-00/45 and 00/51. It was concluded that this species is widespread over the shelf within the depth range 100–460 m. The densest aggregations appear to be concentrated to the northwest of the island with the largest fish being found there and also at Shag Rocks. The smallest fish tended to be in the southwest and southeast of the island.

3.83 Arising from the series of trawl surveys around Heard Island, it has been noted that *C. gunnari* tend to be concentrated in the east plateau, Gunnari Ridge and Shell Bank areas. The recent survey described in WG-FSA-00/40 confirmed these ideas on distribution were correct, although abundance on Shell Bank this season was very low.

3.84 During a recent trawl survey around South Georgia undertaken by the *Atlantida*, described in WG-FSA-00/51, significant amounts of *C. gunnari* were detected acoustically in the pelagic zone. Although it has been known for some time that these fish migrate into the water column to feed at night, it has been unclear what proportion of the population is present pelagically by day and if this is a phenomenon that is present year-round and between years. Examination of daytime echocharts indicated that significant amounts might be present in that zone by day.

3.85 Observations made during commercial fishing operations in December 1999 and January 2000, and presented in WG-FSA-00/19, indicated that large schools were present pelagically by day. In addition, schools that were present on or close to the bottom often extended up to 50 m above the seabed. Such schools would be very poorly sampled by the bottom trawls used for the recent assessment surveys described in WG-FSA-00/21 and 00/51. The potential influence of these observations on the assessment of *C. gunnari* abundance is further discussed in paragraphs 4.187 and 4.203.

3.86 During the course of the *Atlantida* survey, sampling had been undertaken to determine the potential for assessing *C. gunnari* acoustically. The results were presented in WG-FSA-00/31. Theoretical estimates of target strength, based on comparisons with similar fish which lack a swimbladder, were close to *in situ* measurements. It is concluded that with current technology it should be possible to discriminate between schools of krill and fish. The Working Group agreed to investigate this development with a view to determining a revised protocol for undertaking assessment surveys for *C. gunnari*.

3.87 An analysis of a very large dataset containing information on size and age distribution of *C. gunnari* around South Georgia since the commencement of commercial fishing was presented in WG-FSA-00/32. The study highlighted the similarity between the population size structure on the western shelf and Shag Rocks regions. Few small fish are found around Shag Rocks and it appears that when 15–25 cm long they migrate from the South Georgia shelf to that region. Fish around 15–25 cm total length predominate at the eastern end of the island.

Reproduction

3.88 WG-FSA-00/51 contained information on the maturation process observed during December 1999 and January 2000. Most fish progress from stage 2 to stage 3 during this time. The only fish which had progressed to stage 4 were greater than 45 cm total length.

3.89 Analysis of information from UK research surveys presented in WG-FSA-00/27 indicated that fish in maturity stages 3 (developing) and 5 (spent) were widespread over the shelf, whereas stage 4 (ripe) fish were only present on the northeast shelf and Shag Rocks. Shore-based observations show fish appear close inshore in spawning condition in March and April. Plankton sampling transects running offshore indicate that the highest concentrations of larvae occur close inshore either in bays or within about four miles of the island. The authors infer that there is a spawning migration around the island to the northeast shelf and from there into the bays in that region.

3.90 Support for the presence of migration to the north and northeast fjords was given in WG-FSA-00/32. The same paper indicates spawning, but at much lower intensity, on the southwestern shelf area.

Feeding

3.91 WG-FSA-00/20 and 00/51 provided information on the diet of *C. gunnari* during January 2000. At that time the dominant food was krill, present in 86% of stomachs. The hyperiid amphipod *Themisto* was less frequent and present in 28% of stomachs. The feeding index was below the long-term mean. The fish were apparently feeding predominantly in the pelagic zone.

Ectoparasites

3.92 Analysis of ectoparasites present on *C. gunnari* taken by the commercial vessel *Zakhar Sorokin* fishing in Subarea 48.3 was presented in WG-FSA-00/20. A total of 1 332 fish were examined. The degree of infestation of two species of ectoparasite was: *Trulliobdella capitis* present on 11.9% of fish and *Eubrachiella antarctica* present on 37% of fish.

Crabs

3.93 Crabs had appeared in large numbers in the experimental pot fishery for *D. eleginoides* and information was provided in WG-FSA-00/24. Three species were present in the catches. *Paralomis spinosissima* were caught (20 628 – 98% discarded) mainly in water 200–800 m deep. *P. formosa* were caught (119 893 – 96% discarded) mainly in water 400–1 600 m deep. In addition, 6 740 *P. anamerae* were caught, all of which were discarded. *P. anamerae* has previously been described from the Argentine slope in water 132–135 m deep. At South Georgia this species was taken in water 530–1 210 m deep. In addition, *Neolithoides diomedeae* and *Lithodes murrayi* were present in small numbers.

Sizes

3.94 Only 3.3% of *P. spinosissima* were greater than the minimum legal size (102 mm carapace, Conservation Measure 181/XVIII) of which 0.6% were females. Similarly, only 11.1% of *P. formosa* were larger than the minimum size (90 mm). None of the *P. anamerae* were larger than the minimum size and the proportion that were mature was not reported.

3.95 The following maturity stages were recognised:

1. Eggs uneyed: eggs orange to yellow in colour, no eye spots.
2. Eggs eyed: eggs orange to yellow in colour, with distinctive eye spots.
3. Eggs dead: eggs entirely white, black or brown.
4. Empty egg cases: eggs absent but egg cases still attached to pleopods.
5. Non ovigerous: eggs absent, no reproductive tissues attached to pleopods.

3.96 The following indices of carapace age were used in the study:

1. Soft: carapace flexible and generally lightly coloured.
2. New hard: carapace hard, no fouling organisms on exterior of carapace.
3. Old: carapace hard, fouling organisms present on exterior of carapace.
4. Very old: carapace hard, fouling organisms present, tips of spines and joints discoloured (often black).

3.97 Rhizocephalan parasite load was determined and the following results given:

P. spinosissima: female 5.8%, male 2.3%,
P. formosa: female 2.3%, male 1.7%,
P. anamerae: female 14.8%, male 6.2%.

3.98 Discard mortality was investigated through two experimental studies. In the first a total of 32 *P. formosa* and 42 *P. spinosissima*, as a representative cross section of the size and sex ratio in the catches and all of which were 'lively', were tagged and placed in pots and reimmersed the next time the pots were set. Of these crabs, 76% were still 'lively' when hauled on board after reimmersion, 13% were alive but 'limp' and the remainder had died. Thirty-five crabs, none of which were tagged, were kept on board as a control. Of this sample, only 63% were 'lively' and 8% died. All the dead crabs from the reimmersion set had been attacked by amphipods and isopods leaving only the shell. The authors suggest that these taxa may have been responsible for killing the crabs, particularly where damage to the shell might have allowed access to the soft tissues of the crab. Arising from this, the authors suggest that physical damage may significantly increase discard mortality.

Skates

3.99 Information on skates taken as by-catch in the Subarea 48.3 longline fishery for *D. eleginoides* was described in WG-FSA-00/59. The authors positively identified two species, *Raja georgiana* and *Bathyraja meridionalis*, and tentatively recognised a third referred to as *Raja* species 1.

3.100 *R. georgiana* and *B. meridionalis* were found all around the South Georgia and Shag Rocks slope area whereas *Raja* species 1 appeared to be concentrated at the western end of South Georgia.

3.101 From an examination of previous catch records the authors suggest that the catches of *B. murrayi* and *B. griseocauda* may have been *B. meridionalis*. Also that previous records of *R. georgiana* may include significant quantities of *Raja* species 1 and that specimens identified as *R. taaf* may have been *R. georgiana*.

3.102 The authors noted that there is a very close similarity between *R. georgiana* and *Raja* species 1. The main differences identified in the paper are associated with the colouration; *R. georgiana* has large areas of white on the underside whereas *Raja* species 1 is dark on the underside and paler on the dorsal surface.

3.103 WG-FSA-00/22 provided information on a small collection of *R. georgiana* caught during the UK fish survey (WG-FSA-00/21). The authors noted that the taxonomic description of the species is spread through several papers and consequently drew together that information to compare with their field samples. A length to mass relationship of:

total mass = 0.00000646 $TL^{3.06}$ (N = 18, length range: 18–95 cm)

was given in WG-FSA-00/22. This is the first length to mass relationship reported for *R. georgiana*.

3.104 Attempts at ageing skates were outlined in WG-FSA-00/59. More detailed information on the technique was given in WG-FSA-00/55 where the authors used vertebrae and the median dorsal thorns and tried several approaches to enhance annuli. The most effective method was by examination under X-ray of thorns that had been cleaned in trypsin and stained with alizarin. The Working Group noted that further work is planned on this topic.

3.105 The maturity scale for skates described by Stehman and Bürkel (1990) was used for the study reported in WG-FSA-00/59. The Working Group agreed that this description of maturity stages would be appropriate for use in the Scheme of International Scientific Observation.

3.106 Information on size at sexual maturity was given in WG-FSA-00/22 and 00/59. Based on the external morphology of the claspers in males and the size of the ovary in females, WG-FSA-00/59 gave the following L_{m50} values for the three species noted in the study:

R. georgianus:	female <88 cm TL, male <86 cm TL
Raja species 1:	female L_{m50} 100 cm, male 96 cm
B. meridionalis:	female ~140 cm, male 120 cm.

3.107 Using the clasper length relative to the pelvic fin length, WG-FSA-00/22 indicated that maturation of male fish occurs at around 80 cm total length. The only mature female in the sample was 91 cm total length.

3.108 The stomach contents of fish were described in WG-FSA-00/21. Smaller fish tended to have been feeding on krill and the mysid *Antarctomysis*. Larger skates had all been feeding on fish, principally *C. gunnari* and *Lepidonotothen larseni*.

3.109 A tagging study was initiated to investigate post-capture survival of skates taken as by-catch in the 1999 Ross Sea longline fishery (WG-FSA-00/55). A total of 2 058 skates had been tagged and released, approximately 20% of all skates caught. 90% of these fish were *Amblyraja georgiana*, the remainder were *B. eatonii* (see also paragraph 4.265).

Fish Identification

3.110 At its 1999 meeting SC-CAMLR had requested the Secretariat, in conjunction with CCAMLR technical coordinators, to prepare taxonomic keys for target and by-catch species of finfish commonly encountered in the longline fishery.

3.111 In response to a request from the Secretariat, the J.L.B. Smith Institute, Grahamstown, South Africa, had given permission for limited sections of their volume *Fishes of the Southern Ocean*, edited by O. Gon and P.C. Heemstra (1990), to be copied and used by CCAMLR scientific observers for observation programs on board longline vessels fishing in the Convention Area. This development was welcomed by the Working Group but it was recognised that the use at sea of such a volume, or even a subset as outlined above, was impracticable.

3.112 The Working Group discussed documentation available for 'at-sea' identification of fish. In addition to the extracts prepared by the Secretariat, there are the *FAO/CCAMLR Species Identification Sheets* which several members had found very useful. It was reported that the Australian Antarctic Division and AMLR Programs had prepared coloured waterproof documents giving photographs of those species most likely to be encountered in the fisheries along with key identification information. It was noted that some species, particularly Macrouridae, were very difficult to identify from photographs although the otoliths were diagnostic.

3.113 A subgroup, led by Dr Everson and including Drs Barrera-Oro, E. Fanta (Brazil), Kock, M. Vacchi (Italy), Mr Watkins and Mr Williams, met and discussed the most effective way of providing suitable information to observers.

3.114 Using the species reported by observers in their reports as a guide, the group drew up the following list of target and by-catch species likely to be taken in longline fisheries:

(i) Sharks: *Lamna nasus, Somniosus microcephalus;*

(ii) Rajiformes: *Amblyraja georgiana, Raja taaf, Bathyraja meridionalis, B. murrayi, B. eatonii, B. irrasa, B. maccaini;*

(iii) Chimaeridae;

(iv) Synaphobranchidae: *Histiobranchus bathybius;*

(v) Muraenolepidae: *Muraenolepis microps, M. orangiensis;*

(vi) Macrouridae: *Macrourus whitsoni, M. carinatus* (*M. holotrachys*);

(vii) Moridae: *Antimora rostrata, Halargyreus johnsonii*; and

(viii) Nototheniidae: *Dissostichus eleginoides, D. mawsoni*.

3.115 The following species were considered likely to be taken as target species or by-catch in current CCAMLR trawl fisheries:

(i) Myctophidae: *Electrona antarctica, E. carlsbergi, Gymnoscopelus braueri, G. bolini, G. nicholsi, G. opisthopterus*;

(ii) *Brama brama*;

(iii) Nototheniidae: *Aethotaxis mitopteryx*, *Dissostichus eleginoides, D. mawsoni, Gvozdarus svetovidovi, Notothenia rossii, N. coriiceps, N. neglecta, N. cyanobrancha, Paranotothenia magellinaca, Gobionotothen gibberifrons, G. acuta, Lepidonotothen squamifrons, L. mizops, L. larseni, L. kempi, Patagonotothen guntheri, Trematomus eulepidotus, T. hansoni, Pleuragramma antarcticum*;

(iv) Harpagiferidae: *Artedidraco* spp., *Pogonophryne* spp.;

(v) Channichthyidae: *Champsocephalus gunnari*, *Chaenocephalus aceratus, Pseudochaenichthys georgianus, Channichthys rhinoceratus, Chaenodraco wilsoni, Chionodraco hamatus, C. myersi, C. rastrospinosus, Chionobathyscus dewitti;* and

(vi) Liparidae.

3.116 The subgroup agreed, that to be of greatest practical use, the guide should be set out in the form of a field guide composed of individual sheets with two to four similar species per page. These pages might be left on display in the work area of a fishing vessel. They would contain the following information:

(i) good quality picture, either a colour photograph or line drawing with markers to indicate key diagnostic features;

(ii) illustration, where appropriate, of other key diagnostic features such as otoliths;

(iii) species name and CCAMLR species code;

(iv) brief description, in clear print, occupying no more than three lines, of obvious features, such as colour spination, position of fins etc., that make for near-certain species identification. Allometric relationships should be stated; and

(v) depth range and geographical distribution (map).

3.117 It was agreed that the preparation of this guide should be assigned a high priority and it was agreed that Drs Everson and Kock should prepare an initial draft for comment by the end of January 2001 with a view to preparing a guide for the longline fisheries before the anticipated start of the fishing season. Text would initially be in English but Members would be encouraged to provide translations into other languages. The preparation for a similar guide for use in trawl fisheries would be developed using the experience gained in drawing up the longline fishery guide. Observers should be invited to comment on the usefulness of the key at the end of their cruises. These comments would then be considered for inclusion in a final version of the key. The cost associated with the preparation of the sheets would be born by the participants. However, funding would be required to reproduce the sheets in colour for distribution to observers. An estimated A$500 was requested for this purpose.

3.118 Recognising that these guides would not allow observers to identify all fish accurately, it was agreed that observers should be encouraged to label and store deep frozen all specimens whose identification was uncertain, and should request their technical coordinators to arrange for transmission of the specimens to appropriate taxonomists.

Other Species

3.119 Information on the ecology of nine inshore fish species sampled over a number of years at Danco Coast, Subarea 48.1, was described in WG-FSA-00/63. Two species, *G. gibberifrons* and *C. aceratus*, had been taken in significant numbers as by-catch during commercial fishing. Relative densities of *G. gibberifrons* in the South Shetland Islands, where commercial fishing has taken place, were still much lower than at Danco Coast, the site of the current observations. The authors concluded that this difference was due to slow recovery following heavy fishing in the 1970s.

3.120 Similar results were obtained in a study on the diet of the Antarctic shag (*Phalacrocorax bransfieldensis*) in the same region (WG-EMM-00/9). The agreement between both studies highlights the utility of the standard method implemented by WG-EMM, on the use of the Antarctic shag to monitor changes in the abundance of inshore demersal fish populations (paragraph 5.6).

Developments in Assessment Methods

3.121 WG-FSA-00/36 presented new software, 'Fish Heaven', for modelling the dynamics of fish stocks with spatial characteristics governed by habitat variables. It is a simple spatially explicit age-structured model, containing the basic features of the GYM with extensions to provide for different environmentally driven distributions of fish stocks. It is designed to allow environmental simulations with fishing while capturing various statistics about the status of the system. It allows fishing to be undertaken with basic fishing strategies and can be used to simulate sampling of fish stocks generally. These are intended to be extended. The software is available for distribution through the Australian Antarctic Division or the Secretariat.

3.122 The Working Group welcomed these developments and encouraged further work, noting that this model will have wider applications internationally.

3.123 WG-FSA-00/39 provided a method for integrating standardised CPUE time series into assessments using the GYM. This follows the proposal by Dr P. Gasiukov (Russia) in 1999 to undertake such an integration (WG-FSA-99/60) and the request by the Working Group to develop this work further during the intersessional period (SC-CAMLR-XVIII, Annex 5, paragraphs 3.143 to 3.145). The procedure in this paper was based on the sampling/ importance-resampling (SIR) method for estimating a likelihood of a given time series of fishable biomasses in a trial of the GYM given the time series of standardised CPUE over the same period. These likelihoods can be used to statistically weight each of the trials in the evaluation of the criteria in the GYM rather than assuming equal likelihood for all trials. This procedure is able to use all the trials in the final assessment without giving preference to the CPUE or GYM input parameters as the primary indicators of stock abundance.

3.124 The Working Group discussed the resampling step of SIR and agreed to discuss this further intersessionally. The Working Group endorsed the use of this procedure in the assessments this year and noted that a greater number of trials may be required to improve the application of the method. An Excel spreadsheet with macros was provided with the paper to apply this method to the outputs of the GYM.

3.125 A new version of the GYM (version 3.02) was now available to the Working Group to enable the use of a recruitment time series and reporting to a user-friendly file of the status of the population each year. These modifications were required to facilitate the integration of CPUE into GY assessments. The Working Group agreed to have these minor improvements validated at this meeting in order that the latest version of the GYM could be used. Dr Gasiukov kindly agreed to undertake the validation and validated this version during the meeting prior to the assessments. The Working Group endorsed the use of the validated GYM in this year's assessments.

3.126 WG-FSA-00/43 presented an assessment undertaken by Australia of the harvested population of *D. eleginoides* at Macquarie Island based on data from a tag-recapture experiment initiated during the 1995/96 fishing season. Population models that include dynamics of tagged and untagged fish, daily releases, catches, recaptures, natural mortality and annual net recruitment are used to assess the population of one of the main fishing regions of Macquarie Island. The pre-tagging abundance is estimated by incorporating a Petersen approach in a novel semi-parametric model using maximum likelihood methods. The software provides for a number of assessment models, including a basic model that assumes the recaptures are Poisson distributed, and the recapture expectations are conditional on catch numbers and previous recaptures. A second model attempts to account for apparent decreasing availability with length.

3.127 The Working Group noted that this approach may have wider applicability in assessing stocks targeted by longline fishing for which no direct estimates of abundance may be possible. One such example could be the future assessment of tagged fish arising from the experiment begun this year at South Georgia (WG-FSA-00/26).

3.128 WG-FSA-00/46 provided another new method for assessing the status of *Dissostichus* spp. stocks. It used a dynamic age-structured production model of *Dissostichus* spp. and trends in CPUE and recruitment indices to estimate parameters of the model, including pre-exploitation biomass and the stochastic part of recruitments. The initial results of the application of this model show differences between the outputs of the GYM and this approach, as well as differences in the recruitment series estimated from surveys. These differences need to be explored further. Dr Gasiukov proposed that further development of this method could provide the foundation for short-term assessments of the status of the stock.

3.129 The Working Group welcomed these new developments of assessment methods and agreed to discuss this further in the subgroup assessing *Dissostichus* spp. It encouraged further development of this approach, including the undertaking of sensitivity trials (paragraph 4.105).

3.130 WG-FSA-00/52 used time series of estimates of cohort strength arising from mixture analyses of length-density information to estimate jointly recruitment and natural mortality. Currently, natural mortality is an input parameter to the process of estimating recruitments. However, natural mortality has not been directly estimated for *D. eleginoides*, but instead is assumed to be about two to three times the value of the von Bertalanffy k. The paper proposes a method for the joint estimation of recruitment and M using a negative log-likelihood method. This entails first decomposing length-density distributions of a time series of trawl survey data into mixtures of different aged cohorts by means of the method of de la Mare (1994). Next, under the assumption of constant mortality for all cohorts in all years, a negative log-likelihood function was derived using a series of several cohorts from the mixtures to produce an estimate of M and the abundance of recruits at a nominated age for each cohort in the analysis. The procedure was provided on a Mathcad 2000 Professional worksheet.

3.131 The Working Group welcomed the introduction of this method, noting that mortality has not yet been directly estimated for *D. eleginoides*. It also suggested that a log-normal error function should be used in place of the error function described in the paper, in order to be consistent with the general expectation of a lognormal distribution of recruitments. With this modification, the Working Group endorsed the use of the method in the assessments this year.

ASSESSMENTS AND MANAGEMENT ADVICE

New and Exploratory Fisheries

New and Exploratory Fisheries in 1999/2000

4.1 One conservation measure relating to new fisheries and 13 conservation measures relating to exploratory fisheries were in force during 1999/2000. These are summarised in Table 18.

4.2 In only five of these 14 new or exploratory fisheries did fishing actually occur during 1999/2000. Information on these fisheries is summarised in Table 19. In most cases, the numbers of days fished and the catches reported were very small. The notable exception was the exploratory fishery for *Dissostichus* spp. in Subarea 88.1, conducted under Conservation Measure 190/XVIII, where three vessels fished for a total of 162 days, taking 745 tonnes of *D. mawsoni*.

4.3 Reviewing the information in Tables 18 and 19, the Working Group strongly reiterated its concern, expressed at previous meetings, about the number of times that new and exploratory fisheries have been notified but never actually activated. The Working Group also noted that often the same or similar notifications have been made repeatedly, but in each case no fishing had eventuated. Table 20 summarises the history of new and exploratory fishery notifications and the catches subsequently taken.

4.4 Each time a notification is made, the Working Group is required to review it and, to the extent possible, to provide advice on precautionary catch limits. Given the large number of notifications received over the last few years, an increasingly large proportion of the time available to the Working Group had to be devoted to consideration of new and exploratory fisheries. Despite this, and despite notifications having been made for a large number of subareas and divisions, once again the Working Group has essentially no new information on *Dissostichus* stocks in most of these areas. The concern is further heightened by the fact that substantial amounts of IUU fishing are believed to have occurred in these areas.

4.5 The Working Group agreed that some of these difficulties may be alleviated if changes were made to the system of notification and classification of fisheries. This is discussed further under 'Regulatory Framework' (paragraphs 4.270 to 4.274).

4.6 Conservation Measure 182/XVIII, governing exploratory fisheries, requires that once the catch in a small-scale research unit (SSRU) has exceeded a trigger level (10 tonnes or 10 hauls), research hauls must be carried out and the results reported to CCAMLR. Table 21 summarises the research data submitted in accordance with this conservation measure.

4.7 In only three of the active exploratory fisheries were the catches taken in SSRUs sufficiently large that the requirement to undertake research hauls was triggered. This occurred in SSRUs A, B and C in respect of the Uruguayan exploratory longline fishery in Division 58.4.4, in SSRUs A and B in respect of South African longline fishery in Subarea 58.6 and in SSRUs A, B, C and D in respect of the New Zealand exploratory longline fishery in Subarea 88.1.

4.8 Based on data contained in the observer report, the Working Group noted that the South African vessel undertaking exploratory fishing in Subarea 58.6 had taken some 22 tonnes of *D. eleginoides*. Mr Watkins indicated that the fine-scale catch information for this vessel had been despatched to the Secretariat, but due to the vessels late return (3 October 2000), the information had not yet arrived. For this reason, the Working Group reiterated that as indicated in Table 21, the available data were incomplete.

4.9 The Working Group noted with regret that by the start of its meeting no commercial or research catch data for this exploratory fishery had been received by the Secretariat. These data were received during the course of the meeting, but too late for the Working Group to review them. The Working Group also noted with some surprise that 55 tonnes had been taken in other grounds not covered by defined SSRUs. As such, no research requirements are mandated under Conservation Measure 182/XVIII. There may be a need to reconsider the specification of SSRUs for this division.

4.10 Last year the Working Group had concluded that it would be unable to provide reliable advice on precautionary catch limits for new or exploratory fisheries until new information directly pertaining to the subareas or divisions involved became available. Currently, the only likely source of such data is from new and exploratory fisheries carried out in these areas, especially the research data collected in accordance with the requirements of Conservation Measure 182/XVIII. It is vital that these research requirements are continued and complied with for all future new or exploratory fisheries.

4.11 The Working Group also emphasised that the research plans mandated by Conservation Measure 182/XVIII represent minimum research requirements. It is likely that these and additional research data will need to be collected for a number of years before reliable assessments will be possible. In this context, the Working Group encouraged the submission, wherever possible, of more comprehensive research plans, extending further than those required under Conservation Measure 182/XVIII.

4.12 The exploratory longline fishery in 1999/2000 by New Zealand for *D. mawsoni* in Subarea 88.1 provided a welcome and notable exception to the general lack of information about new and exploratory fisheries outlined above. A total of 745 tonnes was taken in 489 longline hauls, and research data were collected and submitted for four SSRUs. In most cases, the numbers of research hauls made exceeded the research requirements of Conservation Measure 182/XVIII.

4.13 Research activities associated with this exploratory fishery were summarised in WG-FSA-00/35, and a comprehensive analysis of data collected by this fishery from 1997/98 to 1999/2000 was given in WG-FSA-00/55. Dr Constable noted that, in addition to the considerable amounts of new biological data collected, a sufficiently large number of SSRUs may now have been fished in this subarea to allow a characterisation of the distribution of CPUEs across large parts of the subarea. If so, these data may allow a comparison of observed densities in Subarea 88.1 with those in Subarea 48.3.

4.14 The precautionary catch limit of *Dissostichus* spp. in Subarea 88.1 for the 1999/2000 season was 2 090 tonnes, comprising catch limits of 175 tonnes north of 65°S, and 478 tonnes in each of the four SSRUs to the south of 65°S (Conservation Measure 190/XVIII). Three New Zealand vessels fished during the season, with a reported catch of 745 tonnes (CCAMLR-XIX/BG/1). The majority of the catch was *D. mawsoni*, with only 0.3 tonnes of *D. eleginoides*.

4.15 The exploratory fishery has now been in operation by New Zealand vessels for three seasons with a gradual increase in catch from 41 tonnes by one vessel in 1998, to 296 tonnes by two vessels in 1999, and to 745 tonnes by three vessels in 2000. During this time there has been a widespread distribution of effort with at least four SSRUs and from 28 to 44 fine-scale rectangles fished each year, and a total of 76 fine-scale rectangles fished overall (WG-FSA-00/55). This has contributed significantly to the knowledge and distribution of both *Dissostichus* spp. and other fish fauna in this subarea.

4.16 *D. mawsoni* were caught in over 95% of all sets, and in all five SSRUs (WG-FSA-00/55). They were the dominant species in all sets apart from those made in the northern SSRU. Over 20 000 fish have been measured and sexed, and over 2 000 otoliths collected, of which 1 500 have been read. Gonad samples have also been collected and examined histologically to help identify size and age at maturity.

4.17 During the period of the exploratory fishery the impact on dependent species has been low (WG-FSA-00/35). The main by-catch species have been rat tails which have averaged about 10% (range 6–17% by weight) of the annual catch, and skates which have averaged about 8% (range 5–11%) of the annual catch. For age determination purposes, otoliths have been collected from rat tails and vertebrae from skates, and a skates tagging experiment has been initiated to determine their post-hauling survival rate. To date, 2 000 skates have been tagged, of which four have been recaptured. New Zealand has also conducted line-weighting experiments to mitigate seabird by-catch and there has been no incidental mortality of seabirds or marine mammals.

4.18 Observer length-frequency data for *D. mawsoni* were examined for variation in area, trip, and set type (commercial/research), and were then stratified and scaled up to the commercial catch for each of the past three seasons (WG-FSA-00/55). The resulting catch-weighted length frequencies are shown in Figure 2. Most fish in the catch ranged from 70–160 cm, with two broad modal peaks at 80–110 cm and 130–140 cm.

4.19 About 500 otoliths were read from *D. mawsoni* each year and the resulting ages were compiled into year-specific age–length keys. These were then applied to the scaled length-frequency distributions to produce catch-at-age distributions for each year (WG-FSA-00/55) (Figure 3). Most *D. mawsoni* in the catch were 8–16 years old (range 3–35 years). The data suggest an increase in the size and age of fish caught over the three-year period, probably due to changes in fishing practices.

4.20 The Working Group used a similar approach to that used at last year's meeting to calculate precautionary catch limits for Subarea 88.1. Yields were estimated for Subarea 88.1 by relating the CPUE from research sets and biological parameters for *D. mawsoni* to the CPUE, biological parameters and yield estimate for *D. eleginoides* in Subarea 48.3.

4.21 A formula for estimating yield was derived from the approach used for krill where:

$$\text{Yield} = \gamma B_0$$

and that CPUE is considered to be an approximate relative estimate of biomass density. These can be combined to give the following:

$$Y_{881} = \frac{g_{881} f_{881} A_{881}}{g_{483} f_{483} A_{483}} Y_{483}$$

where γ is the precautionary pre-exploitation harvest level for each area, f is the relative density (a function of CPUE and fishing selectivity), A is the seabed area, and Y is the pre-exploitation precautionary yield. This assumes that the catchability and the relationship between CPUE and actual density is the same for both species/fisheries. A full derivation of the formula is lodged with the CCAMLR Secretariat.

4.22 While the general approach adopted was similar to last year, there were several key improvements. Firstly, several alternative approaches were used to adjust for relative seabed areas. The first two of these approaches were identical to that used last year, where the adjustment was based on relative areas of fishable seabed, and recruitment areas. The third approach involved the calculation of the area of seabed that has actually been fished in Subarea 88.1 over the past three seasons. A fourth estimate adds the area that is likely to be fished in the 2000/01 fishing year to that which has already been fished.

4.23 The Working Group agreed that, as the proportional adjustment was applied to the actual fished area, in principle the third approach should be more scientifically justifiable than the first two. However, it also noted that this should be regarded as a minimum estimate of the area of *Dissostichus* spp. habitat. The Working Group reviewed the three sets of estimated seabed areas and noted that a larger area would probably be fished in 2000/01.

4.24 The second improvement was in the estimation of relative fish density between the two areas. A total of 100 research sets were carried out in four SSRUs in Subarea 88.1 during 1999/2000 as part of Conservation Measure 190/XVIII. Relative density of recruited biomass between the two areas was estimated by comparing the CPUE from Subarea 48.3 for the 1986/87 to 1991/92 fishing seasons, with the CPUE from the research sets in Subarea 88.1. These seasons were chosen for Subarea 48.3 because these are data available from the fishery at a time when the stock was close to pre-exploitation levels. Data from 1985/86 were excluded because fishing was in very shallow water in that year (paragraph 4.109). CPUE was calculated as kg/hook for each set in each of the smaller regions in Subarea 48.3 and in each of the SSRUs fished in Subarea 88.1.

4.25 As CPUE is very variable in space and time, and is being used in this analysis as an indicator of the relative differences in abundance between the two areas, the ratio was determined by finding the one-sided lower 95% confidence bound of this ratio using a bootstrap procedure. This is consistent with the principles applied in the short-term assessment of yield for *C. gunnari* (paragraph 4.204). Firstly, the haul-by-haul CPUE estimates were weighted by the proportion of sets and the proportion of the total area fished in that SSRU (SC-CAMLR-XVIII, Annex 5, paragraph 4.127). Then the CPUE estimates from each area were resampled with replacement, averaged and the ratio of CPUE between the areas calculated. This was repeated 10 000 times and the one-sided lower 95% confidence bound of this ratio calculated.

4.26 The aim of this second adjustment was to take explicit account of observed relative densities between the two areas. In calculating the adjustment factor in this way, the Working Group recognised that effectively it was treating CPUE data for a well-established commercial fishery as being directly comparable with CPUE data from randomly carried out research sets in fishing areas that were not well known or fully explored. It is possible that this may lead to an underestimate of the appropriate adjustment factor, but the Working Group agreed that, if this occurred, the resulting precautionary catch limit would also be underestimated. Any disadvantages this approach entailed were felt by the Working Group to be far outweighed by the advantages of taking account of relative densities on the fishing grounds. Consistent with exploratory fisheries elsewhere, the assessment of yield will be improved with more information as the fishery develops.

4.27 Because the estimate of CPUE relates only to the recruited biomass, a third adjustment was required to convert this value to total biomass. The ratio of total biomass to recruited biomass was calculated from each of the two fisheries using the appropriate biological parameters. The fishing selectivity was estimated from the left side of the length-frequency distributions for the combined commercial length-frequency data for Subarea 88.1 (Figure 4) and the earliest reliable commercial length-frequency data (from 1995) for Subarea 48.3. For Subarea 48.3, length at 50% selectivity equalled 70 cm with a range from 55 to 85 cm. The ratios for each of the two fisheries were very similar and equalled 1.10 for *D. mawsoni* and 1.13 for *D. eleginoides*.

4.28 The final adjustment was made by comparing the precautionary pre-exploitation harvest levels (γ) between the two areas. These were calculated from the biological and fishery parameters for each of the two subareas. Biological and fishery parameters for *D. eleginoides* were the same as that used for the Subarea 48.3 assessment (Table 34). However, the fishing selectivity pattern was again taken from the left side of the 1995 commercial length-frequency distribution.

4.29 Updated biological parameters for *D. mawsoni* were provided in WG-FSA-00/55. Growth parameter estimates for both sexes were updated using data from 1999/2000 and equalled L_{∞} = 180.2 cm, k = 0.095 yr^{-1}, t_0 = 0.04. The length–weight relationship calculated from 1998 to 2000 data combined was $W = 4.7 \times 10^{-6} L^{3.199}$. M was estimated from the age of the oldest 1% of fish in the commercial catch and ranged from 0.15 to 0.22 yr^{-1}. Fish were assumed to be selected into the fishery at 80 cm with a range from 65 to 95 cm. The size at maturity was assumed to be 100 cm with a range from 85 to 115 cm. Biological and fishery parameters used for *D. mawsoni* in the GY calculations are shown in Table 22.

4.30 Estimates of γ from the GYM equalled 0.037 for *D. mawsoni* and 0.034 for *D. eleginoides*. This suggests that *D. mawsoni* is more productive than *D. eleginoides* which appears to be counter intuitive for a species inhabiting higher latitudes. The Working Group agreed to explore this result further taking into account uncertainties in the estimate.

4.31 Total seabed area was the same as was calculated for the assessment last year (SC-CAMLR-XVIII, Annex 5, paragraphs 4.44 and 4.45). Recruited seabed area for South Georgia was taken from Everson and Campbell (1990). Estimates of fished area were taken by summing the area in the contours between 600 and 1 800 m fished by New Zealand vessels during the 1997/98 to 1999/2000 seasons. The estimate of fished area proposed for 2001 equals the area of seabed that is likely to be fished in the 2000/01 fishing season, and includes the area already fished and an estimate of the areas of new ground which will be explored by New Zealand vessels. A component of the research plan adopted by New Zealand is to continue to expand knowledge on the distribution of *D. mawsoni*. This analysis is based on projections by the New Zealand vessels to fish in deeper water (1 400–1 700 m) and further south than in previous years.

4.32 The pre-exploitation precautionary yield for Subarea 48.3 was calculated using the recruitment parameters from the results of the CMIX analyses, together with the other biological parameters used for the calculations of γ, using zero catches. This yield (4 690 tonnes) was then adjusted by the ratio of gammas, densities (a function of CPUE and fishing selectivity), and seabed areas to give estimates of yield for *D. mawsoni* in Subarea 88.1.

4.33 The resulting estimates of yield are given in Table 23. Because it is based on the known adult habitat of *D. mawsoni* in Subarea 88.1, the best available estimate of yield is based on the fished area and equals 3 616 tonnes.

4.34 The Working Group noted that whilst the current assessment provided several improvements to earlier assessments of this area, there was still considerable uncertainty present. This uncertainty stems from uncertainty in biological and fishery parameters for both *Dissostichus* spp., and the assumption of the relationship between CPUE and density.

4.35 In light of this uncertainty, the Working Group agreed that some discount still needs to be applied to the results of this assessment. The Working Group noted that in previous years a range of discount factors (from 0.25 to 0.5) has been applied to new and exploratory fisheries for *Dissostichus* spp.

4.36 The value of including a research component in Conservation Measure 182/XVIII is demonstrated by the use of the CPUE estimates from the research sets in the assessment of *D. mawsoni* in Subarea 88.1 (paragraphs 4.20 and 4.21). The Working Group agreed that further collection of data from research sets would be valuable for the assessments next year. This use of research sets was considered to be important both for Subarea 88.1 and for other new and exploratory fisheries (e.g. Division 58.4.4) generally. Members were also requested to investigate further during the intersessional period the application of research set data in assessments.

4.37 The Working Group agreed it would be desirable to develop a time series of research sets in the SSRUs to help provide indices of abundance. For example, in the second or subsequent years of the fishery, vessels which have already completed a series of research sets in a particular SSRU could be required to complete their research sets in a similar location (same fine-scale rectangle) and at a similar time to their first set. If this causes operational difficulties (e.g. ice), a new set could be undertaken instead. Alternatively, research sets could continue to be used as an effort spreading mechanism. The Working Group also agreed that tag studies initiated early in the fisheries would help in long-term assessments (paragraphs 3.126 and 3.127).

New and Exploratory Fisheries Notified for 2000/01

General Issues

4.38 A summary of new and exploratory fisheries notifications for 2000/01 is given in Table 24. As was done last year, the Working Group discussed notifications of new and exploratory fisheries together. Research survey notifications for *Dissostichus* spp. were also discussed under this item.

4.39 All notifications had been received by the Secretariat on or before the due date. Recalling the experiences of last year, the Working Group recommended that in future years neither it nor the Scientific Committee should consider any notifications received after the due date.

4.40 Dr Miller noted that some of the notifications for new or exploratory fisheries in Division 58.4.4 have neglected to specify that they applied only to areas outside national EEZs. This needs to be rectified when conservation measures are being drawn up.

4.41 The Working Group noted that the Argentinian notification (CCAMLR-XIX/12) included an intent to fish in Subareas 48.1 and 48.2, and the Brazilian notification (CCAMLR-XIX/5) included an intent to fish in Subarea 48.2. Conservation Measures 72/XVII and 73/XVII clearly state that the taking of finfish in these subareas, other than for research purposes, is prohibited until such time as a survey of stock biomass is carried out, its results reported to and analysed by the Working Group, and a decision that the fishery be reopened is made by the Commission based on the advice of the Scientific Committee. As these conditions have not yet been met, the Working Group recommended that new or exploratory fisheries for finfish should not take place in these subareas in the coming season.

4.42 The Brazilian notification (CCAMLR-XIX/5) also indicated an intent to fish for *D. eleginoides* in Subareas 48.3 and 48.4. The Working Group noted that the fisheries in these subareas are fisheries regulated under Conservation Measures 179/XVIII and 180/XVIII respectively. Thus new or exploratory fishing for this species cannot be considered in these areas.

4.43 The Working Group welcomed what it believed to be the primary intent of the Brazilian notification, which was to inform CCAMLR that Brazil intended, for the first time, to participate in fisheries in those areas. It agreed that the submission of such information was very useful. Further discussion regarding notifications may be found under ‘Regulatory Framework’ (paragraphs 4.270 to 4.274).

Review of Individual Notifications

4.44 Argentina submitted a notification (CCAMLR-XIX/12) for exploratory longline fisheries for *Dissostichus* spp. in Subareas 48.1, 48.2, 48.6, 58.6, 88.1, 88.2, 88.3 and Divisions 58.4.1, 58.4.2, 58.4.3, 58.4.4 and 58.5.1 outside EEZs.

4.45 Aside from the recommendation above regarding Subareas 48.1 and 48.2 (paragraph 4.41), the Working Group drew attention to the fact that the available area outside national EEZs in Division 58.5.1 was small, so appropriate precautionary catch limits for these areas should also be similarly small.

4.46 Australia submitted a notification (CCAMLR-XIX/10) for exploratory bottom trawl fisheries for *Dissostichus* spp. in Divisions 58.4.1 and 58.4.3 and a notification (CCAMLR-XIX/11) for an exploratory trawl fishery for *Dissostichus* spp., *C. wilsoni, L. kempi, T. eulepidotus, P. antarcticum* and other species in Division 58.4.2. The second notification was a resubmission of a notification made last year.

4.47 In response to a query about potential effects of trawling on the bottom substrate and benthic fauna, Dr Constable explained that in Divisions 58.4.1 and 58.4.3 most of the area contained rough ground, with only small areas suitable for trawling. In contrast, Division 58.4.2 contained large areas suitable for demersal trawling. As indicated in CCAMLR-XIX/11, the research plan for this division calls for a series of open and closed areas as required in Conservation Measure 182/XVIII. In addition, the research plan also included specific experiments to examine the effects of demersal trawling on the benthic community. Results of these experiments will be reported to the Working Group next year.

4.48 Brazil submitted a notification (CCAMLR-XIX/5) for exploratory longline fisheries for *D. eleginoides* in Subareas 48.2, 48.3, 48.4 and 48.6, and Divisions 58.4.4, 58.5.1 and 58.5.2 (outside the EEZs of South Africa, France and Australia).

4.49 As noted above (paragraph 4.41), until a survey has been completed as required in Conservation Measure 73/XVII, the Working Group recommended that no exploratory fishing should take place for finfish in Subarea 48.2. Any catches taken in Subareas 48.3 and 48.4 should be considered to be taken as part of the fisheries established in those subareas (paragraph 4.42).

4.50 With regard to exploratory fishing in Divisions 58.5.1 and 58.5.2, the Working Group drew attention to the fact that the available area outside national EEZs in these divisions is small, so appropriate precautionary catch limits for these areas should also be similarly small.

4.51 France submitted a notification (CCAMLR-XIX/13) for new and exploratory longline fisheries for *D. eleginoides* and *Raja, Bathyraja* and *Macrourus* spp. in Subareas 58.6 and 58.7 and Divisions 58.4.3, 58.4.4, 58.5.1 and 58.5.2 outside the EEZs of South Africa, Australia and France.

4.52 The notification by France indicated that *Raja, Bathyraja* and *Macrourus* spp. were not considered to be target species, but that some commercial return was to be sought from by-catches of these species. It is thus unclear whether catches of these species should be treated as by-catches, in which case Conservation Measure 182/XVIII would apply, or whether they should be treated as new fisheries. The Working Group agreed that further clarification was needed on this matter.

4.53 Fishing for *D. eleginoides* in Subarea 58.7 is governed by Conservation Measure 160/XVII, which prohibits the taking of this species until such time as a survey of stock biomass is carried out, its results reported to and analysed by the Working Group, and a decision that the fishery be reopened is made by the Commission based on the advice of the Scientific Committee. The French notification suggested that a survey will be undertaken in Subarea 58.7, but no notification of research vessel activity has been made, nor has any detailed research plan and survey design been submitted for consideration by the Working Group. The Working Group believes that clarification is needed of what is intended in Subarea 58.7.

4.54 With respect to exploratory fishing in Divisions 58.5.1 and 58.5.2, as for the Brazilian notification, the Working Group drew attention to the fact that the available area outside national EEZs in these divisions was small, so appropriate precautionary catch limits for these areas should also be similarly small.

4.55 Consideration by the Working Group of the potential effects of the intended catches was hampered by the fact that no breakdown of catches by subarea and division was given in the French notification.

4.56 Finally, the Working Group noted that it was a strict requirement of Conservation Measure 182/XVIII that exploratory fishing vessels should carry a CCAMLR scientific observer.

4.57 New Zealand submitted a notification (CCAMLR-XIX/17) for an exploratory longline fishery for *Dissostichus* spp. in Subarea 88.1. This represents a continuation of the exploratory fishing program carried out by New Zealand in previous years in this subarea, for which considerable catch and research information has been submitted (see WG-FSA-00/35 and 00/55).

4.58 Dr Hanchet emphasised the long-term commitment by New Zealand to continued exploratory fishing and research in this subarea. He also indicated that consideration was being given to extending tagging studies, currently under way for skates and rays, to *D. mawsoni*. This may provide an alternative assessment method for this species and subarea.

4.59 Dr Hanchet also indicated that fishers had found the by-catch provisions for *Macrourus* spp. in Conservation Measure 182/XVIII to be too restrictive. In the 1999/2000 season in Subarea 88.1, on 22% of the exploratory sets and 20% of the research sets the catch of *Macrourus* spp. exceeded 100 kg, triggering a requirement to move to another location. A total of 17% of all sets caught more than 200 kg of *Macrourus* spp. and 11% of all sets caught more than 300 kg of *Macrourus* spp.

4.60 The New Zealand notification for 2000/01 indicated an intended catch of up to 300 tonnes of *M. carinatus* south of 65°S. The Working Group noted that species identification for *Macrourus* spp. remains problematic, but it is apparent that they are an abundant species in these latitudes. Dr Hanchet clarified that, while New Zealand national regulations required the retention of all *Macrourus* spp. catches, they were definitely considered a by-catch species by the commercial fishers.

4.61 The Working Group noted that the way Conservation Measure 182/XVIII operated for this fishery was to require a change of location from high *Macrourus* spp. by-catch areas about 20% of the time. A valuable result of this is that it encourages fishing over a wide geographic range, as intended by paragraph 2 of Conservation Measure 182/XVIII.

4.62 Given their relatively high level, the Working Group agreed that the provisions of Conservation Measure 182/XVIII with respect to *Macrourus* spp. by-catches need to be reviewed. This will require, at least, an assessment of *Macrourus* spp. to have been carried out. Means of achieving this are discussed later (paragraph 4.100).

4.63 South Africa submitted a notification (CCAMLR-XIX/6) for exploratory longline fisheries for *Dissostichus* spp. in Subareas 48.6, 58.6, 88.1 and 88.2 and Division 58.4.4. The Working Group had no specific comments or queries about this notification.

4.64 Ukraine submitted a notification (CCAMLR-XIX/7) for an exploratory longline fishery for *Dissostichus* spp. in Division 58.4.4. The Working Group had no specific comments or queries about this notification.

4.65 Ukraine had also submitted results of seven historical research surveys conducted on four cruises on the Ob and Lena Banks in 1980, 1982, 1986 and 1989. The Working Group welcomed the submission of these valuable data and they were passed to the *Dissostichus* spp. subgroup for preliminary analysis (paragraph 4.158).

4.66 Ukraine is also currently carrying out a longline research survey in Division 58.4.4 under the provisions of Conservation Measure 64/XII, with an estimated catch of less than 50 tonnes. The Working Group noted that, for *Dissostichus* spp., there was some incompatibility between the requirements of this conservation measure and those of Conservation Measure 182/XVIII in terms of the relationship between catch levels and research requirements. This is discussed further under 'Advice to the Scientific Committee' (paragraphs 4.77 to 4.102).

4.67 Uruguay submitted a notification (CCAMLR-XIX/15) for exploratory longline fisheries for *Dissostichus* spp. in Subareas 88.1, 88.2 and 88.3 and Division 58.4.4.

4.68 Recalling that Uruguay had conducted an exploratory longline fishery in Division 58.4.4 during 1999/2000, but that data for this fishery had been received too late for consideration during this meeting, the Working Group was unable to assess the various fishery and research plans proposed in this notification. The Working Group emphasised that timely submission of data was essential for the Working Group to provide the advice required by the Scientific Committee and Commission.

4.69 Uruguay submitted a notification (CCAMLR-XIX/16) for an exploratory pot fishery for *D. eleginoides* in Subarea 48.3. It also submitted a notification (CCAMLR-XIX/16) for an exploratory pot fishery for crabs in Subarea 48.3. In accordance with Conservation Measure 64/XII, the UK submitted a notification (CCAMLR-XIX/9) of research vessel activity involving pot fishing for *D. eleginoides* with an expected catch over 50 tonnes in Subarea 48.3. The USA also notified (CCAMLR-XIX/BG/18) its intent to participate in the crab fishery in Subarea 48.3 in accordance with Conservation Measure 181/XVIII.

4.70 The Working Group recalled its discussion of UK research vessel activity involving pot fishing for *D. eleginoides* in Subarea 48.3 last year (SC-CAMLR-XVIII, Annex 5, paragraphs 4.28 to 4.31) and subsequent discussion by the Scientific Committee (SC-CAMLR-XVIII, paragraphs 8.3 to 8.5). It had been made clear that any pot catches of *D. eleginoides* should be counted against the *D. eleginoides* catch limit in Subarea 48.3. Similarly, any retained catch of crabs should be counted against the crab catch limit for Subarea 48.3. The Working Group strongly reiterated these views.

4.71 Dr Parkes drew attention to the analyses of the UK pot fishing research contained in WG-FSA-00/23. He noted that pot fishing had proved to be an effective method for catching *D. eleginoides* with no incidental mortality of seabirds. The size frequency of *D. eleginoides* taken in pots was almost identical to those for longlines. Pot fishing was, however, associated with a substantial by-catch of crabs. A very high proportion of the crab by-catch was undersized. These were discarded and nominally do not count against the crab catch limit. While evidence suggests that most discarded undersized crabs survive, there certainly is some discard mortality. Data in

WG-FSA-00/23 were used to estimate crab discard mortality (paragraph 3.98), and account should be taken of this when assessing crab stock status.

4.72 Dr Parkes further indicated that there was some evidence that large crab catches were associated with lower catches of *D. eleginoides*. The pot fishing research planned for the coming season was aimed at reducing the crab by-catch as much as possible.

4.73 The Working Group noted that both Uruguayan notifications should be treated as notifications of intended participation in established fisheries, rather than as exploratory fisheries. The Working Group regretted that it had not been possible for a Uruguayan scientist to participate in the current meeting and provide further information about the proposed pot fishing activities. However, it welcomed the fact that a CCAMLR scientific observer will be carried on board the vessel.

4.74 Further discussion of these notifications was referred to the subgroups dealing with *D. eleginoides* (paragraphs 4.108 to 4.155) and crabs in Subarea 48.3 (paragraphs 4.238 to 4.244).

4.75 The Republic of Korea and the UK submitted a notification (CCAMLR-XIX/8) for an exploratory jig fishery for *Martialia hyadesi* in Subarea 48.3.

4.76 Dr Miller noted that, in accordance with Conservation Measure 148/XVII, it was mandatory for VMS to be installed on the exploratory fishing vessel. He also noted that Conservation Measure 183/XVIII requires the presence of a CCAMLR scientific observer.

Advice to the Scientific Committee

4.77 Despite considerable efforts, last year the Working Group had found itself unable to carry out the assessments needed to provide reliable advice on precautionary catch limits for new and exploratory fisheries, using the data and assessment methods currently available. In reaching this conclusion, the Working Group had further agreed that reliable assessments would not be possible for subareas and divisions for which new or exploratory fisheries had been notified until considerable further data pertaining directly to these areas became available. For the 1999/2000 season, with the exception of Subarea 88.1 which was considered separately, very little new information was available. In consequence, the Working Group agreed that it would only attempt an assessment for the exploratory fishery notified for Subarea 88.1 at this meeting.

4.78 For each of the remaining subareas and divisions subject to notifications for new and exploratory fisheries, the Working Group was unable to provide advice on appropriate levels of precautionary yields that should apply to whole subareas or divisions. It agreed, however, that catch and effort expended in exploratory fisheries should continue to be governed by the measures contained in Conservation Measure 182/XVIII, which include, *inter alia*, that fishing in each fine-scale rectangle shall be restricted to one vessel at a time, and that fishing in each fine-scale rectangle shall cease when the reported catch reaches 100 tonnes.

4.79 The nine notifications for new or exploratory longline or trawl fisheries for *Dissostichus* spp. in the 2000/01 season pertained to 16 subareas or divisions. Table 24 summarises the numbers of vessels, gears and intended catches by country and area.

4.80 Subareas 48.1, 48.2 and 58.7 are covered by conservation measures (72/XVII, 73/XVII and 160/XVII respectively) prohibiting the taking of finfish until such time as a survey of stock biomass is carried out, its results reported to and analysed by the Working Group, and a decision that the fishery be reopened is made by the Commission based on the advice of the Scientific Committee. In the absence of such surveys, the Working Group recommended that no exploratory fishing should take place in these subareas. For Subarea 58.7, clarification is needed of precisely what activities are intended in the French notification.

4.81 Subareas 48.3 and 48.4 are the subject of established fisheries and/or catch limits. It is therefore inappropriate for exploratory fisheries for *Dissostichus* spp. to take place in those subareas. The notifications should be taken as notifications of intent to participate in these established fisheries.

4.82 For Divisions 58.5.1 and 58.5.2, the Working Group noted that last year the Scientific Committee had advised that the amount of fishable grounds in divisions that lie outside national EEZs is very small, and that new or exploratory fisheries in those areas are unlikely to be viable (SC-CAMLR-XVIII, paragraph 9.50). Based on this advice, the Commission had agreed that the proposed exploratory fisheries in these divisions would be unviable (CCAMLR-XVIII, paragraph 7.23).

4.83 As is clear from Table 25, not all notifications specified the intended catch in each subarea or division. Furthermore, even where these were specified, different notifications took different approaches to determining them. In the South African and Argentinian notifications, for example, attempts were made to specify realistic levels of intended catches, bearing in mind the expected times to be spent in the areas, the expected catch rates, and the trade-off between the needs for research and for assessing the viability of the fisheries. In other cases, the intended catch was simply stated to be less than or equal to the current precautionary catch limit for the area. While this inconsistency remains, it is difficult to assess the likely effects of several new or exploratory fisheries operating in the same area in the same season.

4.84 Similarly, very few notifications specify the number of vessels that will operate in individual subareas or divisions. Again, this impedes evaluation of the levels of effort that may be applied in subareas and divisions for which there are multiple notifications.

4.85 In all but one of the other subareas and divisions in Table 25, more than one new or exploratory fishery notification has been made, and in six subareas or divisions, three or more notifications have been made. In Division 58.4.4, six notifications have been made, involving up to a maximum of 14 vessels. If the catch limit for this division remains the same as for last season, and all notified fisheries are activated, then this would imply approximately 60 tonnes per notified fishery. Clearly there is a potential for the catch limit to be taken in a relatively short time and for the catch limit to be overshot.

4.86 A further practical problem arises when there are multiple exploratory fisheries operating in a subarea or division. Conservation Measure 182/XVIII requires that fishing in any fine-scale rectangle shall cease when the reported catch reaches 100 tonnes, and that only one vessel at a time may fish in any fine-scale rectangle. Currently, catches within SSRUs are monitored by the Secretariat via the five-day reporting system. The Working Group agreed that this system would in principle be capable of ensuring appropriate compliance with Conservation Measure 182/XVIII, provided the five-day reporting system operates accurately and in a timely manner.

4.87 It is clear from CCAMLR-XIX/BG/5, however, that the timeliness of five-day report submissions last season was not very good. If a similar performance occurs next season, the five-day reporting system may not be sufficient to monitor accurately compliance with the requirements of Conservation Measure 182/XVIII with respect to SSRUs, when more than one exploratory fishery is operating in an area. In principle, the presence of VMS on each vessel would allow accurate monitoring of vessel positions, but without a central coordinating body it is difficult to see how this information could be used.

4.88 The Working Group also discussed the appropriateness of the 100 tonne catch limit per SSRU in light of the intent of Conservation Measure 182/XVIII to ensure that exploratory fishing occurs over as wide a geographic area as possible. Table 26 summarises the frequency distribution of catches per SSRU over the last four seasons. In most cases, the reported catches per SSRU have been less than 50 tonnes and catches over 50 tonnes have only been recorded in Subarea 88.1. Obviously, a reduction of the 100 tonne limit per SSRU would encourage a wider geographical distribution of effort. However, the Working Group believed that this issue needed further consideration, and agreed that it should be reviewed again at its next meeting.

4.89 Both longline and trawl fisheries have been notified for Divisions 58.4.1, 58.4.2 and 58.4.3. As these two fishing gears have different selectivities, last year the Working Group had recommended that precautionary catch limits should be apportioned differentially for these gears.

4.90 Recognising that different selectivities need to be taken into account, the Working Group agreed that it was also important to give priority to those exploratory fisheries which were more likely to provide information which would enhance the ability to conduct assessments in the future. Historical experience suggests that this has occurred more frequently with trawl fisheries than with longline fisheries, especially when these have involved the conducting of research surveys, though useful information has been gathered by the exploratory longline fishery in Subarea 88.1. Another factor that favours trawl over longline exploratory fisheries at the early stages of their development is that trawl fisheries take a wider size range of fish and they are thus more likely to produce information on growth and natural mortality.

4.91 Another factor that needs to be taken into account when comparing trawl and longline exploratory fisheries is the extent to which each is associated with incidental mortality and with other ecosystem effects. Generally, trawl fisheries cause lower incidental mortality than longlines, though occasional instances of substantial incidental mortality have occurred with trawls (paragraphs 8.4 and 8.6). On the other hand, trawl fisheries involving moderate to high levels of effort in restricted areas can have substantial effects on the seabed and associated benthic communities.

4.92 The potential fishing areas in Divisions 58.4.1 and 58.4.3 are largely confined to the Elan and BANZARE Banks. The Working Group agreed that separate precautionary catch limits should be set for these two banks, rather than for the two divisions. It also recommended that exploratory fishing activities in these divisions should be restricted to these banks only. The evidence from previous trawl surveys on these banks is that the abundance of fish is probably low. Accordingly, the Working Group recommended that precautionary catch limits for these banks should be set as follows:

Elan Bank:	trawl fishing – 145 tonnes; longline fishing – 145 tonnes
BANZARE Bank:	trawl fishing – 150 tonnes; longline fishing – 150 tonnes.

4.93 For Division 58.4.2, last year a precautionary catch limit of 500 tonnes was set for the exploratory trawl fishery for *Dissostichus* spp. notified by Australia. This year, an exploratory trawl fishery and an exploratory longline fishery have been notified for this division. The Working Group recommended that the total precautionary catch limit set for *D. eleginoides* for this division should be split equally between the trawl and longline fisheries, since it is expected that they will be fishing on the same part of the stock in this division.

4.94 The best available estimate of yield for *D. mawsoni* in Subarea 88.1 is 3 616 tonnes.

4.95 The Working Group noted that there is greater uncertainty in this assessment than that for Subarea 48.3 and some level of discounting is still appropriate (paragraph 4.35).

4.96 The Working Group agreed that further collection of data from research sets would be valuable for the assessments next year (paragraph 4.36).

4.97 For Subareas 48.6, 58.6 and 88.2 and Division 58.4.4, precautionary catch limits for *Dissostichus* spp. had been set at CCAMLR-XVIII. The Working Group noted that during the 1999/2000 season, Conservation Measure 172/XVIII prohibited directed fishing for *Dissostichus* spp. in subareas and divisions, for which no specific conservation measures had been adopted.

4.98 The Working Group agreed that, until it had gained more information on areas currently fished for *Dissostichus* spp. under new and exploratory fishery regimes and more experience with the operations of SSRUs, it would be inappropriate at present to open previously unfished areas to fishing for *Dissostichus* spp., or to reopen areas that have not been fished for *Dissostichus* spp. in recent years. It therefore recommended that Subarea 48.5, the Antarctic coastal part of Division 58.4.1, and Subarea 88.3 be closed to directed fishing for *Dissostichus* spp.

4.99 In the Uruguayan exploratory fishery during 1999/2000 in Division 58.4.4, 55 tonnes of *D. eleginoides* were taken outside designated SSRUs. As catches outside SSRUs do not have the potential to trigger research activities regardless of their size, the Working Group recommended that the entire area of Division 58.4.4 currently not contained in designated SSRUs be designated as an SSRU.

4.100 The New Zealand notification for an exploratory fishery in Subarea 88.1 (CCAMLR-XIX/17) included an intended catch of *M. carinatus* of up to 300 tonnes south of 65°S. As discussed in paragraphs 4.58 to 4.62, the by-catch provisions of Conservation Measure 182/XVIII had been found to be too restrictive by the fishers. The Working Group noted that Conservation Measure 182/XVIII in fact did not specify a total by-catch limit for *Macrourus* spp., and that the appropriateness of the trigger levels in this conservation measure also needs consideration. The Working Group encouraged Members to submit an assessment of *Macrourus* spp. at its next meeting.

4.101 The 50 tonnes maximum catch specified in Conservation Measure 64/XII for scientific research activities, below which certain exemptions pertain and no detailed research plan need be submitted for review, applies regardless of the species to be taken or the gear to be used. Conservation Measure 182/XVIII, which applies to exploratory longline or trawl fisheries for *Dissostichus* spp., triggers specific research activities whenever the catch in a SSRU exceeds 10 tonnes. These two conservation measures are therefore inconsistent in their application to *Dissostichus* spp.

4.102 The Working Group recommended that the application of Conservation Measure 64/XII to research surveys for *Dissostichus* spp. should be amended so that the exemptions only apply to catches up to 10 tonnes. Research plans for research vessel activity involving catches of *Dissostichus* spp. exceeding 10 tonnes should be subject to a full review by WG-FSA and the Scientific Committee. The Working Group agreed that, as amended, Conservation Measure 64/XII should continue to apply to all gears (e.g. including pot fishing for *Dissostichus* spp.).

Assessed Fisheries

Dissostichus eleginoides

4.103 Methods for assessing *D. eleginoides* were established by WG-FSA in 1995 (SC-CAMLR-XIV, Annex 5, including Appendix E). The procedure for assessing long-term annual yields was modified this year to allow for recommendations made during the WG-FSA meeting in 1999. A method of incorporating a time series of recruitments to the GYM was introduced (WG-FSA-00/39) and an updated model made available to the Working Group. Additionally, a procedure of introducing estimated trends of standardised CPUE into results of the GYM was used during assessment (paragraphs 3.121 to 3.125). The Working Group focused primarily on determining trends in CPUE, estimating recruitment indices, natural mortality, growth parameters, and assessing long-term annual yields using the GYM. These were the primary components of the work this year.

4.104 The potential application of the Age Structured Production Model (ASPM) approach for *Dissostichus* spp. stock assessment was described in WG-FSA-00/46. WG-FSA welcomed the introduction of new quantitative assessment techniques such as the ASPM, and encouraged progress toward the testing and potential application of alternative quantitative tools for *Dissostichus* spp. assessment.

4.105 With respect to the ASPM approach, the Working Group felt that this model may have a useful role in future assessments. However, the Working Group expressed concern over several of the estimated parameters presented in WG-FSA-00/46 and the resulting effect on biomass. In particular, the estimate of the steepness parameter h that describes stock recruitment was 0.292, which is unrealistic for any fish species. For most stocks, values of h will likely fall within a range of 0.75 to 0.95. In addition, there are other parameters estimated by the ASPM model, such as the autoregressive parameter, that require further study as to the effect on *Dissostichus* spp. biomass estimates. A sensitivity analysis of ASPM model parameters was encouraged and the Working Group recommended that this analysis should be carried out prior to using this model for any assessment purposes.

4.106 Analysis of CPUE data was undertaken for Subarea 48.3 where new longline haul-by-haul data were made available. The details and extensions of the analysis are discussed under these subareas.

4.107 Assessments of long-term annual yield were reviewed for Subarea 48.3 and Division 58.5.2. Several input parameters to the GYM were reassessed, and new estimates of parameters were generated for both Subarea 48.3 and Division 58.5.2. The methods for estimating the parameters were those used in the Workshop on Methods for the Assessment of *Dissostichus eleginoides* (WS-MAD) held in 1995 (SC-CAMLR-XIV, Annex 5, Appendix E), and methods presented in WG-FSA-00/52.

South Georgia (Subarea 48.3)

4.108 The catch limit of *D. eleginoides* in Subarea 48.3 for the 1999/2000 season was 5 310 tonnes (Conservation Measure 179/XVIII) for the period 1 May to 21 July 2000. A total of 16 licensed vessels from Chile, Republic of Korea, South Africa, Spain, Ukraine, UK and Uruguay fished during the season. The fishery was closed on 21 July 2000 when the reported catch in the longline fishery reached 5 210 tonnes (CCAMLR-XIX/BG/5) and 17 tonnes had been reported in the experimental pot fishery (see also pagraph 3.58).

Standardisation of CPUE

4.109 Haul-by-haul catch and effort data for Subarea 48.3 submitted on C2 forms (fine-scale data) for the 1991/92 to 1999/2000 fishing seasons have been supplemented by historical data for Ukrainian longline vessels operating in Subarea 48.3 in the seasons 1985/86 to 1988/89 and 1990/91 (WG-FSA-00/33). GLM analyses were conducted using this extended dataset, except for data for the first season (1985/86), when fishing had been restricted to very shallow depths (mainly less than 300 m). Last year, when analysing CPUE data for the seasons 1991/92 to 1998/99, the Working Group had agreed that only data for the winter months (March to August inclusive) would be used in the analyses. This year, given the results of analyses of an extended CPUE dataset (seasons 1985/86 to 1998/99) reported in WG-FSA-00/33, data for all months were included in the analyses.

4.110 CPUE in kg/hook was used as the response variable, and nationality, season, month, area (East South Georgia, NW South Georgia, South Georgia, West Shag Rocks and Shag Rocks) (SC-CAMLR-XVIII, Annex 5, Figure 5), depth and bait type were considered as predictor variables. Following the suggestion last year (SC-CAMLR-XVIII, Annex 5, paragraph 4.113), depth was coded as a factor with four levels (0–500 m, 500–1 000 m, 1 000–1 500 m, 1 500 m and above), in order to allow interactions of other predictor variables and depth to be investigated. GLM analyses were conducted on positive CPUE data only, with an adjustment for zero catches being made afterwards. This year, because of the frequency of hauls for which catch numbers were not reported, no analyses were conducted using CPUE in numbers/hook as the response variable.

4.111 The basic approach used to fit the GLMs was the same as that used last year, with a square root transformation being applied and a robust form of GLM fitted. In addition to fitting models with each of the listed predictor variables as main effects, models incorporating season–nationality, season–month, season–depth, nationality–depth and nationality–month interactions were also fitted. In contrast to the analyses conducted last year, the only statistically significant effects were nationality, season and depth. None of the remaining main effects or interactions even approached significance. A QQ-plot of residuals from the fitted model (Figure 5) revealed some departures from the assumed error model, but these were not sufficient to reject the fit. However, the Working Group noted that the extended dataset remained very unbalanced, with fishing in the early seasons (1986/87 to 1992/93) being carried out primarily in summer months by eastern European vessels, and in the later seasons (after 1993/94) mainly in winter months by fleets of different nationalities (largely South American). This implies that some doubt must still remain about how well the relative levels of standardised CPUEs in early and later seasons have been estimated.

4.112 The standardised time series of CPUEs in kg/hook is plotted in Figure 6 and given in Table 27. The standardisation is with respect to Chilean vessels fishing at depths of 1 000–1 500 m. This time series has also been adjusted for the presence of hauls with zero catches, by multiplying the standardised CPUEs predicted from the GLMs by the proportions of non-zero catches given in Table 28. Adjusted, standardised catch rates have fluctuated around a relatively constant level between 1986/87 and 1994/95. As was seen last year, the adjusted standardised catch rates declined substantially between 1994/95 and 1996/97, but they have increased each season since then.

4.113 Examination of the distributions of depths fished in Subarea 48.3 by season and area revealed that the trend in recent seasons towards increased longline fishing at shallow depths (300–700 m) has continued in the 1999/2000 season, particularly to the north of Shag Rocks. Histograms of depths fished by season are shown in Figure 7, and by area around South Georgia for the 1998/99 and 1999/2000 seasons in Figures 8 and 9. When these distributions are grouped by different levels of CPUE, it is clear that the shallow-depth fishing contributed substantially to the overall CPUEs (Figure 10).

4.114 The Working Group examined the (full-season) catch-weighted length frequencies by season and area (Figures 11 to 13). These figures indicate that in the last three seasons the modal length around South Georgia was lower than in previous seasons. Around Shag Rocks, there was a notable decline in modal length in the last three seasons and also a notable reduction in the spread of the length-frequency distributions. However, the length frequencies for depths above and below 900 m at Shag Rocks were very similar.

4.115 The Working Group updated the weighted length-frequency plots for *D. eleginoides* caught in the longline fishery in Subarea 48.3. The plots are split into three series: for South Georgia (Figure 11), for Shag Rocks <900 m (Figure 12), and for Shag Rocks >900 m (Figure 13). The length frequencies for Shag Rocks <900 m show that the mean length in the catches was 87 cm in 1996 and 1997, but dropped to 77 cm in 1998. In 1999 and 2000 the mean lengths in the catches increased slightly to 79 cm and 81 cm respectively.

4.116 A change in the mean length in catches like this is consistent with the recruitment of a new large year class to the fishery. According to the von Bertalanffy length–age relationship for this stock presented during 1999 (SC-CAMLR-XVIII, Annex 5, Figure 21), 7-, 8- and 9-year-old fish would be about 75, 82 and 90 cm respectively. It is, however, possible that a large year class may have slower growth than average due to competition for food, and the year class that has recruited to the fishery in 1998 may be from 1991 or one of the preceding year classes.

4.117 WG-FSA in 1999 (SC-CAMLR-XVIII, Annex 5, paragraph 4.119) noted that smaller fish were contributing more to the catches than in the past, and that the selectivity of fish was likely to be changing. A change in the size composition of the catches may be due to a change in the size composition of the stock, to a change in the fishing pattern, or both. A change in the size composition of the stock is possible or even likely, as indicated above. As the smaller fish tend to be found in shallower water than the older fish (Agnew et al., 1999), it is possible that the fishery may have moved into shallower depths in order to target the newly recruited and smaller fish, which may have given higher catches.

Determination of Long-term Annual Yields using the GYM

4.118 The analysis of long-term annual yield was updated with recent catches taken from Subarea 48.3, including the new recruitment estimates from the 2000 UK survey, the use of the recruitment time series and standardised CPUE estimates into the GYM analysis.

Growth, Mortality and Fishing Selectivity

4.119 Estimates of the von Bertalanffy parameters were obtained from a reanalysis conducted in 1999 (SC-CAMLR-XVIII, Annex 5, paragraph 4.116) of length-at-age data first used in 1995. The values of L_∞, k and t_0 were estimated by combining the lengths at age from two sources: otoliths collected in the UK survey around South Georgia in January and February 1991; and an age–length key compiled by Aguayo (1992) from readings of scales taken from the commercial longline fishery during February to May 1991. The estimated parameters used were L_∞ = 194.6 cm, k = 0.066.yr^{-1} and t_0 = -0.56 years.

4.120 The Working Group discussed the findings of WG-FSA-00/28 which concluded that scale readings likely provide underestimates of age. The Working Group noted that estimates of growth parameters based on otoliths from longline catches were provided in WG-FSA-00/44. However, researchers and custodians of the raw data felt that the information was not ready for release until full review and documentation. Thus, the Working Group had no access to the data and felt that it was premature to incorporate this information for analysis. Therefore, the values of L_∞, k and t_0 used during the 1999 assessment were considered the best available estimates for assessment purposes.

4.121 Although the estimates of growth parameters were carried forward from the previous assessment, the uncertainties contained within these growth parameters greatly concerned the Working Group, as the underlying foundation of the modelling approaches used are greatly affected by these parameters. This led to the examination of alternative approaches regarding growth. These approaches are described in paragraphs 4.130 to 4.142. The Working Group stressed that work to refine and validate age-determination methods, including the validation of annual formation of rings in otoliths, is of the highest priority for future assessments.

4.122 The Working Group expressed concern that *D. eleginoides* exhibits considerable difference in size between the sexes. Female fish grow to a larger maximum size and mature at a greater length than males. The growth curve used as one of the basic inputs to the assessment is based on data from 1991, combined for both sexes. The difference in growth pattern between the sexes is thus not taken into account in the assessment.

4.123 With the present selection pattern showing 50% recruitment to the fishery at 67 cm length, female *D. eleginoides* may be subject to fishing for several years before first spawning (length at 50% maturity is 93 cm). As recruitment depends on the number and size of mature females, the current fishing pattern may present a threat to the stock that is not reflected in the current assessment. The Working Group considers that high priority should be given to the construction of separate growth curves for males and females of *D. eleginoides* in Subarea 48.3, and integration of these data into the assessment model.

Trends in Selectivity

4.124 There was new information on longline selectivity patterns presented to the Working Group. An updated analysis of selectivity in size to the fishery for *D. eleginoides* in Subarea 48.3 was conducted with the purpose of obtaining a more accurate estimate of the retention at 50%, the size at the beginning of exploitation and the size at which the species is totally recruited to the fishery. The available information for the analysis was the length densities of captures (combined sexes) for the years 1995, 1997, 1998, 1999 and 2000, and the parameters of growth and natural mortality used by WG-FSA in 1999.

4.125 The methodology was based on analysis of the capture curve. Catch curves are informative in that their right side in relation to the applied levels of total mortality follow the same exponential decline to that in the population (totally recruited individuals). The right side of the catch curve, assuming exponential decline, provides information regarding the levels of partial recruitment to size, since the capture probability changes as a function of size due to fishing selectivity, as well as depth, spatial and temporal distribution of the resources.

4.126 The methodological procedure (Pauly, 1984) consisted of extrapolating the catch levels to the sizes that should have been present if those sizes or ages have been totally recruited, under the hypothesis of the exponential decline of cohorts. The ratio between the observed capture and the estimated capture as fully recruited gives an estimate of the pattern of exploitation or selective effect on size. The estimated selectivity was then adjusted to the classic ogive curve, where the size at 50% of recruitment and the size at the beginning of exploitation were estimated.

4.127 The patterns of selectivity based on this approach are shown in Figure 14 and the resulting selectivity estimates by season in Table 29. These results show that the size at 50% selectivity for the year 2000 was 74 cm, the 5% selectivity was 66 cm and the 95% selectivity was 83 cm. The Working Group noted that the selectivity of fish was likely to be changing such that smaller fish were contributing more to the catches than in the past. Evidence that supports this contention is demonstrated in Table 29, where the size at 50% selectivity was 91.8 cm in 1995, and has decreased each year to the current 50% level of 74 cm.

4.128 The Working Group thought this approach was useful in detecting changes in selectivity between years. However, at this stage selectivity patterns between years cannot be fitted in the GYM. The Working Group encouraged further examination of this approach for next year's assessment, and agreed to retain values used in previous years (SC-CAMLR-XVIII, Annex 5, paragraph 4.118). These estimates indicated a size at 50% selectivity of 67 cm, with selection of fish into the fishery occurring greater than 55 cm and full selection at greater than 79 cm.

4.129 Selectivity patterns of *D. eleginoides* captured in pots were considered by the Working Group. Based on a comparison of the length-frequency distributions of *D. eleginoides* from the experimental pot fishery and longline fishery presented in WG-FSA-00/23, it was concluded that the selectivity of the longline and pot gear types does not appear substantially different. Therefore, for assessment purposes, catches from both methods were combined.

Recruitment and Natural Mortality

4.130 As for previous meetings (1995, 1997 and 1999), the Working Group analysed length-frequency data from trawl surveys expressed in terms of density (numbers/km^2) using the CMIX program (de la Mare, 1994) (termed 'length-density' or 'mixtures') (SC-CAMLR-XVIII, Annex 5, paragraphs 4.121 to 4.135), in order to generate estimates of recruitment to the population of *D. eleginoides* in Subarea 48.3. An important element of decomposing length-density data into densities of cohorts is to identify how many cohorts are likely to be present in the sample and to set length ranges in which the mean length of each cohort would be expected to be found. To this end, length-at-age relationships are used as a guide for setting these initial conditions in an analysis. The quality of the results is judged according to how well the expected densities from the analysis compares to the observed length densities.

4.131 Last year a reanalysis of the length densities was undertaken to help reconcile the existing length-at-age growth model with the length-density data from surveys (SC-CAMLR-XVIII, Annex 5, paragraphs 4.116 and 4.122). This analysis is referred hereafter as 'high k analysis'. The growth parameters used last year were derived from a reanalysis of length-at-age information used in 1995, which had been based on age readings from both otoliths and scales (SC-CAMLR-XVIII, Annex 5, paragraphs 4.116 and 4.117). While many cohorts appeared well resolved by these analyses, some of the expected lengths at age arising from the mixtures did not coincide well with the length-at-age curve (Figure 15) and some peaks in the observed length densities were not accommodated in the analysis. Also, the lengths at age may have been underestimated because scale readings were used to determine age for older fish and these are known to provide underestimates of age (SC-CAMLR-XVIII, Annex 5, paragraph 4.117 and WG-FSA-00/44). As a result, more cohorts may be present in the range of length densities than expected previously at the workshop in 1995.

4.132 The length-density data were reanalysed at this meeting allowing for the presence of more cohorts in the dataset. The expected mean length of cohorts was determined by using the growth rate, k, from the Heard Island length-at-age relationship estimated last year (k = 0.041) but keeping the other von Bertalanffy parameters the same as those used previously (L_∞ = 1 946 mm, t_0 = -0.21), hereafter called the 'low k analysis'. The results of the new fits to the survey data are shown in Figure 16.

4.133 Length-density distributions were extracted from a total of 14 trawl surveys in Subarea 48.3 (Table 30). However, data from only 12 surveys were used in the final analyses. Two new surveys were conducted during 2000 in Subarea 48.3, one by the UK in January–February and another by Russia in February.

4.134 Analysis of the survey data showed that in some cases, whilst catches of *D. eleginoides* were recorded, very few fish had been measured. In the case of the *Anchar* survey in 1990, the total catch was 3.7 tonnes, but only 210 fish had been measured throughout the survey. A large proportion of the catch (2.7 tonnes) was taken at two stations where only 34 fish were measured in total. The Working Group considered that due to the small sample sizes relative to the size of the catch, the length-density estimates might not provide a good representation of the size distribution of young fish in that year, particularly in view of the extent of the extrapolation required. It was therefore decided to omit this survey from the analysis. This was also the case for the most recent Russian survey where a total of 118 kg of *D. eleginoides* was caught and only 62 fish measured. A mixture analysis was attempted on this dataset but the sample size was too small and the mixtures could not be resolved. Thus, this survey was also excluded from the analysis.

4.135 There were also several hauls in some surveys where catches of *D. eleginoides* were recorded, but no fish were measured. Because length densities measure absolute numbers of fish in a given area, the Working Group agreed that even though length distributions for these catches were not available, it was necessary to include these fish in the analysis, in order that the estimates of recruitment would reflect the total abundance of fish in the survey catches. This was achieved using the same methodology as last year (SC-CAMLR-XVIII, Annex 5, paragraph 4.126).

4.136 The densities of fish up to age 10 were estimated for each survey following the procedure used at last year's meeting (SC-CAMLR-XVIII, Annex 5, paragraphs 4.127). Similarly, length densities for separate strata were pooled according to the method described in paragraph 4.127 of SC-CAMLR-XVIII, Annex 5. The area under each fitted distribution component is assumed to estimate the density of the corresponding age class. The assignment of nominal ages to mixtures assumed a birthday of 1 November.

4.137 The densities derived from the 1999 mixture analyses are given in Table 31, including results from the 2000 UK survey. For the 'low k analysis', the results of the fitting process are illustrated in Table 32 and Figure 16. The graphs in Figure 16 illustrate the observed length densities, the fitted mixtures and the age of the cohort. The resulting densities for each age are given in Table 32. In all cases, the positions of the modes of the fitted mixtures were consistent with the growth rate expected from the new value of k. Differences between sums of observed expected densities were generally small and the fits to the data were considered to be good. The only survey for which the fit to the data was poor was the UK survey in January 1991. Although the expected densities were much less than the observed densities, the respective modes seemed to coincide. In all cases, the sum of the expected densities at age were adjusted so that the sum of the densities across ages equalled the sum of the observed densities (SC-CAMLR-XVIII, Annex 5, paragraph 4.130). These were then scaled up to give estimates of total abundance using the total seabed area for 50–500 m of 40 993.3 km^2 (Everson and Campbell, 1990).

4.138 The Working Group noted some consistency in the patterns of age modes moving through the population sampled by the survey, but also noted that in some cases, apparently strong year classes in one year did not appear in the samples the following year. This was a problem highlighted last year (SC-CAMLR-XVIII, Annex 5, paragraph 4.129).

4.139 In 1999 a range of estimates of M had been used based on M = 2k (0.13 yr^{-1}) to M = 3k (0.20 yr^{-1}) (SC-CAMLR-XVIII, Annex 5, paragraph 4.120). As no direct estimates of M had been obtained prior to this meeting, the Working Group agreed to use the method in WG-FSA-00/52 (paragraphs 3.130 and 3.131) to estimate M along with estimates of recruitment.

4.140 The estimates of abundance at age were then grouped into year classes. Cohorts with two or more estimates of abundance were used for assessing recruitment strength at age 4 (the first age in the assessments) and natural mortality. The value of M estimated using this procedure was used to project cohorts to age 4 for which only one estimate was available.

4.141 The Working Group considered the two time series of recruitments estimated from mixture analyses (paragraphs 4.131 and 4.132). The estimate of natural mortality using either series of cohorts were higher than expected for *D. eleginoides*, between M = 0.25 yr^{-1} and M = 0.35 yr^{-1}. The Working Group agreed that some of the estimates of cohort strength were much higher than the expected magnitude for the given cohorts. As a result, it was agreed to exclude these observations from the respective series for the purpose of estimating natural mortality. This resulted in one of the eight cohorts being excluded from the 'high k analysis', and two of the remaining seven had one less observation. For the 'low k analysis', three out of the 10 cohorts had one less observation and one had two less. The estimates of recruitment from this analysis remained largely unaltered after exclusion of the respective observations. Thus, the estimates of recruitment from the full analysis were used in the recruitment series.

4.142 The resulting estimates of natural mortality were M = 0.196 for the 'high k analysis' and M = 0.082 for the 'low k analysis'. These estimates are in the same ranges used in the South Georgia and Heard Island assessments last year. The Working Group agreed to use these estimates in determining the age-4 recruitment of cohorts for which only one observation was available. The respective series of age-4 recruits are presented in Table 33, along with the mean and standard deviations used for determining the parameters of a lognormal recruitment function for use in stock projections using the GYM.

Assessment

4.143 In light of the new mixture analyses available and various assumptions regarding growth, recruitment and natural mortality, the Working Group conducted five alternative approaches for using this information as inputs for assessment of long-term yield in Subarea 48.3. The alternatives were:

(i) recruitment estimates and growth parameters from the 'low k analysis' (2000 mixture analysis) with mortality ranging from M = 0.082–0.196;

(ii) recruitments estimates and growth parameters from the 'high k analysis' (1999 mixture analysis) with mortality ranging from M = 0.082–0.196;

(iii) the 'high k analysis' using an internally consistent fixed M of 0.196;

(iv) the 'low k analysis' using an internally consistent fixed M of 0.082; and

(v) the 'high k analysis' with the range of M values used in last year's assessment (M = 0.132–0.198).

4.144 The Working Group considered that option (v) was the best approach because the upper bound of M was almost identical to that predicted by the 'high k analysis', and the lower bound of M was more consistent with the estimate of k from the 1999 growth parameters. Option (i) was rejected because the upper bound of M was incompatible with the low value of k. Option (ii) was rejected because the lower bound of M was inconsistent with the high value of k. Options (iii) and (iv), while having internally consistent parameters, did not allow for uncertainty in the estimate of natural mortality.

4.145 The Working Group therefore agreed to use option (v) for the final assessment of long-term yield. The other options were examined by the Working Group as an analysis of the sensitivity of the GYM to different estimates of growth, M and recruitment.

4.146 The Working Group noted that the results of yield from these assessments are sensitive to the estimates of natural mortality used in the projections, notably that lower estimates of M would result in an increase in yield. Given this and the need for growth parameters (k) and M to be approximately consistent, the Working Group agreed that option (v) was appropriate to use as the basis of this year's assessment until uncertainties in growth parameters are considered during the intersessional period. The range of M applied is consistent with a range of 2 to 3 times k. This range coincided with the greater estimate of M from the 'high k analysis'. The Working Group noted that the estimate of yield was at the lower end of the range considered in these options.

4.147 The input parameters for the GYM are shown in Table 34, giving the updated parameters as derived above. As in previous years, 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 4 120 tonnes. The median escapement for this level of catch was 0.546.

Integration of CPUE into Assessment

4.148 The Working Group agreed that the procedure described in WG-FSA-00/39 for integrating the time series of standardised CPUE for Subarea 48.3 into the long-term yield assessment should be used this year (see paragraphs 3.123 and 3.124). This procedure involved weighting each of the 1 001 trajectories simulated by the GYM by their likelihood with respect to the standardised CPUE time series, rather than giving them equal weights as was done in past assessments.

4.149 A histogram of weights assigned to each of the 1 001 trajectories is shown in Figure 17. Figures 18 and 19 illustrate the effects of the weighting procedure by showing the 50 simulated trajectories accorded the greatest weight and least weight respectively, along with the scaled standardised CPUE series. In each figure, the standardised CPUE has been scaled using the average estimated catchability coefficient for the respective sets of 50 simulations.

4.150 The effect of using this procedure was to increase the estimate of the long-term yield marginally to 4 180 tonnes, with an adjusted median escapement of 0.54.

4.151 This was an increase in yield on the unadjusted estimate because the trials given least weight are those with a generally upwards trajectory (in contrast to the CPUE) and are most likely to have started near to or below 0.2 of the pre-exploitation median spawning biomass (Figure 19). Given their reduced weight in the assessment, the probability of depletion for the unadjusted estimate is reduced, thereby allowing a slight increase in yield.

4.152 The estimated long-term annual yield is lower than in previous years primarily as a result of reduced recruitment in Subarea 48.3 estimated from the most recent survey and incorporation of the recruitment series in the GYM analysis.

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

4.153 The Working Group welcomed the considerable progress made at this year's meeting in refining the data inputs into the GYM, particularly with respect to incorporating a time series of recruitments and integrating the CPUE series into the assessment model. The Working Group reiterated its advice from last year that the development of methods to integrate different indicators of stock status into assessments is a high priority.

4.154 The Working Group agreed that the catch limit for the 2000/01 season should be 4 180 tonnes. Other management measures for *D. eleginoides* in Subarea 48.3 in the 2000/01 season should be similar to the 1999/2000 season.

4.155 Any catch of *D. eleginoides* taken in other fisheries (such as the pot fishery) in Subarea 48.3 should be counted against this catch limit.

South Sandwich Islands (Subarea 48.4)

4.156 Despite a catch limit of 28 tonnes for *D. eleginoides* (Conservation Measure 156/XVII), no fishing in this subarea was reported to the Commission during the 1999/2000 season. No new information was made available to the Working Group on which to base an update of the assessment. The Working Group was also unable at this year's meeting to consider the period of validity of the existing assessment.

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

4.157 The Working Group recommended that Conservation Measure 156/XVII be carried forward for the 2000/01 season. As last year, it was also recommended that the situation in this subarea be reviewed at next year's meeting with a view to considering the period of validity of the existing assessment.

Ob and Lena Banks (Division 58.4.4)

4.158 Ukraine has submitted data on three bottom trawl surveys of Ob Bank (Subdivision 58.4.4a) from 1980, 1986 and 1989, and four surveys of Lena Bank (Subdivision 58.4.4b) from 1980, 1982, 1986 and 1989. The target species of these surveys was *L. squamifrons*. By-catch species included *D. eleginoides, N. rossii* and *Nototheniops tchizh*. Along with the target species, measurements of all by-catch species were taken. A limited number of *D. eleginoides* were measured at Ob Bank, with a much larger quantity measured at Lena Bank.

4.159 Initial exploratory analysis suggests that there may be a sufficient data series from Lena Bank that could be used to estimate the level of recruitment of fish in Subdivision 58.4.4b. The available data do not appear to confirm any distinguishing characteristics between *D. eleginoides* captured at Ob and Lena Banks. Thus, it may be appropriate to combine the data series in future analysis. Because these data were presented to the Working Group at the time of the meeting, there was insufficient time to conduct any rigorous analysis of the survey data. The Working Group recommended that these data be analysed at the next WG-FSA meeting as this represents potentially valuable information for *Dissostichus* spp. stock status and assessment in Division 58.4.4.

Kerguelen Islands (Division 58.5.1)

4.160 According to STATLANT data reporting, the total catch in the fishery in Division 58.5.1 during the period 1 September 1999 to 31 August 2000 was 4 876 tonnes. Of this, about 2 615 tonnes were taken by longline, and 2 261 tonnes were taken by trawl. No assessments of long-term annual yields were undertaken this year.

Standardisation of CPUE in the Longline Fishery

4.161 Haul-by-haul catch and effort data for longline fisheries in Division 58.5.1 were made available to the Working Group this year. Using this information, a standardisation of CPUE was performed for the first time.

4.162 For the standardisation of CPUE at the Kerguelen Islands (Division 58.5.1), GLM analyses were performed using catch and effort data from longliners for the 1996/97 to 1999/2000 fishing seasons. Since this is the first time that longline CPUEs have been standardised in Division 58.5.1, CPUEs for all months (January–April and October–December inclusive) were used in the analyses. However, because of the experimental nature of this analysis, only the CPUEs in numbers/hook were analysed. Therefore, CPUE in numbers of fish per hook was defined as a response variable and fishing season, month, vessel, bait and mean depth of each haul were considered as predictor variables. For nationality, only the Ukrainian vessels were considered since the vessels of other nationalities did not provide sufficient information for this analysis. The analyses were conducted both on positive and zero values of CPUE.

4.163 The basic approach used to fit the GLMs was the same as that used for *D. eleginoides* in Subarea 48.3. Details of the methodology are provided in SC-CAMLR-XIV, Annex 5, Appendix G. However, some modifications were made in the CPUE data transformation and type of GLM analysis. These modifications were made to have a satisfactory distribution of residuals produced by the GLM functioning in S-plus software. A square root transformation of the response variable and a robust form of GLM analysis were carried out. The model used was GLM ((cpue) ~ fishing season + month + vessel + bait + mean depth), family = robust (quasi (link = sqrt, variance =

constant)). This resulted in a much more satisfactory distribution of residuals than any other transformations and probability functions searched over during this analysis (Figure 20). All predictive variables used in the model were highly statistically significant.

4.164 The time series of standardised CPUE indices (numbers/hook) from longliners in the Kerguelen Islands area is plotted in Figure 21 and given in Table 35. Results show that the adjusted and standardised catch rates appear to have increased between the 1996/97 and 1998/99 fishing seasons, while they decreased during the last season, from 1998/99 to 1999/2000.

Standardisation of CPUE in the Trawl Fishery

4.165 The total catch in the trawl fishery in Division 58.5.1 during the 1999/2000 season was about 2 261 tonnes. It was not possible to undertake an analysis of trawl CPUE data at this year's meeting because haul-by-haul data were not available for analysis.

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

4.166 The Working Group has no information from the French authorities on whether there will be trawling and longlining in their EEZ within this division in the 2000/01 season (1 September 2000 to 31 August 2001).

4.167 The Working Group discussed the role of WG-FSA in assessment and management decisions regarding Kerguelen. At present, WG-FSA is not able to conduct assessments or give advice concerning *D. eleginoides* population status or exploitation in Division 58.5.1. There is currently no capacity to revise the stock assessment because recent haul-by-haul data were not provided by France. The Working Group recommended that these data should be made available for assessment purposes, as well as any other information that would help determine the current stock status. In addition, the Working Group felt that the presence of a French scientist would be beneficial, and would greatly add to the understanding of the state of *Dissostichus* spp. stocks in Division 58.5.1.

Heard and McDonald Islands (Division 58.5.2)

4.168 The catch limit of *D. eleginoides* in Division 58.5.2 for the 1999/2000 season was 3 585 tonnes (Conservation Measure 176/XVIII) for the period 1 December 1999 to the end of the Commission meeting in 2000. The catch reported for this division at the time of the WG-FSA-2000 meeting was 3 008 tonnes. Two Australian vessels participated in the fishery.

Length Frequency

4.169 The Working Group examined the available catch-weighted length frequencies by season (Figure 22) for the Division 58.5.2 trawl fishery. These figures demonstrate that little change in modal length and spread of the distribution has taken place in the four seasons of available data.

Determination of Long-term Annual Yields using the GYM

4.170 The analysis of long-term annual yield was updated with the recent catches taken from Division 58.5.2, the new recruitment estimates from the 2000 Australian survey and the use of the recruitment time series in the GYM. Parameters for growth, maturity and fishing selectivity were carried forward from the 1999 assessment as no new information was made available to the Working Group.

4.171 Estimates of the von Bertalanffy growth parameters were carried over from the 1999 assessment of Heard Island. The Working Group noted that there is a continuing problem with the samples from Heard Island being comprised primarily of small fish. Because of this, the Working Group agreed to continue the use of the L_∞ estimated for South Georgia (194.6 cm). The estimates of k and t_0 were generated during the 1999 assessment by non-linear regression, and were 0.0414 yr^{-1} and -1.80 years respectively. The Working Group requested that further work be undertaken to clarify the growth model for this area.

4.172 The method for jointly estimating recruitment and natural mortality (paragraphs 3.130 and 3.131) was attempted for the survey series (four surveys in all) but only two cohorts had two observations, the rest had only single observations. Natural mortality was estimated to be less than 0. Consequently, the Working Group decided to apply the values for natural mortality from last year. The lower bound was consistent with the estimate of M for the slower growth rate determined in the assessment of Subarea 48.3 (paragraph 4.116). The Working Group agreed to use a range of M as for last year because of the uncertainty remaining in this parameter.

4.173 The recruitment series from 1999 was updated using the results of the 2000 survey described in WG-FSA-00/42. As fish greater than 450 mm are expected to be more widely distributed than the survey area, only the abundance of ages 3- and 4-year-old fish from this survey were used. The method for combining repeat estimates of cohorts was applied as for last year and the time series of recruitments is presented in Table 36. This resulted in an increase in the estimated abundance of the 1995 year class and the addition of the 1996 and 1997 year classes.

Assessment

4.174 The input parameters for the GYM are shown in Table 34, giving the updated parameters as derived above. As in previous years, 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 2 995 tonnes. The median escapement for this level of catch was 0.547.

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

4.175 The Working Group recommended that the catch limit by trawling for Division 58.5.2 in the 2000/01 season be revised to 2 995 tonnes, representing the long-term annual yield estimate from the GYM.

General Advice

4.176 In addition to the advice pertaining to specific fisheries, the Working Group noted that many of the parameters used in the assessments, such as growth and natural mortality, remain uncertain. In some cases, the results are sensitive to changes in M (paragraph 4.146). These uncertainties have been taken account of, where possible, in the assessment procedures, such as having ranges of natural mortality in the assessments of long-term annual yield. However, some decisions need to be made at different stages in the work of the Working Group. For example, the assessment of *D. eleginoides* in Subarea 48.3 required choosing between different options as a result of compiling new information (paragraph 4.143). In this case, the Working Group chose the option that had the greatest internal consistency amongst estimates of parameters while allowing for uncertainty in M. The resulting estimate of yield was lower than most of the other options.

4.177 The Working Group recognised that taking full account of such uncertainties in the assessment process will require further work and sensitivity analyses during the intersessional period. It considered this to be an urgent priority.

4.178 The Working Group noted that adjustment of the recruitment parameters in *D. eleginoides* assessments in Subarea 48.3 and Division 58.5.2 is expected from one year to the next in the early years of estimating strengths of recruitment from surveys. This is illustrated in Figure 23 which shows, for increasing numbers of observed year classes, the departure of estimates of mean recruitment from the true mean given a recruitment CV of 1.0. Only after estimates of abundance for 15 to 20 cohorts have been obtained can it be expected that recruitment parameters would not alter appreciably given the addition of new cohorts to the assessments. Even then, the estimate may be biased and result in some adjustments over time.

Champsocephalus gunnari

South Georgia (Subarea 48.3)

4.179 The 1999/2000 season for the commercial fishery for *C. gunnari* around South Georgia (Subarea 48.3) was split into two periods: the first from 1 December 1999 to 29 February 2000 and the second from 1 June 2000 to 30 November 2000. There was a closed season from 1 March to 31 May to protect spawning concentrations. The catch limit agreed by the Commission for the 1999/2000 season was 4 036 tonnes (Conservation Measure 175/XVIII). Several other conditions applied to this fishery, including overall by-catch limits (Conservation Measure 95/XIV), per haul by-catch limits, a provision to reduce the catch of small (<24 cm) fish, data reporting on a haul-by-haul basis, and the presence of a CCAMLR scientific observer on every vessel.

4.180 Two vessels took part in the commercial fishery in 1999/2000. WG-FSA-00/20 provided summary information on the activities of the Russian-registered stern trawler *Zakhar Sorokin*. The other vessel involved in the fishery was the Chilean-registered trawler *Betanzos*. Fishing took place between 11 December 1999 and 31 January 2000 when the catch limit was expected to be taken. The total reported catch was 4 110 tonnes. This was 74 tonnes over the catch limit set by the Commission, due to late submission of five-day catch reports in the period leading to the closure of the fishery.

4.181 The main by-catch species was *G. nicholsi* with a total catch of 67.7 tonnes. Other by-catch included *G. bolini* (120 kg), *P. guntheri* (210 kg), Loliginidae (310 kg) and Elasmobranchii (100 kg).

4.182 Both vessels carried observers designated by the UK in accordance with the CCAMLR Scheme of International Scientific Observation, and observer reports were submitted to the Secretariat. The *Zakhar Sorokin* also carried a national observer from Russia.

Past Assessment

4.183 The catch limit for the 1999/2000 season was derived from a short-term cohort projection first performed at the 1997 meeting of WG-FSA (SC-CAMLR-XVI, Annex 5, paragraphs 4.179 to 4.182). This was based on a one-sided lower 95% confidence bound of the biomass estimate from the UK trawl survey in September 1997, calculated using a bootstrap procedure during the 1997 meeting (SC-CAMLR-XVI, Annex 5, paragraphs 4.199 to 4.208). The projection was used to calculate catch limits for a period of two years: 1999/2000 and 2000/01. The estimated catch limit for 2000/01 was 2 774 tonnes.

New Information Available in 2000

4.184 Although the assessment at last year's meeting had calculated a catch limit for the forthcoming season, the Working Group considered the range of new information available at this year's meeting that could be used to reassess the status of the *C. gunnari* stock in Subarea 48.3 and make recommendations for catch limits in 2000/01. The new information comprised catch/effort and biological data from the commercial fishery, which represented the first substantial fishing for this species since the 1989/90 season. The Working Group also received reports and data from two bottom trawl surveys in January and February 2000 by the UK and Russia respectively (see also paragraphs 6.5 and 6.6).

Commercial Fishing

4.185 Fishing was concentrated primarily in one area of very high catch rates on the shelf to the west of South Georgia, located in stratum SGNW (Figure 24). WG-FSA-00/19 reported on acoustic observations in this area by the *Zakhar Sorokin* that indicated the presence of dense aggregations of fish with a vertical range of between 10–20 m and 30–40 m, and a horizontal range of 0.2–1.2 n miles.

4.186 Average daily catch rates (catch/hour fishing) from the two vessels operating in the fishery are plotted in Figure 25. Both vessels undertook two trips. Catch rates during the first trip were highly variable, ranging between 2 tonnes/hour and nearly 25 tonnes/hour. Catch rates during the second trip were less variable being in the range of 1–6 tonnes/hour. The report of the CCAMLR observer on the *Zakhar Sorokin* noted that the catch rates were so high that the processing capacity of the vessel was sometimes insufficient to keep pace with the supply of fish. At these times, the net was left in the water, but moved away from the area where fish were indicated on the fishfinder, so that the backlog of catch could be processed before the next catch was brought on board. The observer therefore cautioned that calculation of catch rates on the basis of the period during which the net was in the water might be misleading because the net would not have been actively fishing for all of this period.

4.187 Catch-weighted length distributions for the two vessels by month are provided in Figure 26, along with length distributions for previous years where available. Length distributions from the two vessels fishing in 1999/2000 appear to be different. Both vessels fished mainly in the same area, suggesting that the differences resulted from the fishing gear and the way in which it was fished. Both vessels used pelagic otter trawls but the size of the Russian trawl was substantially greater than the Chilean trawl (horizontal openings 90 m and 40 m respectively). Also codend mesh sizes differed; these were 92 mm for the Russian trawl and 110 mm for the Chilean trawl.

4.188 On the basis of age estimates from previous analyses and the age–length key in WG-FSA-00/51, the length distributions indicate that the bulk of the catch was composed of fish aged 2 to 5.

Research Surveys

4.189 The results of the two surveys undertaken in the 1999/2000 season were reported in WG-FSA-00/21 (UK), and 00/47 and 00/51 (Russia).

4.190 Figure 24 shows the locations of stations sampled during the two surveys and the catch rates (densities) at each station. The Russian survey sampled 81 stations (67 at South Georgia and 14 at Shag Rocks). The UK survey sampled only 41 stations (30 at South Georgia and 11 at Shag Rocks). The number of stations fished by the UK survey was less than on previous surveys, due to time constraints and difficulties in fishing at predetermined locations due to icebergs and fog.

4.191 A combined ranking of the catch densities resulting from the two surveys indicated that the densities of fish encountered over the shelf were broadly similar with the exception of a few large catches. The *Atlantida* (Russia) had several large catches to the north and west of South Georgia, with two particularly large catches (one of 1.6 tonnes and the other of just over 3 tonnes per half hour tow) taken in the vicinity of the area fished by the commercial fishery. The UK survey had no large catches around South Georgia and did not sample in the area fished by the commercial fishery in the 1999/2000 season. The UK survey had a single large catch on the shelf to the east of Shag Rocks (2.6 tonnes per half hour tow), while the Russian survey had no large catches on the Shag Rocks shelf.

4.192 Both surveys used random stratified designs and provided estimates of standing stock (Table 37). Standing stock estimates were calculated using the swept area (Saville, 1977) and TRAWLCI (de la Mare, 1994) methods. For the South Georgia shelf, the standing stock estimated by the

Russian survey was considerably higher than that estimated by the UK survey. On the Shag Rocks shelf, the situation was reversed.

Assessment at this Year's Meeting

4.193 In considering options for the assessment of catch limits for *C. gunnari* in the 2000/01 season, the Working Group again recalled its discussions from previous years regarding variability in M between years in relation to the availability of krill and predation by fur seals, and the need to consider appropriate decision rules for application of the GYM to assessing precautionary yield for this fishery (e.g. SC-CAMLR-XVI, paragraphs 4.171 to 4.178).

4.194 WG-FSA-00/51 provided an alternative explanation for the fluctuations in biomass observed by the bottom trawl surveys. Based on acoustic observations during the *Atlantida* survey in January–February 2000, the paper suggested that the observed fluctuations could be explained by changes in the vertical distribution of fish in the water column. Low biomass may be recorded by the bottom trawl at times when the fish are distributed in the water column above the range sampled by the bottom trawl, and conversely high biomass may be recorded when the fish are present in high concentrations that are distributed closer to the seabed. The Working Group noted this alternative hypothesis and discussed the effects of the vertical distribution of fish under the heading of catchability (paragraphs 4.199 to 4.201).

4.195 As last year, there was no new information available to the Working Group on the properties of possible decision criteria for applications of the GYM to fisheries for *C. gunnari*. There was, however, new information regarding standing stock and there was evidence from the commercial fishery that there were commercial concentrations of *C. gunnari* in Subarea 48.3 during the 1999/2000 season.

4.196 The Working Group therefore agreed that the short-term projection used at the last two meetings of the Working Group, updated with new information on biomass and age structure, was the best available method for assessing catch limits for the 2000/01 season. The Working Group reiterated, however, that this is an interim approach used to ensure there is a low probability of depleting the stock in the short term, and increased efforts should be made to address the issue of a longer term management approach of *C. gunnari* fisheries in the Convention Area (paragraphs 10.1 to 10.6).

4.197 The data inputs required for the short-term assessment are listed in Table 42 of last year's report of the Working Group (SC-CAMLR-XVIII, Annex 5). In summary, these are a biomass estimate, distribution of numbers at age, an estimate of M, a selection function, von Bertalanffy growth parameters, a weight–length relationship and known catches since the time of the biomass estimate.

4.198 The Working Group agreed to use the results of the surveys in January and February 2000 to update the estimates of biomass and the distribution of numbers at age.

4.199 The Working Group discussed whether the catch densities from the surveys should be adjusted for catchability. The bottom trawl surveys are generally considered to provide indices of abundance rather than estimates of absolute biomass. One of the main factors affecting catchability is the distribution of the fish in the water column above the level sampled by the bottom trawls routinely used during the surveys. The pattern of diurnal vertical migration shown by *C. gunnari* has been reported in the past and was again described in WG-FSA-00/19, using observations from the *Zakhar Sorokin* in 1999/2000.

4.200 Past surveys have attempted to take this phenomenon into account by taking bottom trawl samples for biomass estimation only during the hours of daylight when the fish are assumed to be distributed close to the seabed within that range sampled by the net (the average headline height of the trawls used during the surveys in 1999/2000 were approximately 6 m and 8 m for the UK and Russian surveys respectively). Evidence presented in WG-FSA-00/19, however, suggests that the behaviour of the fish is variable. During January 2000, some dense pelagic schools with a vertical development of 10 to 20 m were observed acoustically during the day and caught using a pelagic trawl. However, observations during other surveys have also shown that dense concentrations of fish may stay close to the bottom during the day, within the vertical range of the bottom trawl.

4.201 The Working Group agreed that evidence presented in WG-FSA-00/19 suggested that there may be a substantial amount of fish distributed in the water column above the level sampled by survey bottom trawls during the day. This effect would tend to make the catchability of these trawls less than 1. The Working Group noted that catchability can be estimated in the assessment process, as has been done in the past when VPAs were used to assess the absolute abundance of the stock. However, the extent of vertical distribution during the day, and hence the effect on the biomass estimates, appears to be variable. The presence of significant quantities of fish above the level sampled by bottom trawls may be a phenomenon associated with particular conditions and fish behaviour, such as aggregations feeding on krill, which may not be typical at other times and locations. Nevertheless, in years when the fish aggregate, a substantial part of the biomass is present in patches of high concentration and using a bottom trawl to estimate the abundance of fish in these patches may lead to a disproportionately low estimate compared to areas outside the patches.

4.202 The Working Group agreed that there was an urgent need to assess patterns of vertical distribution and movements of *C. gunnari* under different circumstances. This could be achieved through the combined use of bottom trawls, pelagic trawls and acoustic observations. The possible design and use of a bottom trawl with a very high opening (up to 30 m) might also be considered, although the Working Group noted that such a net would be difficult to operate and require a very powerful survey vessel to be used effectively.

4.203 Two specific proposals were put before the Working Group. The first was a preliminary acoustic survey aimed at assessing the distribution and movements of fish in the water column (WG-FSA-00/31; see also paragraph 3.86), and the second was that bottom trawl surveys should be undertaken during the winter season when previous observations suggest that the vertical migration of fish is much less pronounced. The Working Group recommended that these proposals be given more detailed consideration as part of a Workshop on Assessment Methods for Icefish (WAMI) (paragraphs 10.1 to 10.6).

4.204 The one-sided lower 95% confidence bounds of the biomass estimates from the two trawl surveys were calculated using the same bootstrap procedure as used during the last three meetings of the Working Group (SC-CAMLR-XVI, Annex 5, paragraphs 4.199 to 4.208). The results of this analysis are presented in Table 38.

4.205 Numbers at age from the Russian survey were provided in WG-FSA-00/51, based on a new age–length key from readings of otoliths taken during that survey. No age–length data were available for the UK survey. To estimate numbers at age from this survey, the CMIX program (de la Mare, 1994) was used to analyse length densities of *C. gunnari* applying the same methodology as used in the estimation of numbers at age for *D. eleginoides* in Subarea 48.3 and Division 58.5.2 (paragraph 4.130). This method was also used to analyse length densities from the Russian survey to compare the resulting age distribution with that obtained from the age–length key. The age distributions from the CMIX analyses and the Russian age–length key are presented in Table 39. The observed and expected length densities are plotted in Figure 27.

4.206 There was a much greater proportion of age-1 fish in the catches of the UK survey compared to the Russian survey, which estimated that 80% of the stock was composed of fish aged 2 and 3. The UK survey also detected a greater proportion of fish aged 4 and above.

4.207 In comparing the results provided by the two approaches used to analyse the Russian survey data, the Working Group noted that the CMIX analysis allocated fish more evenly between ages 2 and 3, compared to the age–length key, which estimated that 55% of the stock comprised fish of age 2.

4.208 The Working Group considered the results of the two surveys and noted differences in both the age distribution and the estimated biomass. Concern was expressed over the small number of stations sampled by the UK survey on the South Georgia shelf, and whether it was possible to obtain a reliable estimate of stock status from such a small number of hauls.

4.209 In order to achieve a single best estimate of standing stock and age structure in the 1999/2000 season, the Working Group decided to combine the two sets of density-at-length data from the two surveys into a single dataset. The stratification, number of stations in each stratum and the results of the bootstrap analysis to estimate the one-sided lower 95% confidence bound are presented in Table 40. The geographic distribution of the strata is illustrated in Figure 24.

4.210 The bootstrap on the combined dataset was performed using the same method as used to analyse the UK and Russian surveys separately. The Working Group noted that the single-sided lower 95% confidence bound of the combined dataset (35 085 tonnes) was higher than the values calculated independently for UK and Russian surveys (Table 38). This is consistent with the higher number of stations in the combined dataset and the consequently greater precision of the biomass estimate.

4.211 The combined dataset was analysed using the CMIX program to estimate numbers of fish at age for the short-term projection. The results are presented in Table 41 and Figure 28. The means of the mixture components from Table 41 are compared with the growth curve in Figure 29.

4.212 The data inputs for the short-term projection are presented in Table 42. The one-sided lower 95% confidence bounds of the biomass estimate and the distribution of numbers at age were derived from the combined survey dataset. Based on the catch-weighted length distributions from the commercial fishery, the age when fish first recruit to the fishery was fixed at 2 years, with full selection at age 3. The von Bertalanffy growth and weight–length parameters were the same as those used at last year's meeting.

4.213 With a projected fishing mortality of 0.14 for 2000/01 and 2001/02, the catch limit satisfying the agreed criteria is 11 895 tonnes over two years. This is made up of 6 760 tonnes in the first year (1 December 2000 to 30 November 2001) and 5 135 tonnes in the second year (1 December 2001 to 30 November 2002).

Closed Season

4.214 At last year's meeting the Working Group recommended, and the Commission adopted, a change in the closed season for the *C. gunnari* fishery in Subarea 48.3, based on a review of information regarding the timing of the spawning season. The Working Group also recommended that a more detailed analysis of the distribution of young fish from surveys and the exploitation pattern of the fishery operating under existing measures to protect young fish be undertaken, in order to provide advice on the possible benefits of the use of refuges for protecting young fish as part of the management procedure for *C. gunnari* (SC-CAMLR-XVIII, Annex 5, paragraph 4.183). WG-FSA-00/27 and 00/32 presented information on the location of spawning in Subarea 48.3 (paragraphs 3.89 and 3.90). The Working Group considered this new information and concluded there was no reason to recommend a change to the closed season adopted by the Commission last year (Conservation Measure 175/XVIII).

4.215 The Working Group also discussed the need to consider predator requirements and whether a closed season might be appropriate during peak periods of foraging activity. The Working Group agreed that this was an important issue, and it was recommended that the topic be considered more fully during WAMI (paragraphs 10.1 to 10.6).

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

4.216 The Working Group agreed that the management measures for *C. gunnari* in Subarea 48.3 should be similar to those of the 1999/2000 season.

4.217 The Working Group agreed that the total catch limit should be revised to 6 760 tonnes for the period from 1 December 2000 to 30 November 2001, with a closed season between 1 March and 31 May 2001.

Kerguelen Islands (Division 58.5.1)

4.218 No commercial fishing for *C. gunnari* took place in this division during the 1999/2000 season and no surveys were reported.

4.219 The Working Group recalled that the most recent data available remain from a brief survey conducted in February 1998 which indicated that the previous strong cohort (4+ years old) had almost disappeared, but that a new year 1+ cohort (~170 mm long fish) was present in 1997/98. In addition, according to information provided to the Working Group last year, a survey in 1998/99 revealed practically zero biomass on the traditional northeastern fishing ground. Only a few mature specimens (36 cm cohort) and some immature fish (22 cm cohort) were caught from late April to early May.

4.220 The Working Group has no information on whether a resumption of fishing is being contemplated at this time or whether a survey will be conducted in the 2000/01 season.

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

4.221 In the absence of recent data from this division, the Working Group is unable to offer any new management advice. It is strongly recommended that a survey of *C. gunnari* abundance is conducted and the results analysed by the Working Group before commercial fishing is recommenced.

Heard and McDonald Islands (Division 58.5.2)

Commercial Catch

4.222 The commercial fishery for *C. gunnari* around Heard Island (Division 58.5.2) was open from the end of the Commission meeting in November 1999 to 30 November 2000. The catch limit agreed by the Commission for this period was 916 tonnes to be taken on the Heard Island Plateau area only (Conservation Measure 177/XVIII). This conservation measure included several other conditions to be applied to this fishery, including per haul by-catch limits, a provision to reduce the catch of small (<24 cm) fish, data reporting on a haul-by-haul basis, and the presence of a scientific observer on every vessel. Overall by-catch limits covering all fishing activities in Division 58.5.2 also applied (Conservation Measure 178/XVII).

4.223 The commercial catch in the 1999/2000 fishing season was 39 tonnes. This was because the strong cohort, now aged 4, that was detected in a survey in 1998 had almost disappeared.

4.224 A survey was conducted on the Heard Island Plateau and Shell Bank in May 2000 to assess the abundance and size structure of the *C. gunnari* populations. This survey used the same methodology as previous surveys in this area in 1997 and 1998 and detected a high abundance of principally 2-year-old fish on the Heard Plateau, but very few fish on Shell Bank (WG-FSA-00/40). As in previous years, fish were concentrated on the southeast part of the plateau in the Gunnari Ridge and Plateau East strata (Table 43), and these areas seem to be a region of consistent high abundance of *C. gunnari* whenever a strong cohort is present.

4.225 An assessment of short-term yield over the next two years was presented to the Working Group in WG-FSA-00/41. This assessment used the same methodology as used in previous assessments at the 1998 meeting, as adopted during the 1997 meeting (SC-CAMLR-XVI, Annex 5, paragraph 4.181) and described in de la Mare et al. (1998) and as used in the assessments for Subarea 48.3 described in paragraphs 4.212 and 4.213. Results of the survey conducted in 2000 were used as input. Estimates of yield for Shell Bank were not made because of the very low abundance of this population. Data inputs for the short-term projection are provided in Table 44.

4.226 With a projected fishing mortality of 0.14 for 2000/01 and 2001/02, the catch limit satisfying the agreed criteria is 2 150 tonnes over two years. This is made up of 1 150 tonnes in the first year and 1 000 tonnes in the second year.

4.227 The Working Group reviewed WG-FSA-00/41 and agreed with its findings. Consequently, no other assessment was performed at the meeting.

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

4.228 The Working Group agreed that the management of the fishery for *C. gunnari* on the Heard Island Plateau part of Division 58.5.2 during the 2000/01 season should be similar to that in force last season, as detailed in Conservation Measure 177/XVIII. The total catch limit should be revised to 1 150 tonnes in accordance with this year's short-term yield calculations. The fishery on Shell Bank should remain closed.

Other Fisheries

Other Finfish Fisheries

4.229 Other fisheries considered by the Working Group were those in Subareas 48.1, 48.2, 48.4, 88.2, 88.3, and Divisions 58.4.1 and 58.4.2.

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

4.230 No commercial fishing has taken place in Subareas 48.1 and 48.2 in the 50–500 m depth range since the 1989/90 season when CCAMLR introduced conservation measures for these two areas (currently Conservation Measures 72/XVII and 73/XVII). An extensive review of the fishery, status and biology of fish stocks in these two subareas was provided in WG-FSA-00/14. The authors concluded that there is currently little scope for a viable commercial fishery and suggested that the two subareas should remain closed.

4.231 There are two new bottom trawl surveys planned around Elephant Island and the lower South Shetland Islands for March and November–December 2001 by Germany and the USA, with participation by scientists from a number of other CCAMLR Members.

Management Advice

4.232 There appears to be little scope to reopen the fishery in the two subareas in the near future given the comparatively low biomass of the abundant fish species. The Working Group therefore recommended that Conservation Measures 72/XVII and 73/XVII should remain in force.

South Sandwich Islands (Subarea 48.4)

4.233 A catch limit of 28 tonnes for *D. eleginoides* is in force in Subarea 48.4 (Conservation Measure 180/XVIII). No fishing was reported to the Commission in the 1999/2000 season. No new information was made available to the Working Group on which an update of the assessment could be based.

Management Advice

4.234 The Working Group recommended that Conservation Measure 180/XVIII be retained until new information becomes available and a new assessment could be attempted.

Antarctic Coastal Areas of Divisions 58.4.1 and 58.4.2

4.235 A notification for an exploratory fishery was submitted to CCAMLR by Australia for Division 58.4.2 for the fishing season 1999/2000, while no trawl fishing was planned for Division 58.4.1. Because of ice, little exploratory fishing was possible. A new notification for the 2000/01 season was submitted for Division 58.4.2 by Australia. Details of the plan can be found in paragraph 4.46. Again, no fishing is planned for the Antarctic coastal area of Division 58.4.1.

Pacific Ocean Sector (Subareas 88.2 and 88.3)

4.236 No fishing occurred in these two subareas in 1999/2000. Notifications for conducting a longline fishery in the 2000/01 season primarily on *Dissostichus* spp. in Subareas 88.2 and 88.3 were lodged by Argentina, South Africa (Subarea 88.2 only) and Uruguay. Details on the proposed development of the fisheries were provided in paragraphs 4.44, 4.63, 4.67 and 4.68.

Management Advice

4.237 The Working Group envisaged assessing at its meeting in 2001, Division 58.4.2 and Subareas 88.2 and 88.3, after the completion of the exploratory fisheries.

Crabs

4.238 Five species of crabs currently occur in catches around South Georgia: *P. spinosissima*, *P. formosa*, *P. anemerae*, *N. diomedeae* and *L. murrayi*. Only the three species of the genus *Paralomis* are of interest to the crab fishery. *P. formosa* has been the predominant species in the crab fishery conducted in 1997/98, while *P. spinosissima* prevailed in the experimental pot fishery on *D. eleginoides* in 1999/2000. The difference is mostly due to the different depth range covered by the two fisheries.

4.239 Conservation measures in force in the crab fishery are Conservation Measure 150/XVIII which regulates the experimental harvest regime on crabs, and 181/XVIII which sets limits on the catch at 1 600 tonnes green weight per season of all species combined and limits the number of vessels to one per country.

4.240 Two countries have notified crab fishing in the 2000/01 season: USA and Uruguay. The USA has already fulfilled the requirement of an experimental harvest regime as set out in Conservation Measure 150/XVIII, whereas Uruguay has not.

4.241 WG-FSA-00/23 presented CPUE data on the by-catch of crabs and fish from the experimental pot fishery on *D. eleginoides* in Subarea 48.3. However, WG-FSA-00/24 presented a more extensive analysis of the same dataset. Crabs formed 45.5% of the total weight of all species and 96.1% of all numbers caught. Few crabs were males above the legal size that could be retained. Soak time of the pots was positively correlated with the numbers of crabs being taken. Biological data on crabs are presented in paragraphs 3.93 to 3.98. Preliminary results from reimmersion experiments on crabs suggested that about 10% of apparently lively discarded crabs would die subsequently. Attempts are currently under way to reduce the by-catch of crabs by making changes to the design of pots.

4.242 CFs of crab products to green weight are insufficiently known. The Working Group recommended that investigations into CFs be carried out in the near future.

Management Advice

4.243 The Working Group recommended that the Uruguayan vessel applying for a permit should conduct Phase 1 of the experimental harvest regime specified in Conservation Measure 150/XVIII. The US vessel has already fulfilled these requirements.

4.244 The Working Group agreed that the high by-catch of undersized crabs in the directed fishery on crabs and the by-catch of crabs in the directed fishery on *D. eleginoides* using pots is of concern in both fisheries. Mortality rates of crabs discarded by these fisheries are insufficiently known and need further consideration by the Working Group in forthcoming years. The Working Group encouraged further experiments on mortality rates of undersized crabs to be conducted in the near future.

Squid

4.245 Conservation Measure 183/XVIII is currently in force to regulate this fishery. No fishing took place in the 1999/2000 season. The UK and the Republic of Korea have submitted a joint proposal to conduct an exploratory fishery on *M. hyadesi* in waters north of South Georgia (Subarea 48.3) in the 2000/01 season (paragraph 4.75).

4.246 The scientific basis on which the current precautionary conservation measure was based has not changed. Discussion on this matter can be found in SC-CAMLR-XVI, paragraphs 9.15 to 9.18; SC-CAMLR-XVI, Annex 4, paragraphs 6.83 to 6.87; and SC-CAMLR-XVI, Annex 5, paragraphs 4.2 to 4.6. The catch limit is considered to be precautionary (SC-CAMLR-XV, paragraph 8.3).

Management Advice

4.247 The Working Group recommended that a conservative management scheme as contained in Conservation Measure 183/XVIII is still considered to be appropriate for this fishery.

General By-catch Provisions

4.248 During the last two meetings, WG-FSA reviewed the need to study elasmobranch by-catch in fisheries in the Convention Area (SC-CAMLR-XVII, Annex 5, paragraphs 4.201 to 4.209; SC-CAMLR-XVIII, Annex 5, paragraphs 4.88 to 4.98). During last year's meeting, several papers were presented which provided rates of by-catch experienced in the Convention Area fisheries; an assessment of yield and status of the by-catch species *M. carinatus* on BANZARE Bank in Divisions 58.4.1/58.4.3; and a definition of a research program to assess the impact of the exploratory fishery for *Dissostichus* spp. for Subarea 88.1.

4.249 The amount of by-catch reported from longline fisheries targeting *Dissostichus* spp. during the 1998/99 season was estimated from data reported in the five-day catch and effort reports, in scientific observer data and in the fine-scale data (SC-CAMLR-XVIII, Annex 5, Table 30). Finally, overall species composition of the by-catch reported in the observer data from longline fisheries in the 1998/99 season was also reported (SC-CAMLR-XVIII, Annex 5, Table 31).

4.250 The precise identification of by-catch species was found to be problematic for some groups and the need for better keys to be made available for observers on board the vessel was recognised (SC-CAMLR-XVIII, Annex 5, paragraph 4.97). In response, WG-FSA-00/15 was submitted. A discussion on this paper can be found in paragraphs 3.110 to 3.118.

4.251 This year, the Secretariat again calculated the amount of by-catch reported from the longline fisheries (Table 45) and determined the overall species composition of the by-catch reported in the observer data (Table 46). In addition, both tables were expanded to include by-catch data reported from the trawl fisheries in the Convention Area.

4.252 The largest by-catch (255 tonnes) was reported for the *D. eleginoides* longline fishery in Division 58.5.1 from fine-scale data; however, no catch and effort reports or observer data were available for this fishery (Table 45). Other large by-catches, for fine-scale data, occurred in the longline fisheries for *Dissostichus* spp. in Subareas 88.1 (118 tonnes) and 58.6 (81 tonnes). In general, comparisons among the three data sources were difficult because of missing data, pooling effects etc.

4.253 For the reasons discussed above, comparisons of by-catch amounts in the longline fisheries during the 1999/2000 season with those reported during the 1998/99 season (SC-CAMLR-XVIII, Annex 5, Table 30) were also difficult. Therefore, the Working Group requested the Secretariat to intersessionally investigate the feasibility of expanding Table 45 to include the previous year's data.

4.254 Although data presented in Table 46 are those recorded by observers and are therefore a subset of the total by-catch, it does illustrate that a wide variety of species are taken in fisheries in the Convention Area. Most are taken in small amounts by weight.

4.255 Several papers presented data associated with by-catch in CCAMLR fisheries in 1999/2000. These include: SC-CAMLR-XIX/BG/1 (catches in the Convention Area for split-year 1999/2000); WG-FSA-00/18 (summary of trawl observations); WG-FSA-00/59 (skate by-catch in Subarea 48.3 observed from one vessel); WG-FSA-00/55 (Ross Sea Antarctic toothfish fishery from 1997/98 to 1999/2000); WG-FSA-00/23 (fishing for toothfish using pots); WG-FSA-00/24 (crab by-catch in experimental toothfish pot fishery); and Annex 4, paragraphs 2.29 to 2.31 (fish by-catch in the krill fishery).

4.256 SC-CAMLR-XIX/BG/1 presented catches from STATLANT data for the 1999/2000 split-year (both trawl and longline) for the purpose of allowing Members to check their data prior to publication in the *CCAMLR Statistical Bulletin*. However, it also provided some useful information relative to by-catch species caught by trawl and longline fisheries combined. Table 1 of the paper provided catches in the 1999/2000 split-year for seven species which were at least 5 tonnes. Of the by-catch species, *Macrourus* spp. had the largest take (334 tonnes). Catch is also provided by species by region (Table 2 of the paper), species by month by region (Table 5 of the paper) and by country by species by region (Tables 3 and 4 of the paper).

4.257 WG-FSA-00/18 presented a summary of scientific observations of trawl operations completed under Conservation Measures 175/XVIII, 177/XVIII and 186/XVIII during the 1999/2000 season. Table 3 of the paper provided a listing of all species caught. Observations were made from four vessels which conducted eight trawl operations targeting finfish in the Convention Area.

4.258 In Subarea 48.3, one Russian and one Chilean trawler conducted 266 trawls of which 189 were observed. Five by-catch species were observed in catches which amounted to only 1.6% of total catch. *G. nicholsi* represented 1.5% of the by-catch.

4.259 Two Australian-flagged vessels conducted six cruises in Division 58.5.2 and one Australian vessel conducted part of a trip in Division 58.4.2. In Division 58.5.2, 810 trawls were undertaken targeting *D. eleginoides* of which 761 trawls were observed and 29 trawls were undertaken targeting *C. gunnari* of which 26 were observed. In Division 58.5.2, by-catch species in trawls targeting *D. eleginoides* and *C. gunnari* comprised 2.9% and 6.6% of the total catch respectively.

4.260 In Division 58.4.2, one trawl targeting *D. eleginoides* was observed and all eight trawls targeting *C. wilsoni* were observed. In the first case, Octopodidae comprised 13.4% of the catch while in the second case the target species only comprised 1.1% of the catch. Ten species groups, including *M. whitsoni* (45.3% of catch) and Medusae (21.4%) comprised by-catch of the *C. wilsoni* trawls.

4.261 WG-FSA-00/59 presented an examination of skate by-catch from one longline vessel in Subarea 48.3 during the 1999/2000 longline *Dissostichus* spp. season and is a follow-up to the skate research program initiated in 1999 (Agnew et al., 1999). This year a detailed study of skate caught on one vessel was designed to establish the total number of skates caught. Anatomical features (colour, spination etc.) were discussed to aid in improving field identifications of skates. Information is also provided relative to skate size and maturity, distribution, discard mortality, growth and age determination, and morphology.

4.262 During the cruise, 336 skates were caught with a rate of 0.236 (numbers/thousand hooks) (Table 1 of report). Three rajid species were caught as by-catch. No small skates were caught, most were estimated between 10 and 25 years of age, although many appeared to be sexually immature. Results of discard mortality experiments indicated that of 44 skates observed only seven (16%) were found to be alive after a period of 12 hours from hauling. There seems to be a clear relationship between depth from which skates are hauled and their survival. No skate survived which had been hauled from a depth greater than 1 550 m. Only one of eight animals tested was found to survive after being hauled from a depth of 1 450 m. Because longlines catch larger specimens of skate which are at or nearing maturity, this may represent a threat to the population levels of all three species found in the study.

4.263 The Working Group noted that the mortality of by-catch species caught on longlines may be affected by the manner in which they are removed from the hooks. If specimens are removed in a manner causing injury to the mouth, head etc., then mortality will be much greater.

4.264 WG-FSA-00/55 presented an analysis of the New Zealand Ross Sea Antarctic toothfish fishery from 1997/98 to 1999/2000. The main by-catch species were rat tails which averaged about 10% (range 6–17%) of the annual catch and skate which averaged about 8% (range 5–11%) of the annual catch. Species misidentification and grouping of the species by observers made it difficult to ascertain actual percentage by-catch by individual species. Other by-catch species (including icefish and moray cods) each contributed less than 1% of the catch overall. A summary of catches is given in Table 2 of the paper.

4.265 WG-FSA-00/55 also presented results of a tag and release program to assess post-capture survival of skate. A total of 2 058 skates were tagged (approximately 20% of all skates caught), some in all of the four SSRUs fished. Specimens of both *A. georgiana* (90%) and *B. eatonii* were tagged. Four skates were recaptured during the 1999/2000 season, despite the vessels not fishing over the same grounds again. The mean time at liberty was 14.5 days, with two skates caught 22 days after release, and mean distance travelled was 7.3 n miles. Further recaptures are expected in the 2001 season as vessels undertake exploratory voyages in the area again. However, the within-season results provide evidence that at least some of the skates released survived after being caught.

4.266 WG-FSA-00/23 presented CPUE of by-catch of crabs and fish in the experimental pot *Dissostichus* spp. fishery around South Georgia in 2000 (Figure 2 of the paper). However, WG-FSA-00/24 presented a fuller analysis of the crab by-catch in the experimental fishery. Results are discussed in paragraph 4.241.

4.267 The by-catch of fish in the krill fishery was presented to WG-EMM (Annex 4, paragraphs 2.29 to 2.31). A CCAMLR-designated observer from the USA on board a Japanese krill vessel reported five small fish from 22 hauls but the observer did not have free access to sample catches. This was found to be regrettable by the Working Group.

4.268 A national observer working on the Ukrainian vessel reported several hauls taken to the west of the South Orkney Islands were found to contain *C. gunnari* (length range 5–7 cm, maximum 12 cm). The largest catch was 200 *C. gunnari* per tonne of krill. WG-EMM noted that these catch rates did not appear to be large and, in the case of the Ukrainian information, were confined to a limited area.

Advice to the Scientific Committee

4.269 The Working Group agreed that substantial information regarding the amount of by-catch in various fisheries had been presented. However, there is still an urgent need for the calculation and presentation of by-catch rates in both longline and trawl fisheries. An intersessional subgroup has been tasked with collating these data (paragraph 10.9(vi)).

Regulatory Framework

4.270 Over the past two years, the Scientific Committee and Commission have discussed the need for a unified framework for providing management advice on all fisheries in the Convention Area (CCAMLR-XVII, paragraphs 10.3 to 10.7). In the 1998/99 intersessional period, the Chairman of the Scientific Committee convened a task group to explore the scientific basis for a regulatory framework. A draft of the latest report of the task group, prepared during the 1999/2000 intersessional period, was circulated at the meeting and discussed in detail by the Working Group. It was agreed that any changes to the document required as a result of these discussions would be made and the revised report presented as a background paper to the 2000 meeting of the Scientific Committee.

4.271 The Working Group noted the substantial progress made by the task group since last year's meeting. The new report proposed a move away from a rigid framework of defined stages of fishery development towards a more generalised structure that would allow individual fisheries to be developed at a pace commensurate with the acquisition of information required by the Scientific Committee to develop management advice. This would remove the need to define stages of fishery development (e.g. new, exploratory, established). The Working Group welcomed proposals in the report to streamline the process of annual review and assessment of fisheries by the Scientific Committee and its working groups, in the face of a mounting workload created by the increasing number of fisheries in the Convention Area.

4.272 The report summarises the regulatory requirements currently stipulated for new and exploratory fisheries under Conservation Measures 31/X and 65/XII, and notes that these requirements are often also highly desirable features of the management of fisheries other than those classified as new and exploratory. The report makes proposals for how application of these requirements could be generalised to apply to all fisheries in the Convention Area.

4.273 An important component of the proposed framework is the development of a new reference document called a *Fishery Plan* for each fishery that has ever been prosecuted in the Convention Area. This document would be a compilation of information from the conservation measures and other sources, providing a standardised point of reference to support the application of regulatory requirements to all fisheries and track developments and changes in individual fisheries over time. The task group has developed a proposed structure for the *Fishery Plan* that could be used as a replacement for the assessment summaries which have been appended to the Working Group's report. The structure also provides a list of the standard harvest controls and reporting requirements routinely included in conservation measures that could be used to standardise the structure of the conservation measures.

4.274 The Working Group welcomed the proposal to prepare *Fishery Plans* for all fisheries and recommended that this be regarded as a high priority. The Working Group requested the Scientific Committee to consider how this task could be undertaken.

CONSIDERATION OF ECOSYSTEM MANAGEMENT

Interaction with WG-EMM

By-catch of Young Fish in the Krill Fishery

5.1 WG-EMM had considered a single submission (WG-EMM-00/12) documenting the incidental catch of fish during krill fishing (Annex 4, paragraphs 2.29 to 2.31).

5.2 WG-FSA welcomed the additional information provided and encouraged future submissions detailing fish by-catch by the krill fishery. It was again emphasised that such information may provide further information on the distribution of juvenile fish. Every effort should be taken to ensure that sampling program(s) are stratified to take account of geographical differences in juvenile fish density.

Other Information arising from WG-EMM's Deliberations of relevance to WG-FSA

5.3 WG-FSA noted the growing importance which WG-EMM is attaching to interactions between components of the ecosystem other than krill (Annex 4, paragraphs 4.45 and 4.46).

5.4 Key areas of focus to be noted include the interactions of *C. gunnari* with both krill as well as land-based predators at South Georgia (Annex 4, paragraph 4.45). Ongoing work demonstrated that an index of *C. gunnari* condition appears to respond rapidly to changes in krill availability (Annex 4, paragraphs 4.38 to 4.40).

5.5 Other work within WG-EMM noted that myctophids are an important food source for some bird species, with south polar skuas in the Antarctic Peninsula region (Annex 4, paragraph 4.58), snow petrels on Laurie Island (Annex 4, paragraph 3.25) and king penguins (Annex 4, paragraph 4.57) among them.

5.6 WG-FSA also supported the ongoing study of fish prey taken by South Georgia shags and Antarctic shags from the South Orkney Islands and the Antarctic Peninsula respectively (Annex 4, paragraphs 4.48 to 4.50). The ongoing submission of such data was endorsed as a means to improve knowledge of potential changes in the interactions between certain ecosystem components. It was recognised that there may be merit in broadening regional case studies to examine the food-web interactions of all predators, including those on fish.

Ecosystem Assessment

5.7 WG-EMM made ongoing efforts to provide and improve approaches to ecosystem assessment (Annex 4, paragraphs 4.86 to 4.117). It was noted that the approach being developed by WG-EMM for krill could also be adapted to fish. WG-FSA recognised that the use of ecological information is relevant for the formulation of management advice on fish since the characterisation of specific ecosystems could take account of the expected dynamics of different system components. This would not only improve insights into the variability of certain ecosystem components but would also serve to relate ‘extreme events’ to long-term population trends as well as the application of management measures (Annex 4, paragraphs 4.106 to 4.109). Good examples include the documentation of *C. gunnari* condition as well as some of the topics identified within the terms of reference of the forthcoming *C. gunnari* workshop.

Marine Protected Areas

5.8 WG-EMM embarked on the development of criteria for the designation of marine protected areas relevant to CCAMLR’s perceived needs (Annex 4, paragraphs 5.54 to 5.61). A key consideration in the development of such areas requires that due account be taken of existing, and potential, fisheries subject to the provisions of Article II. In this context, CCAMLR’s practice of closing specific areas to fishing (e.g. as contained in Conservation Measures 72/XVII and 73/XVII for Subareas 48.1 and 48.2 respectively) could be viewed as a means to protect fish populations in areas where exploitation has been perceived to compromise the future of the stocks concerned.

5.9 WG-FSA encouraged the further development of criteria for protected/closed areas relevant to CCAMLR and appreciated that the Working Group is likely to be involved in such a development.

Ecological Interactions

Interactions between Marine Mammals and Fishing Operations

5.10 Two papers were submitted to WG-FSA on this topic (WG-FSA-00/56 and 00/60). These are considered in paragraphs 7.47, 7.88 and 8.3.

Effects of Bottom Trawling

5.11 The issue of potential damage by bottom trawling on benthos has been considered by WG-FSA over a number of years. Therefore, the Working Group recognised with appreciation the intentions of Australia to study the potential effects of bottom trawling on benthic communities during the forthcoming fishing season (see also paragraph 4.91). Further research on this matter is planned for the forthcoming AMLR survey in March 2001 in the Elephant Island–Lower South Shetland region.

RESEARCH SURVEYS

Simulation Studies

6.1 There were no simulation studies conducted during 1999/2000. Developments in survey methods included the use of hydroacoustics in surveys for *C. gunnari* in Subarea 48.3 (WG-FSA-00/19).

Recent and Proposed Surveys

6.2 Studies were undertaken by Australia, New Zealand, Russia and the UK. Three research surveys were undertaken in the Convention Area in 1999/2000, covering Subarea 48.3 and Division 58.5.2. Additionally, tagging studies on *Dissostichus* spp. have been conducted in Subareas 48.3 and 88.1 and Division 58.5.2.

6.3 The Australian bottom trawl survey in Division 58.5.2 on board the *Southern Champion* studied the abundance and length distribution of *C. gunnari*, *L. squamifrons* and pre-recruit *Dissostichus* spp. (WG-FSA-00/40).

6.4 The exploratory fishery of New Zealand in Subarea 88.1 conducted tagging studies of skates from its three vessels (paragraphs 3.109 and 4.265).

6.5 The Russian bottom trawl survey on board the *Atlantida* conducted in Subarea 48.3 covered shelf areas down to 500 m around Shag Rocks and South Georgia. The aim of the survey was to estimate the standing stock of *C. gunnari*. Hydroacoustic equipment was in use during the cruise (WG-FSA-00/31, 00/47 and 00/51).

6.6 The UK survey on board the *Argos Galicia* also covered the shelf areas in Subareas 48.3 and was aimed at estimation of the standing stock of *C. gunnari* and other bottom species (WG-FSA-00/40). Tagging of *D. eleginoides* was conducted during the cruise (WG-FSA-00/26).

Proposed Surveys

6.7 Argentina indicated that a bottom trawl survey of Subarea 48.3 during May–June 2001 is being planned.

6.8 Australia plans to repeat the *C. gunnari* and *D. eleginoides* pre-recruit survey in Division 58.5.2 during the coming season.

6.9 New Zealand intends to continue with its skate tagging program, and to start tagging experiments on *D. mawsoni*.

6.10 The USA plans to conduct a bottom trawl survey using a random survey design in Subarea 48.1 on board the *Yuzhmorgeologiya*.

INCIDENTAL MORTALITY ARISING FROM LONGLINE FISHING

Intersessional Work of Ad Hoc WG-IMALF

7.1 The Secretariat reported on the intersessional activities of ad hoc WG-IMALF (WG-FSA-00/5 Rev. 1) according to the agreed plan of intersessional activities for 1999/2000 (SC-CAMLR-XVIII, Annex 5, Appendix D). The report contained records of all activities planned and their results. These were reviewed and appropriate details appear in the 2000/01 plan of intersessional activities of WG-IMALF (Appendix D).

7.2 The Working Group noted the extensive work accomplished intersessionally by ad hoc WG-IMALF, details of which were presented in a number of WG-FSA papers. In general, the group concluded that most tasks planned for 1999/2000 had been successfully implemented. The Working Group thanked the Science Officer for his work on the coordination of IMALF activities. It also thanked the Scientific Observer Data Analyst for his work on the processing and analysis of data submitted to the Secretariat by international and national observers during the course of the 1999/2000 fishing season.

7.3 Of concern was the limited feedback received this year from some technical coordinators on IMALF-related matters. All technical coordinators are urged to respond to requests from WG-IMALF, even if they are unable to report progress.

7.4 The membership of WG-IMALF was reviewed and a number of modifications and additions suggested; the group noted that some CCAMLR Member countries which are involved in longline fishing and/or seabird research in the Convention Area (e.g. European Community, Ukraine, Uruguay and the USA) are not represented on ad hoc WG-IMALF. The Working Group indicated that Dr A. Stagi (Uruguay) and Dr K. Rivera (USA) would be welcome additions to its membership. The attendance at this year's meeting of a representative from Brazil was particularly appreciated; the absence of a representative from France was particularly regretted. Members were asked to review their representation on ad hoc WG-IMALF intersessionally and to facilitate attendance of as many representatives as possible at the meeting.

Research into the Status of Seabirds at Risk

7.5 In response to requests for updates on information summarising national research on seabirds (albatrosses and *Macronectes* and *Procellaria* petrels) vulnerable to longline fisheries interactions, papers were presented by the UK (WG-FSA-00/8), France (WG-FSA-00/9), New Zealand (WG-FSA-00/10) and Australia (WG-FSA-00/49). Reference to research on albatrosses in Chile is included in both WG-FSA-00/8 and 00/49. Of the countries known to be conducting relevant research on these species, no reports to IMALF were received from Argentina, South Africa and the USA. These Members were requested to table information on the current status of these research programs for next year's meeting of WG-FSA. All Members were requested to update regularly information relating to their programs.

7.6 The reports provided were summarised in Table 47, which updates Table 45 in SC-CAMLR-XVIII, Annex 5.

7.7 Essentially, no research programs focusing on relevant seabird populations have been initiated since 1999. Consequently the deficiencies resulting from the lack of relevant research on population dynamics and foraging ecology of most populations remain (SC-CAMLR-XVIII, Annex V, paragraph 7.10). Specifically the urgent requirement for research on the species and populations described in SC-CAMLR-XVIII, Annex V, paragraphs 7.11 to 7.15 remains.

7.8 Prof. Croxall reported that although the directed research program on white-chinned petrels at South Georgia had concluded, the population assessment project had demonstrated a 28% decline in the breeding population over the last 20 years and concluded that, as this could not be attributed to habit modification caused by fur seal activities on land, the likely causes were in the marine environment (Berrow et al., 2000). Full details of this work, which provide a sound baseline for future population monitoring, would be presented at next year's meeting.

7.9 The Working Group recollected that the main reasons for requesting the data summarised in Table 47 were to enable assessment of the availability of data on:

(i) size and trends of populations of albatross species and of *Macronectes* and *Procellaria* petrel species vulnerable to interactions with longline fisheries; and

(ii) the foraging ranges of populations of these species, at different times of year and stages of the breeding cycle, adequate to assess overlap with areas used by longline fisheries and, ideally, to compare at-sea distributions with data on fishing effort.

7.10 From the information summarising current population research provided in Table 47, it remains impossible to determine the adequacy of these data for assessing population trends and providing critical data on population dynamics. Therefore, Members are requested to report in more detail on their seabird research programs, specifically to provide information on the years in which population estimates have been obtained and in which demographic variables (productivity, adult survival and recruitment) have been measured. A similar request should be made to the SCAR Secretariat to obtain relevant information from SCAR members.

7.11 Similarly, Members are requested to provide more detail on their studies to determine foraging range by indicating the year of study, the number of individuals tracked, the breeding stage of study birds and the CCAMLR statistical subareas and divisions frequented by these birds. This information will assist in delineating foraging ranges as well as assisting the assessments of regional risk of seabird by-catch.

7.12 Last year the Working Group had requested information from Members on genetic research relevant to determining the provenance of birds killed in longline fisheries.

7.13 The UK had briefly summarised in WG-FSA-00/7 the species and sites studied in some recent research. Prof. Croxall indicated that this work revealed a limited ability to determine the source populations of black-browed and wandering albatrosses but, at present, no ability to achieve any discrimination between grey-headed albatross populations. More details of this work should be available for presentation at next year's meeting.

7.14 Complementary studies of other species and populations are known to be previously or currently undertaken by Australia, New Zealand, USA and South Africa. Members are requested to provide and update information on the current status of these research programs for next year's meeting of WG-FSA. Additional information detailing the number of samples analysed from each population, as well as the agency responsible for the curation of samples, would be sought.

7.15 The requests outlined in paragraphs 7.10, 7.11 and 7.14 should also be made to the SCAR Secretariat to solicit relevant information from their members.

7.16 The Working Group drew attention to WG-FSA-00/34 which summarised the global status of albatrosses and *Macronectes* and *Procellaria* petrels, as assessed using the IUCN threatened species criteria. The latest IUCN Red List, which contains these assessments, was published in September 2000; the full texts of all these assessments are in BirdLife International (2000), published in October 2000.

7.17 These new category assessments have been incorporated into Table 47, replacing the earlier assessments in Croxall and Gales (1998).

7.18 Of particular concern, in relation to CCAMLR, are those species, identified in WG-FSA-00/34, where the categorisation is based on criteria involving population decline, either solely, or in combination with small range and/or small population size. In most, if not all, such cases, the main cause of decline is known, or inferred, to be incidental mortality associated with longline fishing (BirdLife International, 2000).

7.19 The Working Group noted that WG-EMM-00/16 contained analyses of time-series data of breeding population counts of various albatross and petrel species and populations, viz:

Wandering albatross	*Diomedea exulans*	South Georgia Kerguelen Marion (Prince Edward Islands) Possession (Crozet Islands)
Amsterdam albatross	*Diomedea amsterdamensis*	Amsterdam
Black-browed albatross	*Diomedea melanophrys*	South Georgia Kerguelen
Indian yellow-nosed albatross	*Diomedea chlororhynchos*	Amsterdam Gough
Grey-headed albatross	*Diomedea chrysostoma*	South Georgia Marion
Sooty albatross	*Phoebetria fusca*	Possession
Light-mantled albatross	*Phoebetria palpebrata*	Possession
Southern giant petrel	*Macronectes giganteus*	Marion Possession Mawson Davis Casey
Northern giant petrel	*Macronectes halli*	Marion Possession

These data, and analyses, are of considerable potential relevance to the investigations of the Working Group referred to in paragraphs 7.5 to 7.9.

7.20 The Working Group noted that the report of the Workshop on Albatross and Petrel Mortality from Longline Fishing held in Hawaii, USA, in May 2000 (SC-CAMLR-XIX/BG/12), called for enhanced effective monitoring of seabird population trends (including structure and dynamics) and enhanced research into foraging ecology. The workshop also concluded that it was vital to maintain and sustain existing long-term population studies since these are unique sources from which to identify problems, disentangle potentially confounding causal effects and monitor progress towards management targets, including success of remedial measures. Wherever possible, these studies should be designed so as to accompany estimates of population size and trends with other demographic data, especially annual adult survival and recruitment rates. The Working Group endorsed these conclusions.

7.21 The Working Group noted a comment from the Scientific Committee (SC-CAMLR-XVIII, paragraph 4.76(iv)(d)), apparently requesting advice from WG-IMALF on 'appropriate levels of by-catch, on an area-specific basis'.

7.22 Given the lack of detail accompanying this request, and the complexity, both philosophical and practical, of undertaking relevant analyses, the Working Group deferred consideration of this topic.

7.23 It noted, however, that this subject would be extensively discussed at the forthcoming International Fishers' Forum meeting (see paragraphs 7.179 to 7.181). Several members of WG-IMALF would be attending and it was hoped that WG-IMALF would be in a position to discuss this topic next year.

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

2000 Data

7.24 Data were available from 35 longline cruises conducted within the Convention Area during the 1999/2000 season (for details see WG-FSA-00/37 and paragraphs 3.35 to 3.38 and Table 9).

7.25 The Working Group expressed concern, as they did last year (SC-CAMLR-XVIII, Annex 5, paragraph 7.31), that the proportion of hooks being observed to provide overall estimates of seabird mortality was still rather low (WG-FSA-00/37 and Table 48). The Working Group was concerned to note that on seven trips the proportion of hooks observed was less than 20%. A desirable level of observation would be about 40–50% (SC-CAMLR-XVII, Annex 5, paragraphs 3.60 and 7.124 to 7.130); levels below 20% may introduce potentially serious errors into estimates (SC-CAMLR-XVIII, Annex 5, paragraph 7.31; paragraph 3.48).

7.26 The Working Group noted, however, that for vessels with single observers it could be very difficult to achieve observation of a higher proportion of hooks without potentially compromising other duties (paragraph 3.51).

7.27 This problem was compounded this year by the fact that a disproportionate amount of the observed seabird by-catch was reported on vessel cruises with low proportions of hooks observed (e.g. Subareas 58.6/58.7: *Aquatic Pioneer* cruise 3 (10%); *Eldfisk* Cruise 3 (17%); *Koryo Maru 11* cruise 2 (27%)).

7.28 The average proportion of hooks observed (percentages with ranges in parenthesis) over the last four years, for Subareas 48.3, 58.6/58.7 and 88.1 has been as follows:

1997: 48.3 – 34 (5–100); 58.6/58.7 – 60 (15–100);
1998: 48.3 – 24 (1–57); 58.6/58.7 – 43 (14–100);
1999: 48.3 – 25 (10–91); 58.6/58.7 – 34 (13–62); 88.1 – 31 (29–32); and
2000: 48.3 – 24 (11-39); 58.6/58.7 – 42 (10–91); 88.1 – 33 (29–58).

The Working Group understood that the consistently higher values for Subareas 58.6 and 58.7 reflected, at least in part, the use of two observers. The Working Group commended this practice.

7.29 The Working Group expressed disappointment at the continued incorrect reporting of the proportion of hooks observed for seabird by-catch. It was apparent from the data presented that some observers continue to record the number of hooks hauled while they are undertaking biological work, rather than the number of hooks directly observed. For example, in the 2000 data for Subareas 58.6/58.7, the reported value of 91% was found actually to have been 3.7% (Technical Coordinator, South Africa). This problem with the data means that many estimates of seabird by-catch provided to the Working Group are likely to be underestimates.

7.30 The Working Group reiterated (see SC-CAMLR-XVIII, Annex 5, paragraph 7.33) that the level of sampling effort required to estimate seabird mortality should be investigated using existing data and simulation models. This work, which should be undertaken in the intersessional period, should consider the resolution and accuracy of estimates of seabird by-catch rates under various levels of observed by-catch rates.

7.31 The total catch rates were calculated using the total numbers of hooks observed and the total seabird mortality observed (Table 48). No incidental mortality was observed for Subarea 88.1 or Division 58.4.4. The estimated total catch of seabirds by vessel was calculated using the vessel's catch rate multiplied by the total number of hooks set. For those vessels where logbook data for calculating catch rates were unavailable, the catch rate was calculated using the information contained in the observer cruise reports.

Subarea 48.3

7.32 The overall catch rate of birds killed in Subarea 48.3 was 0.0004 birds/thousand hooks; during daylight setting the rate (0.002 birds/thousand hooks) was higher than that for night setting (0.0002 birds/thousand hooks).

7.33 The total estimated seabird mortality in Subarea 48.3 for this season was 21 birds (Table 49), compared with 210 for the previous season. Of the six birds observed killed, half were southern giant petrels (*Macronectes giganteus*); the remainder were equally divided between black-browed albatrosses (*Diomedea melanophrys*), northern giant petrels (*Macronectes halli*) and cape petrels (*Daption capense*) (Table 50).

Subareas 58.6 and 58.7

7.34 For Subareas 58.6 and 58.7, the overall catch rate of birds killed was 0.022 birds/thousand hooks; during daylight setting the rate (0.013 birds/thousand hooks) was significantly lower than that for night setting (0.027 birds/thousand hooks) (Table 51) (see also paragraph 7.41).

7.35 The total estimated seabird mortality in Subareas 58.6 and 58.7 for this season was 516 birds, a three-fold increase compared with the previous season. The white-chinned petrel (*Procellaria aequinoctialis*) was the most commonly observed species killed, comprising 90% of the total seabird mortality (Table 50).

7.36 Further analysis of seabird by-catch in the South African EEZ around the Prince Edward Islands was presented in WG-FSA-00/30. This paper reports on the observer data from 11 fishing trips involving a fishing effort of 7.4 million hooks, up 45% from the 1998/99 season. During 1999/2000, 268 seabirds from six species were reported killed. White-chinned petrels comprised 92% of the total, with smaller numbers of Indian yellow-nosed albatross (*Diomedea chlororhynchos*) and grey-headed albatross (*Diomedea chrysostoma*), grey petrels (*Procellaria cinerea*) and giant petrels.

7.37 The average catch rate was 0.036 birds/thousand hooks, more than double that in 1998/99 (0.016), but considerably lower than the values recorded in either 1997/98 (0.117) or 1996/97 (0.289). By-catch rate varied greatly among trips, but only one trip had a by-catch rate exceeding 0.1 birds/thousand hooks. Just over 2 million hooks were set through the Mustad funnel fitted to the *Eldfisk*, significantly reducing by-catch rates in comparison with daytime sets when the funnel was not in use (see paragraph 7.117). Excluding these sets, the mean by-catch rate was 0.043 birds/thousand hooks (233 birds killed on 5.36 million hooks).

7.38 Seabirds were killed during 134 of 1 748 sets (7.7%), with 68% of birds killed on only 49 sets (2.8%) that had multiple casualties. With the exception of grey petrels (all killed June–September), most birds were caught in summer. The highest by-catch rate was in early summer (October–November) during the pre-laying and early incubation period of white-chinned petrels.

7.39 Time of setting was another important determinant of seabird by-catch. Thus, 21.2% of sets (20.3% of hooks) were set during the day or spanned nautical dawn or dusk. Excluding all underwater sets, the by-catch rate for day sets (0.065 birds/thousand hooks) was almost twice that of night sets (0.038). As was the case in previous years, the seabird by-catch rate showed peaks around dusk and dawn.

7.40 Most fishing effort took place >200 km from the islands. Bird by-catch was greatest between 100 and 200 km from the island due to a peak in white-chinned petrel mortality in this region. Four of the five grey petrels were killed >200 km from the islands, but other species were mostly caught close to the islands (<100 km). The by-catch rate also varied as a function of wind strength. Most birds were killed during sets made at moderate wind speeds (force 4–5). However, the by-catch rate was greatest in calm conditions at night, and at stronger wind speeds during the day.

7.41 The Working Group noted differences between WG-FSA-00/30 and 00/37 in respect of data from Subareas 58.6 and 58.7, which reflected that:

(i) WG-FSA-00/30 included reports of dead birds not directly recorded by the observer, resulting in higher by-catch totals and rates; and

(ii) different definitions of day and night with respect to time of line setting (in WG-FSA-00/37 dusk and dawn was included in daylight, whereas in WG-FSA-00/30 most dusk and dawn periods were included in night time) resulting in different conclusions on by-catch rates in day and night periods.

7.42 Both analyses, however, indicated that:

(i) by-catch levels had increased (over 1999 values) to values similar to those in 1997 and 1998, presumably due to the increased fishing effort;

(ii) by-catch rates had shown no reduction – and possibly even an increase – compared to 1999 values; and

(iii) by-catch rates were still consistently higher than those in Subarea 48.3.

7.43 The differences in by-catch rates between Subarea 48.3 and Subareas 58.6 and 58.7 were clearly attributable to:

(i) vessels in the latter subareas fishing in close proximity to major breeding sites of albatrosses and petrels during their breeding season; and

(ii) poor compliance with night-time setting requirements.

7.44 The Working Group reaffirmed its recommendations from last year (SC-CAMLR-XVIII, Annex 5, paragraph 7.46) that:

(i) reduction in the by-catch rate would likely be achieved by elimination of daytime setting and by line-weighting regimes that comply with Conservation Measure 29/XVI; and

(ii) fishing within 200 n miles of the Prince Edward Islands should be prohibited from January to March inclusive.

7.45 The Working Group expressed regret that, once again, no data on seabird by-catch from fishing operations within the French EEZ in Subarea 58.6 had been submitted to the meeting. It reiterated its request to France to submit such data in order to assist the Working Group in conducting comprehensive evaluations.

Division 58.5.1

7.46 The Working Group expressed regret that, once again, no data on seabird by-catch from fishing operations within the French EEZ in Division 58.5.1 had been submitted to the meeting. It reiterated its request to France to submit such data in order to assist the Working Group in conducting comprehensive evaluations.

Subarea 88.1

7.47 For the third successive season, observers reported no seabird by-catch in association with longline fishing carried out in this subarea by New Zealand (WG-FSA-00/56). The data on seabird species and numbers associated with the fishing vessels, however, emphasised that potential for by-catch exists if mitigating measure requirements were less stringent. This year, in addition to continuing to use streamer lines that met all specifications in Conservation Measure 29/XVI, no offal discharge was made at any time during the cruise, in full compliance with Conservation Measure 190/XVIII. In previous years some offal and by-catch had been stored and discharged only when the vessel was not engaged in fishing activities.

General

7.48 Table 52 summarises data on seabird by-catch and by-catch rates for the last four years (1997–2000) for the best-documented subareas.

7.49 In Subarea 48.3 the total estimated seabird by-catch in 2000 was 10% of that in 1999 and 4% of that in 1997. By-catch rates in 2000 were 0.05% of those in 1997. These changes, achieved in large part by restricting fishing to winter months, but also by improved compliance with Conservation Measure 29/XVI, particularly night setting, have culminated in reducing seabird by-catch in the regulated fishery to negligible levels.

7.50 In Subareas 58.6 and 58.7 the total estimated seabird by-catch in 2000 increased three-fold compared to 1999, reverting to values similar to 1998; the by-catch rate, however, was 27% lower than the 1999 value. The increased by-catch in 2000 is likely due to increased fishing effort, although compliance with Conservation Measure 29/XVI was slightly worse in 2000 than in 1999. By-catch rates in these subareas are unlikely to be reduced further either:

(i) as long as fishing is undertaken during the breeding seasons of the seabird species mainly at risk; or

(ii) until more effective mitigation measures (e.g. fully effective underwater setting and/or line weighting) can be developed and used.

Compliance with Conservation Measure 29/XVI

7.51 Compliance with this conservation measure this year, as set out in WG-FSA-00/38, is summarised in Table 53, in comparison with similar data from previous years.

Streamer Lines

7.52 Compliance with the streamer-line design was poor and only 33% of the streamer lines deployed complied fully with the specifications in Conservation Measure 29/XVI (Table 54). The length of most of the streamer lines was less than 150 m and this continues to be the main reason for the low compliance. All of the streamer lines deployed in Subareas 58.6 and 58.7 and Division 58.4.4 were less than 150 m in length, and only 25% of the lines used in Subarea 48.3 and 67% of the lines in Subarea 88.1 were greater than 150 m in length (but see footnote to Table 53). Some vessels have persistently poor compliance with this element of the conservation measure (e.g. *Aquatic Pioneer*, *Argos Helena*, *Eldfisk*, *Illa de Rua, Isla Gorriti, Lyn, Jacqueline, Magallanes III, No. 1 Moresko* and *Tierra del Fuego*). Compliance with other elements such as the attached height of the line and the number and spacing of streamers per line remains high (85–100%). Nineteen observers indicated that spare streamer-line material was present on board.

Offal Discharge

7.53 In Subareas 58.6, 58.7 and 88.1 there was 100% compliance with the requirement either to hold offal on board, or to discharge on the opposite side to where the line was hauled. In Subarea 48.3, 76% of the vessels discharged offal on the opposite side to hauling (compared with 71% in 1999); of these vessels 50% did not discharge offal during hauling operations.

7.54 In Subarea 48.3 four vessels (*Faro de Hercules*, *Isla Sofía*, *Isla Camila* and *Jacqueline*) are still operating with offal discharge on the same side as the haul, in contravention of Conservation Measure 29/XVI.

Night Setting

7.55 Compliance with night setting has improved in Subarea 48.3 from 80% last season to 92% this season. In Subareas 58.6 and 58.7 compliance fell slightly from 84% to 72% this season. Night setting for the new fishery in Division 58.4.4 was only 50%.

7.56 Vessels which have fished for at least three cruises in two years and consistently failed to comply with this element of the conservation measure include the *Eldfisk*, *Isla Camila, Isla Gorriti* and *Tierra del Fuego*.

7.57 Fishing in Subarea 88.1 (where only 6% of lines were set at night) operated under Conservation Measure 190/XVIII which contained an exemption from night-setting requirements for vessels south of 65°S in order to conduct line-weighting trials.

Line Weighting

7.58 As in previous years, no vessels complied with line weighting for Spanish longline systems (6 kg every 20 m). The median weight and line spacing for Subareas 48.3, 58.6, 58.7 and Division 58.4.4 was 6 kg every 44 m, 6 kg every 88 m and 5 kg every 45 m respectively.

Thawed Bait

7.59 This year two vessels were reported to have used frozen bait regularly; up to 68% of the lines on the *Aquatic Pioneer* and 34% of the lines on the *RK-1* were set with frozen bait. The Working Group noted that there are technical problems for autoline vessels using fully thawed baits, and that the use of partially thawed baits on autoline vessels was unlikely to adversely affect autoline sink rate.

General

7.60 Details of compliance with streamer line, offal discharge and night-setting requirements of Conservation Measure 29/XVI are summarised on a vessel-specific basis in Table 55. In addition to the persistent compliance failures summarised in paragraphs 7.52, 7.54 and 7.56, this also reveals that several vessels which first entered longline fisheries in the Convention Area in 2000 failed to comply with one (*Faro de Hercules*) or two (*Isla Alegranza* and *Isla Santa Clara*) of these three elements of the conservation measure.

Fishing Seasons

7.61 Last year the Commission decided that the timing of the fishing season for longlining in Divisions 58.4.3, 58.4.4, 58.5.1, 58.5.2 and Subareas 48.3, 48.4 and 58.6 should be changed from 15 April–31 August to 1 May–31 August (CCAMLR-XVIII, paragraph 9.3).

7.62 Only for Subarea 48.3 are sufficient data available to the Working Group to assess the impact this change might have had on seabird by-catch.

7.63 If, in previous years, the fishing season in Subarea 48.3 had opened on 1 May rather than 15 April, then the proportion of mortality occurring at or after the latter date, that would have been avoided, is as follows:

1996 – 71% (58 of 82 birds)
1997 – 43% (103 of 239 birds)
1998 – 23% (18 of 80 birds)
1999 – 36% (21 of 59 birds).

This suggests that the delay in starting the fishing season for longlining in 2000 had a significant beneficial effect on seabird by-catch.

Incidental Mortality of Seabirds during Unregulated Longline Fishing in the Convention Area

Unregulated Seabird By-catch

7.64 As no information is available on seabird by-catch rates from the unregulated fishery, estimates have been made using both the average by-catch rate for all cruises from the appropriate period of the regulated fishery and the highest by-catch rate for any cruise in the regulated fishery for that period. Justification for using the worst by-catch rate from the regulated fishery is that unregulated vessels accept no obligation to set at night, to use streamer lines or to use any other mitigation measure. Therefore by-catch rates, on average, are likely to be considerably higher than in the regulated fishery. For Subarea 48.3, the worst-case by-catch rate was nearly four times the average value and applies only to a single cruise in the regulated fishery. Using this by-catch rate to estimate the seabird by-catch rate of the whole unregulated fishery may produce a considerable overestimate.

7.65 In view of the fact that:

(i) seabird by-catch rates in the regulated fishery have been reduced substantially since 1997 due to much better compliance with CCAMLR conservation measures, including those relating to closed seasons; and

(ii) it is unreasonable to assume that the unregulated fishery made comparable improvements to the timing and practice of its operations;

the Working Group decided that it should continue to use the seabird by-catch rates from 1997, as was done in this assessment last year. The assessment this year, therefore, followed the identical procedure to that used last year (SC-CAMLR-XVIII, Annex 5, paragraphs 7.60 to 7.62).

Unregulated Effort

7.66 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.

Catch rates for Divisions 58.4.4 and 58.5.2 were assumed to be identical to those for Division 58.5.1.

7.67 The fishing year was divided into two seasons, a summer season (S: September–April) and a winter season (W: May–August), corresponding to periods with substantially different seabird by-catch rates. There is no empirical basis on which to split the unregulated catch into summer and winter components. Three alternative splits (80:20, 70:30 and 60:40) were used.

7.68 The seabird by-catch rates used were:

Subarea 48.3 –
summer: mean 2.608 birds/thousand hooks; maximum 9.31 birds/thousand hooks;
winter: mean 0.07 birds/thousand hooks; maximum 0.51 birds/thousand hooks.

Subareas 58.6, 58.7, Divisions 58.5.1 and 58.5.2 –
summer: mean 1.049 birds/thousand hooks; maximum 1.88 birds/thousand hooks;
winter: mean 0.017 birds/thousand hooks; maximum 0.07 birds/thousand hooks.

Division 58.4.4 –
summer: mean 0.629 birds/thousand hooks; maximum 1.128 birds/thousand hooks;
winter: mean 0.010 birds/thousand hooks; maximum 0.042 birds/thousand hooks.

Results

7.69 The results of these estimations are shown in Tables 56 and 57.

7.70 For Subarea 48.3, depending on the proportionate split of catches into summer and winter, estimates of the seabird by-catch in the unregulated fishery range from a lower level (based on the mean by-catch rate of regulated vessels) of 1 800–2 400 birds in summer (and 20–30 in winter) to a potentially higher level (based on the maximum by-catch rate of regulated vessels) of 6 400–8 600 birds in summer (and 120–230 in winter).

7.71 For Subareas 58.6 and 58.7 combined, depending on the proportionate split of catches into summer and winter, estimates of the seabird by-catch in the unregulated fishery range from a lower level (based on the mean by-catch rate of regulated vessels) of 15 300–20 500 birds in summer (and 80–140 in winter) to a potentially higher level (based on the maximum by-catch rate of regulated vessels) of 27 600–37 100 birds in summer (and 340–680 in winter).

7.72 Subarea 58.7, mainly due to low levels of fishing and catch rates of fish, makes rather little contribution to this year's total.

7.73 For Divisions 58.5.1 and 58.5.2, depending on the proportionate split of catches into summer and winter, estimates of the seabird by-catch in the unregulated fishery range from a lower level (based on the mean by-catch rate of regulated vessels) of 7 600–10 200 birds in summer (and 40–80 in winter) to a potentially higher level (based on the maximum by-catch rate of regulated vessels) of 13 900–18 600 birds in summer (and 170–340 in winter).

7.74 For Division 58.4.4, depending on the proportionate split of catches into summer and winter, estimates of the seabird by-catch in the unregulated fishery range from a lower level (based on the mean by-catch rate of regulated vessels) of 1 700–3 000 birds in summer (and 10–20 in winter) to a potentially higher level (based on the maximum by-catch rate of regulated vessels) of 2 200–4 000 birds in summer (and 40–70 in winter).

7.75 The overall estimated totals for the whole Convention Area (Tables 56 and 57) indicate a potential seabird by-catch in the unregulated fishery of 26 400–35 300 (lower level) to 50 900–68 300 birds (higher level) in 1999/2000.

7.76 This compares with totals of 17 000–27 000 (lower level) to 66 000–107 000 (higher level) in 1996/97; 43 000–54 000 (lower level) to 76 000–101 000 (higher level) in 1997/98; and 21 000–29 000 (lower level) to 44 000–59 000 birds (higher level) in 1998/99. Attempts to draw inferences regarding changes in by-catch levels in the IUU fishery should be viewed with caution, given the uncertainties and assumptions involved in these calculations.

7.77 Note that the lower level value for 1998/99 in paragraph 7.76 has been corrected (from 18 000–24 000) because an incorrect seabird by-catch rate (0.049 instead of 1.049) was inadvertently used last year in the estimation of mean values for Subareas 58.6 and 58.7 and Divisions 58.5.1 and 58.5.2.

7.78 The composition of the estimated potential seabird by-catch based on data from 1997 is set out in Table 58. This indicates a potential by-catch in 1999/2000 of 7 000–15 000 albatrosses, 1 000–2 000 giant petrels and 19 000–37 000 white-chinned petrels in the unregulated fishery in the Convention Area.

7.79 As in the last three years, it was emphasised that the values in Tables 56 to 58 are very rough estimates (with potentially large errors). The present estimates should only be taken as indicative of the potential levels of seabird mortality occurring in the Convention Area due to unregulated fishing and should be treated with caution.

7.80 Nevertheless, even taking this into account, the Working Group endorsed its conclusions of recent years that such levels of mortality are entirely unsustainable for the populations of albatrosses and giant and white-chinned petrels breeding in the Convention Area.

Summary Conclusion

7.81 WG-IMALF once again urgently drew the attention of WG-FSA, the Scientific Committee and the Commission to the numbers of albatrosses and petrels being killed by unregulated vessels fishing in the Convention Area. In the last four years, an estimated total of 237 000 to 333 000 seabirds have been killed by these vessels. Of these:

(i) 21 900–68 000 were albatrosses, including individuals of four species listed as globally threatened (vulnerable) using the IUCN threat classification criteria (BirdLife International, 2000);

(ii) 5 000–11 000 were giant petrels, including one globally threatened (vulnerable) species; and

(iii) 79 000–178 000 were white-chinned petrels, a globally threatened (vulnerable) species.

7.82 These levels of loss of birds from the populations of these species and species-groups is broadly consistent with such data as exist on the population trends of these taxa, including deterioration in conservation status as measured through the IUCN criteria.

7.83 These and several other albatross and petrel species are facing potential extinction as a result of longline fishing. The Working Group again urgently requested the Commission to take action to prevent further seabird mortality by unregulated vessels in the forthcoming fishing season.

Incidental Mortality of Seabirds in relation to New and Exploratory Fisheries

New and Exploratory Longline Fisheries Proposed in 2000

7.84 As in previous years concerns were raised relating to the numerous proposals for new fisheries and the potential for these new and exploratory fisheries to lead to substantial increases in seabird incidental mortality.

7.85 In order to address these concerns, the Working Group prepared assessments for relevant subareas and divisions of the Convention Area in relation to:

(i) timing of fishing seasons;
(ii) need to restrict fishing to night time; and
(iii) magnitude of general potential risk of by-catch of albatrosses and petrels.

7.86 The Working Group again noted that the need for such assessments would be largely unnecessary if all vessels were to adhere to all elements of Conservation Measure 29/XVI. It is considered that these measures, if fully employed, and if appropriate line-weighting regimes could be devised for autoliners, should permit longline fishing activities to be carried out in any season and area with negligible seabird by-catch.

7.87 In 1999 the Working Group carried out comprehensive assessments on the potential risk of interaction between seabirds, especially albatrosses, and longline fisheries for all statistical areas in the Convention Area. These assessments were combined into a background document for use by the Scientific Committee and Commission (SC-CAMLR-XVIII/BG/23). It was agreed in 1999 that this document should be tabled and updated annually for the Scientific Committee.

7.88 This year new data on at-sea distribution of albatrosses and petrels were provided in WG-FSA-00/56. New data on at-sea distribution from satellite-tracking studies were also obtained from Terauds (2000). This information was used to update the assessment of potential risk of interaction between seabirds and longline fisheries for Subareas 88.1 and 88.2. The revised assessments for these areas are set out below (with changes/additions underlined):

(i) Subarea 88.1:

Breeding species in this area: none.

Breeding species known to visit this area: Antipodean albatross from Antipodes Island, black-browed albatross, grey-headed albatross and light-mantled albatross from Macquarie Island.

Breeding species inferred to visit this area: light-mantled albatross from Auckland, Campbell and Antipodes Islands; sooty albatross from Indian Ocean populations; grey-headed albatross and Campbell albatross from Campbell Island; wandering albatross from Macquarie Island; Chatham albatross from Chatham Islands; northern giant petrel from Macquarie, Auckland and Campbell Islands; southern giant petrel from Macquarie Island; and grey petrel from Macquarie Island and New Zealand populations.

Other species: short-tailed shearwater, sooty shearwater.

Assessment: the northern part of this area lies within the foraging range of eight albatross species (seven threatened) and is probably used by other albatrosses and petrels to a greater extent than the limited available data indicate. The southern part of this subarea has potentially fewer seabirds at risk.

Advice: average risk overall. Average risk in northern sector (*D. eleginoides* fishery), average to low risk in southern sector (*D. mawsoni* fishery); longline fishing season limits of uncertain advantage; the provisions of Conservation Measure 29/XVI should be strictly adhered to.

(ii) Subarea 88.2

Breeding species in this area: none.

Breeding species known to visit this area: grey-headed albatross and light-mantled albatross from Macquarie Island.

Breeding species inferred to visit this area: light-mantled albatross from Auckland, Campbell and Antipodes Islands; Antipodean albatross from Antipodes Island; grey-headed albatross and Campbell albatross from Campbell Island; wandering albatross and black-browed albatross from Macquarie Island; grey petrel and white-chinned petrel from New Zealand populations.

Other species: sooty shearwater.

Assessment: although there are few observational data from this area, the northern part of this area lies within the suspected foraging range of six albatross species (five threatened) and is probably used by other albatrosses and petrels to a greater extent than the limited available data indicate. The southern part of this subarea has potentially fewer seabirds at risk.

Advice: low risk. No obvious need for restriction of longline fishing season; apply Conservation Measure 29/XVI as a seabird by-catch precautionary measure.

7.89 Because the revisions to the assessments are not extensive, the Working Group did not feel there was a need to produce a revised version of SC-CAMLR-XVIII/BG/23 this year. However, it drew to the attention of the Scientific Committee and Commission that in Figure 1 of SC-CAMLR-XVIII-BG/23 the codes for potential risk of interaction with seabirds for Subareas 48.1 and 48.4 should be 1 and 3 respectively (not 2 as depicted).

New and Exploratory Longline Fisheries Operational in 1999/2000

7.90 Of the 22 proposals last year for new and exploratory longline fisheries, only four were actually undertaken: by Uruguay in Division 58.4.4, by France and by South Africa in Subarea 58.6 and by New Zealand in Subarea 88.1.

7.91 No seabird by-catch was reported to have been observed in any of these fisheries. Those in Division 58.4.4 and Subarea 58.6 were undertaken in winter. That in Subarea 88.1 followed the specific requirements set out in Conservation Measure 190/XVIII, the results being described in detail in CCAMLR-XIX/17 and WG-FSA-00/37.

New and Exploratory Longline Fisheries for 2000/01

7.92 The areas for which proposals for new and exploratory longline fisheries were received by CCAMLR in 2000 were:

Subarea 48.1	Argentina
Subarea 48.2	Argentina
Subarea 48.6	Argentina, Brazil, South Africa
Division 58.4.1	Argentina
Division 58.4.2	Argentina
Division 58.4.3	Argentina, France
Division 58.4.4	Argentina, Brazil, France, South Africa, Ukraine, Uruguay
Division 58.5.1	Argentina, Brazil, France
Division 58.5.2	Brazil, France
Subarea 58.6	Argentina, France, South Africa
Subarea 58.7	France
Subarea 88.1	Argentina, New Zealand, South Africa, Uruguay
Subarea 88.2	Argentina, South Africa, Uruguay
Subarea 88.3	Argentina, Uruguay.

7.93 All the areas listed above were assessed in relation to the risk of seabird incidental mortality according to the approach and criteria set out in paragraph 7.85, SC-CAMLR-XVIII/BG/23 and paragraph 7.88. A summary of risk level, risk assessment, WG-IMALF recommendations relating to fishing season and any inconsistencies between these and the proposals for new and exploratory longline fisheries in 2000, is set out in Table 59.

New Zealand Proposal in respect of Subarea 88.1

7.94 The Working Group noted New Zealand's request for a continuation of the variation to Conservation Measure 29/XVI for Subarea 88.1, as provided for previously by Conservation Measures 169/XVII and 190/XVIII. The variation is to allow line-weighting experiments to continue south of 65°S in Subarea 88.1 (CCAMLR-XVIII/10 and CCAMLR-XIX/17). Conservation Measures 169/XVII and 190/XVIII allowed New Zealand vessels to set lines during the daytime south of 65°S in Subarea 88.1 if vessels weighted their lines and achieved a minimum sink rate of 0.3 m/s for all parts of the longline. The variation was sought because during austral summer (December to March) there are insufficient periods of darkness at these latitudes for exploratory fishing to occur.

7.95 In 1998 the Working Group noted that line weighting has the best potential as an alternative mitigation measure, and noted the need to urgently gain information on longline sink rates. Accordingly, the Working Group supported the New Zealand proposal. In 1999 the Working Group noted that the experiment had been conducted successfully in the 1998/99 season, no seabird mortality had occurred and that valuable data had been collected on autoline sink rates. However, the Working Group noted that operational issues needed to be further investigated and more data collected. The Working Group again supported the proposal to allow a variation to Conservation Measure 29/XVI for this experiment.

7.96 The Working Group assessed the current proposal (CCAMLR-XIX/17) on the basis of data provided in WG-FSA-00/58. The model presented is now well developed, but requires further data on variation in weight-spacing regimes to be useful for monitoring line sink rates without mechanical verification.

7.97 The Working Group noted that, with this further experimentation, it should be possible to specify line-weighting regimes for autoline vessels which, in conjunction with all other mitigating measures, should enable these vessels to fish during daylight with zero, or insignificant, by-catch of seabirds, at least in areas of average (or lower) risk (see also paragraph 7.148).

7.98 The Working Group, therefore, strongly supported the New Zealand proposal for a variation to Conservation Measure 29/XVI for those New Zealand flagged vessels prepared to undergo line sink-rate certification and comply with all experimental protocols.

7.99 The Working Group noted that the proposals for longline fishing in Subarea 88.1 by Argentina, South Africa and Uruguay did not contain any proposal for line-weighting (or other) experiments in support of any potential exemption from the night-setting provision contained in paragraph 3 of Conservation Measure 29/XVI.

7.100 The Working Group recommended that any other vessels allowed to conduct longline fishing in Subarea 88.1 should meet the same requirements as set out in paragraph 7.98.

7.101 The Working Group also noted the proposal by New Zealand to place a limit on any potential seabird by-catch during the daylight setting variation to Conservation Measure 29/XVI on a per-vessel basis. Any vessel catching three seabirds would have to revert immediately to Conservation Measure 29/XVI.

7.102 The Working Group endorsed this proposal, noting that placing a limit on a per-vessel basis was a commendable way of encouraging greater responsibility at the level of individual vessels. Further, the Working Group agreed with the limit of three seabirds per vessel proposed by New Zealand, whilst noting this number was not a scientific estimation of an appropriate level of seabird by-catch, but a precautionary small number.

7.103 The Working Group recommended that any other vessels allowed to conduct longline fishing in Subarea 88.1 should be subject to the same seabird by-catch limit, and consequential requirements, as set out in paragraph 7.101.

Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area

7.104 WG-FSA-00/13 evaluated interactions between seabirds and longline fisheries operating around Tristan da Cunha and Gough Islands. The demersal fisheries for bluefish and alfoncino, despite setting in daytime and attracting many birds (including albatrosses), had an observed by-catch rate of 0.001 birds/thousand hooks. In contrast, limited observations on board a Japanese autoliner longline fishing in winter for tuna, suggested that by-catch rates may exceed 1 bird/thousand hooks. Black-browed albatross (probably from the South Georgia population) was the only species observed caught. However at other times of year, the globally endangered Tristan albatross

(*Diomedea dabbenena*) and the globally critically endangered spectacled petrel (*Procellaria conspicillata*) would be potentially at high risk.

7.105 The Working Group endorsed the recommendations in WG-FSA-00/13 that tuna longliners operating in these waters should be required to apply mitigating measures, preferably identical to those required for high-risk areas within the Convention Area.

7.106 It was disturbing to note the lack of any measures to reduce seabird by-catch on Japanese longliners, as the Working Group understood, from previous reports by Japan to ICCAT and CCSBT, that these vessels were required to use at least streamer lines wherever and whenever fishing.

7.107 Mr Smith reported that New Zealand continued to undertake observations of both pelagic and demersal longline fisheries. Records of actual by-catch numbers observed and, where possible, estimates of total seabird by-catch continue to be made annually and are available in Baird (2000).

7.108 Mr Baker reported that no Australian longline observer program had been in operation last year. Previous years' experiences had been reported in detail in SC-CAMLR-XVIII, Annex 5, paragraphs 7.96 to 7.100.

7.109 The Working Group regretted the absence of other data from Members on incidental mortality of seabirds, especially for regions adjacent to the Convention Area, such as southern South America and the Falkland/Malvinas Islands.

7.110 Prof. Croxall indicated that some relevant data, particularly from Argentina and Brazil, had been presented at the Albatross Conference in Hawaii, USA (paragraph 7.20), and at a recent Marine Science Congress in Argentina. He would try to arrange the circulation of such information intersessionally.

7.111 The Working Group regretted that so little information had been forthcoming from areas adjacent to the Convention Area on topics of considerable significance, viz:

(i) longline fishing effort;
(ii) incidental mortality of seabirds breeding within the Convention Area; and
(iii) implementation of the provisions of Conservation Measure 29/XVI in adjacent fisheries.

7.112 The Working Group reiterated the request to Members to provide such data to the next meeting of WG-IMALF.

Research into and Experience with Mitigating Measures

Offal Discharge

7.113 In Subarea 48.3 four vessels were discharging offal on the same side as the haul, in contravention of Conservation Measure 29/XVI (paragraph 7.56). Three of these vessels (*Isla Sofía*, *Isla Camila* and *Jacqueline*) have persisted with the practice for the last three years.

7.114 Offal discharge should be on the opposite side of the haul irrespective of whether or not offal is stored during line hauling. On long cruises, vessels may not have the freezer capacity to freeze and store offal for discharge at the end of the cruise (200 tonnes of toothfish might accrue 80 tonnes of offal). The retention of offal on a daily basis might also present problems, particularly during periods of high fish catch rates and production of offal. Unless under strict observation, the incentive will be great to jettison offal as it is accrued during the fishing operation. This problem can be rectified if vessels re-engineer offal dumping facilities to discharge offal on the opposite side to the line-hauling site of vessels. Re-engineering offal discharge facilities will also result in vessels discharging offal in a seabird-safe manner when vessels leave the Convention Area for other fishing grounds.

7.115 Offal discharge sites should be re-engineered according to the engineering diagrams of the *Koryo Maru 11* (SC-CAMLR-XVIII, Annex 5, paragraph 7.110).

7.116 In Subarea 88.1 the three New Zealand vessels achieved full compliance with the conservation measure by processing offal into fish meal on board, or returning all offal to port for onshore processing into fish meal. This includes all baits returned on board and removed from hooks. Other vessels should be encouraged to adopt the same solution to the problem.

Underwater Funnel

7.117 WG-FSA-00/29 reported that in Subareas 58.6 and 58.7, the *Eldfisk* used a Mustad underwater funnel (setting the line 1–2 m underwater). It set 5.12 million hooks over a two-year period, the results of the first year being reported in WG-FSA-00/42 Rev. 1 (SC-CAMLR-XVIII, Annex 5, paragraph 7.122). Bait loss and fish catch rates were not affected by the use of the funnel. At night in summer, by-catch rates were 0.013 birds/thousand hooks when the funnel was not in use and 0.009 birds/thousand hooks when the funnel was in use. Comparable rates for summer daytime sets were 0.05 and 0.02 birds/thousand hooks for control and underwater setting respectively. Birds caught were white-chinned petrels (88% of the 114 birds killed).

7.118 The Working Group noted that this three-fold reduction in seabird by-catch rates when the funnel was in use is encouraging. However, the Mustad funnel is short, deploys bait above the propeller turbulence (forces baited hooks to the surface) and setting depth is affected by both swell height and the load status of the vessel (sits lower in the water if fully fuelled and has full freezers). To avoid these problems, underwater setting tubes should deploy baits beneath the propeller turbulence so that the turbulence forces the baits down.

7.119 WG-FSA-00/64 reported the results of preliminary trials (12 260 hooks) of an underwater setting tube in the Australian domestic tuna fishery. The tube set the line 6 m under water. A total of eight birds was caught during the development trials but none were caught once design and operational deficiencies were corrected. The results to date look promising. Potentially, for tuna fishing at least, setting lines deep under water (beneath propeller turbulence) could be the most effective measure to date to reduce seabird mortality.

7.120 WG-FSA-00/61 reported on several years of experimentation to reduce seabird by-catch (principally northern fulmars) in Norwegian longline fisheries. The results of trials with bird-scaring lines, an underwater setting tube and a line shooter were reported. Catches were 0–0.40 birds/thousand hooks when mitigation measures were tested and 0.55–1.75 birds/thousand hooks when no measures were employed. The setting funnel reduced by-catch by 72% (126 900 hooks in total) and the line shooter reduced by-catch by 59% (58 420 hooks in total).

7.121 It should be noted, however, that in the Norwegian fishery the dominant seabird species, the northern fulmar (*Fulmarus glacialis*), although very abundant, is not a proficient diver and is unable to ingest baited hooks whole. Most captures occur by birds getting hooked in the wing or body; the North Sea does not have albatross species or proficient divers like white-chinned petrels and grey petrels, whose interaction with fishing vessels is more difficult to mitigate. Nonetheless, the results of WG-FSA-00/61 are encouraging and if adopted in Norwegian longline fisheries, reduction of seabird by-catch would be expected to reach levels where potential threats to populations are eliminated.

Streamer Lines

7.122 In Norwegian trials (186 132 hooks in total) (WG-FSA-00/61), the most effective measure was the streamer line which reduced seabird by-catch by 98–100%. Significantly, the use of the bird-scaring line gave a 32% increase in fish catch compared to control sets, because fewer baits were lost to seabirds.

7.123 Because streamer lines may lose their effectiveness when line setting in crosswinds, the use of paired streamers lines, which should increase longline protection in this type of weather condition, should be investigated, particularly for vessels which fish in summer in Subareas 58.6 and 58.7. The USA recommends the use of paired streamer lines in the Gulf of Alaska halibut fishery.

7.124 To address this problem, New Zealand vessels in Subarea 88.1 use a boom and bridle system to allow the streamer line to be deployed directly over the longline being set, irrespective of the wind direction.

7.125 More attention is still needed to the correct design and deployment of streamer lines. As a minimum requirement, vessels must use streamer lines to CCAMLR specifications in regard to length, attachment height on vessels, number of streamers, length of streamers and distance between streamers. All these characteristics of streamer lines will have an important influence on the effectiveness of streamer lines in reducing seabird by-catch. Better provision should be made for observers to report on these characteristics of streamer lines.

Line Shooter

7.126 Norwegian trials (WG-FSA-00/61) also examined the effect of a line shooter on seabird by-catch rates. The line shooter reduced seabird by-catch by 59% (58 420 hooks), less than for streamer lines and the underwater funnel. Nevertheless, this device may have considerable utility as an auxiliary mitigating measure for autoline vessels.

Artificial Bait

7.127 WG-FSA-00/50 reported that no experiments testing the performance of natural and artificial baits regards attraction to seabirds have been conducted.

Line Weighting

7.128 WG-FSA-00/58 reported on the effect on longline sink rate of a range of environmental and operational issues of autoline vessels fishing in Subarea 88.1. Of the effects tested, added weight explained 72% of the variance in the sink rate of longlines to 15 m depth. Swell height and setting speed explained an additional 4% and 2% respectively. The results to date are preliminary, but when the work is completed the ensuing model will, potentially, eliminate the need to use time-depth recorders to estimate longline sink rates on autoline vessels.

Toothfish Pots

7.129 WG-FSA-00/23 reported on the use of pots to catch toothfish, as a method to avoid seabird by-catch, in Subarea 48.3. A total of 11 088 pots was deployed between 16 March and 11 May 2000. No seabirds were caught during the trial, although plenty of seabirds were available to interact with vessels. This suggests that the use of pots will eliminate seabird by-catch. However, present catch rates of toothfish were not commercially viable and there was a significant catch of crabs. Technological refinements are necessary before the feasibility of this fishing practice can be verified and further trials are planned.

Other Measures

7.130 Mr Smith reported that initial trials had been undertaken with a laser gun and aircraft spotlights within the New Zealand EEZ. The results were such that full trials were considered inappropriate as the measures appeared totally ineffective.

General

7.131 The Working Group considered a New Zealand report on the technical feasibility of video monitoring of seabird interactions on fishing vessels (WG-FSA-00/62). The study concluded that the technology is now available to go forward with this method, that the costs are still moderately high and that without suitable software the issue of viewing all footage onshore remains. However, the study suggests that the method is technically feasible and that a pilot trial should go ahead.

7.132 The Working Group cautioned that when considering the substitution of observers with video surveillance of fishing operations, there is enhanced potential for fishers to disguise by-catch events. For example, the practice in some fisheries of line-cutting prior to landing of a by-catch species (WG-FSA-98/31) could mean that the identity of by-catch could go unrecorded by video.

7.133 Nevertheless, the Working Group concluded that video monitoring of seabird interactions on fishing vessels could be very useful and possibly one way of increasing the proportion of hooks observed for seabird by-catch.

Policy Considerations in relation to Mitigating Measures and Conservation Measure 29/XVI

7.134 Conservation Measure 29/XVI is the key element in minimisation of incidental mortality of seabirds during longlining in the Convention Area.

7.135 Last year WG-FSA and the Scientific Committee advised the Commission (SC-CAMLR-XVIII, Annex 5, paragraph 7.150) that:

(i) sustained development of underwater setting offers the most likely medium- to long-term solution to the problem;

(ii) work to develop line-weighting regimes to ensure sink rates that will preclude seabirds accessing bait offers the best short-term solution, as well as the likelihood of permitting exemption from several other mitigating measures currently in use in the Convention Area; and

(iii) in the meantime, improved compliance with the existing suite of mitigation measures in Conservation Measure 29/XVI is essential.

7.136 Although there is still some continuing improvement in compliance with Conservation Measure 29/XVI – and simple means exist to improve this further – three important problems remain:

(i) how to get fishers to comply with the straightforward elements of the conservation measure, in respect of offal discharge, streamer lines and night setting;

(ii) how to tackle the consistent inability of vessels to comply with the element of the conservation measure that specifies the line-weighting regime for Spanish system longliners; and

(iii) how to develop the requirements for an appropriate line-weighting regime for autoliners.

7.137 Some suggestions on the way forward on these topics, including the potential for revision of elements of Conservation Measure 29/XVI, are set out below.

Offal Discharge

7.138 The Working Group noted the reluctance of some vessels fishing in the Convention Area to implement easy-to-achieve conservation measures such as discharging offal on the opposite side of the haul. Three vessels (*Isla Sofia*, *Isla Camila* and *Jacqueline*) continued to discharge offal on the same side as the haul, in direct contravention of Conservation Measure 29/XVI. Attention was drawn to this situation involving these three vessels last year (SC-CAMLR-XVIII, Annex 5, paragraph 7.110). This year the *Faro de Hercules* also discharged offal in a manner in contravention of the conservation measure. Reconfiguring vessels to comply with this measure is clearly feasible, as demonstrated by the compliance achieved by most vessels currently fishing in the Convention Area (i.e. in Subarea 48.3 no compliance in 1997; 76% compliance in 2000). The fact that the vessels mentioned above continue to be licensed each year is contrary to the expressed views of the Commission on this topic (CCAMLR-XVII, paragraph 6.42(i)). The Working Group reiterated that vessels which have proven unable or unwilling to comply with this provision of Conservation Measure 29/XVI should not be allowed to fish in the Convention Area.

Streamer Lines

7.139 Paragraph 7.125 indicates the importance of adhering strictly to the provisions of Conservation Measure 29/XVI in this regard, as a minimum requirement. Paragraphs 7.123 (use of paired streamer lines) and 7.124 (device to centre a streamer line over the longline) indicate potential improvements to the nature and operation of streamer lines which could be reflected in some future revision of the conservation measure. Members are urged to test these potential improvements and report to the Working Group on their efficacy.

Night Setting

7.140 The Working Group reiterated the importance of avoiding setting during daylight, and in particular during dusk and dawn, as many species, particularly white-chinned petrels, are very active at these times.

7.141 It is possible that part of the failure to comply with this measure reflects uncertainty over the definition of the light levels that constitute the beginning and end of night. It was suggested that some simple device (e.g. light meter, Secchi disk) might be provided to give fishing masters and observers unambiguous empirical guidance as to when line setting should commence. Members were encouraged to investigate this further.

7.142 Even without such assistance, compliance with this element of the conservation measure – which is of particular importance – is very straightforward. Vessels which are unable or unwilling to comply should not be allowed to fish in the Convention Area.

Line Weighting – Spanish System

7.143 The current prescription for Spanish system longlining of a minimum of a 6 kg weight spaced every 20 m has proven consistently unattainable by any vessel since its introduction. Dr Robertson reported that correspondence with fishing masters indicated that 20 m weight spacing was insufficient to bridge undulations in bottom topography, causes line tangles during setting and hauling, and requires slower setting speeds and heavier mother lines.

7.144 Although none of these problems are incapable of solution, albeit at extra cost and effort to the fisher, the Working Group felt that there was a strong case for an interim relaxation of the current requirements of this element of Conservation Measure 29/XVI.

7.145 The Working Group recollected the line-weighting experiment carried out last year (SC-CAMLR-XVIII, Annex 5, paragraphs 7.111 to 7.115) which showed that increasing line weighting from 4.25 kg at 40 m to 8.5 kg at 40 m reduced bird mortality from 3.98 birds/thousand hooks to <1.0 birds/thousand hooks when setting during daylight in the breeding season of susceptible albatross and petrel species in Subarea 48.3.

7.146 In circumstances where all other elements of Conservation Measure 29/XVI apply (e.g. in respect of night setting, streamer lines and offal discharge) and with appropriate closed seasons, the Working Group recommended that the line-weighting regime for the Spanish system of longlining should be set at weights of a minimum of 8.5 kg spaced at no more than 40 m intervals.

7.147 Members, technical coordinators and observers were encouraged to report in detail on the use of, and compliance with, this requirement. Further experiments on line weighting were encouraged to try to develop a regime that might be appropriate for use at times of year other than winter and for times of day other than night time.

Line Weighting – Autoline System

7.148 Currently, Conservation Measure 29/XVI does not include a line-weighting requirement for autoline vessels. The Working Group noted New Zealand's proposed experimental work in Subarea 88.1 to complete a predictive model for autoline sink rates taking into account line weight and environmental variables. The Working Group strongly supported this initiative. It encouraged Members to conduct similar trials in areas where the interaction between albatrosses and diving species of petrels and longlines will be more difficult to mitigate. At the completion of such trials the Working Group should be in a good position to recommend a line weighting for autoline vessels that will have utility for all subareas of the Convention Area.

General Observations

7.149 The Working Group recommended that seabird by-catch in the Convention Area should be managed by measures adopted in Subarea 48.3, where in the 1999/2000 season with over 14 million hooks set only 21 seabirds were estimated to have been caught. In Subarea 48.3 the combination of a closed season in summer, night setting, the use of streamer lines and proper offal discharge practices has effectively solved the seabird by-catch problem.

7.150 The Working Group recognised that the ultimate aim in managing seabird by-catch in the Convention Area will be to allow fishing at any time of day without seasonal closure of fishing grounds. However, current indications are that allowing fishing in summer, at night, using streamer lines, proper offal discharge practices and c. 40 m between weights on longlines (current practice for Spanish system vessels) will still result in unacceptably high mortality of seabirds. Clearly, more time is required to allow experimentation into the effectiveness of line-weighting concepts and underwater setting devices with the Spanish system that will reduce seabird by-catch and be more acceptable to the fishing industry. In the meantime, the Working Group believed that seabird by-catch in the Convention Area should be managed in accordance with practices adopted in Subarea 48.3.

Vessel Accreditation

7.151 In spite of the successes in Subarea 48.3, best practice regarding the use of streamer lines, night setting and offal discharge procedures has not been achieved and should be, especially since these mitigating measures are simple and easy to use.

7.152 The Working Group therefore recommended that vessels should not be allowed to fish in the Convention Area unless they comply completely with all the elements of Conservation Measure 29/XVI relating to streamer lines, night setting and offal discharge.

7.153 The Working Group recommended that these requirements should be brought to the attention of technical coordinators (and through these to fishing companies and fishers) at the earliest opportunity after the conclusion of the Commission meeting this year. It should be made absolutely clear that vessels unable to comply with the elements of Conservation Measure 29/XVI relating to night setting, offal discharge and streamer lines should not expect to be allowed or licensed to fish in the Convention Area in 2000/01.

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

Workshop on Albatross and Petrel Mortality from Longline Fishing

7.154 This workshop, held in Hawaii, USA, in May 2000 and attended by approximately 75 biologists, resource managers and conservationists from many countries (including eight members of WG-IMALF), reviewed the effects of longlining on albatrosses and petrels on a global scale (SC-CAMLR-XIX/BG/12). The workshop made recommendations, relating to albatross research and conservation, in respect of:

(i) the use of appropriate multilateral, intergovernmental instruments, mechanisms and fora;

(ii) improved practical means to reduce seabird by-catch and promote their wide and effective use; and

(iii) enhanced monitoring of seabird by-catch and population trends, complemented by relevant research into population structure, dynamics and foraging ecology.

7.155 The workshop indicated that priorities for sustaining existing research and monitoring work, and developing new studies were:

(i) monitoring of status and trends of albatross populations, complemented by demographic research;

(ii) undertaking genetic studies to understand structure and stock identity within albatross species and populations;

(iii) collecting comprehensive data on by-catch rates and fishing effort; and

(iv) defining foraging ranges by age, sex and season, using new technologies, devices and analytical approaches.

7.156 In order to facilitate cooperation and information exchange throughout the international seabird research and conservation communities, the workshop recommended that the issue of seabird mortality in longline fisheries should be addressed by means of further national and international workshops and conferences. BirdLife International was invited, in the context of its 'Save the Albatross Campaign', to sponsor a workshop in 2001 among Latin-American states to address the issue of seabird by-catch in longline fisheries in that region.

7.157 The Working Group was informed that this workshop is to be held in Montevideo, Uruguay, and will be co-convened by Uruguayan and Brazilian scientists. Dates will be advised to CCAMLR as soon as they are available.

7.158 In respect of training scientific observers for longline fisheries, the Hawaiian workshop attempted to facilitate collaboration between New Zealand and South American countries. New Zealand funding for such initiative is understood to be available and it is hoped that a way to utilise this will be arranged at the Montevideo workshop.

FAO International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries (IPOA–Seabirds)

7.159 Last year Members were invited to report on progress in developing NPOA–Seabirds under the FAO–IPOA initiative (SC-CAMLR-XVIII, paragraph 4.75(i) and Annex 5, paragraph 7.131).

7.160 Mr Smith reported that New Zealand has completed its review of seabird interactions with longline fisheries as required by FAO. The review has resulted in the development of a draft NPOA–Seabirds. The draft has been circulated within New Zealand for consultation, and implementation is planned for early 2001. Copies are available from New Zealand and requests can be forwarded to <smithn@fish.govt.nz>.

7.161 Mr Baker reported that Australia's responsibilities in meeting the requirements of an NPOA are largely met by the implementation of the Threat Abatement Plan (TAP) for the incidental catch (or by-catch) of seabirds during oceanic longline fishing operations. This plan was prepared by the Australian Government following the listing in 1995 of longline fishing as a key threatening process under the *Endangered Species Protection Act 1992*.

7.162 The objective of the TAP is to reduce seabird by-catch in all fishing areas, seasons and fisheries to below 0.05 birds/thousand hooks, based on 1998 fishing levels. This represents a reduction of up to 90% of seabird by-catch within the Australian Fishing Zone (AFZ), and should be achievable within the five-year life of the plan. The TAP prescribes the actions necessary to achieve this objective.

7.163 Australia is still intending to prepare an NPOA. The main contribution of the NPOA will be to outline an approach by which the issue of seabird by-catch can be promoted through regional fisheries fora, including the facilitation of information exchange and mitigation technologies. It is expected that a draft document will be prepared by the end of the year.

7.164 For Brazil, Dr Fanta indicated that, as part of the initiatives being generated by new national committees responsible for fisheries and environmental matters, scientists with experience of longline fisheries and seabird interactions had been invited to collaborate in the preparation of a draft NPOA.

7.165 Prof. C. Moreno (Chile) indicated that he was responsible for coordinating the preparation of a draft NPOA for Chile.

7.166 Prof. Croxall reported that the European Community had recently decided to embark on an assessment of Community longline fisheries. A questionnaire had been circulated to members requesting information on the nature and extent of longline fishing (and associated incidental catches of seabirds) in the waters of European Community Member States and on the high seas, and what, if any, actions are being taken to address by-catch issues. It was hoped that the European Community would agree to produce a Community-based plan to ensure harmonisation among fleets operating in different European Community EEZs and regional seas. Some issues relating to operations regarding overseas territories may still need to be clarified.

7.167 Dr Holt reported that the USA draft NPOA would be completed by the end of 2000. Further details can be obtained from www.nmfs.noaa.gov or from <kim.rivera@noaa.gov>.

7.168 Norway was understood to be developing an NPOA but no details were available to the meeting.

7.169 No information on progress towards NPOAs was available for other CCAMLR Members. All Members were requested to provide WG-IMALF with information on the progress of their NPOAs, making copies as widely available as appropriate.

Convention on the Conservation of Migratory Species

7.170 The 6th Conference of Parties (COP) to the Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention), was held in South Africa in November 1997. Dr J. Cooper (South Africa) attended as an observer of the CCAMLR Scientific Committee. SC-CAMLR-XIX/BG/7 reports on discussions and outcomes of this conference which may be of interest to CCAMLR.

7.171 A proposal by South Africa to add five species of *Procellaria* and two species of *Macronectes* petrels to Appendix II of the CMS was accepted. This listing opens the way for the development of a Range-State Agreement to further their protection. At earlier meetings of the CMS Scientific Council the need for a Southern Hemisphere Albatross Agreement had been recognised. As albatrosses, *Procellaria* petrels and *Macronectes* petrels are all subject to incidental mortality arising from longline fishing, the moves by CMS to further the conservation and protection of these birds were welcomed by the Working Group.

Regional Agreement for the Conservation of Albatrosses

7.172 The WG-IMALF meeting in 1999 was informed of the efforts by the Group of Temperate Southern Hemisphere Countries (known as the Valdivia Group) to develop an agreement for the conservation of albatrosses in cooperation with other southern hemisphere albatross Range States. Members of the Valdivia Group are Argentina, Australia, Brazil, Chile, New Zealand, South Africa and Uruguay. The Working Group was advised of further actions to progress this initiative which have taken place over the last 12 months (CCAMLR-XIX/BG/10 and BG/15).

7.173 Following Resolution 6.3 at the 6th COP to the CMS in South Africa, Australia held a number of informal consultations with relevant Range States to discuss the development of an international Agreement on albatross conservation.

7.174 The positive outcomes of these consultations resulted in Australia hosting the first international meeting to which all southern hemisphere albatross and petrel Range States were invited. This meeting was held in Hobart, Australia, from 10 to 14 July 2000, and aimed to facilitate the development of an Agreement on the Conservation of Albatrosses and Petrels of the Southern Hemisphere. The meeting was a significant step towards effective global cooperation in albatross and petrel conservation. A total of 28 parties was invited to attend the meeting, including Range States and international organisations. Twelve Range States of southern hemisphere albatrosses and petrels and five international organisations attended the meeting. CCAMLR was represented by its Science Officer.

7.175 The meeting unanimously supported the fundamental principle of developing an international agreement focused on the conservation of albatrosses and petrels. The purpose of the agreement is to establish a cooperative and comprehensive framework and process to restore southern hemisphere albatrosses and petrels to a favourable conservation status. The agreement aims to stop or reverse population declines by coordinating action to mitigate known threats to albatross and petrel populations.

7.176 The general structure and format for an Action Plan (Annex 2 of the Agreement) was developed. The details of this Action Plan were subject to further consideration by participating parties, who were requested to provide comments to the Chair of the CMS Scientific Council by the end of September 2000. The Convener of WG-IMALF coordinated responses on the Action Plan from Working Group members.

7.177 All participants at the Hobart meeting (paragraph 7.174) agreed that a formal negotiation towards a legally binding agreement to promote albatross conservation should be the next step, and that this should occur as soon as practicable. South Africa has offered to host the next meeting, provisionally early next year. It is hoped that a technical meeting to further develop the content of the draft Action Plan could be held immediately prior to the proposed negotiation session.

7.178 The Working Group welcomed the progress made towards an agreement which had very substantial implications for the conservation of seabirds in marine and terrestrial ecosystems. It recommended that all Members of CCAMLR should participate actively in these meetings, especially by facilitating the attendance of appropriate technical and scientific experts.

International Fishers' Forum

7.179 The Working Group noted that New Zealand's International Fishers' Forum (IFF) on Solving the Incidental Capture of Seabirds in Longline Fisheries is to be held the week after the CCAMLR Commission meeting.

7.180 The forum will be an opportunity for fishers, gear technologists and researchers to meet and discuss mitigation measures used in longline fisheries around the world, and to learn about new measures currently under development. A second objective for the forum will be to address the use of modelling tools to predict the impact of fisheries on seabird species. Seabird modelling experts will report on projects undertaken to date and will consider questions posed by workshop participants.

7.181 The Working Group encouraged Member countries longlining in the Convention Area to facilitate the participation of other scientists, fishery managers and fishers in the IFF. It noted that several members of the Working Group would participate in the IFF.

Commission for the Conservation of Southern Bluefin Tuna (CCSBT)

7.182 No information was available this year to the Working Group from this Commission or from its Ecologically Related Species Working Group (ERSWG). It was understood that the ERSWG had not met in 2000.

Indian Ocean Tuna Commission (IOTC)

7.183 No information was available this year to the Working Group from this Commission.

General

7.184 Prof. Moreno summarised recent initiatives in Chile, under the auspices of WG-IMALF, which had arisen from the tri-nation collaborative project (involving Australia, Chile and the UK) of research on albatrosses at Islas Diego Ramirez.

7.185 Prof. Moreno, Drs J. Valencia (INACH) and Robertson held discussions with Mr D. Albarran Ruiz-Clavijo, Undersecretary of Fisheries and Chair of the Chilean CCAMLR Committee, to discuss potential Chilean activities to address incidental mortality of seabirds in longline fisheries.

7.186 The meeting had recollected the importance of Chilean waters and activities by Chilean fisheries with respect to albatrosses breeding at Chilean sites and to those visiting from elsewhere, particularly New Zealand.

7.187 It was agreed that:

(i) relevant data could be collected from Chilean artisanal longline fisheries and from the longline fisheries for hake in the southern channels (which are believed to have very low seabird by-catch rates due to using droplines);

(ii) future discussions and actions relating to incidental mortality should involve collaboration with the major commercial fishery interests;

(iii) a meeting would be held, before the end of 2000, with companies involved in southern demersal longline fisheries, to discuss how to reduce incidental mortality; and

(iv) legislation would be prepared to provide an appropriate basis, along the lines of the CCAMLR scheme, for the operation of scientific observers on board Chilean longline vessels operating in national waters.

7.188 The Working Group congratulated Prof. Moreno and Dr Robertson for facilitating these important developments and offered whatever assistance would be appropriate to develop these and other initiatives (e.g. FAO–NPOA).

7.189 The Working Group noted with appreciation the efforts of the World Bird Federation of Taiwan (in association with BirdLife International) to provide information for fishers on the avoidance of incidental mortality in longline fisheries. Copies of the two leaflets, widely circulated within Taiwanese fishing industries, are provided in SC-CAMLR-XIX/BG/21.

Advice to the Scientific Committee

Research into the Status of Seabirds at Risk

7.190 The review of availability of data on:

(i) size and trends of populations of albatross species and of *Macronectes* and *Procellaria* petrel species vulnerable to interactions with longline fisheries (paragraph 7.9(i));

(ii) the foraging ranges of populations of these species adequate to assess overlap with areas used by longline fisheries (paragraph 7.9(ii)); and

(iii) genetic research relevant to determining the provenance of birds killed in longline fisheries (paragraph 7.12);

revealed that considerable further detail is necessary for which Members will be requested during the coming year (paragraphs 7.10, 7.11 and 7.14).

Incidental Mortality of Seabirds during Regulated
Longline Fishing in the Convention Area in 2000

7.191 (i) Timely data submission ensured comprehensive analysis of this year's data (Tables 48 to 51).

(ii) Accuracy of seabird by-catch estimation is still affected by the low proportion of hooks being observed on some cruises, particularly in Subarea 48.3 (paragraphs 7.25 to 7.29); intersessional work to address this issue is required (paragraph 7.30).

(iii) For Subarea 48.3 the total estimated seabird by-catch was only 21 birds at a rate of 0.0004 birds/thousand hooks (paragraphs 7.32 and 7.33) (compared with 210 at a rate of 0.01 birds/thousand hooks last year); fishing season restrictions and improved compliance with Conservation Measure 29/XVI have reduced by-catch in the regulated fishery in this subarea to negligible levels (paragraph 7.49).

(iv) For Subareas 58.6 and 58.7 the total estimated seabird by-catch was 516 birds (a three-fold increase over last year) at a rate of 0.02 birds/thousand hooks (compared with 0.03 birds/thousand hooks last year) (paragraphs 7.34 and 7.35). Increased by-catch this year was mainly due to greater fishing effort, but poorer compliance with Conservation Measure 29/XVI also contributed (paragraph 7.50).

(v) Differences in by-catch rates between Subarea 48.3 and Subareas 58.6 and 58.7 were clearly attributable to:

(a) vessels in the latter subareas fishing in close proximity to major breeding sites of albatrosses and petrels during their breeding season; and

(b) poor compliance with night-time setting requirements (paragraph 7.43).

The Working Group reiterated its recommendation of last year that fishing within 200 n miles of the Prince Edward Islands should be prohibited from January to March inclusive (paragraph 7.44).

(vi) Once again, the data for the French EEZs in Subarea 58.6 and Division 58.5.1 were not available for analysis; their submission was requested (paragraphs 7.45 and 7.46).

(vii) For Subarea 88.1 there had been no seabird by-catch for the third successive year due to strict compliance with Conservation Measure 29/XVI (including the exemption from night setting) and Conservation Measure 190/XVIII (paragraph 7.47). No seabird by-catch was reported for fishing in Division 58.4.4 (paragraph 7.31).

Compliance with Conservation Measure 29/XVI

7.192 (i) Overall compliance with this conservation measure this year, compared to last year, was slightly improved in Subarea 48.3, slightly poorer in Subareas 58.6 and 58.7, poor in Division 58.4.4 and complete in Subarea 88.1.

(ii) Streamer lines – compliance with the streamer-line design was poor; only 33% of the streamer lines deployed complied fully, mainly because their length was less than 150 m. Vessels which have not complied with this element of the conservation measure over at least the last two years include *Argos Helena*, *Eldfisk*, *Illa de Rua*, *Isla Gorriti, Lyn, Jacqueline*, *Magallanes III, No. 1 Moresko* and *Tierra del Fuego* (Table 55 and paragraph 7.52).

(iii) Offal discharge – in Subareas 58.6, 58.7 and 88.1 there was 100% compliance with the requirement either to hold offal on board, or to discharge on the opposite side to where the line was hauled. In Subarea 48.3, 76% of the vessels discharged offal on the opposite side to hauling (compared with 71% in 1999); of these vessels 50% did not discharge offal during hauling operations. Three vessels (*Isla Sofía*, *Isla Camila* and *Jacqueline*) have never complied with this element of Conservation Measure 29/XVI (Table 55 and paragraphs 7.53 and 7.54).

(iv) Night setting – compliance improved in Subarea 48.3 from 80% last season to 92% this season, has reduced in Subareas 58.6 and 58.7 from 84% to 72%, and for the new fishery in Division 58.4.4 was only 50% (paragraph 7.55). Several vessels (*Eldfisk*, *Isla Camila*, *Isla Gorriti*, *Magallanes III*, *No. 1 Moresko* and *Tierra del Fuego*) have fished for at least the last two seasons and consistently failed to comply with this element of the conservation measure (Table 55 and paragraph 7.56).

(v) Line weighting – as in previous years, no vessels complied with line-weighting requirements for Spanish longline systems (6 kg every 20 m) (paragraph 7.58).

(vi) Three vessels which first entered longline fisheries in the Convention Area in 2000, failed to comply with two or more elements of the conservation measure (Table 55 and paragraph 7.60).

Fishing Seasons

7.193 The Commission decision last year to delay the start of longline fishing in Divisions 58.4.3, 58.4.4, 58.5.1, 58.5.2 and Subareas 48.3, 48.4 and 58.6 from 15 April to 1 May probably contributed significantly to the reduction in seabird by-catch in Subarea 48.3 (paragraph 7.63).

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

7.194 (i) The estimates of potential seabird by-catch by area for 2000 (paragraphs 7.70 to 7.74, Tables 56 and 57) were:

Subarea 48.3:	1 800–2 400 to 6 500–8 800 seabirds;
Subareas 58.6 and 58.7:	15 400–20 600 to 27 900–37 800 seabirds;
Divisions 58.5.1 and 58.5.2:	7 000–10 300 to 14 100–18 900 seabirds; and
Division 58.4.4:	1 700–3 000 to 2 200–4 100 seabirds.

(ii) The overall estimated totals for the whole Convention Area (paragraph 7.75 and Table 57) indicate a potential seabird by-catch in the unregulated fishery of 26 400–35

300 (lower level) to 50 900–68 300 birds (higher level) in 1999/2000. This compares with totals of 17 000–27 000 (lower level) to 66 000–107 000 (higher level) in 1996/97 and 43 000–54 000 (lower level) to 76 000–101 000 (higher level) in 1997/98 and 21 000–29 000 (lower level) to 44 000–59 000 (higher level) in 1998/99.

(iii) The species composition of the estimated potential seabird by-catch (Table 58) indicates a potential by-catch of 21 900–68 000 albatrosses, 5 000–11 000 giant petrels and 79 000–178 000 white-chinned petrels in the unregulated fishery in the Convention Area over the last four years (paragraph 7.81).

(iv) The Working Group endorsed its conclusion of last year that such levels of mortality are entirely unsustainable for the populations of albatrosses, giant petrels and white-chinned petrels breeding in the Convention Area (paragraph 7.80).

(v) The Scientific Committee was asked to recommend that the Commission take the most stringent measures possible to combat unregulated fishing in the Convention Area (paragraph 7.83).

Incidental Mortality of Seabirds in relation to
New and Exploratory Fisheries

7.195 (i) Of the 22 new and exploratory fisheries approved for 1999, only four were operational in 1999/2000; no seabird by-catch was reported for any of these fisheries (in Subareas 58.6 and 88.1, and Division 58.4.4) (paragraphs 7.90 and 7.91).

(ii) The assessment of potential risk of interactions between seabirds and longline fisheries for all statistical areas in the Convention Area was reviewed, revised for Subareas 88.1 and 88.2, and provided as advice to the Scientific Committee and Commission in SC-CAMLR-XVIII/BG/23 (paragraph 7.89).

(iii) The 33 proposals by six Members for new and exploratory longline fisheries in 14 subareas/divisions of the Convention Area in 2000/01 were addressed, in relation to advice in SC-CAMLR-XVIII/BG/23 and Table 59.

(iv) The potential problems identified were:

(a) in proposals by Argentina for Subareas 48.1 and 48.2 and Divisions 58.4.2, 58.5.1 and 58.5.2, the desired fishing season has substantial overlap with the recommended season closure to protect seabirds;

(b) proposals by France (for Divisions 58.4.3, 58.4.4, 58.5.1, 58.5.2 and Subareas 58.6 and 58.7) do not specify a fishing season so cannot be assessed in this important regard; and

(c) in Subarea 88.1 there are important issues relating to exemptions from the night-setting requirements of Conservation Measure 29/XVI (paragraphs 7.94 to 7.103).

Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area

7.196 (i) The only formal report received related to potential by-catch of black-browed albatrosses (probably from South Georgia) in the Japanese autoliner longline fishery around Tristan da Cunha and Gough Islands (paragraphs 7.104 and 7.105).

(ii) The Working Group again requested reports from Members, for regions adjacent to the Convention Area, on longline fishing effort, on incidental mortality of seabirds and on implementation of mitigating measures (paragraphs 7.111 and 7.112). It also regretted the absence of any feedback to the meeting from CCAMLR observers at meetings of tuna commissions (paragraphs 7.182 and 7.183).

Research into and Experience with Mitigating Measures

7.197 (i) Offal discharge – all vessels operating in the Convention Area should be encouraged either to process offal into fish meal on board, or return all offal to port for onshore processing into fish meal as is the practice by New Zealand (paragraph 7.116); any vessels still discharging offal on the same side as the haul, in contravention of Conservation Measure 29/XVI, should be re-engineered, according to the engineering diagrams of the *Koryo Maru 11* (see SC-CAMLR-XVIII, Annex 5, paragraph 7.110), or prohibited from fishing in the Convention Area.

(ii) Underwater setting – promising results were obtained from trials:

(a) by South Africa, of the Mustad funnel in Subareas 58.6 and 58.7 where, on night-time and daytime sets in summer, seabird by-catch was reduced from 0.013–0.009 and 0.03–0.02 birds/thousand hooks respectively;

(b) by Australia, using a funnel setting at 6 m depth, in its domestic tuna longline fishery, eventually resulting in zero seabird by-catch (paragraph 7.119); and

(c) by Norway, in domestic longline fisheries, where setting funnels reduced the by-catch of northern fulmars by 72% (paragraphs 7.120 and 7.121).

(iii) Streamer lines – the importance of adhering, as a minimum, to the specifications set out in Conservation Measure 29/XVI was re-emphasised; some potential modifications, to enhance performance, were recommended for testing (paragraphs 7.123 to 7.125).

(iv) Line weighting – New Zealand vessels operating in Subarea 88.1 successfully achieved the required experimental line sink rates (WG-FSA-00/58 and paragraph 7.128); some further trials, however, are required before a weighting regime for autoliners can be incorporated into Conservation Measure 29/XVI (paragraph 7.148).

(v) Pots – no seabird by-catch had been reported in association with the experimental use of pots to catch toothfish (WG-FSA-00/23 and paragraph 7.129).

(vi) Other – trials by New Zealand of a laser gun and aircraft spotlights had been unsuccessful.

Policy Considerations in relation to Mitigating Measures and Conservation Measure 29/XVI

7.198 Conservation Measure 29/XVI is the key element in minimisation of incidental mortality of seabirds during longlining in the Convention Area. Compliance is still substantially deficient, particularly in some key elements. Improving the current situation requires:

(i) further development of underwater setting, which offers the most likely medium- to long-term solution to the problem;

(ii) work to develop line-weighting regimes to ensure sink rates that will preclude seabirds accessing bait. This offers the best short-term solution, as well as the likelihood of permitting exemption from several other mitigating measures currently in use in the Convention Area; and

(iii) in the meantime, better compliance with the existing suite of mitigation measures in Conservation Measure 29/XVI is essential (paragraphs 7.134 and 7.135).

7.199 The main issues relating to compliance with Conservation Measure 29/XVI are:

(i) how to get fishers to comply with the straightforward elements of the conservation measure, in respect of offal discharge, streamer lines and night setting;

(ii) how to tackle the consistent inability of vessels to comply with the element of the conservation measure that specifies the line-weighting regime for Spanish system longliners; and

(iii) how to develop the requirements for an appropriate line-weighting regime for autoliners (paragraph 7.136).

7.200 To address these problems, the Working Group provided some detailed comments and practical suggestions (paragraphs 7.138 to 7.150) and advises that:

(i) given the simplicity of complying with the elements of Conservation Measure 29/XVI relating to offal discharge, night setting and streamer lines, vessels unable, or failing, to comply with these elements should be prohibited from fishing in the Convention Area; this should be emphasised to technical coordinators, fishing companies and national authorities at the earliest opportunity (paragraphs 7.151 to 7.153);

(ii) in circumstances where all other elements of Conservation Measure 29/XVI apply (e.g. in respect of night setting, streamer lines and offal discharge) and with appropriate closed seasons, the line-weighting regime for the Spanish system of longlining should be set at weights of a minimum of 8.5 kg spaced at no more than 40 m intervals (paragraph 7.146);

(iii) once experimental trials of autoline weighting are completed in Subarea 88.1 and similar trials have been carried out in areas of higher risk to seabirds, the Working Group should be able to recommend a line weighting for autoline vessels that will have utility for all subareas of the Convention Area (paragraph 7.148);

(iv) the ultimate aim in managing seabird by-catch in the Convention Area will be to allow fishing at any time of day without seasonal closure of fishing grounds. However, current indications are that allowing fishing in summer, at night, using streamer lines, proper offal discharge practices and c. 40 m between weights on longlines (existing practice for Spanish system vessels), will still result in unacceptably high mortality of seabirds. Clearly, more time is required to allow experimentation into the effectiveness of line-weighting concepts and underwater setting devices with the Spanish system that will reduce seabird by-catch and be more acceptable to the fishing industry. In the meantime, seabird by-catch in the Convention Area should be managed in accordance with practices adopted in Subarea 48.3, where a combination of a closed season in summer, night setting, the use of streamer lines and proper offal discharge practices has effectively solved the seabird by-catch problem (paragraphs 7.149 and 7.150).

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

7.201 (i) FAO–NPOAs – New Zealand and USA had draft plans available for consultation; Australia's TAP contained the essence of its NPOA (which would be prepared in due course); Brazil and Chile were commencing to prepare plans; the European Community had started the assessment process (paragraphs 7.160 to 7.169).

(ii) Regional Agreement for the Conservation of Albatrosses under the CMS – considerable progress had been made at an initial meeting in Hobart, Australia, in July 2000; the details of the Action Plan are under consultation; a second meeting is planned in South Africa in early 2001. This agreement has very substantial implications for the conservation of seabirds in marine and terrestrial ecosystems; all Members of CCAMLR should participate actively in the meetings, especially by facilitating the attendance of appropriate technical and scientific experts (paragraphs 7.170 to 7.178).

(iii) New Zealand's International Fishers' Forum on Solving the Incidental Capture of Seabirds in Longline Fisheries is to be held the week after the CCAMLR Commission meeting; Members longlining in the Convention Area were encouraged to facilitate the participation of other scientists, fishery managers and fishers (paragraphs 7.179 to 7.181).

(iv) Uruguayan and Brazilian scientists will convene a BirdLife International workshop in Montevideo, Uruguay, in 2001 to address issues relating to seabird by-catch in South America (paragraphs 7.156 and 7.157).

OTHER INCIDENTAL MORTALITY

Longline Vessels – Marine Mammals

8.1 One Antarctic fur seal was hooked and drowned in Subarea 58.6 (WG-FSA-00/38, Table 3). No entanglements were reported this year (Table 60).

8.2 Interactions with marine mammals resulting in a potential loss of fish were reported in Subareas 48.3, 58.6 and 58.7 and Division 58.4.4 (WG-FSA-00/38, Table 3):

Subarea 48.3: 13 of 17 cruises; killer whale (12), sperm whale (1), fur seal (5);
Subareas 58.6/58.7: 9 of 12 cruises; killer whale (6), sperm whale (4), unknown (3);
Division 58.4.4: 1 of 1 cruise; killer whale.

No such interactions were reported for Subarea 88.1 despite sightings of killer whales from the fishing vessels.

8.3 WG-FSA-00/60 reported interactions between killer whales, sperm whales and a longline vessel fishing around the Falkland/Malvinas Islands. The interactions reported were complex and restricted to the time of line hauling. Nevertheless, all available evidence indicated that the whales were not taking fish from the line.

Trawl Fishing

8.4 In the Report of Member's Activities by Australia, in respect of trawl fisheries in Division 58.5.2, one dead Antarctic prion (*Pachyptila desolata*), the remains of one dead white-chinned petrel and one injured common diving petrel (*Pelecanoides urinatrix*) were reported found on trawl decks in circumstances and at times suggesting interactions with fishing gear.

8.5 Two Antarctic fur seals were caught and killed in trawl nets in Subarea 48.3 (WG-FSA-00/38).

8.6 In Subarea 48.3 the same trawler, targeting *C. gunnari*, reported that 19 black-browed albatrosses were killed while attempting to feed on fish as the net was being hauled. This level of mortality by a single vessel is almost the same as the total estimated seabird by-catch (21 birds killed) for all 16 vessels longlining in Subarea 48.3 in 1999/2000.

8.7 Considerable concern was expressed at this. Mr Smith indicated that there were some reports of similar interactions in New Zealand domestic fisheries. Last year extensive observations from vessels trawling for *Dissostichus* spp. in Division 58.5.2 and around Macquarie Island (WG-FSA-99/72) reported numerous interactions with seabirds but very low levels of mortality.

8.8 Further details on the circumstances of incidents such as that reported in paragraph 8.6 were required in order to establish if anything could be done to prevent them. Observers were encouraged to make full reports in such circumstances.

CCAMLR WEBSITE

9.1 The Working Group reviewed the recent development of the CCAMLR website (WG-FSA-00/12). Most sections of the website are now available in the four official languages of CCAMLR. General information about CCAMLR is presented on public webpages. Secure webpages are used to communicate information to CCAMLR Members only (accessible via 'MEMBERS' menu options).

9.2 Secure webpages are accessed via user names and passwords. The Secretariat has provided each Scientific Committee contact (nominated by the Commissioners) with the user names and passwords required to access the secure webpages of the Scientific Committee, and it is the responsibility of each Scientific Committee contact to provide access to members of their scientific team. Similarly, Members who need access to the secure webpages of the Commission should contact their Commissioners for the user names and passwords.

9.3 Intersessional developments in support of WG-FSA have included:

(i) updating the data section on the CCAMLR website to include detailed information on the CCAMLR data requirements and the submission of data (paragraphs 3.12 to 3.14);

(ii) dissemination of meeting documents via the website; and

(iii) loading available WG-FSA meeting documents on the server used by the Working Group at the meeting to provide easy access to the electronic documents during the meeting (SC-CAMLR-XVIII, Annex 5, paragraph 10.6).

9.4 Many WG-FSA participants who had accessed the website reported problems in downloading documents prior to the meeting. The most common problem encountered was the long download time required to view (or print) individual documents. Download times of 30–60 minutes/document were reported, making access to documents via the website an impractical option.

9.5 Where possible, these difficulties will be addressed by the Secretariat during the intersessional period. The long download times are due to the 'slow' 64 Kbps connection between the Secretariat and the Internet. Under optimum condition (i.e. only one user at any time), the average-sized document at WG-FSA-2000 (900 Kb) would take approximately two to three minutes to download. These conditions are infrequent as there is generally a number of users at any one time using the Secretariat's Internet connection, either internally or external website users. This connection also carries the fairly constant email traffic between the Secretariat and external recipients. A two-fold increase of the connection speed would require a two-fold increase in the Secretariat's cost of the connection; the current connection costs approximately A$1 200 per month.

9.6 The Working Group recommended that the connection speed be increased by 10-fold during the month leading up to major CCAMLR meetings. This would allow meeting participants to efficiently access documents on the website and prepare for the meetings. The present long download times had prevented the widespread dissemination of WG-FSA documents via the website.

FUTURE WORK

Workshop on Assessment Methods for Icefish

10.1 The Working Group discussed the need to undertake a workshop on the development of management procedures for *C. gunnari*, as first recommended in 1997 (SC-CAMLR-XVI, paragraphs 5.58 to 5.65). The Working Group agreed that the requirement for the types of analyses listed in the provisional terms of reference for this workshop remained high. The Working Group also recalled its discussion from last year regarding the urgent need to undertake analyses required under the major biological components of the terms of reference (SC-CAMLR-XVIII Annex 5, paragraph 9.10).

10.2 At this year's meeting a number of specific issues arose during discussions of the assessment of *C. gunnari* that would benefit from detailed consideration at such a workshop. These included:

(i) the development of longer term approaches to the management of *C. gunnari* fisheries in the Convention Area;

(ii) methods for assessing standing stock of *C. gunnari*, including the use of acoustic survey techniques; and

(iii) causes and effects of changes in the vertical and horizontal distribution of *C. gunnari*.

10.3 The Working Group agreed that these issues would be addressed by the existing terms of reference (SC-CAMLR-XVI, paragraph 5.62). Two additional issues were identified for attention at the workshop:

- the exploration of the potential to predict changes in M should be extended to explore the manner in which changes in M might be managed; and

- determine, as necessary for the development of a management procedure, whether the ecosystem in Subarea 48.3 could support, in the future, a *C. gunnari* fishery at the scale experienced at the beginning of that fishery.

This would provide a comparative basis for consideration of *C. gunnari* fisheries in other areas (e.g. Division 58.5.1).

10.4 The Working Group recommended that the workshop, as proposed previously, should be held in association with the next meeting of WG-FSA. Planning for the workshop should proceed in accordance with the previous proposal, and a deadline of 1 August 2001 should be set for the submission of data and appropriate papers. At that time, a final decision to hold the workshop could be taken by the Convener of WG-FSA, in consultation with the Chair of the Scientific Committee and the Data Manager.

10.5 The Working Group formed a subgroup (see paragraph 10.9 below) to assist with the preparation of information for the workshop and to refine the workshop terms of reference should it go ahead. This subgroup would also liaise with WG-EMM on matters concerning ecosystem interactions involving *C. gunnari*.

10.6 The Working Group also noted that the requirements identified in last year's report (SC-CAMLR-XVIII, Annex 5, paragraph 9.10) and in paragraph 10.3 apply equally to *D. eleginoides*, and the further development of knowledge on that species.

Intersessional Work of Subgroups

10.7 The Working Group reviewed the activities of subgroups which had worked during the intersessional period. These subgroups, with the support of the Secretariat, had provided essential information to the meeting. WG-FSA agreed that the tasks assigned to the subgroups had generally far exceeded the time available to each subgroup. However, each subgroup had produced valuable work and information which had contributed to the assessments and review of information available at the meeting. WG-FSA agreed that the activities of each group should be extended during the 2000/01 intersessional period. Where possible, each subgroup would focus on a small number of key issues. The subgroups would also provide a conduit for information on a wide range of related research. In addition, other tasks were specifically assigned to the Secretariat and/or Members.

10.8 The Working Group reminded participants that the membership to the subgroups was open, and that the reason for nominating coordinators and others at the meeting was to facilitate the establishment of subgroups.

10.9 WG-FSA assigned some of the major tasks arising from the 2000 meeting to the following groups:

(i) A subgroup to plan the *C. gunnari* workshop, coordinated by the WG-FSA Convener with the assistance of the Chair of the Scientific Committee and the Data Manager. This task should include the preparation of information and the development of the terms of reference, should the workshop go ahead (paragraph 10.5).

(ii) Failing the hiring of new Secretariat staff to assist with the CDS (paragraph 3.31) and the collation of information on IUU fishing, a subgroup to determine total removals of *Dissostichus* spp., including landings reported under the new CDS and information on IUU fishing activities. The subgroup would be coordinated by Mr Watkins, and assisted by Profs Moreno and G. Duhamel (France), and others.

(iii) A subgroup to review observer reports and information, coordinated by Dr Barrera-Oro with assistance from Dr E. Balguerías (Spain) and Ms J. Molloy (IMALF, New Zealand).

(iv) A subgroup to continue developing assessment methods coordinated by Dr Constable, and assisted by Drs D. Agnew (UK) and Gasiukov, Mr Jones and Drs Kirkwood and Parkes.

(v) A subgroup to review, and where necessary assess, the biology and demography of species considered by the Working Group, coordinated by Dr Everson. The subgroup was tasked with:

- standardising methods for age determination of *D. eleginoides* using otoliths: Drs J. Ashford (UK), P. Horn (New Zealand) and I. Knuckey (Australia);

- developing guidelines for determining maturity stage in *D. mawsoni* (paragraph 3.78): Mr G. Patchell (New Zealand); and

- developing fish identification guides for scientific observers: Drs Barrera-Oro, Fanta, Herasymchuk, Kock and Vacchi amd Mr Watkins and Mr Williams (paragraphs 3.113 to 3.117).

(vi) A subgroup to document the extent of by-catch in CCAMLR fisheries, coordinated by Dr Everson with the assistance of Ms E. van Wijk (Australia), Drs Agnew and Hanchet and Mr Williams.

(vii) A subgroup to revise the method used by scientific observers to subsample catches from longlines, coordinated by Dr Agnew, and assisted by Ms van Wijk, Mr Watkins and Dr Ashford. Problems encountered using the current method are outlined in paragraph 3.48.

(viii) The Secretariat was tasked with the review of notifications for new and exploratory fisheries in 2001/02, and obtaining information on catches of *D. eleginoides* taken outside the Convention Area and trade statistics for *Dissostichus* spp. in 2000/01.

10.10 The responsibilities for coordinating the intersessional activities of ad hoc WG-IMALF are set out in Appendix D.

Other Intersessional Work

10.11 The Working Group identified a number of tasks which should be carried out by participants and the Secretariat during the intersessional period. The main tasks are listed below with reference to paragraphs in the report which contain details of these tasks; routine tasks are not included.

10.12 The following tasks were identified as part of the development of the scientific observer program:

Secretariat:

(i) Consult with technical coordinators and seek their comments and proposals on research priorities (paragraph 3.41), and solutions to difficulties experienced in the completion of the observer duties (paragraph 3.47), including the longline random-sampling design (paragraph 3.48; also see paragraph 10.9(vii)).

Members:

(ii) Request that scientific observers submit data on electronic logbooks developed in Microsoft Excel format by CCAMLR (paragraph 3.38).

(iii) Encourage technical coordinators to continue to bring changes and updates of the *Scientific Observers Manual* to the attention of the scientific observers (paragraph 3.46).

(iv) Encourage scientific observers to make their own assessments of ovarian status of *D. mawsoni* with a view to developing a scale for macroscopic maturity stages (paragraph 3.78).

(v) Encourage scientific observers to label and store, deep frozen, all specimens whose identification was uncertain, for subsequent forwarding to appropriate taxonomists (paragraph 3.118).

(vi) Encourage scientific observers and fishing masters to continue collecting information on CFs using the CCAMLR format and concentrating on product which constitutes the largest fraction of the fish processed (paragraph 3.64).

(vii) Remind scientific observers that data on CFs should be collected on a fish-by-fish basis (paragraph 3.65).

10.13 Various other tasks were identified as follows:

Secretariat:

(i) Maintain a watching brief on IUCN, CITES and FAO in relation to developments on the Red List (paragraph 11.12), and report any new development to the Working Group during the intersessional period.

Members:

(ii) Consider options for reorganising the work of the Working Group during its meetings (paragraph 13.1).

(iii) Encourage further work and sensitivity analyses to take full account of uncertainties in the assessment process (paragraphs 4.176 and 4.177).

(iv) Consider further applications of research sets from new and exploratory fisheries (paragraph 4.36).

(v) Encourage the development of an assessment of *Macrourus* spp. in Subarea 88.1 (paragraph 4.100).

(vi) Where possible, submit documents electronically to the Secretariat at least two weeks prior to the start of the 2001 meeting of WG-FSA (paragraphs 11.7 and 11.8).

(vii) Encourage further development of criteria for protected/closed areas relevant to CCAMLR (paragraph 5.9).

(viii) Submit data on by-catch which can be used to estimate catch rates in terms of both numbers and weight per unit of effort (paragraph 4.269).

Secretariat Support at Future Meetings

10.14 The Working Group found that the level of hardware and software support provided by the Secretariat at the meeting was inadequate. As a result, it was not possible for the Working Group to complete all planned analyses within the time available at the meeting. This led to inefficiencies in the work of WG-FSA, and created tension which was both unnecessary and counter-productive.

10.15 While the Working Group understood the financial difficulties under which the Secretariat was operating, the group concluded that it could not undertake future assessments using the outdated hardware and software facilities of the Secretariat.

10.16 The following facilities were available to the Working Group during its meeting (WG-FSA-00/4):

- a network hub providing 32 connections for laptops using 10BaseT Ethernet;
- one computer (Alpha XL 266 MHz) with a shared hard disk containing files used previously by WG-FSA;
- a laser printer;
- Microsoft Office 97 applications;
- Visual FORTRAN (5.0);
- MapInfo Professional (version 4.5);
- S-Plus 2000 (release 2); and
- MathCad (version 6.0 for Windows 95).

10.17 The length-density analyses using CMIX could not be run on the Alpha computer because CMIX required a faster and more compatible computer. The graphic interface in CMIX was also found to be unstable on certain laptops, including the Secretariat's laptop. In addition, the short-term assessment model developed in MathCad could not be run on the Secretariat's version because it was outdated.

10.18 In addition, access to the Internet and email which had been provided to participants in previous years was not available at the start of the meeting. Participants personally contributed A$400 (the connection cost at WG-FSA-99) so that Internet and email access could be provided during the meeting.

10.19 Finally, through necessity, the Secretariat had placed a restriction on the amount of overtime which support staff could work during the meeting. This had limited some of the analyses which could be undertaken during the meeting.

10.20 As a minimum requirement at the 2001 meeting of WG-FSA, the Working Group would require:

- a network hub providing 32 connections for laptops using 10BaseT Ethernet;

- Internet access enabling web and email services;
- two high-powered computers (at least 1 GHz) each capable of running all routine assessment tools used at the meeting;
- a Microsoft Windows compatible desktop computer for word processing;
- a Microsoft Windows compatible laser printer accessible via the network; and
- latest versions (2000 releases or more recent) of all software required for analyses.

10.21 In addition, the Secretariat should ensure that the WG-FSA network and provided services are compatible with Microsoft Windows 95 and Microsoft Windows 98 (and future versions) since these are more commonly used by WG-FSA participants than the Windows NT/2000 deployed within the Secretariat.

10.22 The Scientific Committee was urged to ensure that sufficient funds were available to the Secretariat in 2001 to support the work of WG-FSA.

OTHER BUSINESS

CCAMLR Science and the *Science Citation Index*

11.1 The Working Group welcomed news that *CCAMLR Science* has now been selected by the Institute for Scientific Information (ISI) for coverage in Current Contents/Agriculture, Biology and Environmental Sciences (CC/AB&ES). Coverage of *CCAMLR Science* will begin with the 2000 issue of the journal, which is currently being printed and will be distributed in November 2000.

Fishery Data Manual

11.2 The Working Group reviewed the options for publishing the *Fishery Data Manual*. This manual describes the CCAMLR requirements for the collection and submission of catch and effort reports, fine-scale data and STATLANT data. The manual was developed with the aim of promoting the standard methods for collecting data across all CCAMLR fisheries.

11.3 An edited version of the manual was considered by the Working Group last year (WG-FSA-99/8), and a recommendation to publish this manual in loose-leaf format in the four languages of the Commission had been forwarded to the Scientific Committee (SC-CAMLR-XVIII, Annex 5, paragraph 10.13). Subsequently, the Scientific Committee decided to postpone translation and publication until 2000, pending developments in the data requirements for new and exploratory fisheries (SC-CAMLR-XVIII, paragraph 12.5).

11.4 As an interim measure, the Secretariat placed the *Fishery Data Manual* in English only on the data section of the CCAMLR website (paragraph 3.12).

11.5 The Working Group identified three options for consideration by the Scientific Committee at its forthcoming meeting:

(i) postpone translation and publication until the data requirements for new and exploratory fisheries are further developed;

(ii) translate the manual and disseminate in all four languages via the website; and

(iii) translate the manual and publish in loose-leaf format (i.e. the original proposal).

11.6 Dr Ramm stated that, as a minimum, it would be desirable to translate the manual so as to enhance the collection of quality data in CCAMLR fisheries, and align the documentation for these data with that available for data collected by the scientific observers (*Scientific Observer Manual*) and under CEMP (*CEMP Standard Methods*). The total costs for the translation and publication of the *Fishery Data Manual* would be A$7 500 in 2001.

Deadline for the Submission of Meeting Papers

11.7 The Working Group considered WG-EMM's decision that papers submitted at its 2001 meeting must be lodged electronically with the Secretariat at least two weeks prior to the start of that meeting. Further, papers for WG-EMM-2001 which did not comply with this principle would not be accepted at the 2001 meeting (Annex 4, paragraph 9.5).

11.8 The Working Group encouraged all participants at future meetings of WG-FSA to strive towards the new deadline set by WG-EMM. However, the Working Group felt that it would not be possible for all documents to be submitted to Secretariat two weeks prior to the start of the meetings of WG-FSA.

11.9 The Working Group reaffirmed that the current deadline for the submission of papers (0900 h of the first day of the meeting) was not negotiable.

IUCN Criteria for Globally Threatened Species

11.10 Last year, WG-EMM requested the Secretariat to obtain information on the criteria and process applied in the preparation of IUCN's new Red List of endangered and vulnerable species. WG-EMM asked that this information be relayed to WG-FSA because some Antarctic fish species may be candidates for globally threatened status under the new criteria (Annex 4, paragraphs 7.77 and 7.78).

11.11 The information obtained by the Secretariat was listed in WG-FSA-00/48, and the material was available at the meeting. The IUCN database may be searched online at www.redlist.cymbiont.ca/search.asp.

11.12 There is presently little overlap between the fish species listed in the Red List and those considered by WG-FSA. However, the Working Group agreed that it should review the criteria used, and the species listed in the Red List, in relation to CCAMLR matters. The Working Group also noted current initiatives within CITES aimed at developing criteria for CITES designation of marine species, including fish. The Secretariat was requested, as these may affect the matters of interest to the Working Group, to maintain a watching brief on IUCN and CITES, as well as related developments within FAO. Any new development should be brought to the attention of the Working Group during the intersessional periods.

Fish and Fish Resources of Antarctica

11.13 Last year, the Scientific Committee supported the Working Group's recommendation to translate, from Russian to English, the headings, figure and table captions, and the references to Dr Shust's book *Fish and Fish Resources of Antarctica* (SC-CAMLR-XVIII, paragraphs 12.11 and 12.12).

11.14 As requested, the translation was completed during the intersessional period and forwarded to the Editorial Board of *CCAMLR Science* for advice on further translation of the book. This matter was considered at the last meeting of the Board, and the advice will be reported to the Scientific Committee.

Bibliography on Antarctic Fish

11.15 Last year, the Scientific Committee considered the request of the Working Group to update and distribute a bibliography on Antarctic fish which is being compiled by Dr Kock. Dr Miller was tasked to explore the possibility of SCAR sponsoring the completion of the bibliography in CD-ROM format (SC-CAMLR-XVIII, paragraph 12.13).

11.16 Dr Miller advised the Working Group that SCAR was unable to fund this work. Based on this advice, Dr Kock agreed to continue to develop the bibliography as a low priority task. Once completed, the bibliography would be available via a website.

ADOPTION OF THE REPORT

12.1 The report of the meeting was adopted.

CLOSE OF THE MEETING

13.1 The Working Group noted that, as in previous years, it had been hard pressed to complete its work and to validate fully the assessments which it had undertaken. It agreed that the meeting should not be extended beyond the current duration and that members should give some thought on how to structure WG-FSA's work. The Working Group agreed that an item to this effect should be included in the agenda for the Working Group's 2001 meeting and a proposed structure circulated with the draft agenda. Items which warrant consideration include:

(i) undertaking sensitivity analyses intersessionally in an attempt to identify and bind key parameters to be used in assessments;

(ii) identifying stocks for which annual assessments are mandatory;

(iii) identifying stocks for which revised assessments are not required or not possible; and

(iv) improving organisation of the meeting schedule including reducing downtime on the first day, attempting to clear less difficult items from the agenda at the beginning of the meeting and initiating subgroup work on the first day.

13.2 Dr Miller advised the Working Group that this was the last time he was participating in the meeting in the capacity of Chair of the Scientific Committee. He thanked the Convener, Mr Williams, Working Group participants and the Secretariat for another very successful meeting. All had worked long hours and made major contributions to the discussions and the drafting of the report. The Scientific Committee appreciated the level of commitment of WG-FSA, and the Committee was grateful for the major contribution which the Working Group makes to the work of CCAMLR.

13.3 In closing the meeting, the Convener thanked the Working Group, once again, for their excellent work, and members of the Secretariat for their support. He also thanked the rapporteurs for their efforts. On behalf of WG-FSA, Mr Williams thanked Dr Miller for his long-standing contribution to the debates and analyses of the Working Group; the Working Group looked forward to his continued participation at future meetings.

13.4 The meeting was closed.

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Table 1: Catches (tonnes) of target species by region and gear reported for the 1999/2000 fishing season. Source: catch and effort reports submitted by 7 October 2000.

Fishery and Target Species	Conservation Measure	Region	Gear	Catch Limit (tonnes)	Reported Catch (tonnes)
Euphausia superba					
	32/X	48	Trawl	1 500 000	101 742
	106/XV	58.4.1	Trawl	775 000	0
	45/XIV	58.4.2	Trawl	450 000	0
Dissostichus spp. (established fisheries)					
	179/XVIII	48.3	Longline	5 310	5 210[1]
	180/XVIII	48.4	Longline	28	0
	176/XVIII	58.5.2	Trawl	3 585	3 008
	-	58.6 (in the South African EEZ)	Longline	-	67
	-	58.6 (in the French EEZ)	Longline	-	59[2]
	-	58.7 (in the South African EEZ)	Longline	-	844
	-	58.5.1 (in the French EEZ)	Longline	-	2 102[2]
	-	58.5.1 (in the French EEZ)	Trawl	-	1 368[2]
Dissostichus spp. (exploratory fisheries)					
	188/XVIII	58.4.4 North of 60°S (outside EEZs)	Longline	370	99
	189/XVIII	58.6 (outside EEZs)	Longline	450	14
	187/XVIII	58.4.3 (outside Australian EEZ)	Longline	250	0
	187/XVIII	58.4.3 and 58.4.1 (outside Australian EEZ)	Longline	300	0
	184/XVIII	48.6 north of 60°S	Longline	455	0
	184/XVIII	48.6 south of 60°S	Longline	455	0
	190/XVIII	88.1 north of 65°S	Longline	175	0
	190/XVIII	88.1 south of 65°S	Longline	1 915	745
	191/XVIII	88.2 south of 65°S	Longline	250	0
	186/XVIII	58.4.2	Trawl	500	<1
	185/XVIII	58.4.3 (Elan Bank)	Trawl	145	0
	185/XVIII	58.4.1 and 58.4.3 (BANZARE Bank)	Trawl	150	0
Champsocephalus gunnari					
	177/XVIII	58.5.2	Trawl	916	39
	175/XVIII	48.3	Trawl	4 036	4 110
Electrona carlsbergi					
	174/XVIII	48.3	Trawl	109 000	0
Chaenodraco wilsoni (new fishery)					
	186/XVIII	58.4.2	Trawl	500	<1
Martialia hyadesi					
	183/XVIII	48.3	Jig	2 500	0
Crab					
	181/XVIII	48.3	Pot	1 600	0

[1] An additional 39 tonnes of *Dissostichus* were taken during research on pot fishing (paragraph 3.58).
[2] 1 December 1999 to 30 June 2000, reported in STATLANT data.

Table 2: Catches (tonnes) by species and region reported for the 1999/2000 split-year (1 July 1999 to 30 June 2000). Source: STATLANT data submitted by 7 October 2000.

Species Name	All Areas	Area/Subarea/Division									
		48	48.1	48.2	48.3	58.4.2	58.5.1	58.5.2	58.6	58.7	88.1
Amblyraja georgiana	36				<1						36
Antimora rostrata	10								6	4	<1
Bathyraja eatonii	5										5
Bathyraja meridionalis	<1				<1						
Bathyraja murrayi	<1								<1	<1	
Bathyraja spp.	<1								<1	<1	
Benthos	<1				<1						
Bothidae	<1				<1						
Chaenocephalus aceratus	<1				<1						<1
Champsocephalus gunnari	4 195				4 114			81			
Channichthyidae	<1										<1
Channichthys rhinoceratus	2							2			
Dissostichus eleginoides	13 689				4 694		5 009	2 579	688	720	<1
Dissostichus mawsoni	751										751
Euphausia superba	101 147	68 034	27 064	6 049							
Gobionotothen gibberifrons	1				1						
Gymnoscopelus nicholsi	<1				<1						
Lithodes murrayi	<1									<1	
Lithodidae	3				<1				<1	3	
Macrourus carinatus	65										65
Macrourus spp.	335				5	<1	116	3	86	125	<1
Macrourus whitsoni	9				<1	<1				3	5
Medusae	5				5						
Muraenolepis microps	5				<1						5
Muraenolepis spp.	2				<1						2
Myctophidae	67				67						
Notothenia rossii	<1				<1						
Notothenia squamifrons	5				5						
Nototheniidae	<1										<1
Nototheniops larseni	<1				<1						
Nototheniops nudifrons	<1				<1						
Osteichthyes spp.	<1					<1		<1			
Parachaenichthys georgianus	<1				<1						
Paralithodes spp.	<1				<1						
Paralomis aculeata	<1									<1	
Paralomis formosa	3				3						
Paralomis spinosissima	<1				<1						
Patagonotothen brevicauda	1				1						
Pogonophryne permitini	<1										<1
Pseudochaenichthys georgianus	<1				<1						
Rajiformes spp.	103				4		88		9	1	<1
Unknown	<1				<1						
Total	120 442	68 034	27 064	6 049	8 901	<1	5 214	2 665	789	857	869

Table 3: Reported catches (tonnes) of *Dissostichus eleginoides* and *Dissostichus mawsoni* by Members and Acceding States in EEZs and in the Convention Area, and estimates of unreported catches from the Convention Area by Members and Acceding States in the 1999/2000 split-year. Catches for the 1998/99 split-year are given in parentheses. The information in this table may be incomplete.

Member/ Acceding State	Outside CCAMLR Area Catch in EEZs		CCAMLR Area Reported Catch		CCAMLR Area Estimates of Unreported Catches by Members		Estimated Total Catch All Areas	
Chile	2 704[1]	(9 093)[2]	1 609	(1 668)	0	(3 280)	4 313	(14 120)
Argentina	4 667	(8 297)	0	(10)	0	(800)	4 667	(9 107)
France	0	(0)	5 503	(6 260)	0	(0)	5 503	(6 260)
Australia	82	(100)	2 579	(5 451)	0	(0)	2 661	(5 551)
South Africa	180	(75)	1 239	(948)	0	(0)	1 419	(957)
UK	3 919[3]	(>1 416)[3]	1 221	(1 238)	0	(0)	5 140	(2 654)
Uruguay	0	(1 059)	767	(517)	0	(0)	767	(1 576)
Ukraine	0	(0)	128	(760)	0	(0)	128	(760)
Spain	0	(0)	264	(154)	0	(0)	264	(154)
Rep. of Korea	0	(0)	380	(255)	0	(0)	380	(255)
Peru	0	(0)	0	(0)	0	(0)	0	(0)
Japan	0	(0)	0	(0)	0	(0)	0	(0)
New Zealand	<1	(<1)	751	(296)	0	(0)	751	(323)
USA	0	(0)	0	(<1)	0	(0)	0	(<1)
All countries	11 553	(20 041)	14 441	(17 558)	0	(4 080)	25 993	(41 718)

1 Based on reports from CDS to August 2000
2 1998 calendar year
3 From Falkland/Malvinas Islands

Table 4: Estimated landings (tonnes) of IUU-caught *Dissostichus eleginoides* in African, South American and European ports in the 1999/2000 split-year and the beginning of the 2000/01 split-year. Landed green weight + estimated green weight add up to estimates of total IUU catches.

Port	July 1999–June 2000		July–August 2000		July 1999–June 2000		July–August 2000	
	Landed Product Weight	Landed Green Weight	Landed Product Weight	Landed Green Weight	Estimated Product Weight	Estimated Green Weight	Estimated Product Weight	Estimated Green Weight
Walvis Bay	932	1 584						
Durban	21	36						
Mauritius	3 740	6 358	2 074	3 526	1 840	3 128	600	1 020
Montevideo	149	253						
Vigo	110	187						

[1] Catches/landings conversion factor of product to green weight 1.7.

[2] Landings from confidential sources, estimates from Prof. G. Duhamel (France) on additional catches.

Table 5: Estimated effort, mean catch rates/day and total catches by subarea/division in the unregulated fishery on *Dissostichus eleginoides* in the 1999/2000 split-year. Estimates for the 1998/99 split-year are given in parentheses. The total estimated unreported catch for 1999/2000 is 6 546 tonnes. The reported catch for 1999/2000 is given in Table 3. The estimated total catch for 1999/2000 is 19 937 tonnes.

Area/ Subarea/ Division	Estimated Start of Unregulated Fishery	No. of Vessels Sighted in Unregulated Fishery[1,7]		No. of Fishing Vessels		Estimated No. of Vessels Fishing Illegally		No. of Days Fishing per Fishing Trip	No. of Trips/Year	Estimated Effort in Days Fishing[6] (1)		Mean Catch Rate per Day[3] (tonnes) (2)	Estimated Unreported Catch (1) x (2)		Estimated Total Catch	
48.6	No info															
48.3	1991	5	(1)[2]	18		5	(1)[4]	30	1.2	180	-	2.2	396	(300–400)	5 090	(4 931)
58.7	Apr/May 1996	1	(1)	3	(6)	2	(2)	40	2.5	200	(100)	1.1	220	(140)	940	(345)
58.6	Apr/May 1996	7	(4)	5	(4)	11[5]	(6)	40	2.5	1 100	(920)	1.8	1 980	(1 748)	2 668	(3 660)
58.5.1	Dec 1996	7	(11)	0	(6)	7	(15)	40	2.5	700	(310)	3.0	2 100	(620)	7 109	(6 022)
58.5.2	Feb/Mar 1997	2[1]	(2)	2	(2)	4	(4)	40	2.5	400	(80)	2.0	800	(160)	3 379	(5 611)
58.4.4	Sep 1996	1	(2)	1	(0)	7	(7)	40	2.5	700	(1 230)	1.5	1 050	(1 845)	1 050	(1 845)
58			(3)				(5)				(1 000)	1.5				(1 500)
88.1															751	(297)
Total													6 546	(4 813–4 913)[8]	20 987	(24 211)

[1] Two vessels sighted; one with 125 tonnes on board and the other estimated to have 346 tonnes on board.
[2] Double sightings in one zone not counted.
[3] Data from Secretariat.
[4] Report of additional three vessels in 1998/99 in this subarea.
[5] Estimated number of vessels not in area throughout period, but moving between areas.
[6] Calculated as no. of vessels fishing illegally x no. fishing days/trip x no. trips/year.
[7] Vessel sightings (sources): AFMA, MRAG, Prof. G. Duhamel (France), observers (South Africa).
[8] The estimate of additional 1 920 tonnes of catch from three vessels reported in Subarea 48.3 is not included.

Table 6: Estimated total catch (tonnes) by subarea/division of *Dissostichus eleginoides* and *D. mawsoni* in the Convention Area for the 1999/2000 split-year. Estimates for the 1998/99 split-year are in parentheses.

Subarea/ Division	Estimated Total Catch		Reported Catch 1999/2000		Estimated Unreported Catch		Unreported Catch as % of the Estimated Total Catch
48.1	–	(<1)		(0)	probably low		
48.2	–	(<1)		(0)	probably low		
48.3	5 090	(4 931)[1]	4 694	(4 291)	396	(300–400)[1]	8
58.4.4	1 050	(1 845)	-	(0)	1 050	(1 845)	no data
58.5.1	7 109	(6 022)	5 009	(5 402)	2 100	(620)	30
58.5.2	3 379	(5 611)	2 579	(5 451)	800	(160)	24
58.6	2 668	(3 660)	688	(1 912)[3]	1 980	(1 748)	74
58.7	940	(345)	720	(205)[3]	220	(140)	23
88.1	751	(297)	751	(297)	probably low		
88.3	-	(<1)	0	(0)	probably low		
All subareas	20 987	(24 211)[2]	14 441	(17 558)	6 546	(4 813–4 913)[1]	32

[1] Not included is estimate of additional 1 920 tonnes of catch from three vessels reported in Subarea 48.3.
[2] Includes 1 500 tonnes of unreported catch for Area 58 as a whole.
[3] From South African EEZ

Table 7: Imports (tonnes) of frozen whole and filleted *Dissostichus eleginoides* to the USA and Japan 1999 (January–December) and 2000 (Japan: January–June; USA: January–July). Trade data supplied by the USA and by FAO for Japan. Green weights were estimated by the Secretariat using a factor of 2.2 to convert fillet weight to green weight.

Country	1999 (January–December)	2000 (January–July)	2000 (January–June)
USA (green weights)	11 545	7 597	
Japan (whole weights)	20 203		8 105
Japan (other products)	8 201		5 703

Table 8: Landed weights (tonnes) of *Dissostichus* spp. product reported in the CDS by 5 October 2000, and estimated whole weights (tonnes). Whole weights were estimated by the Secretariat using the following CFs: whole weight = 1.0 x WHO; whole weight = 1.6 x HAG; whole weight = 1.7 x HAT; whole weight = 1.7 x HGT; whole weight = 2.3 x FLT; OTH was not used to estimate whole weights because that product may be included in the conversion from other types of cuts. FLT – fillet; HAG – headed and gutted; HAT – headed and tailed; HGT – headed, gutted and tailed; OTH – other; WHO – whole.

Year	Month	Estimated Whole Weight (tonnes)	Product Weight (tonnes)					
			FLT	HAG	HAT	HGT	OTH	WHO
Area ?								
2000	?	30				18		
2000	April	103				61		
2000	May	31		<1		18		
2000	June	116				68	13	
2000	July	48	<1			28	2	
Area 41								
?	?	41				24	3	
1999	Nov	68				40		
2000	Feb	281				165	73	
2000	Jan	465				274	83	
2000	April	635		36		340	91	
2000	May	418		13		229	72	9
2000	June	557		3		320	94	9
2000	July	156				92	38	
2000	Aug	606				357	56	
2000	Sept	155		1		91	40	
Area 47								
2000	April	251				148	38	
2000	June	30				18	4	
Area 48								
1999	Oct	10				6	<1	
2000	May	36				21	1	
2000	June	2 068		154		1 072	225	
2000	July	2 266		454	112	793	260	
2000	Aug	297				175	44	
Area 51								
2000	April	<1					36	
2000	June	657				387	93	
2000	July	560				329	75	
2000	Aug	341				201	31	
Area 56								
– no information available –								
Area 57								
2000	April	7	<1			4	2	
2000	July	83				49	26	

(continued)

Table 8 (continued)

Year	Month	Estimated Whole Weight (tonnes)	Product Weight (tonnes)					
			FLT	HAG	HAT	HGT	OTH	WHO
Area 58								
2000	Jan	532	1			286	192	45
2000	March	764	62			344	225	38
2000	April	580	2			332	225	10
2000	May	1 259				740	90	
2000	June	2 724	2			1 589	444	18
2000	July	734	123			265	21	
2000	Aug	98				57	13	
Area 84								
2000	Aug	7						7
Area 86								
2000	June	4		2		1		
Area 87								
1999	April	16				10	<1	
1999	Nov	9	2			3	<1	
1999	Dec	90	18			29	9	
2000	Jan	351	42			149	8	
2000	Feb	578	1			339	16	1
2000	March	215	<1			122	7	7
2000	April	150	2			75	11	17
2000	May	87	1			6	13	74
2000	June	132		3		2	5	123
2000	July	156						156
2000	Aug	238		<1		<1		236
2000	Sept	34		1				32
Area 88								
2000	March	533	1	332			47	<1
Total		19 608	260	1 001	112	9 678	2 729	783

Table 9: Summary of observations on longline fisheries conducted in the 1999/2000 season by scientific observers.

Flag State	Vessel	Fishing Method	Observer	Subarea / Fishery	Period of Observation	Report / Date Submitted	Data Reported
Chile	*Faro de Hercules*	LLS Spanish	P. Wright UK	48.3 *D. eleginoides*	18/5–27/7/00	Scientific Observer Logbook 18/9/00 Cruise Report 12/9/00	Cruise, vessel, and IMALF details
Chile	*Isla Camila*	LLS Spanish	A. Williams UK	48.3 *D. eleginoides*	15/4–27/7/00	Scientific Observer Logbook 18/9/00 Cruise Report 12/9/00	Cruise, vessel, and IMALF details
Chile	*Isla Santa Clara*	LLS Spanish	R. Gater UK	48.3 *D. eleginoides*	12/4–27/7/00	Scientific Observer Logbook 31/8/00 Cruise Report 12/9/00	Cruise, vessel, and IMALF details
Chile	*Isla Sofía*	LLS Spanish	C. Herrera Argentina	48.3 *D. eleginoides*	20/6–21/7/00	Scientific Observer Logbook 28/8/00 Cruise Report 29/8/00	Cruise, vessel, and IMALF details
Chile	*Magallanes III*	LLS Spanish	P. Wright UK	48.3 *D. eleginoides*	23/4–18/5/00	Scientific Observer Logbook 18/9/00 Cruise Report 12/5/00	Cruise, vessel, and IMALF details
Chile	*Magallanes III*	LLS Spanish	M. Lozano Uruguay	48.3 *D. eleginoides*	10/7–21/7/00	Cruise Report 12/9/00	Cruise details
Chile	*Tierra del Fuego*	LLS Spanish	M. Murphy UK	48.3 *D. eleginoides*	1/5–21/7/00	Scientific Observer Logbook 13/8/00 Cruise Report 28/9/00	Cruise, vessel, and IMALF details
France	*Cap Kersaint*	LLS Spanish	D. Capdeville France	58.6 *D. eleginoides*	9/7–19/7/00	Scientific Observer Logbook 19/9/00	Cruise, vessel, and IMALF details
France	*Croix de Sud I*	LLS Auto	N. Gasco France	58.6 *D. eleginoides*	28/7–31/7/00	Scientific Observer Logbook 19/9/00	Cruise, vessel, and IMALF details
UK	*Argos Georgia*	LLS Spanish	M. Purves South Africa	48.3 *D. eleginoides*	18/5–28/7/00	Scientific Observer Logbook 18/9/00 Cruise report 12/9/00	Cruise, vessel, and IMALF details
UK	*Argos Helena*	LLS Spanish	Y. Marín Uruguay	48.3 *D. eleginoides*	1/5–21/7/00	Cruise report 2/10/00	Cruise details
UK	*Jacqueline*	LLS Spanish	C. Vera Cárdenas Chile	48.3 *D. eleginoides*	1/5–21/7/00	Scientific Observer Logbook 13/9/00 Cruise Report 25/9/00	Cruise, vessel, and IMALF details
UK	*Lyn*	LLS Spanish	P. Casas–Cordero Chile	48.3 *D. eleginoides*	1/5–21/7/00	Scientific Observer Logbook 13/9/00 Cruise Report 25/9/00	Cruise, vessel, and IMALF details
New Zealand	*Janas*	LLS Auto	J. Wium South Africa	88.1 *Dissostichus* spp.	4/1–24/3/00	Scientific Observer Logbook 6/7/00 Cruise Report 3/7/00	Cruise, vessel, and IMALF details

(continued)

Table 9 (continued)

Flag State	Vessel	Fishing Method	Observer	Subarea / Fishery	Period of Observation	Report / Date Submitted	Data Reported
New Zealand	*San Aotea II*	LLS Auto	F. Stoffberg South Africa	88.1 *Dissostichus* spp.	3/1–18/3/00	Scientific Observer Logbook 6/7/00 Cruise Report 3/7/00	Cruise, vessel, and IMALF details
New Zealand	*Sonrisa*	LLS Auto	B. Fairhead South Africa	88.1 *Dissostichus* spp.	21/1–7/3/00	Scientific Observer Logbook 6/7/00 Cruise Report 27/4/00	Cruise, vessel, and IMALF details
Republic of Korea	*No. 1 Moresko*	LLS Spanish	S. Hutton UK	48.3 *D. eleginoides*	26/4–21/7/00	Scientific Observer Logbook 18/7/00 Cruise Report 12/7/00	Cruise, vessel, and IMALF details
South Africa	*Aquatic Pioneer*	LLS Spanish	P. Nel* South Africa	58.7 *D. eleginoides*	23/8–5/10/99	Scientific Observer Logbook 6/11/99 Cruise Report 20/12/99	Cruise, vessel, and IMALF details
South Africa	*Aquatic Pioneer*	LLS Spanish	M. Davies* South Africa	58.6 *D. eleginoides*	9/10–10/12/99	Scientific Observer Logbook 1/2/00 Cruise Report 1/2/00	Cruise, vessel, and IMALF details
South Africa	*Aquatic Pioneer*	LLS Spanish	E. Simpson* South Africa	58.6, 58.7 *D. eleginoides*	17/1–15/3/00	Scientific Observer Logbook 27/4/00 Cruise Report 27/4/00	Cruise, vessel, and IMALF details
South Africa	*Aquatic Pioneer*	LLS Spanish	H. Crous* South Africa	58.6, 58.7 *D. eleginoides*	29/3–11/5/00	Scientific Observer Logbook 3/7/00 Cruise Report 3/7/00	Cruise, vessel, and IMALF details
South Africa	*Aquatic Pioneer*	LLS Spanish	R. Pienaar* South Africa	58.6, 58.7 *D. eleginoides*	13/7–8/9/00	Cruise Report 28/9/00	Cruise details
South Africa	*Eldfisk*	LLS Auto	B. Fairhead* South Africa	58.7 *D. eleginoides*	26/7–1/10/99	Scientific Observer Logbook 27/4/00 Cruise Report 26/11/99	Cruise, vessel, and IMALF details
South Africa	*Eldfisk*	LLS Auto	Crous, Enticott* South Africa	58.6, 58.7 *D. eleginoides*	8/10–17/12/99	Scientific Observer Logbook 1/2/00 Cruise Report 1/2/00	Cruise, vessel, and IMALF details
South Africa	*Eldfisk*	LLS Auto	Davies, Dyer* South Africa	58.6, 58.7 *D. eleginoides*	5/1–17/3/00	Scientific Observer Logbook 27/4/00 Cruise Report 27/4/00	Cruise, vessel, and IMALF details
South Africa	*Eldfisk*	LLS Auto	Fairhead, Koen* South Africa	58.6, 58.7 *D. eleginoides*	23/3–2/6/00	Scientific Observer Logbook 3/7/00 Cruise Report 3/7/00	Cruise, vessel, and IMALF details
South Africa	*Eldfisk*	LLS Auto	Stoffberg, Davies* South Africa	58.6, 58.7 *D. eleginoides*	16/6–23/8/00	Cruise Report 28/9/00	Cruise details
South Africa	*Koryo Maru 11*	LLS Spanish	G. Westhuizen* South Africa	58.6, 58.7 *D. eleginoides*	16/10–10/11/99	Scientific Observer Logbook 1/2/00 Cruise Report 1/2/00	Cruise, vessel, and IMALF details

(continued)

Table 9 (continued)

Flag State	Vessel	Fishing Method	Observer	Subarea / Fishery	Period of Observation	Report / Date Submitted	Data Reported
South Africa	*Koryo Maru 11*	LLS Spanish	B. Stander* South Africa	58.6, 58.7 *D. eleginoides*	16/1–7/4/00	Scientific Observer Logbook 3/7/00 Cruise Report 3/7/00	Cruise, vessel, and IMALF details
South Africa	*Koryo Maru 11*	LLS Spanish	P. Usher UK	48.3 *D. eleginoides*	18/4–2/7/00	Scientific Observer Logbook 18/9/00 Cruise Report 18/9/00	Cruise, vessel, and IMALF details
Spain	*Ibsa Quinto*	LLS Spanish	M. Endicott UK	48.3 *D. eleginoides*	23/4–21/7/00	Scientific Observer Logbook 18/9/00 Cruise Report 12/9/00	Cruise, vessel, and IMALF details
Ukraine	*RK-1*	LLS Auto	L. Fearnhough UK	48.3 *D. eleginoides*	25/4–24/7/00	Scientific Observer Logbook 31/8/00 Cruise Report 12/9/00	Cruise, vessel, and IMALF details
Uruguay	*Illa de Rua*	LLS Spanish	J. Bailey UK	48.3 *D. eleginoides*	14/4–25/7/00	Scientific Observer Logbook 31/8/00 Cruise Report 12/9/00	Cruise, vessel, and IMALF details
Uruguay	*Isla Alegranza*	LLS Spanish	H. Pavez Chile	58.4.4 *D. eleginoides*	26/6–30/8/00	Scientific Observer Logbook 30/9/00 Cruise Report 2/10/00	Cruise, vessel, and IMALF details
Uruguay	*Isla Gorriti*	LLS Auto	M. Keen UK	48.3 *D. eleginoides*	18/4–22/7/00	Scientific Observer Logbook 31/8/00 Cruise Report 12/9/00	Cruise, vessel, and IMALF details

* National observers, deployed within national EEZs

Table 10: Summary of information contained in the observer cruise reports for the 1999/2000 fishing season. Nationality: AUS – Australia, CHL – Chile, ESP – Spain, GBR – United Kingdom, JPN – Japan, KOR – Republic of Korea, NZL – New Zealand, RUS – Russia, UKR – Ukraine, URY – Uruguay, ZAF – South Africa; Fishing method: A – autoliner, Sp – Spanish, OTM – midwater trawl, OTB – bottom trawl; Information on: LF – length frequency, CF – conversion factor; Y – yes, N – no.

Vessel Name (Nationality)	Dates of Trip	Fishing Method	IMALF Data	Mammal Interactions	Debris Information	Information on					Samples		Observer Manual Comments
						By-catch	LF	Weight	Maturity	CF	Otoliths	Scales	
Subarea 48.3													
Argos Helena (GBR)	18/5–28/7/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Argos Helena (GBR)	1/5–27/7/00	Sp	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N
Betanzos (CHL)	10/12/99–2/2/00	OTM	Y	Y	N	Y	Y	Y	Y	Y	Y	N	N
Faro de Hercules CHL)	18/5–27/7/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Ibsa Quinto (ESP)	23/4–25/7/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y
Illa de Rua (URY)	18/4–25/7/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Isla Camila (CHL)	15/4–22/7/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N
Isla Gorriti (URY)	18/4–25/7/00	A	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y
Isla Santa Clara (CHL)	12/4–27/7/00	Sp	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N
Isla Sofia (CHL)	20/6–28/7/00	Sp	Y	Y	N	Y	Y	N	Y	Y	Y	Y	N
Jacqueline (GBR)	30/4–25/7/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Koryo Maru 11 (ZAF)	1/5–21/7/00	Sp	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y
Lyn (GBR)	24/4–25/7/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Magallanes III (CHL)	23/4–9/5/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Magallanes III (CHL)	3/7–5/8/00	Sp	Y	Y	N	Y	Y	N	Y	N	Y	N	N
No.1 Moresko (KOR)	26/4–25/7/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
RK-1 (UKR)	25/4–24/7/00	A	Y	Y	N	Y	Y	Y	Y	Y	N	N	Y
Tierra del Fuego (CHL)	1/5–21/7/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Zakhar Sorokin (RUS)	27/11/99–22/2/00	OTM	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Subareas 58.6 and 58.7													
Aquatic Pioneer (ZAF)	23/8–5/10/99	Sp	Y	Y	N	Y	Y	Y	N	Y	N	N	N
Aquatic Pioneer (ZAF)	9/10–10/12/99	Sp	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Aquatic Pioneer (ZAF)	17/1–18/3/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Aquatic Pioneer (ZAF)	29/3–11/5/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N

(continued)

Table 10 (continued)

Vessel Name (Nationality)	Dates of Trip	Fishing Method	IMALF Data	Mammal Interactions	Debris Information	Information on By-catch	LF	Weight	Maturity	CF	Samples Otoliths	Scales	Observer Manual Comments
Aquatic Pioneer (ZAF)	13/7–8/9/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
Eldfisk (ZAF)	26/7–1/10/99	A	Y	Y	N	Y	Y	Y	Y	N	Y	N	N
Eldfisk (ZAF)	8/10–17/12/99	A	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y
Eldfisk (ZAF)	5/1–17/3/00	A	Y	Y	Y	Y	Y	Y	Y	N	N	N	N
Eldfisk (ZAF)	23/3–2/6/00	A	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Eldfisk (ZAF)	16/6–18/8/00	A	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Koryo Maru 11 (ZAF)	20/8–12/12/99	Sp	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N
Koryo Maru 11 (ZAF)	11/1–7/4/00	Sp	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N
Subarea 88.1													
Janas (NZL)	3/1–24/3/00	A	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y
San Aotea II (NZL)	8/1–18/3/00	A	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Sonrisa (NZL)	21/1–7/3/00	A	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Division 58.5.2													
Austral Leader (AUS)	20/10–20/12/99	OTB	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Austral Leader (AUS)	19/4–7/6/00	OTB	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Southern Champion (AUS)	3/12–25/1/00	OTB	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
Southern Champion (AUS)	31/1–3/4/00	OTB	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Southern Champion (AUS)	20/4–27/6/00	OTB	Y	Y	N	Y	Y	Y	N	N	Y	N	Y
Divisions 58.4.1, 58.4.3 and 58.5.2													
Austral Leader (AUS)	17/2–14/4/00	OTB	Y	Y	N	Y	Y	Y	N	Y	Y	N	N
Area 48													
Chiyo Maru No.5 (JPN)	31/1–1/3/00	OTM	Y	Y	N	Y	Y	Y	Y	Y	N	N	Y
Division 58.4.4													
Isla Alegranza (CHL)	14/7–31/8/00	Sp	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N

Table 11: Disposal of wastes and oil reported by observers during the 1999/2000 season. Nationality: AUS – Australia, CHL – Chile, ESP – Spain, GBR – United Kingdom, JPN – Japan, KOR – Republic of Korea, NZL – New Zealand, RUS – Russia, UKR – Ukraine, URY – Uruguay, ZAF – South Africa; Fishing method: A – autoliner, Sp – Spanish, OTM – midwater trawl, OTB – bottom trawl; Y – disposed of over board, N – waste retained or burnt at sea, - no information.

Vessel Name (Nationality)	Dates of Trip	Fishing Method	Bands (bait etc.)	Oil	Gear Debris	Garbage (galley, other)	Hooks in Discards
Subarea 48.3							
Argos Georgia (GBR)	18/5–28/7/00	Sp	N	-	N	Y	-
Argos Helena (GBR)	1/5–27/7/00	Sp	N	-	N	N	-
Betanzos (CHL)	10/12–2/2/00	OTM	-	-	-	-	-
Faro de Hercules (CHL)	18/5–27/7/00	Sp	N	N	N	N	N
Ibsa Quinto (ESP)	23/4–25/7/00	Sp	-	-	Y	-	Y
Illa de Rua (URY)	18/4–25/7/00	Sp	N	-	N	Y	Y
Isla Camila (CHL)	15/4–22/7/00	Sp	-	-	Y	-	Y
Isla Gorriti (URY)	18/4–25/7/00	A	-	-	N	-	-
Isla Santa Clara (CHL)	12/4–27/7/00	Sp	-	-	Y	Y	-
Isla Sofía (CHL)	20/6–28/7/00	Sp	Y	Y	N	Y	-
Jacqueline (GBR)	30/4–25/7/00	Sp	N	N	N	N	Y
Koryo Maru 11 (ZAF)	1/5–21/7/00	Sp	N	N	Y	N	-
Lyn (GBR)	24/4–25/7/00	Sp	N	-	Y	N	Y
Magallanes III (CHL)	23/4–9/5/00	Sp	Y	Y	Y	Y	-
Magallanes III (GBR)	3/7–5/8/00	Sp	-	-	-	-	-
No.1 Moresko (KOR)	26/4–25/7/00	Sp	N	-	Y	N	-
RK-1 (UKR)	25/4–24/7/00	A	-	-	-	-	-
Tierra del Fuego (CHL)	1/5–21/7/00	Sp	N	-	Y	Y	Y
Zakhar Sorokin (RUS)	27/11/99–22/2/00	OTM	-	-	-	-	-
Subareas 58.6, 58.7							
Aquatic Pioneer (ZAF)	23/8–5/10/99	Sp	-	-	-	-	-
Aquatic Pioneer (ZAF)	9/10–10/12/99	Sp	Y	-	Y	N	-
Aquatic Pioneer (ZAF)	17/1–18/3/00	Sp	N	N	N	N	N
Aquatic Pioneer (ZAF)	29/3–11/5/00	Sp	-	N	N	N	N
Aquatic Pioneer (ZAF)	13/7–8/9/00	Sp	N	N	N	N	Y
Cap Kersaint (FRA)	8/7–15/7/00	Sp	-	-	-	-	-
Croix du Sud I (FRA)	28/7–31/7/00	Sp	-	-	-	-	-
Eldfisk (ZAF)	26/7–1/10/99	A	-	-	-	-	-
Eldfisk (ZAF)	8/10–17/12/99	A	-	N	N	Y	-
Eldfisk (ZAF)	5/1–17/3/00	A	-	Y	-	Y	-
Eldfisk (ZAF)	23/3–2/6/00	A	N	N	N	N	N
Eldfisk (ZAF)	16/6–18/8/00	A	Y	N	Y	Y	N
Koryo Maru 11 (ZAF)	20/8–12/12/99	Sp	N	N	Y	N	Y
Koryo Maru 11 (ZAF)	11/1–7/4/00	Sp	N	N	Y	Y	N
Subarea 88.1							
Janas (NZL)	3/1–24/3/00	A	-	-	-	-	-
San Aotea II (NZL)	8/1–18/3/00	A	N	N	N	Y	N
Sonrisa (NZL)	21/1–7/3/00	A	N	N	N	N	N
Division 58.5.2							
Austral Leader (AUS)	20/10–20/12/99	OTB	N	N	N	N	
Austral Leader (AUS)	19/4–7/6/00	OTB	N	N	N	N	
Southern Champion (AUS)	20/4–27/6/00	OTB	N	N	N	N	
Southern Champion (AUS)	31/1–3/4/00	OTB	N	N	N	N	
Southern Champion (AUS)	3/12–25/1/00	OTB	N	N	N	N	
Divisions 58.5.2, 58.4.3, 58.4.1							
Austral Leader (AUS)	17/2–14/4/00	OTB	N	N	N	N	
Area 48							
Chiyo Maru No.5 (JPN)	31/1–1/3/00	OTM	-	-	-	-	
Division 58.4.4							
Isla Alegranza (CHL)	14/7–31/8/00	Sp	N	-	N	N	-

Table 12: Summary of biological data collected by observers in trawl fisheries during the 1999/2000 season.

Area/Subarea/Division	Number of Measurements			
	Length	Weight	Sex	Maturity
48.1				
Euphausia superba	13 102	4 743	13 102	4 743
48.3				
Champsocephalus gunnari	5 894	5 893	5 894	5 894
Gobionotothen gibberifrons	9	9	9	8
58.4.2, 58.5.2				
Champsocephalus gunnari	4 230	1 921	1 906	1 885
Pleuragramma antarcticum	3	3	3	3
Bathyraja eatonii	376	374	374	7
B. irrasa	22	22	22	2
B. murrayi	103	101	99	4
Neopagetopsis ionah	13	13	13	13
Channichthys rhinoceratus	1 394	1 315	677	660
Notothenia squamifrons	1 340	1 339	1 301	1 176
Chionodraco hamatus	11	11	11	11
Dissostichus mawsoni	3	3	3	3
Dissostichus eleginoides	11 072	11 047	9 076	9 063
Trematomus eulepidotus	59	59	59	59
Macrourus whitsoni	50	50	50	50
Chaenodraco wilsoni	43	43	43	43

Table 13: Scientific observations conducted on board trawl vessels within the Convention Area for the 1999/2000 season. Flag/Nationality: AUS – Australia, CHL – Chile, GBR – United Kingdom, JPN – Japan, RUS – Russia, UKR – Ukraine; Target species: TOP – *Dissostichus eleginoides*; ANI – *Champsocephalus gunnari*, KRI – *Euphausia superba*, WIC – *Chaenodraco wilsoni*.

Vessel	Flag	Observer (Nationality)	Observation Dates	Area	Target Species	Number of Trawls		
						Total	Observed	(%)
Austral Leader	AUS	J. Parkinson (AUS)	20/10–20/12/99	58.5.2	TOP	75	75	(100)
Austral Leader	AUS	L. Pschenichnov (UKR)	17/2–14/4/00	58.4.2	WIC	8	8	(100)
					TOP	1	1	(100)
				58.5.2	ANI	4	4	(100)
					TOP	125	125	(100)
Austral Leader	AUS	J. Hamill (AUS)	19/4–7/6/00	58.5.2	TOP	185	172	(93)
					ANI	8	8	(100)
Betanzos	CHL	G. Fulton (GBR)	10/12/99–2/2/00	48.3	ANI	94	75	(80)
Chiyo Maru No. 5	JPN	W. Rain (USA)	28/1–29/2/00	48.1	KRI	252	82	(33)
Southern Champion	AUS	M. Tucker (AUS)	3/12/99–25/1/00	58.5.2	TOP	76	76	(100)
					ANI	3	3	(100)
Southern Champion	AUS	J. Parkinson (AUS)	31/1–3/4/00	58.5.2	TOP	158	122	(77)
					ANI	9	6	(67)
Southern Champion	AUS	L. Pschenichnov (UKR)	3/5–29/5/00	58.5.2	TOP	191	191	(100)
					ANI	5	5	(100)
Zakhar Sorokin	RUS	R. Hartnell (GBR)	27/11/99–31/1/00	48.3	ANI	172	114	(66)

Table 14: Overall species composition of catches reported by scientific observers in trawl and longline fisheries in the 1999/2000 season. The relative abundance of each taxon is expressed as the percentage, by weight, of the total catch observed. Data limited to those where weight provided. Target species: ANI – *Champsocephalus gunnari;* KRI – *Euphausia superba*; TOA – *Dissostichus mawsoni*; TOP – *Dissostichus eleginoides*; WIC – *Chaenodraco wilsoni*.

Gear	Trawl						Longline			
Target species	KRI	ANI	ANI	TOA	TOP	WIC	TOP	TOP	TOP	TOA
Subarea/Division	48.1	48.3	58.5.2	58.4.2	58.5.2	58.4.2	48.3	58.4.4	58.6/7	88.1
Elasmobranchs		<0.1								
Callorhinchidae										
Callorhinchus capensis									<0.1	
Laminidae										
Lamna nasus			0.5							
Rajidae			<0.1		<0.1		2.3	0. 9	0.7	<0.1
Amblyraja georgiana							<0.1		0.6	5.7
Bathyraja eatonii			0.2		0.2		<0.1			0.9
Bathyraja irrasa			<0.1		<0.1					
Bathyraja maccaini					<0.1	0.7			<0.1	
Bathyraja meridionalis							<0.1			
Bathyraja murrayi			<0.1		<0.1				<0.1	
Bathyraja spp.									<0.1	
Raja spp.							0.3			
Squalidae										
Etmopterus granulosus									<0.1	
Somniosus microcephalus									0.1	
Somniosus pacificus					0.2					
Bony Fishes										
Achiropsettidae										
Mancopsetta maculata					<0.1					
Artedidraconidae										
Artedidraco mirus										<0.1
Bathylagidae										
Bathylagus antarcticus					<0.1					
Bothidae					<0.1					
Bramidae										
Brama brama									<0.1	
Carapidae										
Echiodon cryomargarites									<0.1	
Ceratiidae										
Ceratias tentaculatus					<0.1					
Channichthyidae					<0.1		<0.1			<0.1
Chaenocephalus aceratus										<0.1
Chaenodraco wilsoni						1.1				
Champsocephalus gunnari		98.5	93.4		1.9		<0.1			
Channichthys rhinoceratus			4.0		<0.1					
Chionodraco hamatus						0.4				
Neopagetopsis ionah						1.4				
Pagetopsis macropterus										<0.1
Pseudochaenichthys georgianus					<0.1		<0.1			

(continued)

Table 14 (continued)

Gear	Trawl						Longline			
Target species	KRI	ANI	ANI	TOA	TOP	WIC	TOP	TOP	TOP	TOA
Subarea/Division	48.1	48.3	58.5.2	58.4.2	58.5.2	58.4.2	48.3	58.4.4	58.6/7	88.1
Congiopodidae										
Zanclorhynchus spinifer					<0.1					
Gempylidae										
Paradiplospinus antarcticus					<0.1					
Paradiplospinus gracilis					<0.1					
Harpagiferidae										
Pogonophryne permitini										<0.1
Pogonophryne spp.										<0.1
Lampridae										
Lampris immaculatus					<0.1					
Macrouridae										
Macrourus carinatus			<0.1		<0.1		<0.1			7.9
Macrourus holotrachys					<0.1		0.1			
Macrourus spp.			<0.1		<0.1		0.9	18.2	19.4	<0.1
Macrourus whitsoni					<0.1	45.3	0.6		<0.1	0.5
Merlucciidae										
Macruronus novaezelandiae			<0.1		<0.1					
Moridae			<0.1		<0.1					
Antimora rostrata					<0.1		0.1	0.6	2.7	<0.1
Muraenolepididae										
Muraenolepis microps									<0.1	0.6
Muraenolepis orangiensis										<0.1
Muraenolepis spp.					<0.1				<0.1	0.2
Myctophidae					<0.1					
Electrona carlsbergi					<0.1					
Gymnoscopelus bolini		<0.1			<0.1					
Gymnoscopelus nicholsi		1.5			<0.1					
Notacanthidae										
Notacanthus chemnitzii					<0.1					
Nototheniidae							<0.1			<0.1
Dissostichus eleginoides			1.3		97.2		95.6	80.2	76.3	<0.1
Dissostichus mawsoni				86.6						84.1
Notothenia acuta			<0.1		<0.1					
Notothenia coriiceps			<0.1		<0.1					
Notothenia neglecta							<0.1			
Notothenia rossii					<0.1		<0.1			
Notothenia squamifrons			<0.1		0.2		<0.1			
Nototheniops mizops			<0.01		<0.1					
Nototheniops nudifrons							<0.1			
Pagothenia hansoni										
Patagonotothen brevicauda		<0.1					<0.1			
Pleuragramma antarcticum						2.0				
Trematomus eulepidotus						5.2				
Paralepididae										
Notolepis coatsi					<0.1					
Scorpaenidae							<0.1			

(continued)

Table 14 (continued)

Gear	Trawl						Longline			
Target species	KRI	ANI	ANI	TOA	TOP	WIC	TOP	TOP	TOP	TOA
Subarea/Division	48.1	48.3	58.5.2	58.4.2	58.5.2	58.4.2	48.3	58.4.4	58.6/7	88.1
Stomiidae										
Stomias boa boa					<0.1					
Zoarcidae										
Melanostigma spp.					<0.1					
Other					<0.01		<0.1		<0.1	
Invertebrates										
Euphausia spp.			<0.1							
Euphausia superba	100									
Lithodidae							<0.1		<0.1	
Lithodes murrayi							<0.1		<0.1	
Lithodes spp.								0.2		
Loliginidae		<0.1	<0.1		<0.1					
Moroteuthis ingens			<0.1		<0.1	4.9				
Octopodidae				13.4	<0.1	1.2				
Paralithodes spp.							<0.1			
Paralomis anamerae							<0.1		<0.1	
Paralomis formosa							<0.1			
Paralomis spinosissima							<0.1			
Paralomis spp.							<0.1			
Other			0.4		0.1	38.0	<0.1		<0.1	

Table 15: Frequency of occurrence (%) of longline hauls where at least one example of a particular taxon was taken as reported by observers for the 1999/2000 season. N – number of hauls.

Species Name	Subarea/Division			
	48.3 (N = 1987)	58.4.4 (N = 68)	58.6, 58.7 (N = 1 617)	88.1 (N = 485)
Amblyraja georgiana	1.3		1.5	61.0
Antimora rostrata	17.9	77.9	21.6	6.6
Artedidraco mirus				3.1
Bathyraja eatonii	1.0		0.1	52.8
Bathyraja maccaini			0.1	
Bathyraja meridionalis	0.8			
Bathyraja murrayi			2.4	
Bathyraja spp.	0.2		1.0	
Brama brama			0.6	
Callorhinchus capensis			0.2	
Chaenocephalus aceratus				1.0
Champsocephalus gunnari	<0.1			
Channichthyidae	0.2			35.3
Crustacea			0.2	
Dissostichus eleginoides	80.3	100.0	89.5	1.4
Dissostichus mawsoni				98.4
Echinodermata	0.6		0.1	
Echiodon cryomargarites			0.3	
Elasmobranchii			0.2	
Electrona spp.			0.2	
Etmopterus granulosus			0.3	
Lithodes murrayi	2.9	0.0	3.4	
Lithodes spp.	2.3	47.1		
Lithodidae	5.6		2.4	
Macrourus carinatus				81.6
Macrourus holotrachys	4.8			
Macrourus spp.	40.4	97.1	85.3	1.0
Macrourus whitsoni	12.2		0.4	37.7
Muraenolepis microps			0.1	39.6
Muraenolepis orangiensis				5.8
Muraenolepis spp.			0.8	34.0
Notothenia neglecta	0.2			
Notothenia rossii	0.7			
Notothenia squamifrons	0.2			
Nototheniidae	0.5			1.6
Nototheniops nudifrons	0.3			
Osteichthyes spp.	0.2		1.1	
Pagetopsis macropterus				0.2
Paralithodes spp.	0.1			
Paralomis anamerae	17.2		0.6	
Paralomis formosa	0.2			
Paralomis spinosissima	0.7			
Paralomis spp.	0.2			
Patagonotothen brevicauda	0.4			
Pogonophryne permitini				2.3
Pogonophryne spp.				0.2
Porifera			0.1	
Pseudochaenichthys georgianus	0.2			
Raja spp.	5			
Rajiformes spp.	30	31	6	1
Unknown			1	

Table 16: Summary of observer data on CFs for headed, gutted and tailed fish (HAT).

Area	No. of Vessels	No. of Cruises	No. of Hauls	No. of Fish in Sample Unit[1]	No. of Sample Units
Dissostichus eleginoides					
48.3	10	10	317	1	1 350
48.3	3	3	7	(2–5)	83
48.3	5	5	31	(6–15)	31
48.3	3	3	17	(16–29)	17
48.3	2	2	4	(>30)	4
58.4.4	1	1	1	5	1
58.4.4	1	1	12	(6–15)	12
58.6, 58.7	1	1	3	1	52
58.6, 58.7	1	1	1	4	1
58.6, 58.7	2	3	20	(16–29)	20
58.6, 58.7	2	3	5	(>30)	13
58.7	1	1	1	1	2
58.7	1	1	1	13	1
58.7	1	1	2	(16–29)	2
58.7	1	1	4	(>30)	4
Dissostichus mawsoni					
88.1	1	1	5	1	5
88.1	2	2	4	(2–5)	6
88.1	2	2	7	(6–15)	7
88.1	1	1	4	(16–29)	4

[1] The number of fish used in bins used in the analysis.

Table 17: CFs from different sources and products. Observer data for fillet (FLT), and headed and gutted (HAG) were not available in sufficient quantities.

Area	Product	Vessel[1]	Observer[2]	Observer[3]
Dissostichus eleginoides				
48.3	HAG	1.587	NA	NA
48.3	HAT	1.625	1.665	1.651
58.4.4	HAG	1.73	NA	NA
58.4.4	HAT	1.73	1.737	1.768
58.4.4	FLT	NA	2.777	2.781
58.7	HAG	NA	1.292	1.284
58.7	HAT	NA	1.612	1.574
58.6, 58.7	HAT	NA	1.670	1.752
Dissostichus mawsoni				
88.1	HAG	1.72	1.565	1.581
88.1	HAT	1.72	1.691	1.703

[1] Weighted by the number of data submission.
[2] Weighted by the green weight of the fish observed.
[3] Weighted by the number of fish observed.

Table 18: New and exploratory fisheries managed under conservation measures in force in 1999/2000. Source of data: 5-day catch and effort reports submitted by 7 October 2000.

Conservation Measure	Fishery	Season Start	Season End	Area Fished	Catch Limit (tonnes)	Total Catch (tonnes)	% Catch Limit
183/XVIII	Exploratory jig fishery for *Martialia hyadesi* in Subarea 48.3	01-Dec-99	30-Nov-00	48.3	2 500	0	0
188/XVIII	Exploratory longline fishery for *Dissostichus eleginoides* in Division 58.4.4	01-May-00	31-Aug-00	58.4.4 North of 60°S	370	99	27
189/XVIII	Exploratory longline fishery for *Dissostichus eleginoides* in Subarea 58.6	01-May-00	31-Aug-00	58.6	450	14	3
187/XVIII	Exploratory longline fishery for *Dissostichus* spp. in Division 58.4.3	01-May-00	31-Aug-00	Elan Bank	250	0	0
187/XVIII	Exploratory longline fishery for *Dissostichus* spp. in Divisions 58.4.3/58.4.1	01-May-00	31-Aug-00	BANZARE Bank	300	0	0
184/XVIII	Exploratory longline fishery for *Dissostichus* spp. in Subarea 48.6	01-Mar-00	31-Aug-00	48.6 north of 60°S	455	0	0
184/XVIII	Exploratory longline fishery for *Dissostichus* spp. in Subarea 48.6	15-Feb-00	15-Oct-00	48.6 south of 60°S	455	0	0
190/XVIII	Exploratory longline fishery for *Dissostichus* spp. in Subarea 88.1	01-Dec-99	31-Aug-00	88.1 north of 65°S	175	0	0
190/XVIII	Exploratory longline fishery for *Dissostichus* spp. in Subarea 88.1	01-Dec-99	31-Aug-00	88.1 south of 65°S	1 915	745	39
191/XVIII	Exploratory longline fishery for *Dissostichus* spp. in Subarea 88.2	15-Dec-99	31-Aug-00	88.2 south of 65°S	250	0	0
186/XVIII	Exploratory trawl fishery for *Dissostichus* spp. in Division 58.4.2	01-Dec-99	30-Nov-00	58.4.2	500	<1	0
185/XVIII	Exploratory trawl fishery for *Dissostichus* spp. in Division 58.4.3	01-Dec-99	30-Nov-00	Elan Bank	145	0	0
185/XVIII	Exploratory trawl fishery for *Dissostichus* spp. in Divisions 58.4.1/58.4.3	01-Dec-99	30-Nov-00	BANZARE Bank	150	0	0
186/XVIII	New trawl fishery for *Chaenodraco wilsoni* in Division 58.4.2	01-Dec-99	30-Nov-00	58.4.2	500	<1	0

Table 19: CCAMLR fisheries operating in Areas 58 and 88 in the 1999/2000 season. Source of data: 5-day, 10-day or monthly catch and effort reports submitted by 7 October 2000.

Exploratory longline fishery for *Dissostichus eleginoides* in Division 58.4.4 (188/XVIII)			
Season			1 May–31 Aug 2000
Catch limit (tonnes) for target species			370
Reported catch (tonnes) of target species			99
Total effort (vessel.day)			45
Number of vessels fishing			1
	by country	Uruguay	1
Exploratory longline fishery for *Dissostichus eleginoides* in Subarea 58.6 (189/XVIII)			
Season			1 May–31 Aug 2000
Catch limit (tonnes) for target species			450
Reported catch (tonnes) of target species			4
Total effort (vessel.day)			17
Number of vessels fishing			3
	by country	France	2
		South Africa	1
Exploratory trawl fishery for *Dissostichus* spp. in Division 58.4.2 (186/XVIII)			
Season			1 Dec 1999–30 Nov 2000
Catch limit (tonnes) for target species			500
Reported catch (tonnes) of target species			0
Total effort (vessel.day)			2
Number of vessels fishing			1
	by country	Australia	1
New trawl fishery for *Chaenodraco wilsoni* in Division 58.4.2 (186/XVIII)			
Season			1 Dec 1999–30 Nov 2000
Catch limit (tonnes) for target species			500
Reported catch (tonnes) of target species			0
Total effort (vessel.day)			4
Number of vessels fishing			1
	by country	Australia	1
Exploratory longline fishery for *Dissostichus* spp. in Subarea 88.1 (south of 65°S) (190/XVIII)			
Season			1 Dec 1999–31 Aug 2000
Catch limit (tonnes) for target species			1 915
Reported catch (tonnes) of target species			745
Total effort (vessel.day)			162
Number of vessels fishing			3
	by country	New Zealand	3

Table 20: History of new and exploratory fisheries. Catch – target species; x – notified but did not fish; N – notification for 2000/01.

Fishery	Season	Total Reported Catch (tonnes)	Chile	Korea/ UK	South Africa	Norway	Australia	France	Uruguay	Ukraine	Spain	Russia	New Zealand	EC (Portugal)	Argentina	Brazil
Longline fishery for *Dissostichus* spp. in Subarea 48.1																
	1997/98	1	1													
	2000/01	N													N	
Longline fishery for *Dissostichus* spp. in Subarea 48.2																
	1997/98	<1	<1													
	2000/01	N													N	
Jig fishery for *Martialia hyadesi* in Subarea 48.3																
	1995/96	52		52												
	1996/97	81		81												
	1997/98	0		x												
	1998/99	0														
	1999/00	0														
	2000/01	N		N												
Longline fishery for *Dissostichus* spp. in Subarea 48.6																
	1996/97	0			x											
	1997/98	0			x	x										
	1998/99	<1			<1											
	1999/00	0			x									x		
	2000/01	N			N										N	N
Longline fishery for *Dissostichus* spp. in Division 58.4.1																
	2000/01	N													N	
Trawl fishery for *Dissostichus* spp. in Division 58.4.1																
	1998/99	<1					<1									
Trawl fishery for *Dissostichus* spp. in Division 58.4.3																
	1995/96	0					x									
	1996/97	<1					<1									
	1997/98	0					x									
	1998/99	<1					<1									

(continued)

Table 20 (continued)

Fishery	Season	Total Reported Catch (tonnes)	Chile	Korea/ UK	South Africa	Norway	Australia	France	Uruguay	Ukraine	Spain	Russia	New Zealand	EC (Portugal)	Argentina	Brazil
Trawl fishery for *Dissostichus* spp. in Division 58.4.1/58.4.3 (BANZARE and Elan Banks)																
	1999/00	<1					<1									
	2000/01	N					N									
Trawl fishery for *Chaenodraco wilsoni* and other species in Division 58.4.2																
	1999/00	<1					<1									
	2000/01	N					N									
Longline fishery for *Dissostichus* spp. in Division 58.4.2																
	2000/01	N													x	
Longline fishery for *Dissostichus* spp. in Division 58.4.3																
	1996/97	0			x		x									
	1997/98	0			x											
	1998/99	0						x								
	1999/00	0						x						x		
	2000/01	N						N							N	
Longline fishery for *Dissostichus eleginoides* in Division 58.4.4																
	1997/98	0			x					x						
	1998/99	0			x			x	x		x					
	1999/00	99	x		x			x	99					x		
	2000/01	N			N			N	N	N					N	N
Longline fishery for *Dissostichus eleginoides* in Division 58.5.1																
	2000/01	N						N							N	N
Longline fishery for *Dissostichus eleginoides* in Division 58.5.2																
	2000/01	N						N								N
Trawl fishery for deep-water species in Division 58.5.2																
	1995/96	<1					<1									
	1996/97	0					x									

(continued)

Table 20 (continued)

Fishery	Season	Total Reported Catch (tonnes)	Chile	Korea/ UK	South Africa	Norway	Australia	France	Uruguay	Ukraine	Spain	Russia	New Zealand	EC (Portugal)	Argentina	Brazil
Longline fishery for *Dissostichus eleginoides* in Subarea 58.6																
	1996/97	0			x											
	1997/98	1			1					x		x				
	1998/99	0			<1			x								
	1999/00	14	x		11			3						x		
	2000/01	N			N			N							N	
Longline fishery for *Dissostichus eleginoides* in Subarea 58.7																
	1995/96	0			x											
	1996/97	0			x											
	1997/98	<1			<1					x		x				
	1998/99	0			x											
	2000/01	N						N								
Longline fishery for *Dissostichus* spp. in Subarea 88.1																
	1996/97	<1											<1			
	1997/98	39											39			
	1998/99	298											298			
	1999/00	745	x										745	x		
	2000/01	N			N				N				N		N	
Longline fishery for *Dissostichus* spp. in Subarea 88.2																
	1996/97	<1											<1			
	1997/98	0											x			
	1999/00	0	x											x		
	2000/01	N			N				N						N	
Longline fishery for *Dissostichus* spp. in Subarea 88.3																
	1997/98	<1	<1													
	2000/01	N							N						N	

Table 21: Catch of *Dissostichus* spp. and number of hauls undertaken in each small-scale research unit (see Table 1 and Figure 1 of Conservation Measure 182/XVIII, Annex B). Source of data: 5-day catch and effort reports and fine-scale data submitted by 7 October 2000.

SSRU	Catch (tonnes)		Number of Hauls Reported Total	Research
Exploratory longline fishery for *Dissostichus eleginoides* in Division 58.4.4				
A (51–54°S, 40–42°E)	17	catch >10 tonnes, research required	20	no data
C (51–54°S, 46–50°E)	16	catch >10 tonnes, research required	10	no data
B (51–54°S, 42–46°E)	12	catch >10 tonnes, research required	3	no data
Other grounds	55	no research requirements	35	no data
Exploratory longline fishery for *Dissostichus eleginoides* in Subarea 58.6				
A (45–48S, 40–44°E)	9.9	catch <10 tonnes and hauls <10?	8[1]	0
B (45–48S, 44–48°E)	1	catch <10 tonnes and hauls <10?	1[1]	0
Exploratory longline fishery for *Dissostichus* spp. in Subarea 88.1 (south of 65°S)				
A (72–84°S, 170°W–180)	310	catch >10 tonnes, research required	200	26
B (72–84°S, 171°E–180)	159	catch >10 tonnes, research required	136	52
C (65–72°S, 170°W–180)	230	catch >10 tonnes, research required	135	20
D (65–72°S, 150°E–180)	47	catch >10 tonnes, research required	18	2
Exploratory trawl fishery for *Dissostichus* spp. in Division 58.4.2				
C (>62°S, 60–70°E)	0	catch <10 tonnes and hauls <10	1	0

[1] Dataset incomplete

Table 22: Parameters input to the GYM for evaluation of γ for the exploratory fishery for *Dissostichus mawsoni* in Subarea 88.1.

Category	Parameter	*D. mawsoni* Subarea 88.1 Longline
Age structure	Recruitment age	4
	Plus class accumulation	35
	Oldest age in initial structure	55
Recruitment	SD $\log_e$(recruits)	0.803
Natural mortality	Mean annual M	0.15–0.22
von Bertalanffy growth	Time 0	0.37
	L_∞	180.26
	k	0.095
Weight at age	Weight–length parameter – A	0.000005
	Weight–length parameter – B	3.199
Maturity	L_{m50}	100.0
	Range: 0 to full maturity	30.0
Spawning season		01/08
Simulation characteristics	Number of runs in simulation	1 001
	Depletion level	0.2
	Seed for random number generator	-24 189
Characteristics of a trial	Years to remove initial age structure	1
	Observations to use in median SB_0	1 001
	Year prior to projection	1997
	Reference start date in year	01/12
	Increments in year	180
	Years to project stock in simulation	35
	Reasonable upper bound for annual F	5.0
	Tolerance for finding F in each year	0.000001
Fishing mortality	Length, 50% recruited	80.0
	Range over which recruitment occurs	30.0

Table 23: Assessment of long-term annual yield for the exploratory fishery for the *Dissostichus mawsoni* in Subarea 88.1 based on four different estimates of seabed area. Ratios are the ratio of seabed area between Subareas 88.1 and 48.3 based on the appropriate depth range.

	Subarea 48.3		Subarea 88.1			
	Total (600–1 800 m)	Recruited (0–500 m)	Total (600–1 800 m)	Recruited (0–500 m	Fished (600–1 800 m)	Proposed Fished (600–1 800 m)
Seabed areas (km^2)	32 035	42 753	236 391	202 022	49 692	77 158
Seabed area ratios (88.1/48.3)	-	-	7 382	4 725	1 552	2 409
Yields			17 204	11 013	3 616	5 615

Table 24: Summary of notifications of new and exploratory fisheries in 2000/01.

Member	Subarea or Division	Target Species	Gear	Summary (WG-FSA-00/6)
Argentina	48.1[1], 48.2[1], 48.6, 58.4.1, 58.4.2, 58.4.3, 58.4.4, 58.5.1, 58.6, 88.1, 88.2, 88.3	*Dissostichus* spp.	Longline	Table C2
Australia	58.4.1, 58.4.3	*Dissostichus* spp.	Trawl	Table C3
Australia	58.4.2	Mixed species	Trawl	Table C4
Brazil	48.6, 58.5.1, 58.5.2, 58.4.4	*Dissostichus eleginoides*	Longline	Table C5
France	58.6, 58.7[2], 58.4.3, 58.4.4, 58.5.1, 58.5.2	*Dissostichus eleginoides*	Longline	Table C6
New Zealand	88.1	*Dissostichus* spp.	Longline	Table C7
South Africa	48.6, 58.4.4, 58.6, 88.1, 88.2	*Dissostichus* spp.	Longline	Table C8
Ukraine	58.4.4	*Dissostichus eleginoides*	Longline	Table C9
Uruguay	48.3	*Dissostichus* spp.	Pots	Table C10
Uruguay	58.4.4, 88.1, 88.2, 88.3	*Dissostichus* spp.	Longline	Table C11
Uruguay	48.3	Crab	Pots	Table C12
UK, Republic of Korea	48.3	*Martialia hyadesi*	Jig	Table C13

[1] In accordance with Conservation Measure 73/XVII, directed fishing for finfish in Subarea 48.2 is prohibited until such time as a survey of stock biomass is carried out and a decision to reopen the fishery is made by the Commission based on advice of the Scientific Committee.

[2] In accordance with Conservation Measure 160/XVII, taking of *Dissostichus eleginoides* in Subarea 58.7 is prohibited other than for scientific research purposes. The prohibition shall apply until at least such time that a survey of the *D. eleginoides* stock in this subarea is carried out and a decision to reopen the fishery is made by the Commission based on advice of the Scientific Committee.

Table 25: Summary of intended catches and number of vessels per area in new/exploratory fisheries notifications for *Dissostichus* spp. in the 2000/01 season. In each cell: top figure – number of vessels nominated; middle letter L – longline, T – trawl; bottom figure – intended catch.

Country	48.1	48.2	48.3	48.4	48.6	58.4.2	58.4.1/58.4.3	58.4.4	58.5.1	58.5.2	58.6	58.7	88.1	88.2	88.3	No. Vessels	Intended Catch
Argentina	L	L			L	L	L	L	L*		L*		L	L	L	3	CCAMLR-XIX
Australia						2 T 500 t	2 T 145 t Elan 150 t BANZARE									2	
Brazil		L	L	L	L			L	L*	L*						2	Not stated
France							L**	L	L*	L*	L*	L				3	500 t per vessel
New Zealand													3 L 2 090 t			3	
South Africa					Up to 3 L <500 t			Up to 3 L <60 t			Up to 3 L* <100 t		Up to 2 L <560 t	Up to 2 L <60 t		3	
Ukraine								1 L <500 t								1	
Uruguay								L					L	L	L	2	CCAMLR-XIX
Total notifications	1	2	1	1	3	2	3	6	3	2	3	1	4	3	2		
Maximum no. of vessels	3	5	2	2	8	5	8	14	8	5	9	3	10	7	5		
Catch limit set at CCAMLR-XVIII	0	0	5 310 t	28 t	455 t	Trawl 500 t	Trawl: 145 t Elan 150 t BANZARE Longline: 250 t Elan 300 t BANZARE	370 t (N of 60˚S)	0[a]	0[a]	450 t	0	175 t (N of 65˚S) 1 915 t (S of 65˚S)	250 t (S of 65˚S)	0		

* Outside EEZs
** French proposal is for Division 58.4.3 only

[a] Based on Scientific Committee advice that these fisheries are unlikely to be viable.

Table 26: Frequency of catches of *Dissostichus* spp. by fine-scale rectangles for new and exploratory fisheries.

Fishery	Catch (tonnes)	All	Fishing Season 1996/97	1997/98	1998/99	1999/00
Exploratory longline fishery for *Dissostichus eleginoides* in Division 58.4.4	0–10	3				3
	10–20	2				2
	20–30	1				1
	30–40	1				1
Exploratory longline fishery for *Dissostichus eleginoides* in Subarea 58.6 (outside EEZs)	0–10	4		1		3
Exploratory longline fishery for *Dissostichus eleginoides* in Subarea 58.7 (outside EEZ)	0–10	1		1		
Exploratory longline fishery for *Dissostichus* spp. in Subarea 88.1 (south of 65°S)	0–10	76		25	29	22
	10–20	15		1	3	11
	20–30	6			1	5
	30–40	5			4	1
	50–60	2				2
	60–70	2				2
	80–90	1				1
Exploratory trawl fishery for *Dissostichus* spp. in Division 58.4.3	0–10	2			2	
New longline fishery for *Dissostichus* spp. in Subarea 88.1	0–10	1	1			
New longline fishery for *Dissostichus* spp. in Subarea 88.3 (south of 65°S)	0–10	9		9		
New trawl fishery for *Dissostichus* spp. in Division 58.4.3	0–10	1	1			

Table 27: Standardised series of CPUEs in kg/hook for *Dissostichus eleginoides* in Subarea 48.3.

Season	Std. CPUE	SE
1986/87	0.551	0.025
1987/88	0.693	0.029
1988/89	0.517	0.027
1989/90	-	-
1990/91	0.504	0.022
1991/92	0.719	0.015
1992/93	0.712	0.016
1993/94	0.559	0.022
1994/95	0.606	0.012
1995/96	0.355	0.007
1996/97	0.267	0.006
1997/98	0.273	0.007
1998/99	0.309	0.007
1999/00	0.348	0.007

Table 28: Proportions of non-zero catches by season in the haul-by-haul data for *Dissostichus eleginoides* in Subarea 48.3.

Season	Proportion
1985/86	0.977
1986/87	0.976
1987/88	0.975
1988/89	1.000
1989/90	-
1990/91	0.960
1991/92	0.965
1992/93	0.972
1993/94	0.946
1994/95	0.993
1995/96	0.978
1996/97	0.977
1997/98	0.981
1998/99	0.988
1999/00	0.984

Table 29: Estimates of lengths from the analysis of changes in selectivity by season for *Dissostichus eleginoides* in Subarea 48.3.

	1995	1997	1998	1999	2000	1992–2000	1998–2000
L5%	77.2	68.0	64.8	67.0	65.7	67.9	64.4
L10%	80.9	71.2	67.6	69.2	67.9	71.0	67.6
L25%	86.4	75.7	71.8	72.4	71.2	75.6	72.2
L50%	91.8	80.3	75.9	75.7	74.4	80.2	76.8
L75%	97.3	84.9	80.0	78.9	77.6	84.7	81.5
L90%	102.8	89.5	84.1	82.2	80.8	89.3	86.1
L95%	106.5	92.7	86.9	84.4	83.0	92.4	89.3
Range 10–90	21.9	18.4	16.4	13.0	12.9	18.3	18.5
Range 25–75	10.9	9.2	8.2	6.5	6.4	9.2	9.3

Table 30: Trawl surveys from which length-density data were generated at this meeting.

Split-year	Survey	Vessel	Timing
1986/87	US/Polish	*Profesor Siedlecki*	November–December 1986
1987/88	US/Polish	*Profesor Siedlecki*	December 1987–January 1988
1989/90	UK	*Hill Cove*	January 1990
1989/90	USSR	*Anchar*	April–June 1990
1990/91	UK	*Falklands Protector*	January 1991
1991/92	UK	*Falklands Protector*	January 1992
1993/94	UK	*Cordella*	January–February 1994
1993/94	Argentina	*Dr Eduardo L. Holmberg*	February–March 1994
1994/95	Argentina	*Dr Eduardo L. Holmberg*	February–March 1995
1995/96	Argentina	*Dr Eduardo L. Holmberg*	March–April 1996
1996/97	Argentina	*Dr Eduardo L. Holmberg*	March–April 1997
1996/97	UK	*Argos Galicia*	September 1997
1999/00	UK	*Argos Galicia*	January–February 2000
1999/00	USSR	*Atlantida*	February 2000

Table 31: Results of mixture analyses from 1999 including the 2000 UK survey, analysed with the parameters used in 1999. Densities are in numbers of fish per km^2 derived from surveys covering the period 1986/87 to 1999/2000 (assuming a split-year of 1 December to 1 November). The mean lengths at age are specified in SC-CAMLR-XVIII, Annex 5, Table 36.

Survey	Age	Density	SD	Observed Density	Expected Density
1987 US/Polish survey Nov–Dec 86	3.12	20.4784	7.08769	49.7674	47.2886
	4.12	26.9235	4.42636		
1988 US/Polish survey Dec 87–Jan 88	4.21	14.4966	11.2833	21.3409	22.0951
	5.21	8.66871	12.5805		
1990 UK survey Jan 90	3.21	165.111	116.813	468.472	473.282
	4.21	195.885	105.115		
	5.21	85.0901	42.0315		
	6.21	32.3369	19.7487		
1991 UK survey Jan 91	2.21	199.169	121.561	578.823	199.007
1992 UK survey Jan 92	3.21	281.373	174.354	287.62	281.167
1994 Argentine survey Feb–Mar 94	3.33	2.61879	2.65314	48.029	49.578
	4.33	47.3539	9.32859		
1994 UK survey Feb–Mar 94	3.21	36.2709	20.0802	122.462	125.88
	4.21	89.8471	32.6139		
1995 Argentine survey Feb–Mar 95	3.33	8.25306	5.16069	60.5409	65.5784
	4.33	21.9359	9.22319		
	5.33	35.7098	8.83209		
1996 Argentine survey Mar–Apr 96	3.41	114.138	39.7255	167.895	167.867
	4.41	18.0444	5.33346		
	5.41	22.2229	6.7232		
	6.41	17.4433	5.76246		
1997 UK survey Sep 97	3.88	52.9244	32.2021	100.425	111.622
	4.88	45.7511	33.2331		
	5.88	13.6754	16.6639		
1997 Argentine survey Mar–Apr 97	2.41	13.0348	6.78435	122.912	124.561
	3.41	26.3148	8.31875		
	4.41	46.2928	13.4333		
	5.41	16.3421	6.77879		
	6.41	14.8633	4.56242		
	7.41	8.15623	4.48682		
2000 UK survey Jan/Feb 00	1.21	28.0208	17.1977	140.284	125.958
	2.21	59.9535	25.1203		
	3.21	38.2432	11.58		

Table 32: Results of mixture analyses for 2000 using k = 0.041 as a guide (see text for details). Densities are in numbers of fish per km^2 derived from surveys covering the period 1986/87 to 1999/2000 (assuming a split-year of 1 December to 1 November).

Survey	Age	Density	SD	Observed Density	Expected Density
1987 US/Polish survey Nov–Dec 86	5.12	16.4201	7.51189	49.7674	50.7646
	6.12	6.55312	5.04633		
	7.12	25.5005	4.44284		
	8.12	2.34475	1.78873		
1988 US/Polish survey Dec 87–Jan 88	6.21	10.2775	5.2341	21.3409	22.3224
	7.21	9.35829	5.08739		
	8.21	2.79209	3.79403		
1990 UK survey Jan 90	6.21	157.113	101.632	468.472	469.398
	7.21	211.168	100.404		
	8.21	20.0624	25.4541		
	9.21	42.0502	27.522		
	10.21	40.7181	19.3791		
1991 UK survey Jan 91	4.21	134.026	70.4781	578.823	159.452
	5.21	25.503	34.8016		
1992 UK survey Jan 92	5.21	261.338	74.614	287.62	273.139
	6.21	12.022	26.2761		
1994 Argentine survey Feb–Mar 94	6.33	7.35597	3.19371	48.029	45.5537
	7.33	21.4435	9.91993		
	8.33	16.7597	9.89185		
1994 UK survey Feb–Mar 94	6.25	36.2737	20.0839	122.462	125.894
	7.25	89.8582	32.6145		
1995 Argentine survey Feb–Mar 95	5.33	13.8755	12.2588	60.5409	65.8605
	6.33	0.000103	0.003585		
	7.33	25.1863	8.16832		
	8.33	31.8978	8.09693		
1996 Argentine survey Mar–Apr 96	4.41	28.4174	9.9149	202.119	193.396
	5.41	108.184	36.6056		
	6.41	2.21E-06	6.06E-06		
	7.41	15.9357	7.25606		
	8.41	16.3485	8.20869		
	9.41	24.6925	8.10416		
1997 UK survey Sep 97	5.88	7.6774	15.9115	101.464	102.653
	6.88	42.5386	33.1305		
	7.88	30.0979	30.1309		
	8.88	10.4395	13.8247		
	9.88	12.0209	14.4493		
1997 Argentine survey Mar–Apr 97	4.41	14.0384	10.017	122.912	125.534
	5.41	25.1256	9.80466		
	6.41	1.1E-05	5.27E-05		
	7.41	57.7507	20.3484		
	8.41	4.81903	13.0498		
	9.41	24.4348	9.33683		
2000 UK survey Jan/Feb 00	2.21	26.8968	15.3732	140.284	127.461
	3.21	0.674774	0		
	4.21	61.5829	28.4046		
	5.21	17.8197	13.9575		
	6.21	21.6946	15.7049		

Table 33: Time series of recruitments (millions of fish) from the 1999 assessment and for the revised assessments this year guided by the growth parameters from 1999 (k = 0.066) and by k = 0.041 from Heard Island. See text for details about how recruitments were adjusted.

Year Class	Year Age 4	1999 Assessment	k = 0.066	k = 0.041
1979	1983			2.153
1980	1984			1.011
1981	1985			0.776
1982	1986	1.146	1.108	11.241
1983	1987	0.722	0.747	7.705
1984	1988	4.106	4.377	no obs
1985	1989	8.055	8.282	1.332
1986	1990	5.786	5.739	5.039
1987	1991	no obs	no obs	1.587
1988	1992	10.190	5.815	0.072
1989	1993	2.061	2.053	1.503
1990	1994	0.961	1.006	3.310
1991	1995	0.701	0.718	1.183
1992	1996	2.649	2.405	0.583
1993	1997	1.119	0.962	1.173
1994	1998		0.386	0.888
1995	1999		no obs	2.827
1996	2000		1.496	0.003
1997	2001		1.927	1.048
1998	2002		- [1]	
	Mean	3.185	2.517	2.413
	SD	3.219	2.395	2.901
	CV	1.011	0.951	1.202
	n	11	15	18

[1] See SC-CAMLR-XIX, paragraphs 5.45 and 5.46.

Table 34: Input parameters for the GYM to assess the long-term annual yield of *D. eleginoides* taken by longline in Subarea 48.3 and trawl in Division 58.5.2.

Category	Parameter	Subarea 48.3 Longlining	Division 58.5.2 Trawling
Age structure	Recruitment age	4	4
	Plus class accumulation	35	35
	Oldest age in initial structure	55	55
Recruitment	Mean $\log_e$(recruits)	14.481[1]	14.744
	SE of mean $\log_e$(recruits)	0.209[1]	0.256
	SD $\log_e$(recruits)	0.783[1]	0.993
Natural mortality	Mean annual M	0.132–0.198	0.083–0.124
von Bertalanffy growth	Time 0	-0.21	-1.80
	L_∞	194.6	1946.0
	k	0.066	0.04114
Weight at age	Weight-length parameter – A	0.000025	2.59E-09
	Weight-length parameter – B	2.8	3.2064
Maturity	L_{m50}	93.0	
	Range: 0 to full maturity	78–108	
	Maturity at age		0(0), 4.6(0), 5.4(0.005), 6.2(0.009), 7.1(0.025), 8.0(0.048), 9.0(0.066), 10.0(0.129), 11.0(0.150), 12.1(0.202), 13.2(0.296), 14.4(0.389), 15.6(0.677), 16.9(0.8), 18.3(0.909), 19.8(0.923), 23.0(1.0)
	Length, 50% are mature		
	Range over which maturity occurs	30.0	
Spawning season		1 Aug–1 Aug	1 Jul–1 July
Simulation characteristics	Number of runs in simulation	1001	1001
	Depletion level	0.2	0.2
	Seed for random number generator	-24189	-24189
Characteristics of a trial	Years to remove initial age structure	1	1
	Observations to use in median SB_0	1001	1001
	Year prior to projection	1988	1996
	Reference start date in year	01/12	01/12
	Increments in year	365	365
	Vector of known catches	8.501e6 4.206e6 7.309e6 5.589e6 6.605e6 6.171e6 4.362e6 2.619e6 3.201e6 4.3e6 5.5e6	18.96e6 3.913e6 3.628e6 4.385e6
	Years to project stock in simulation	35	35
	Reasonable upper bound for annual F	5.0	5.0
	Tolerance for finding F in each year	0.000001	0.000001

[1] See SC-CAMLR-XIX, paragraphs 5.45 and 5.46.

(continued)

Table 34 (continued)

Category	Parameter	Subarea 48.3 Longlining	Division 58.5.2 Trawling
Fishing mortality	Length, 50% recruited	67.0 cm	
	Range over which recruitment occurs	55–79 cm	
	Fishing selectivity with age		0(0.), 3(0), 3.92(0.016), 4.88(0.207), 5.54(0.473), 5.88(0.512), 6.57(0.708), 7.29(0.886), 7.65(0.909), 8.02(0.745), 8.40(0.691), 8.78(0.642), 9.56(0.485), 9.96(0.325), 10.37(0.222), 11.2(0.099), 11.63(0.066), 12.07(0.049), 12.51(0.033), 13.43(0.014), 14.87(0.011), 16.40(0.008), 21.04(0.005), 25.21(0.002), 31.0(0.0)

Table 35: Standardised CPUE values (number/hook) for longliners in the Kerguelen Islands.

Season	Standard CPUE	SE Standard CPUE
1996	0.0624	0.0055
1997	0.2029	0.0102
1998	0.2565	0.0090
1999	0.1946	0.0093

Table 36: Abundances of fish (millions) at age 4 (birthday 1 November of the year indicated).

Year Class	Year at Age 4	Abundance (millions of fish)
1983	1987	1.550
1984	1988	1.590
1985	1989	3.649
1986	1990	1.956
1987	1991	1.793
1988	1992	4.575
1989	1993	2.435
1990	1994	2.944
1991	1995	5.674
1992	1996	9.548
1993	1997	21.557
1994	1998	3.440
1995	1999	1.059
1996	2000	0.241
1997	2001	0.152
	Mean	4.144
	SD	5.374
	CV	1.297
	N	15

Table 37: Summary of standing stock estimates (tonnes) from bottom trawl surveys in Subarea 48.3 undertaken during the 1999/2000 season.

Shelf	Method	*Argos Galicia* Survey (UK)			*Atlantida* Survey (Russia)		
		Biomass (CV%)	Lower 95%CI	Upper 95% CI	Biomass	Lower 95%CI	Upper 95% CI
South Georgia	Swept Area	10 925 (33%)			45 633.3		
	Trawl CI	9 667	6 551	19 421	85 075		
Shag Rocks	Swept Area	13 859 (87%)			2 192.48		
	Trawl CI	11 540	3 039	2.19E+12	2 231		
Subarea 48.3 (total)	Swept Area	24 784			47 811 (27.2%)		
	Trawl CI	21 027			87 308.5	22 885.3	2.241E+12

Table 38: Lower one-sided 95% confidence bound of biomass from the UK and Russian surveys in 1999/2000.

Survey	Lower One-sided 95% Confidence Bound (tonnes)
UK Survey, Subarea 48.3	8 916.0
Russian Survey, Subarea 48.3	28 098.1

Table 39: Distribution of numbers of fish at age (%) from the UK and Russian surveys based on length densities analysed using CMIX and an age-length key (ALK) from the Russian survey.

Survey		UK Survey	Russian Survey	Russian Survey
Subarea		48.3	48.3	48.3
Method		Length Density + CMIX	Swept Area + ALK	Length Density + CMIX
Numbers at age	1	17	1	0
	2	28	55	48
	3	15	25	36
	4	36	9	8
	5	4	6	8
	6	0	4	0

Table 40: Lower one-sided 95% confidence bound of biomass from the combined survey dataset.

Stratum		No. of Valid Hauls	Mean Biomass	SE	Two-sided Lower 95% CI	Two-sided Upper 95% CI	One-sided Lower 95% Confidence Bound
S1	SGNW <150 m	6	94.7	33.4	37.5	159.2	46.5
S2	SGNW 150–<250 m	8	23 895.7	12 724.0	5 380.7	49 395.2	6 981.4
S3	SGNE <150 m	2	3 903.5	1 773.2	2 130.3	5 676.6	2 130.3
S4	SGNE 150–<250 m	17	3 308.6	1 699.6	665.8	6 982.2	805.4
S5	SGSE <150 m	9	3 380.0	2 632.7	341.4	8 759.9	436.1
S6	SGSE 150–<250 m	9	2 144.2	1 570.3	465.3	5 334.6	490.9
S7	SGSW <150 m	0					
S8	SGSE 150–<250 m	19	13 272.9	3 515.0	6 851.2	20 304.7	7 782.5
S9	SR <150 m	10	5 709.3	4 802.3	154.4	15 457.1	245.5
S10	SR 150–<250 m	9	1 431.3	787.4	174.4	3114.3	238.4
S11	all 250–<500 m	33	1 046.8	314.6	498.6	1 695.8	572.5
All strata combined		122	58 186.9	15 999.2	31 712.0	94 072.9	35 084.6

Table 41: Results of the CMIX analysis for the combined survey dataset.

Sum of the observed densities =	15 465.8			
Sum of the expected densities =	14 603			
ANI00AL4	Component 1	Component 2	Component 3	Component 4
Means of mixture components (mm)	222.42	275.484	325.88	378.969
Standard deviations of mixture components	14.3441	15.4643	16.5282	17.6489
Total density of each mixture component	8 904.77	3476.48	1 568.87	673.445
SD of each mixture component density	2 992.47	1 100.89	535.958	316.301
Parameters of linear standard deviations				
Intercept = 9.64883				
Slope = 0.211101E-01				
Cohorts not fitted in the analysis:	Length Range	Sum of Observed Densities		
Age 1:	115–175 mm	233.8241		
Plus class	415–595 mm	137.466		

Table 42: Inputs for the short term assessment.

Lower single sided 95% CI		35 085
Numbers at age	1	9 585 221
	2	365 035 908
	3	142 512 388
	4	64 313 159
	5	27 606 733
	6	0
Method		Length Density + CMIX
Natural mortality		0.42
Age when fully selected		3
Age when selection begins		2
Birthday (days since start of year)		245
Von Bertalanffy growth parameters		
	Time 0	0
	L_{∞}[1]	455
	K[1]	0.332
Weight length	a (kg)	6.17E-10
	b	3.388
Survey timing: days since start of year		32
Catch since survey (between survey and first year of projection)		0

[1] These values were chosen as 98% of the population had vanished by the time fish reached lengths of 42–44 cm. The true values of K were lower (0.15–0.2) and of L_{∞} were higher (64–70 cm) for this population.

Table 43: Estimates of abundance (kg) of *Champsocephalus gunnari* at Heard Island and McDonald Islands in 2000 (from WG-FSA-00/40).

Stratum	No. of hauls	Value	SE	Lower CI	Upper CI
Plateau West	5	294 603	274 135	26 812	164 131 000
Plateau North	10	56 914	42 546	9 356	443 593
Gunnari Ridge	20	81 481 100	73 856 600	6 084 970	9 332 850 000
Plateau East	25	1 818 310	1 115 970	527 771	15 169 400
Shell Bank	15	722	722	0	0.176×10^{39}
All strata combined		83 594 000	73 865 500	7 958 670	9 334 950 000

Table 44: Parameters for the short-term assessment of yield from the Heard Plateau population of *Champsocephalus gunnari* (from WG-FSA-00/41).

Category	Parameter	*C. gunnari* Heard Plateau	Subarea 48.3
Survey details:	Survey date	20 May 2000	
	Biomass – lower 95% bound	6 522 tonnes	
Mean length at age at time of survey	Age 2	245	
	Age 3	324	
Age structure (density n.km^2)	Age 2	18 361	
	Age 3	48	
Biological parameters:	Birthday	1 November	
Von Bertalanffy growth	Time 0	0.234	
	L_∞	411 mm	
	k	0.41	
Weight at age	Weight-length parameter A	2.6 x 10^{-10} kg	
	Weight-length parameter B	3.515	
Natural mortality	Mean annual M	0.4	
Fishery parameters:	Season	1 Dec–30 Nov	
Selectivity	Age fully selected	3	
	Age first selected	2.5	

Table 45: By-catch (tonnes) reported in the fine-scale data (FS), catch and effort reports (CE) and observer data (OBS) for fisheries in the 1999/2000 season.

Fishery	By-catch (tonnes)		
	FS	CE	OBS
Chaenodraco wilsoni			
Trawl fishery in Division 58.4.2	0	0	e
Champsocephalus gunnari			
Trawl fishery in Division 58.5.1	4	no data	no data
Trawl fishery in Division 58.5.2	3	17[a]	25[d]
Trawl fishery in Subarea 48.3	0	68	68
Dissostichus mawsoni			
Trawl fishery in Division 58.4.2	0	0	e
Dissostichus eleginoides			
Longline fishery in Division 58.4.4	14	0	6
Longline fishery in Division 58.5.1	255	no data	no data
Longline fishery in Subarea 48.3	18	4	85
Longline fishery in Subarea 58.6	81[b]	10[c]	200[c]
Longline fishery in Subarea 88.1	118	115	143
Trawl fishery in Division 58.5.1	8	no data	no data
Trawl fishery in Division 58.5.2	10	49[a]	25[d]
Euphausia superba			
Trawl fishery in Area 48	0	0	0

a Incomplete
b From French EEZ
c Excluding French EEZ
d Both fisheries
e Combined data with Division 58.5.2

Table 46: Overall species composition of catches reported by scientific observers in trawl and longline fisheries in the 1999/2000 season. The relative abundance of each taxon is expressed as the percentage, by weight, of the total catch observed. Data limited to those where weight provided. Target species: ANI – *Champsocephalus gunnari*; KRI – *Euphausia superba*; TOA – *Dissostichus mawsoni*; TOP – *Dissostichus eleginoides*; WIC – *Chaenodraco wilsoni*.

Gear	Trawl						Longline			
Target species	KRI	ANI	ANI	TOA	TOP	WIC	TOP	TOP	TOP	TOA
Subarea/Division	48.1	48.3	58.5.2	58.4.2	58.5.2	58.4.2	48.3	58.4.4	58.6/7	88.1
Elasmobranchs		<0.1								
Callorhinchidae										
Callorhinchus capensis									<0.1	
Laminidae										
Lamna nasus			0.5							
Rajidae			<0.1		<0.1		2.3	0. 9	0.7	<0.1
Amblyraja georgiana							<0.1		0.6	5.7
Bathyraja eatonii			0.2		0.2		<0.1			0.9
Bathyraja irrasa			<0.1		<0.1					
Bathyraja maccaini					<0.1	0.7			<0.1	
Bathyraja meridionalis							<0.1			
Bathyraja murrayi			<0.1		<0.1				<0.1	
Bathyraja spp.									<0.1	
Raja spp.							0.3			
Squalidae										
Etmopterus granulosus									<0.1	
Somniosus microcephalus									0.1	
Somniosus pacificus					0.2					
Bony Fishes										
Achiropsettidae										
Mancopsetta maculata					<0.1					
Artedidraconidae										
Artedidraco mirus										<0.1
Bathylagidae										
Bathylagus antarcticus					<0.1					
Bothidae					<0.1					
Bramidae										
Brama brama									<0.1	
Carapidae										
Echiodon cryomargarites									<0.1	
Ceratiidae										
Ceratias tentaculatus					<0.1					
Channichthyidae					<0.1		<0.1			<0.1
Chaenocephalus aceratus										<0.1
Chaenodraco wilsoni						1.1				
Champsocephalus gunnari		98.5	93.4		1.9		<0.1			
Channichthys rhinoceratus			4.0		<0.1					
Chionodraco hamatus						0.4				
Neopagetopsis ionah						1.4				
Pagetopsis macropterus										<0.1
Pseudochaenichthys georgianus					<0.1		<0.1			

(continued)

Table 46 (continued)

Gear	Trawl						Longline			
Target species	KRI	ANI	ANI	TOA	TOP	WIC	TOP	TOP	TOP	TOA
Subarea/Division	48.1	48.3	58.5.2	58.4.2	58.5.2	58.4.2	48.3	58.4.4	58.6/7	88.1
Congiopodidae										
Zanclorhynchus spinifer					<0.1					
Gempylidae										
Paradiplospinus antarcticus					<0.1					
Paradiplospinus gracilis					<0.1					
Harpagiferidae										
Pogonophryne permitini										<0.1
Pogonophryne spp.										<0.1
Lampridae										
Lampris immaculatus					<0.1					
Macrouridae										
Macrourus carinatus			<0.1		<0.1		<0.1			7.9
Macrourus holotrachys					<0.1		0.1			
Macrourus spp.			<0.1		<0.1		0.9	18.2	19.4	<0.1
Macrourus whitsoni					<0.1	45.3	0.6		<0.1	0.5
Merlucciidae										
Macruronus novaezelandiae			<0.1		<0.1					
Moridae			<0.1		<0.1					
Antimora rostrata					<0.1		0.1	0.6	2.7	<0.1
Muraenolepididae										
Muraenolepis microps									<0.1	0.6
Muraenolepis orangiensis										<0.1
Muraenolepis spp.					<0.1				<0.1	0.2
Myctophidae					<0.1					
Electrona carlsbergi					<0.1					
Gymnoscopelus bolini		<0.1			<0.1					
Gymnoscopelus nicholsi		1.5			<0.1					
Notacanthidae										
Notacanthus chemnitzii					<0.1					
Nototheniidae							<0.1			<0.1
Dissostichus eleginoides			1.3		97.2		95.6	80.2	76.3	<0.1
Dissostichus mawsoni				86.6						84.1
Notothenia acuta			<0.1		<0.1					
Notothenia coriiceps			<0.1		<0.1					
Notothenia neglecta							<0.1			
Notothenia rossii					<0.1		<0.1			
Notothenia squamifrons			<0.1		0.2		<0.1			
Nototheniops mizops			<0.01		<0.1					
Nototheniops nudifrons							<0.1			
Pagothenia hansoni										
Patagonotothen brevicauda		<0.1					<0.1			
Pleuragramma antarcticum						2.0				
Trematomus eulepidotus						5.2				
Paralepididae										
Notolepis coatsi					<0.1					
Scorpaenidae							<0.1			

(continued)

Table 46 (continued)

Gear	Trawl						Longline			
Target species	KRI	ANI	ANI	TOA	TOP	WIC	TOP	TOP	TOP	TOA
Subarea/Division	48.1	48.3	58.5.2	58.4.2	58.5.2	58.4.2	48.3	58.4.4	58.6/7	88.1
Stomiidae										
Stomias boa boa					<0.1					
Zoarcidae										
Melanostigma spp.					<0.1					
Other					<0.01		<0.1		<0.1	
Invertebrates										
Euphausia spp.			<0.1							
Euphausia superba	100									
Lithodidae							<0.1		<0.1	
Lithodes murrayi							<0.1		<0.1	
Lithodes spp.								0.2		
Loliginidae		<0.1	<0.1		<0.1					
Moroteuthis ingens			<0.1		<0.1	4.9				
Octopodidae				13.4	<0.1	1.2				
Paralithodes spp.							<0.1			
Paralomis anamerae							<0.1		<0.1	
Paralomis formosa							<0.1			
Paralomis spinosissima							<0.1			
Paralomis spp.							<0.1			
Other			0.4		0.1	38.0	<0.1		<0.1	

Table 47: Summary of seabirds at risk from longline fisheries in the Convention Area indicating the populations where population monitoring (PM) and foraging ecology (FE) studies are currently being undertaken (information extracted from documents cited in SC-CAMLR-XVIII, Annex 5, paragraph 7.7; also Gales, 1998; Marchant and Higgins, 1990).

Species	Species Status[1]	Study Location	Annual Pairs	Year Commenced	Objectives PM	Objectives FE
Wandering albatross *Diomedea exulans*	Vulnerable	South Georgia	2 178	1972	√	√
		Crozet	1 734	1966	√	√
		Kerguelen	1 455	1973	√	√
		Macquarie	10	1994	√	
				1998		√
		Marion	1 794	1979	√	√
		Prince Edward	1 277			
Antipodean albatross *Diomedea antipodensis*	Vulnerable	Auckland	65	1991	√	√
		Adams	5 762			
		Antipodes	5 148	1994	√	√
Amsterdam albatross *Diomedea amsterdamensis*	Critically Endangered	Amsterdam	13	1983	√	√
Southern royal albatross *Diomedea epomophora*	Vulnerable	Campbell	7 800	1995	√	√
Northern royal albatross *Diomedea sanfordi*	Endangered	Chatham	5 200	1990s	√	√
		Taiaroa	18	1950s	√	√
				1993		√
Grey-headed albatross *Diomedea chrysostoma*	Vulnerable	South Georgia	54 218	1976	√	√
		Diego Ramirez	10 000	1999	√	√
		Macquarie	84	1994	√	
				1999		√
		Campbell	6 400	1987	√	
				1995		√
		Marion	6 217	1984	√	√
		Prince Edward	1 500			
		Kerguelen	7 900			
Black-browed albatross *Diomedea melanophrys*	Near Threatened	South Georgia	96 252	1976	√	√
		Falklands/Malvinas	550 000	1990	√	
				1998		√
		Diego Ramirez	32 000	1999	√	√
		Kerguelen	3 115	1978	√	√
		Macquarie	38	1994	√	
				1999		√
		Antipodes	100	1995	√	
		Heard, McDonald	750			
		Crozet	980			
Campbell albatross *Diomedea impavida*	Vulnerable	Campbell	26 000	1987	√	
				1995		√
Indian yellow-nosed albatross *Diomedea chlororhynchos*	Vulnerable	Amsterdam	25 000	1978	√	√
		Prince Edward	7 000			
		Crozet	4 430			

(continued)

Table 47 (continued)

Species	Species Status[1]	Study Location	Annual Pairs	Year Commenced	Objectives PM	Objectives FE
Buller's albatross	Vulnerable	Snares	8 460	1992	√	√
Thalassarche bulleri		Solander	4 000–5 000	1992	√	√
Chatham albatross	Critically	Chatham	4 000	1998		√
Thalassarche eremita	Endangered					
Salvin's albatross	Vulnerable	Bounty	76 000	1998	√	
Thalassarche salvini		Snares	650			
White-capped albatross	Vulnerable	Antipodes	75	1995	√	
Thalassarche steadi		Disappointment	72 000			
		Adams	100			
		Auckland	3 000			
Light-mantled albatross	Near	Macquarie	1 100	1993	√	
Phoebetria palpebrata	Threatened			1998		√
		Crozet	2 151	1966	√	√
		South Georgia	6 500			
		Marion	201			
		Kerguelen	3 000–5 000	1994	√	
		Heard, McDonald	500-700			
		Auckland	5 000			
		Campbell	>1 500	1995	√	
		Antipodes	<1 000			
Sooty albatross	Vulnerable	Crozet	2 298	1968	√	√
Phoebetria fusca		Amsterdam	300-400	1992	√	√
		Tristan da Cunha	2 750			
		Gough	5 000–10 000	2 000	√	√
		Prince Edward	700			
		Marion	2 055			
Southern giant petrel	Vulnerable	South Georgia	5 000	1980	√	
Macronectes giganteus				1998		√
		Macquarie	2 300	1994	√	
		Crozet	1 017	1981	√	
		Marion		1984	√	√
		Adélie Land	9–11	1964	√	
		South Sandwich	800			
		Gough				
		Prince Edward	3 000			
		Kerguelen	3–5			
		Heard	2 350			
		South Orkney	8 755	1976	√	
		South Shetland	7 185			
		Enderby Land	no estimate			
		Frazier	250			
		Antarctic Peninsula	1 125			
		Falklands/Malvinas	5 000			

(continued)

Table 47 (continued)

Species	Species Status[1]	Study Location	Annual Pairs	Year Commenced	Objectives PM	Objectives FE
Northern giant petrel	Near	South Georgia	3 000	1980	√	
Macronectes halli	Threatened		1 280	1998		√
		Macquarie	1 313	1994	√	
		Crozet		1981	√	
		Marion	500	1984	√	√
		Prince Edward				
		Kerguelen	1 450–1 800	1986	√	
		Auckland	no estimate			
		Campbell	230+			
		Antipodes	320			
		Chatham	no estimate			
White-chinned petrel	Vulnerable	South Georgia	2 000 000	1995–98	√	√
Procellaria aequinoctialis		Crozet	10 000s	1968	√	√
		Prince Edward	10 000s	1996	√	√
		Falklands/Malvinas	1 000–5 000			
		Kerguelen	100 000s			
		Auckland, Campbell, Antipodes	10 000–50 000			
Grey petrel	Near	Gough	100 000s			
Procellaria cinerea	Threatened	Tristan da Cunha	1 000s			
		Prince Edward	1 000s			
		Crozet	1 000s			
		Kerguelen	1 000s			
		Campbell	10 000s			
		Antipodes	10 000s			
		Macquarie	<100			

[1] As classified using IUCN criteria for threatened species. (Birdlife International. 2000. *Threatened Birds of the World*. BirdLife International/Lynx-Edicions, Barcelona; see WG-FSA-00/34).

Table 48: Incidental mortality of seabirds in the longline fisheries for *Dissostichus eleginoides* in Subareas 48.3, 58.6, 58.7 and 88.1 during the 1998/99 season. Sp – Spanish method; Auto – autoliner; N – night-time setting; D – daytime setting (including nautical dawn and dusk); O – opposite side to hauling; S – same side as hauling. * – Data obtained from observer cruise reports.

Vessel	Dates of Fishing	Fishing Method	Sets Deployed N	Sets Deployed D	Sets Deployed Total	Sets Deployed %N	No. of Hooks (thousands) Obs.	No. of Hooks (thousands) Set	% Observed	Hooks Baited %	No. of Birds Caught Dead N	Dead D	Alive N	Alive D	Total N	Total D	Observed Seabird Mortality (birds/1 000 hooks) N	D	Total	Streamer Line in Use % N	D	Offal Discharge During Haul (%)
Subarea 48.3																						
Argos Georgia	1/6–20/7/00	Sp	153	4	157	97	234.1	586.5	39	100	0	0	0	0	0	0	0	0	0	83	100	O (100)
*Argos Helena**	1/5-21/7/00	Sp									0	0	0	0	0	0	0	0	0			
Faro de Hercules	18/5–21/7/00	Sp	114	5	119	96	163.0	784.8	20	100	0	0	4	0	4	0	0	0	0	90	100	S (0)
Ibsa Quinto	2/5–21/7/00	Sp	117	9	126	93	149.7	1360.0	11	99	0	0	0	0	0	0	0	0	0	89	88	O (94)
Illa de Rua	1/5–20/7/00	Sp	163	4	167	97	357.2	1725.2	20	100	0	0	16	0	16	0	0	0	0	97	100	O (59)
Isla Camila	1/5–15/6/00	Sp	141	23	164	86	293.7	1072.4	27	100	0	0	5	0	5	0	0	0	0	98	100	S (100)
Isla Gorriti	1/5–19/7/00	Auto	129	27	156	83	371.9	1362.6	27	98	0	1	0	0	0	1	0	0.019	0.003	96	100	O (100)
Isla Santa Clara	1/5–20/7/00	Sp	148	20	168	88	381.4	1330.2	28	96	2	2	0	0	2	2	0.006	0.044	0.01	53	100	O (95)
Isla Sofía	20/6–18/7/00	Sp	50	0	50	100	111.4	367.8	30	100	0	0	6	0	6	0	0	0	0	100		S (0)
Jacqueline	6/5–20/7/00	Sp	88	12	100	88	347.8	1101.8	31	100	1	0	0	0	1	0	0.003	0	0.003	62	100	S (100)
Koryo Maru 11	1/5–21/7/00	Sp	91	2	93	98	174.7	1118.1	15	99	0	0	0	0	0	0	0	0	0	100	100	O (88)
Lyn	2/5–20/7/00	Sp	115	0	115	100	144.2	1140.3	12	100	0	0	8	0	8	0	0	0	0	100		O (0)
Magallanes III	2/5–9/5/00	Sp	13	2	15	87	23.8	110.3	21	100	0	0	0	0	0	0	0	0	0	92	100	O (0)
*Magallanes III**	7/7–14/7/00	Sp									0	0	0	0	0	0	0	0	0			
No. 1 Moresko	2/5–21/7/00	Sp	100	27	127	79	301.2	1120.8	26	100	0	0	0	0	0	0	0	0	0	99	96	O (98)
RK-1	1/5–20/7/00	Auto	251	20	271	92	210.6	860.0	24	85	0	0	0	0	0	0	0	0	0	14	25	O (98)
Tierra del Fuego	1/5–21/7/00	Sp	131	28	159	82	192.9	668.3	28	95	0	0	0	1	0	1	0	0	0	87	85	O (92)
Total						87	3457.6	14709.1	24								0.0002	0.002	0.0004			
Division 58.4.4																						
Isla Alegranza	26/6–30/8/00	Sp	34	34	68	50	178.8	704.9	25	100	0		0		0		0	0	0	20	85	S (100)
Subareas 58.6, 58. 7																						
Aquatic Pioneer	30/8–28/9/99	Sp	33	0	33	100	129.4	215.0	60	63	3	0	0	0	3	0	0.023	0	0.023	93		O (80)
Aquatic Pioneer	15/10– 3/12/99	Sp	29	22	51	57	380.0	585.3	64	64	19	9	10	1	29	10	0.098	0.048	0.074	93	90	O (96)
Aquatic Pioneer	24/1–11/3/00	Sp	44	0	44	100	54.6	506.0	10	79	17	0	2	0	19	0	0.311	0	0.311	97		O (98)
Aquatic Pioneer	3/4–4/5/00	Sp	31	0	31	100	98.5	356.2	27	75	12	0	1	0	13	0	0.122	0	0.122	100		O (100)
*Aquatic Pioneer**	18/7–1/9/00	Sp					63.7	528.1	12		0	0	0	0	0	0	1	0	0			
Cap Kersaint	8/7–15/7/00	Sp	5	0	5	100	4.2	41.0	10	100	0	0	0	0	0	0	0	0	0	60		O (100)
Croix du Sud I	28/7–31/7/00	Auto	2	0	2	100	19.9	23.1	85	90	0	0	0	0	0	0	0	0	0	0		
Eldfisk	1/8–27/9/99	Auto	245	75	320	77	301.7	968.3	31	90	2	0	0	0	2	0	0.008	0	0.007	100	100	O (100)
Eldfisk	13/10–12/12/99	Auto	128	165	293	44	786.0	858.9	91	90	34	5	1	0	35	5	0.101	0.011	0.050	98	100	O (80)
Eldfisk	10/1–12/3/00	Auto	81	228	309	26	160.9	935.3	17	83	14	9	3	6	17	15	0.262	0.084	0.143	100	99	O (70)

(continued)

Table 48 (continued)

Vessel	Dates of Fishing	Fishing Method	Sets Deployed N	Sets Deployed D	Sets Deployed Total	Sets Deployed %N	No. of Hooks (thousands) Obs.	No. of Hooks (thousands) Set	% Observed	Hooks Baited %	No. of Birds Caught Dead N	Dead D	Alive N	Alive D	Total N	Total D	Observed Seabird Mortality (birds/1 000 hooks) N	D	Total	Streamer Line in Use % N	D	Offal Discharge During Haul (%)
Subareas 58.6, 58. 7 continued																						
Eldfisk	28/3–27/5/00	Auto	95	211	306	31	530.0	915.4	57	86	0	3	0	0	0	3	0	0.008	0.006	98	99	O (100)
*Eldfisk**	16/6–16/8/00	Auto					324.8	676.8	48		4		3		7				0.012			
Koryo Maru 11	25/8–28/9/00	Sp	99	1	100	99	366.0	806.5	45	100	2	0	3	0	5	0	0.005	0	0.005	98	100	O (100)
Koryo Maru 11	16/1– 31/3/00	Sp	108	15	123	88	223.0	844.8	26	99	20	6	11	3	31	9	0.104	0	0.117	99	93	O (100)
Total						77	3442.1	8260.7	42								0.027	0.013	0.022			
Subarea 88.1																						
Janus	13/1–15/3/00	Auto	6	184	190	3	302.2	952.5	31	91	0	0	0	0	0	0	0	0	0	100	100	(0)
San Aotea II	13/1–14/3/00	Auto	32	177	209	15	293.4	997.0	29	88	0	0	0	0	0	0	0	0	0	87	100	S (0)
Sonrisa	30/1–27/2/00	Auto	0	86	86	0	108.6	184.3	58	87	0	0	0	0	0	0	0	0	0		97	(0)
Total						6	704.2	2133.8	33								0	0	0			

Table 49: Estimated seabird mortality by vessel for Subarea 48.3 during the 1999/2000 season. * – Data obtained from observer cruise report.

Vessel	Hooks Observed (thousands)	Hooks Set (thousands)	Percentage of Hooks Observed	% Night Sets	Estimated Number of Birds Caught Dead		
					Night	Day	Total
Argos Georgia	234.1	586.5	39	97	0	0	0
*Argos Helena**					0	0	0
Faro de Hercules	163.0	784.8	20	96	0	0	0
Ibsa Quinto	149.7	1 360.0	11	11	0	0	0
Illa de Rua	357.2	1 725.2	20	97	0	0	0
Isla Camila	293.7	1 072.4	27	86	0	0	0
Isla Gorriti	371.9	1 362.6	27	83	0	4	4
Isla Santa Clara	381.4	1 330.2	28	88	7	7	14
Isla Sofía	111.4	367.8	30	100	0	0	0
Jacqueline	347.8	1 101.8	31	88	3	0	3
Koryo Maru 11	174.7	1 118.1	15	98	0	0	0
Lyn	144.2	1 140.3	12	100	0	0	0
Magallanes III	23.8	110.3	21	21	0	0	0
*Magallanes III**					0	0	0
No. 1 Moresko	301.2	1 120.8	26	26	0	0	0
RK-1	210.6	860.0	24	92	0	0	0
Tierra del Fuego	192.9	668.3	28	82	0	0	0
Total	3 156.4	13 588.3	24	87	10	11	21

Table 50: Species composition of birds killed in longline fisheries in Subareas 48.3, 58.6 and 58.7 during the 1999/2000 season. N – night setting; D – daylight setting (including nautical dawn and dusk); DIM – black-browed albatross; DIC – grey-headed albatross; MAI – southern giant petrel; PRO – white-chinned petrel; MAH – northern giant petrel; DAC – cape petrel; DCR – yellow-nosed albatross; PCI – grey petrel; ( ) – % composition; * – Data obtained from observer cruise report.

Vessel	Dates of Fishing	No. Birds Killed by Group						Species Composition (%)							
		Albatross		Petrels		Total									
		N	D	N	D	N	D	DIM	DIC	MAI	PRO	MAH	DAC	DCR	PCI
Subarea 48.3															
Argos Georgia	1/6–20/7/00	0	0	0	0	0	0								
*Argos Helena**	1/5–21/7/00	0	0	0	0	0	0								
Faro de Hercules	18/5– 21/7/00	0	0	0	0	0	0								
Ibsa Quinto	2/5–21/7/00	0	0	0	0	0	0								
Illa de Rua	1/5–20/7/00	0	0	0	0	0	0								
Isla Camila	1/5–15/6/00	0	0	0	0	0	0								
Isla Gorriti	1/5–19/7/00	0	1	0	0	0	1	1 (100)							
Isla Santa Clara	1/5–20/7/00	0	0	2	2	2	2			2 (50)		1 (25)	1 (25)		
Isla Sofía	20/6–18/7/00	0	0	0	0	0	0								
Jacqueline	6/5–20/7/00	0	0	1	0	1	0			1 (100)					
Koryo Maru 11	1/5–21/7/00	0	0	0	0	0	0								
Lyn	2/5–20/7/00	0	0	0	0	0	0								
Magallanes III	2/5–9/5/00	0	0	0	0	0	0								
*Magallanes III**	7/7–14/7/00	0	0	0	0	0	0								
No. 1 Moresko	2/5–21/7/00	0	0	0	0	0	0								
RK-1	1/5–20/7/00	0	0	0	0	0	0								
Tierra del Fuego	1/5–21/7/00	0	0	0	0	0	0								
Total %								1 (16.5)		3 (50)		1 (16.5)	1 (16.5)		
Subareas 58.6, 58.7															
Aquatic Pioneer	30/8–28/9/99	0	0	3	0	3	0			1 (33.3)		1 (33.3)			1 (33.3)
Aquatic Pioneer	15/10–3/12/99	0	0	19	9	19	9				28 (100)				
Aquatic Pioneer	24/1–11/3/00	0	0	17	0	17	0				17 (100)				
Aquatic Pioneer	3/4–4/5/00	0	0	12	0	0	0				12 (100)				
*Aquatic Pioneer**	18/7–1/9/00	0	0	0	0	0	0								
Cap Kersaint	8/7–15/7/00	0	0	0	0	0	0								
Croix du Sud I	28/7–31/7/00	0	0	0	0	0	0								
Eldfisk	1/8–27/9/99	0	0	2	0	2	0								2 (100)
Eldfisk	13/10–12/12/99	0	0	34	5	34	5				39 (100)				
Eldfisk	10/1–12/3/00	0	6	14	3	14	9		1 (4)		17 (74)			5 (22)	
Eldfisk	28/3–27/5/00	0	1	0	2	0	3		1 (33.3)		2 (66.6)				
*Eldfisk**	16/6–16/8/00	2		2		4			2 (50)	1 (25)					1 (25)
Koryo Maru 11	25/8–28/9/00	0	0	2	0	2	0				2 (100)				
Koryo Maru 11	16/1–31/3/00	0	0	20	6	20	6				26 (100)				
Total %									4 (2.5)	2 (1)	143 (90)	1 (1)		5 (3)	4 (2.5)

Table 51: Estimated seabird mortality by vessel for Subareas 58.6 and 58.7 during the 1999/2000 season. * – Data obtained from observer cruise report.

Vessel	Hooks Observed (thousands)	Hooks Set (thousands)	Percentage of Hooks Observed	% Night Sets	Estimated Number of Birds Caught Dead		
					Night	Day	Total
Aquatic Pioneer	129.4	215.0	60	100	5	0	5
Aquatic Pioneer	380.0	585.3	64	57	33	12	45
Aquatic Pioneer	54.6	506.0	10	100	157	0	157
Aquatic Pioneer	98.5	356.2	27	100	43	0	43
*Aquatic Pioneer**	63.7	528.1	12		0	0	0
Cap Kersaint	4.2	41.0	10	100	0	0	0
Croix du Sud I	19.9	23.1	85	100	0	0	0
Eldfisk	301.7	968.3	31	77	6	0	6
Eldfisk	786.0	858.9	91	44	38	5	43
Eldfisk	160.9	935.3	17	26	64	58	122
Eldfisk	530.0	915.4	57	31	0	5	5
*Eldfisk**	324.8	676.8	48		6	2	8
Koryo Maru 11	366.0	806.5	45	99	4	0	4
Koryo Maru 11	223.0	844.8	26	88	77	0	77
Total	3 030.1	6 991.7	42	72.20	434	83	516

Table 52: Total estimated seabird by-catch and by-catch rate (birds/thousand hooks) in longline fisheries in Subareas 48.3, 58.6 and 58.7, from 1997 to 2000.

Subarea	Year			
	1997	1998	1999	2000
48.3				
Estimated by-catch	5 755	640	210*	21
By-catch rate	0.23	0.03	0.01*	0.0004
58.6, 58.7				
Estimated by-catch	834	528	156	516
By-catch rate	0.52	0.19	0.03	0.022

* Excluding *Argos Helena* line-weighting experiment cruise.

Table 53: Summary of compliance with Conservation Measure 29/XVI, based on data from scientific observers, for 1996/97, 1997/98, 1998/99 and 1999/2000. Values in parentheses are % of observer records that were complete.

Subarea/ Time	Line Weighting (Spanish System Only)				Night Setting	Offal Discharge		Streamer Line Compliance (%)										Total Catch Rate (birds/1 000 hooks)	
	Compliance %		Median Weight (kg)	Median Spacing (m)	(% Night)	(%) Opposite Haul		Overall		Attached Height		Length		No. Streamers		Distance Apart		Night	Day
Subarea 48.3																			
1996/97	0	(91)	5	45	81	0	(91)	6	(94)	47	(83)	24	(94)	76	(94)	100	(78)	0.18	0.93
1997/98	0	(100)	6	42.5	90	31	(100)	13	(100)	64	(93)	33	(100)	100	(93)	100	(93)	0.03	0.04
1998/99	5	(100)	6	43.2	80[1]	71	(100)	0	(95)	84	(90)	26	(90)	76	(81)	94	(86)	0.01	0.08[1]
1999/2000	1	(91)	6	44	92	76	(100)	31	(94)	100	(65)	25	(71	100	(65)	85	(76)	<0.01	<0.01
Division 58.4.4																			
1999/2000	0	(100)	5	45	50	0	(100)	0	(100)	100	(100)	0	(100)	Y	(100)	100	(100)	0	0
Subareas 58.6, 58.7																			
1996/97	0	(60)	6	35	52	69	(87)	10	(66)	100	(60)	10	(66)	90	(66)	60	(66)	0.52	0.39
1997/98	0	(100)	6	55	93	87	(94)	9	(92)	91	(92)	11	(75)	100	(75)	90	(83)	0.08	0.11
1998/99	0	(100)	8	50	84[2]	100	(89)	0	(100)	100	(90)	10	(100)	100	(90)	100	(90)	0.05	0
1999/2000	0	(83)	6	88	72	100	(93)	8	(100)	91	(92)	0	(92)	100	(92)	91	(92)	0.03	0.01
Subarea 88.1																			
1996/97	Auto only		na	na	50	0	(100)	100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
1997/98	Auto only		na	na	71	0	(100)	100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
1998/99	Auto only		na	na	1[3]	100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	100	(100)	0	0
1999/2000	Auto only		na	na	6[4]	No discharge		67[5]	(100)	100	(100)	67[5]	(100)	100	(100)	100	(100)	0	0

1 Includes daytime setting – and associated seabird by-catch – as part of line-weighting experiments on *Argos Helena* (WG-FSA-99/5).
2 Includes some daytime setting in conjunction with use of an underwater-setting funnel on *Eldfisk* (WG-FSA-99/42).
3 Conservation Measure 169/XVII allowed New Zealand vessels to undertake daytime setting south of 65°S in Subarea 88.1 to conduct a line-weighting experiment.
4 Conservation Measure 190/XVIII allowed New Zealand vessels to undertake daytime setting south of 65°S in Subarea 88.1 to conduct a line-weighting experiment.
5 In electronic form only; the written report to CCAMLR and the report of the New Zealand national observer both gave a value of 150 m.

Table 54: Compliance, as reported by scientific observers, with streamer line minimum specifications set out in Conservation Measure 29/XVI during the 1999/2000 season. Nationality: CHL – Chile, ESP – Spain, GBR – United Kingdom, KOR – Republic of Korea, NZL – New Zealand, UKR – Ukraine, URY – Uruguay, ZAF – South Africa; Fishing method: A – autoliner, Sp – Spanish system; Y – yes, N – no, - no information.

Vessel Name (Nationality)	Dates of Trip	Fishing Method	Compliance with CCAMLR Specifications	Compliance with Details of Streamer Line Specifications					Spare Streamers on Board
				Attachment Height above Water (m)	Total Length (m)	Streamers per Line (No.)	Spacing of Streamers per Line (m)	Length of Streamers (m)	
Subarea 48.3									
Argos Georgia (GBR)	18/5–28/7/00	Sp	N	Y (6)	N (120)	Y (7)	Y (5)	Y (1.5–3)	Y
Argos Helena (GBR)	1/5–27/7/00	Sp	N	-	-	-	-	-	Y
Faro de Hercules (CHL)	18/5–27/7/00	Sp	Y	-	-	Y (15)	Y (2.5)	-	-
Ibsa Quinto (ESP)	23/4–25/7/00	Sp	N	-	N (100)	-	Y (5)	-	-
Illa de Rua (URY)	18/4–25/7/00	Sp	N	Y (11)	N (103)	Y (5)	N (8)	-	Y
Isla Camila (CHL)	15/4–22/7/00	Sp	Y	Y (5)	Y (157)	Y (6)	Y (5)	-	-
Isla Gorriti (URY)	18/4–25/7/00	A	N	Y (11)	N (125)	Y (5)	N (8)	-	Y
Isla Santa Clara (CHL)	12/4–27/7/00	Sp	N	Y (5)	N (92)	Y (42)	Y (1.06)	-	-
Isla Sofía (CHL)	20/6–28/7/00	Sp	Y	Y (6)	-	-	-	-	-
Jacqueline (GBR)	30/4–25/7/00	Sp	N	Y (4.5)	N (80)	Y (52)	Y (1.5)	-	Y
Koryo Maru 11 (ZAF)	1/5–21/7/00	Sp	Y	Y (8)	Y (170)	Y (12)	Y (5)	-	-
Lyn (GBR)	24/4–25/7/00	Sp	N	Y (5)	N (120)	-	y (3)	Y (6)	Y
Magallanes III (CHL)	23/4–9/5/00	Sp	N	-	-	-	-	-	-
Magallanes III (CHL)	3/7–5/8/00	Sp	-	-	-	-	-	-	-
No. 1 Moresko (KOR)	26/4–25/7/00	Sp	N	Y (4.5)	N (78)	Y (11)	Y (2)	-	-
RK-1 (UKR)	25/4–24/7/00	A	Y	-	Y (250)	Y (50)	Y (1.5)	-	-
Tierra del Fuego (CHL)	1/5–21/7/00	Sp	N	Y (5.5)	N (70)	Y (26)	Y (2.7)	-	-
Subareas 58.6 and 58.7									
Aquatic Pioneer (ZAF)	23/8–5/10/99	Sp	Y	-	-	-	-	-	-
Aquatic Pioneer (ZAF)	9/10–10/12/99	Sp	N	Y (7)	N (75)	Y (6)	Y (5)	-	Y
Aquatic Pioneer (ZAF)	17/1–18/3/00	Sp	N	Y (10)	N (100)	Y (5)	Y (5)	Y (3)	Y
Aquatic Pioneer (ZAF)	29/3–11/5/00	Sp	N	N (4)	N (120)	Y (5)	Y (5)	-	Y
Aquatic Pioneer (ZAF)	13/7–8/9/00	Sp	N	Y (7.5)	N (117)	Y (6)	Y (5)	Y (3)	Y
Eldfisk (ZAF)	26/7–1/10/99	A	N	Y (5.5)	N (100)	Y (9)	Y (5)	-	Y
Eldfisk (ZAF)	8/10–17/12/99	A	N	Y (5.5)	N (80)	Y (5)	Y (3)	Y (1–4)	Y
Eldfisk (ZAF)	5/1–17/300	A	N	Y (6)	N (100)	Y (7)	N (6)	-	Y
Eldfisk (ZAF)	23/3–2/6/00	A	N	Y (6)	N (100)	Y (7)	Y (5)	-	Y
Eldfisk (ZAF)	16/6–18/800	A	N	Y (6)	N (70)	Y (9)	Y (4.8)	-	Y
Koryo Maru 11 (ZAF)	20/8–12/12/99	Sp	N	Y (5)	N (100)	Y (10)	Y (5)	Y (2–5)	Y
Koryo Maru 11 (ZAF)	11/17/4/00	Sp	N	Y (10)	N (70)	Y (8)	Y (4)	Y (2–5)	Y
Subarea 88.1									
Janas (NZL)	3/1–24/3/00	A	Y	Y (8)	Y (200)	Y (5)	Y (2)	Y (4)	Y
San Aotea II (NZL)	8/1–18/3/00	A	Y	Y (4.5)	Y (200)	Y (6)	Y (5)	-	Y
Sonrisa (NZL)	21/1–7/3/00	A	N	Y (6)	N (125)[1]	Y (5)	Y (5)	Y (3.5)	Y
Division 58.4.4									
Isla Alegranza (CHL)	14/7–31/8/00	Sp	N	Y (4.5)	N (80)	Y (7)	Y (3)	-	-

[1] From electronic forms; the written report to CCAMLR and the New Zealand national observer's report both gave a value of 150 m.

Table 55: Summary of compliance with Conservation Measure 29/XVI regarding night setting, correct configuration and use of streamer lines and offal discharge practices in the Convention Area, from 1998 to 2000. Vessels with a history of non-compliance (at least two consecutive years of non-compliance, including the current year) with a conservation measure are indicated in bold. Vessels in their first year in the fishery that failed to comply with a conservation measure are indicated in italics. Nationality: CHL – Chile, ESP – Spain, GBR – United Kingdom, KOR – Republic of Korea, NZL – New Zealand, PAN – Panama, UKR – Ukraine, URY – Uruguay, ZAF – South Africa; Y – complied, N – did not comply, - did not fish, n/a – not applicable.

Vessel (Nationality)	Subarea/ Division	Night Setting			Streamer Line			Offal Discharge		
		1998	1999	2000	1998	1999	2000	1998	1999	2000
Aquatic Pioneer (ZAF)	58.6, 58.7	Y	N	Y	N	N	**N**	Y	Y	Y
Argos Georgia (GBR)	48.3	-	-	Y	-	-	*N*	-	-	Y
Argos Helena (GBR)	48.3	Y	Y	Y	Y	N	**N**	Y	Y	Y
Cap Kersaint (FRA)	58.6	-	-	Y	-	-	Y	-	-	Y
Croix du Sud I (FRA)	58.6	-	-	Y	-	-	no data	-	-	Y
Eldfisk (PAN)	58.6, 58.7	N	-	-	N	-	-	Y	-	-
Eldfisk (ZAF)	58.6, 58.7	-	N	**N**	-	N	**N**	-	Y	Y
Faro de Hercules (CHL)	48.3	-	-	Y	-	-	Y	-	-	*N*
Ibsa Quinto (ESP)	48.3	-	Y	Y	-	Y	N	-	Y	Y
Illa de Rua (URY)	48.3	N	Y	Y	N	N	**N**	Y	Y	Y
Isla Alegranza (URY)	58.4.4	-	-	**N**	-	-	*N*	-	-	*N*
Isla Camila (CHL)	48.3	Y	N	**N**	N	N	Y	N	N	**N**
Isla Gorriti (URY)	48.3	-	N	**N**	-	N	**N**	-	Y	Y
Isla Santa Clara (CHL)	48.3	-	-	*N*	-	-	*N*	-	-	Y
Isla Sofía (CHL)	48.3	Y	N	Y	N	N	Y	N	N	**N**
Jacqueline (GBR)	48.3	Y	Y	N	N	N	**N**	N	N	**N**
Lyn (GBR)	48.3	-	N	Y	-	N	**N**	Y	Y	Y
Magallanes III (CHL)	48.3	N	N	**N**	N	N	**N**	Y	Y	Y
No. 1 Moresko (KOR)	48.3	-	N	**N**	-	N	**N**	-	Y	Y
RK-1 (UKR)	48.3	-	-	Y	-	-	Y	-	-	Y
Tierra del Fuego (CHL)	48.3	N	N	**N**	N	N	**N**	Y	Y	Y
Janas (NZL)	88.1	-	na	na	-	Y	Y	-	Y	Y
San Aotea (NZL)	88.1	-	na	na	-	Y	Y	-	Y	Y
Sonrisa (NZL)	88.1	-	-	na	-	-	N	-	-	Y
Koryo Maru (ZAF)	58.6, 58.7	Y	Y (Y; 48.3)	N (Y; 48.3)	N	N (Y; 48.3)	N (Y; 48.3)	Y	Y	Y

Table 56: Estimate of seabird by-catch in the unregulated *Dissostichus* spp. fishery in Subareas 48.3, 58.6 and 58.7 and Divisions 58.4.4, 58.5.1 and 58.5.2 in 1999/2000. S – summer, W – winter.

Subarea/ Division	Total Unregulated Catch (tonnes)	Split S:W		Unregulated Catch (tonnes)		*Dissostichus* spp. Regulated By-catch Rate (kg/hooks)	Unregulated Effort (1 000 hooks)		Seabird By-catch Rate (birds/1 000 hooks)				Estimated Total Unregulated Seabird By-catch			
									Mean		Max		Mean		Max	
		S	W	S	W		S	W	S	W	S	W	S	W	S	W
48.3	350	80	20	280	70	0.31	903	226	2.608	0.07	9.31	0.51	2 356	16	8 409	115
	350	70	30	245	105	0.31	790	339	2.608	0.07	9.31	0.51	2 061	24	7 358	173
	350	60	40	210	140	0.31	677	452	2.608	0.07	9.31	0.51	1 767	32	6 307	230
58.6	1 980	80	20	1 584	396	0.09	17 600	4 400	1.049	0.017	1.88	0.07	18 462	75	33 088	308
	1 980	70	30	1 386	594	0.09	15 400	6 600	1.049	0.017	1.88	0.07	16 155	112	28 952	462
	1 980	60	40	1 188	792	0.09	13 200	8 800	1.049	0.017	1.88	0.07	13 847	150	24 816	616
58.7	220	80	20	176	44	0.1	1 760	440	1.049	0.017	1.88	0.07	1 846	7	3 309	31
	220	70	30	154	66	0.1	1 540	660	1.049	0.017	1.88	0.07	1 615	11	2 895	46
	220	60	40	132	88	0.1	1 320	880	1.049	0.017	1.88	0.07	1 385	15	2 482	62
58.4.4	1 050	80	20	840	210	0.24	3 500	875	0.629	0.01	1.128	0.042	2 202	9	3 948	37
	1 050	70	30	735	315	0.24	3 063	1 313	0.629	0.01	1.128	0.042	1 926	13	3 455	55
	1 050	60	40	630	420	0.24	2 625	1 750	0.629	0.01	1.128	0.042	1 651	18	2 961	74
58.5.1	2 100	80	20	1680	420	0.24	7 000	1 750	1.049	0.017	1.88	0.07	7 343	30	13 160	123
	2 100	70	30	1470	630	0.24	6 125	2 625	1.049	0.017	1.88	0.07	6 425	45	11 515	184
	2 100	60	40	1260	840	0.24	5 250	3 500	1.049	0.017	1.88	0.07	5 507	60	9 870	245
58.5.2	800	80	20	640	160	0.24	2 667	667	1.049	0.017	1.88	0.07	2 797	11	5 013	47
	800	70	30	560	240	0.24	2 333	1 000	1.049	0.017	1.88	0.07	2 448	17	4 387	70
	800	60	40	480	320	0.24	2 000	1 333	1.049	0.017	1.88	0.07	2 098	23	3 760	93

Table 57: Estimates of potential seabird by-catch in unregulated longline fishing in the Convention Area in 1999/2000.

Subarea/ Division	Potential By-catch Level	Summer	Winter	Total[1]
48.3	Lower	1 800–2 400	30–30	1 800–2 400
	Higher	6 300–8 400	120–230	6 400–8 600
58.6	Lower	13 800–18 500	70–150	13 900–18 700
	Higher	24 800–33 100	270–540	52 100–33 700
58.7	Lower	1 400–1 800	10–10	1 400–1 800
	Higher	2 500–3 300	30–60	2 500–3 400
58.4.4	Lower	1 700–2 200	10–20	1 700–2 200
	Higher	3 000–3 900	40–70	3 000–4 000
58.5.1	Lower	5 500–7 300	30–60	5 500-7 400
	Higher	9 900–13 200	120–250	10 000–13 500
58.5.2	Lower	2 100–2 800	10–20	2 100–2 800
	Higher	3 800–5 000	50–90	3 900–5 100
Total	Lower	26 300–35 000[1]	150–290[1]	26 000–35 000[2]
	Higher	50 300–66 900[1]	670–1 320[1]	51 000–68 000[2]

[1] Rounded to nearest hundred birds
[2] Rounded to nearest thousand birds

Table 58: Composition of estimated potential by-catch in unregulated longline fisheries in the Convention Area from 1997 to 2000.

Area/Year		Estimated Total Potential Seabird By-catch[1] (lower level above, higher level below)	Composition of Potential Seabird By-catch[2]		
			Albatrosses	Giant Petrels	White-chinned Petrels
Subarea 48.3[3]					
	1996/97	-	-	-	-
	1997/98	-	-	-	-
	1998/99	3 000–4 000 12 000–16 000	1 505 6 020	70 280	1 680 6 720
	1999/2000	1 800–2 400 6 400–8 600	903 3 225	42 150	1 008 3 600
Subareas 58.6, 58.7[4]					
	1996/97	17 000–27 000 66 000–107 000	4 840 19 030	880 3 460	13 860 54 495
	1997/98	9 000–11 000 15 000–20 000	2 200 3 850	400 700	6 300 11 025
	1998/99	13 000–17 000 24 000–32 000	3 300 6 160	600 1 120	9 450 17 640
	1999/2000	15 000–21 000 28 000–37 000	3 960 7 150	720 1 300	11 340 20 475
Divisions 58.5.1, 58.5.2[4]					
	1996/97	-	-	-	-
	1997/98	34 000–45 000 61 000–81 000	8 690 15 620	1 580 2 840	24 885 44 730
	1998/99	2 000–3 000 4 000–5 000	550 990	100 180	1 575 2 835
	1999/2000	8 000–10 000 14 000–19 000	1 980 3 630	360 660	5 670 10 395
Division 58.4.4[4]					
	1996/97	-			
	1997/98	-			
	1998/99	3 000–5 000 4 000–7 000	880 1 210	160 220	2 520 3 465
	1999/2000	2 000 3 000–4 000	440 770	80 140	1 260 2 205
Total	1996/97	17 000–27 000 66 000–107 000	4 840 19 030	880 3 460	13 860 54 495
	1997/98	43 000–54 000 76 000–101 000	10 890 19 470	1 980 3 540	30 185 55 755
	1998/99	21 000–29 000 44 000–59 000	6 235 14 380	930 1 800	15 225 30 660
	1999/2000	26 000–35 000 52 000–68 000	7 283 14 775	1 202 2 250	19 278 36 675
Overall Total		104 000–140 000 237 000–333 000	29 248 67 655	4 992 11 050	78 548 177 585

1 Rounded to nearest thousand birds.
2 Based on averages for lower (above) and higher (below) level values.
3 Based on 43% albatrosses, 2% giant petrels, 48% white-chinned petrels (7% unidentified petrels) (see SC-CAMLR-XVI, Annex 5, Table 44).
4 Based on 22% albatrosses, 4% giant petrels, 63% white-chinned petrels (10% unidentified petrels) (see SC-CAMLR-XVI, Annex 5, Table 42).

Table 59: Summary of IMALF risk level and assessment in relation to proposed new and exploratory longline fisheries in 2000/01.

Area	Risk Scale	IMALF Risk Assessment	Notes
48.1	3	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 to April). Maintain all elements of Conservation Measure 29/XVI.	• Argentina (CCAMLR-XIX/12) proposes to fish from 1 December to 30 November. This will substantially overlap the recommended season closure. • Directed fishing for finfish in this subarea is currently prohibited under Conservation Measure 72/XVII.
48.2	2	Average-to-low risk: Avoid longline fishing during the breeding season of southern giant petrel (October to March). Maintain all elements of Conservation Measure 29/XVI.	• Argentina (CCAMLR-XIX/12) proposes to fish from 1 December to 30 November. This will substantially overlap the recommended season closure. • Directed fishing for finfish in this subarea is currently prohibited under Conservation Measure 73/XVII.
48.6	2	Average to low risk (southern part of area (south of c. 55°S) of low risk): No obvious need for restriction of longline fishing season. Apply Conservation Measure 29/XVI as a seabird by-catch precautionary measure.	• Argentina (CCAMLR-XIX/12) proposes to fish from 1 March to 31 August north of 60°S and from 15 February to 15 October south of 60°S. This does not conflict with advice provided. • Brazil (CCAMLR-XIX/5) – proposal does not conflict with advice provided. Fishing season to be as established at CCAMLR-XIX. • South Africa (CCAMLR-XIX/6) – proposal does not conflict with advice provided. Fishing season to be as established at CCAMLR-XIX. • Conservation Measure 184/XVIII applied in 1999/2000.
58.4.1	3	Average risk: No specific advice on restriction of fishing season. Apply all elements of Conservation Measure 29/XVI. Much of the risk to seabirds in this area arises in the region of the BANZARE Rise in the west of the region, adjacent to Division 58.4.3.	• Argentina (CCAMLR-XIX/12) proposes to fish from 1 December to 30 November. This does not conflict with advice provided.
58.4.2	2	Average-to-low risk: Prohibit longline fishing during the breeding season of giant petrels (October to March). Maintain all elements of Conservation Measure 29/XVI.	• Argentina (CCAMLR-XIX/12) proposes to fish from 1 December to 30 November. This will substantially overlap the recommended season closure.

(continued)

Table 59 (continued)

Area	Risk Scale	IMALF Risk Assessment	Notes
58.4.3	3	Average risk: Prohibit longline fishing during the breeding season of albatrosses, giant petrels and white-chinned petrels (September to April). Maintain all elements of Conservation Measure 29/XVI.	• Argentina (CCAMLR-XIX/12) proposes to fish from 1 May to 31 August. This does not conflict with advice provided. • France (CCAMLR-XIX/13) – fishing season not specified. • Conservation Measure 187/XVIII applied in 1999/2000.
58.4.4	3	Average risk: Prohibit longline fishing during the main breeding season of albatrosses and petrels (September to April). Maintain all elements of Conservation Measure 29/XVI.	• Argentina (CCAMLR-XIX/12) proposes to fish from 1 May to 31 August. This does not conflict with advice provided. • Brazil (CCAMLR-XIX/5) – proposal does not conflict with advice provide. Fishing season to be as established at CCAMLR-XIX. • France (CCAMLR-XIX/13) – fishing season not specified. • South Africa (CCAMLR-XIX/6) – proposal does not conflict with advice provided. Fishing season to be as established at CCAMLR-XIX. • Ukraine (CCAMLR-XIX/7) proposes to fish from 1 May to 31 August. This does not conflict with advice provided. • Uruguay (CCAMLR-XIX/15) proposes to fish from 1 May to 31 August and comply with Conservation Measure 29/XVI. This does not conflict with advice provided. • Conservation Measure 188/XVIII applied in 1999/2000.
58.5.1	5	High risk: Prohibit longline fishing during the main albatross and petrel breeding season (i.e. September to April). Ensure strict compliance with Conservation Measure 29/XVI.	• Argentina (CCAMLR-XIX/12) proposes to fish from 1 December to 30 November. This will substantially overlap the recommended season closure. • Brazil (CCAMLR-XIX/5) – proposal does not conflict with advice provided. Fishing season to be as established at CCAMLR-XIX. • France (CCAMLR-XIX/13) – fishing season not specified. • Fishing for *Dissostichus* outside EEZs in this division was adjudged unlikely to be viable due to the small amount of fishable ground (SC-CAMLR-XVIII, paragraph 9.50; CCAMLR-XVIII, paragraph 7.23(ii)).
58.5.2	4	Average-to-high risk: Prohibit longline fishing within the breeding season of the main albatross and petrel species (September to April). Ensure strict compliance with Conservation Measure 29/XVI.	• Brazil (CCAMLR-XIX/5) – proposal does not conflict with advice provided. Fishing season to be as established at CCAMLR-XIX. • France (CCAMLR-XIX/13) – fishing season not specified. • Longline fishing is currently prohibited within the EEZ around Heard/McDonald Islands. • Fishing for *Dissostichus* outside EEZs in this division was adjudged unlikely to be viable due to the small amount of fishable ground (SC-CAMLR-XVIII, paragraph 9.50; CCAMLR-XVIII, paragraph 7.23(ii)).

(continued)

Table 59 (continued)

Area	Risk Scale	IMALF Risk Assessment	Notes
58.6	5	High risk: Prohibit longline fishing during the main albatross and petrel breeding season (i.e. September to April). Ensure strict compliance with Conservation Measure 29/XVI.	• Argentina (CCAMLR-XIX/12) proposes to fish from 1 May to 31 August. This does not conflict with advice provided. • France (CCAMLR-XIX/13) – fishing season not specified. • South Africa (CCAMLR-XIX/6) – proposal does not conflict with advice provided. Fishing season to be as established at CCAMLR-XIX. • Conservation Measure 189/XVIII applied in 1999/2000.
58.7	5	High risk: Prohibit longline fishing during the main albatross and petrel breeding season (September to April). Ensure strict compliance with Conservation Measure 29/XVI.	• France (CCAMLR-XIX/13) – fishing season not specified. • Directed fishing for *Dissostichus eleginoides* in this subarea is currently prohibited under Conservation Measure 160/XVII.
88.1	3	Average risk overall. Average risk in northern sector (*D. eleginoides* fishery), average to low risk in southern sector (*D. mawsoni* fishery): Longline fishing season limits of uncertain advantage. The provisions of Conservation Measure 29/XVI should be strictly adhered to.	• Argentina (CCAMLR-XIX/12) proposes to fish from 1 December to 31 August and comply with Conservation Measure 29/XVI. This does not conflict with advice provided. • New Zealand (CCAMLR-XIX/17) proposes to fish from 1 December to 31 May, and similarly in the 2001/02 season subject to CCAMLR-XX. Intends to comply with Conservation Measure 29/XVI. Proposes that prohibition on fishing within 10 n miles of Balleny Is, enacted in Conservation Measure 190/XVIII, paragraph 8, should be extended to 50 n miles. Proposes that elsewhere in Subarea 88.1 fishing be prohibited within 10 n miles of coastlines. • New Zealand intends to conduct line-weighting experiments, a condition for an exemption from the application of paragraph 3 (night setting) of Conservation Measure 29/XVI in 1999. • South Africa (CCAMLR-XIX/6) – proposal does not conflict with advice provided. Fishing season to be as established at CCAMLR-XIX. Intends to comply with Conservation Measure 29/XVI, taking into consideration paragraph 9.40 of CCAMLR-XVIII, which defines a fishing season in this subarea from 1 December to 31 August, and gives exemption from the application of paragraph 3 of Conservation Measure 29/XVI. • Uruguay (CCAMLR-XIX/15) proposes to fish from 1 December to 31 August and comply with Conservation Measure 29/XVI. This does not conflict with advice provided. • Conservation Measure 190/XVIII applied in 1999/2000.

(continued)

Table 59 (continued)

Area	Risk Scale	IMALF Risk Assessment	Notes
88.2	1	Low risk: No obvious need for restriction of longline fishing season. Apply Conservation Measure 29/XVI as a seabird by-catch precautionary measure.	• Argentina (CCAMLR-XIX/12) proposes to fish from 15 December to 31 August. This does not conflict with advice provided. • South Africa (CCAMLR-XIX/6) – proposal does not conflict with advice provided. Fishing season to be as established at CCAMLR-XIX. • Uruguay (CCAMLR-XIX/15) proposes to fish from 1 December to 31 August and comply with Conservation Measure 29/XVI. This does not conflict with advice provided. • Conservation Measure 191/XVIII applied in 1999/2000.
88.3	1	Low risk: Restrictions on timing of longline fishery probably inappropriate. Apply Conservation Measure 29/XVI, at least until further data on seabird–fishery interactions are available.	• Argentina (CCAMLR-XIX/12) proposes to fish from 1 December to 31 August. This does not conflict with advice provided. • Uruguay (CCAMLR-XIX/15) proposes to fish from 1 December to 31 August and comply with Conservation Measure 29/XVI. This does not conflict with advice provided.

Table 60: Marine mammal incidental mortality and interactions with fishing operations reported by observers during the 1999/2000 season. Nationality: AUS – Australia, CHL – Chile, ESP – Spain, GBR – United Kingdom, KOR – Republic of Korea, NZL – New Zealand, RUS – Russia, URY – Uruguay, ZAF – South Africa; Y – yes, N – No, DLP – dolphin, KIW – killer whale, SEA – Antarctic fur seal, SPW – sperm whale.

Vessel Name (Nationality)	Dates of Trip	Observation Reported	Mammal Killed	(Species) Entangled	Fish Loss Observed (Species)
Subarea 48.3					
Argos Georgia (GBR)	18/5–28/7/00	Y	N	N	Y (KIW)
Argos Helena (GBR)	1/5–27/700	Y	N	N	Y (KIW, SPW)
Betanzos (CHL)	10/12–2/2/00	Y	Y (SEA)	N	N
Faro de Hercules (CHL)	18/5–27/7/00	Y	N	N	Y (KIW)
Ibsa Quinto (ESP)	23/4–25/7/00	Y	N	N	Y (KIW)
Illa de Rua (URY)	18/4–25/7/00	Y	N	N	Y (KIW, SEA)
Isla Camila (CHL)	15/4–22/7/00	Y	N	N	Y (KIW, SEA)
Isla Gorriti (URY)	18/4–25/7/00	Y	N	N	Y (KIW, SEA)
Isla Santa Clara (CHL)	12/4–27/7/00	Y	N	N	Y (KIW)
Isla Sofía (CHL)	20/6–28/7/00	Y	N	N	N
Jacqueline (GBR)	30/4–25/7/00	Y	N	N	Y (KIW)
Koryo Maru 11 (ZAF)	1/5–21/7/00	Y	N	N	Y (KIW)
Lyn (GBR)	24/4–25/7/00	Y	N	N	N
Magallanes III (CHL)	23/4–9/5/00	Y	N	N	N
Magallanes III (CHL)	3/7–5/8/00	Y	N	N	N
No. 1 Moresko (KOR)	26/4–25/7/00	Y	N	N	Y (SEA)
RK-1 (UKR)	25/4–24/7/00	Y	N	N	Y (KIW)
Tierra del Fuego (CHL)	1/5–21/700	Y	N	N	Y (KIW, SEA)
Zakhar Sorokin (RUS)	27/11–22/2/00	Y	Y (SEA)	N	Y
Subareas 58.6 and 58.7					
Aquatic Pioneer (ZAF)	23/8–5/10/99	Y	N	N	Y
Aquatic Pioneer (ZAF)	9/10–10/12/99	Y	N	N	Y (KIW, SPW)
Aquatic Pioneer (ZAF)	17/1–18/3/00	Y	N	N	N
Aquatic Pioneer (ZAF)	29/3–11/5/00	Y	N	N	Y
Aquatic Pioneer (ZAF)	13/7–8/9/00	Y	N	N	N
Eldfisk (ZAF)	26/7–1/10/99	Y	N	N	N
Eldfisk (ZAF)	8/10–17/12/99	Y	N	N	Y (KIW, SPW)
Eldfisk (ZAF)	5/1–17/3/00	Y	Y (SEA)	N	Y (KIW, SPW)
Eldfisk (ZAF)	23/3–2/6/00	Y	N	N	Y (KIW)
Eldfisk (ZAF)	16/6–18/8/00	Y	N	N	Y (KIW, SPW)
Koryo Maru 11 (ZAF)	20/8–12/12/99	Y	N	N	Y (KIW)
Koryo Maru 11 (ZAF)	11/1–7/4/00	Y	N	N	Y
Subarea 88.1					
Janas (NZL)	3/1–24/3/00	Y	N	N	N
San Aotea II (NZL)	8/1–18/3/00	Y	N	N	N
Sonrisa (NZL)	21/1–7/3/00	Y	N	N	N
Division 58.5.2					
Austral Leader (AUS)	20/10–20/12/99	Y	N	N	N
Austral Leader (AUS)	19/4–7/6/00	Y	N	N	N
Southern Champion (AUS)	20/4–27/6/00	Y	N	N	N
Southern Champion (AUS)	31/1–3/4/00	Y	N	N	N
Southern Champion (AUS)	3/12–25/1/00	Y	N	N	N
Divisions 58.4.1, 58.4.3 and 58.5.2					
Austral Leader (AUS)	17/2–14/4/00	Y	N	N	N
Area 48					
Chiyo Maru No. 5 (JPN)	31/1–1/3/00	Y	N	N	N
Division 58.4.4					
Isla Alegranza (CHL)	14/7–31/8/00	Y	N	N	Y (KIW)

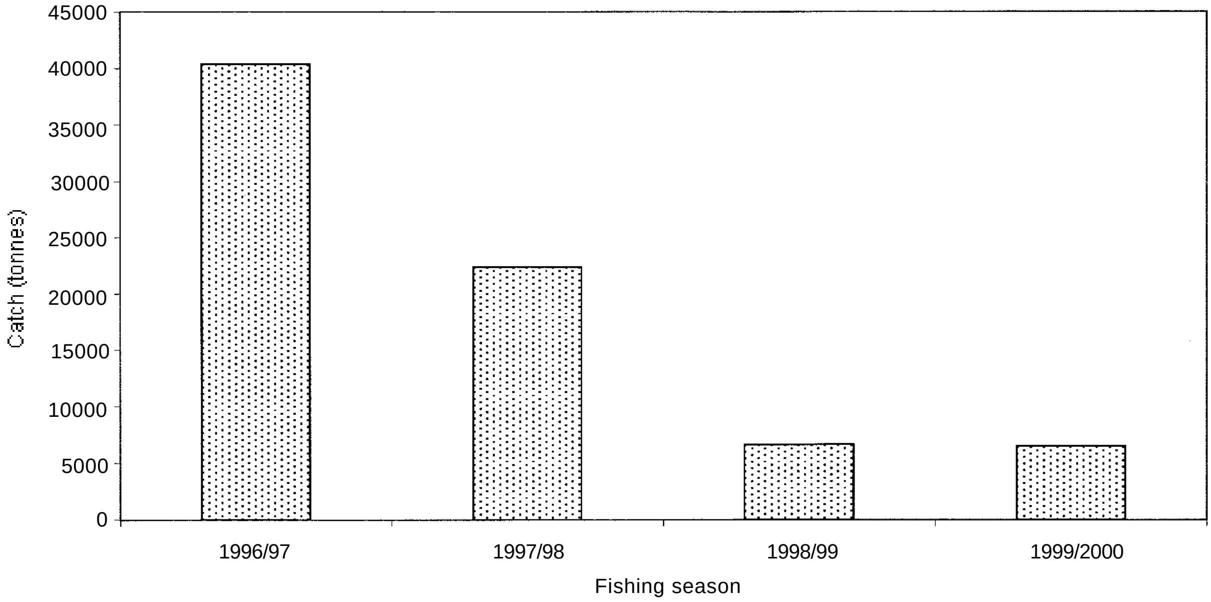


Figure 1: Estimated unreported catches (in tonnes) of *Dissostichus* spp. in the CCAMLR Convention Area for split-years 1996/97 to 1999/2000.

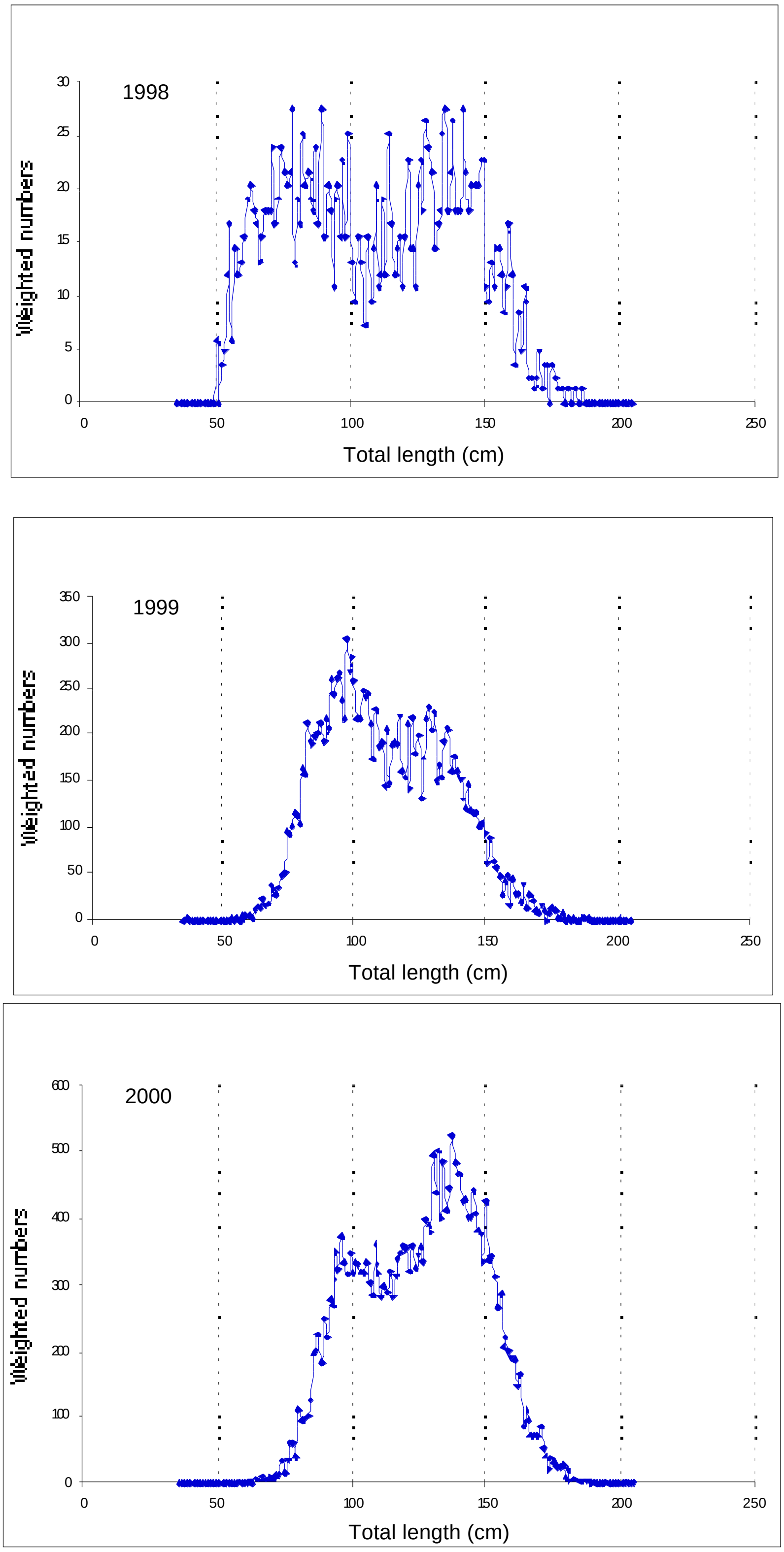


Figure 2: Catch-weighted length frequencies of *Dissostichus mawsoni* by year in the exploratory longline fishery in Subarea 88.1.

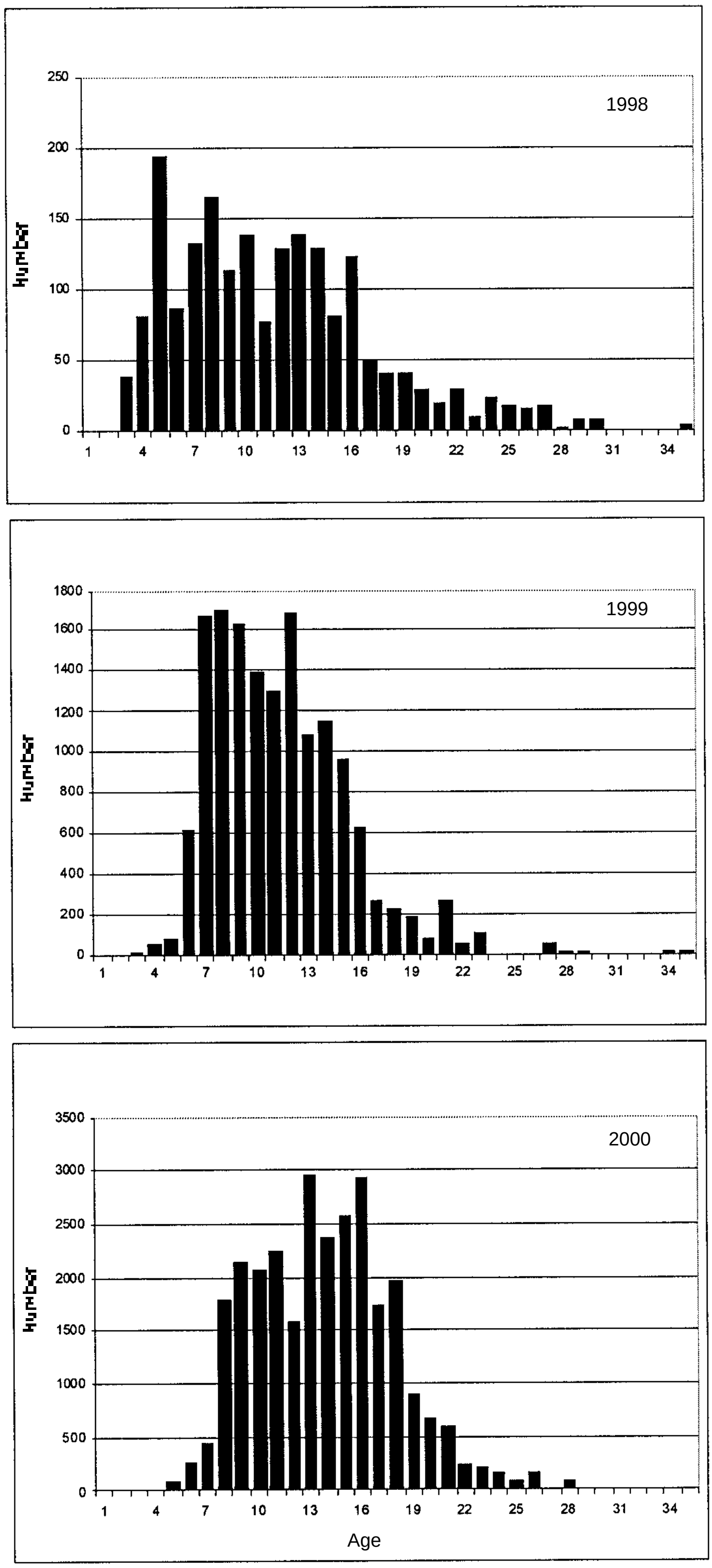


Figure 3: Estimated numbers at age of *Dissostichus mawsoni* by year in the exploratory longline fishery in Subarea 88.1.

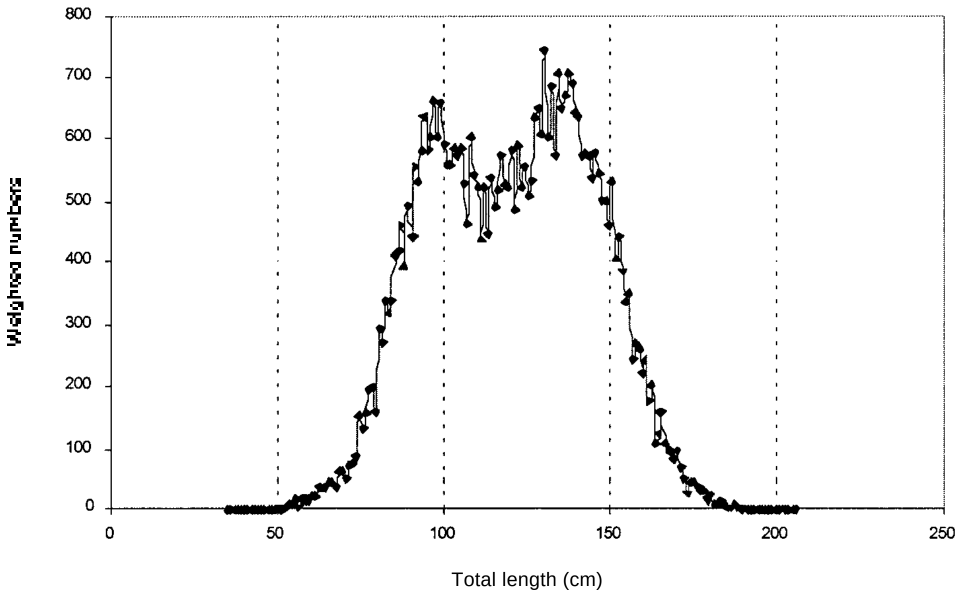


Figure 4: Catch-weighted length frequencies of *D. mawsoni* in the exploratory longline fishery in Subarea 88.1 for 1998–2000.

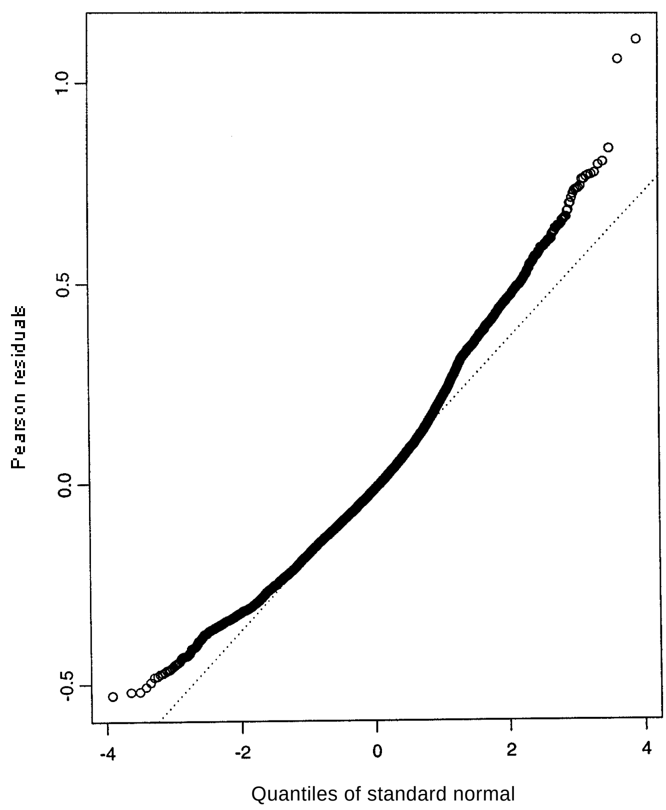


Figure 5: QQ plot of standardised residuals for the GLM fitted to CPUEs in kg/hook, using a robust GLM with the quasi distribution family and a square root link.

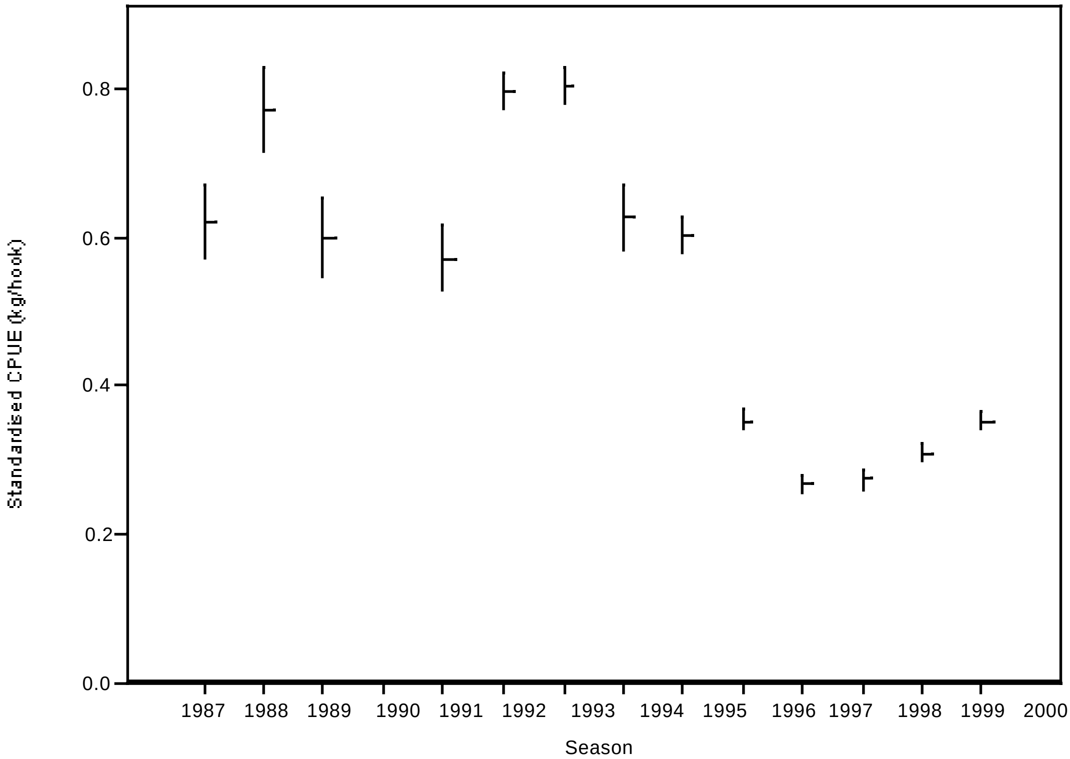


Figure 6: Standardised CPUEs and 95% confidence intervals in kg/hook for Subarea 48.3.

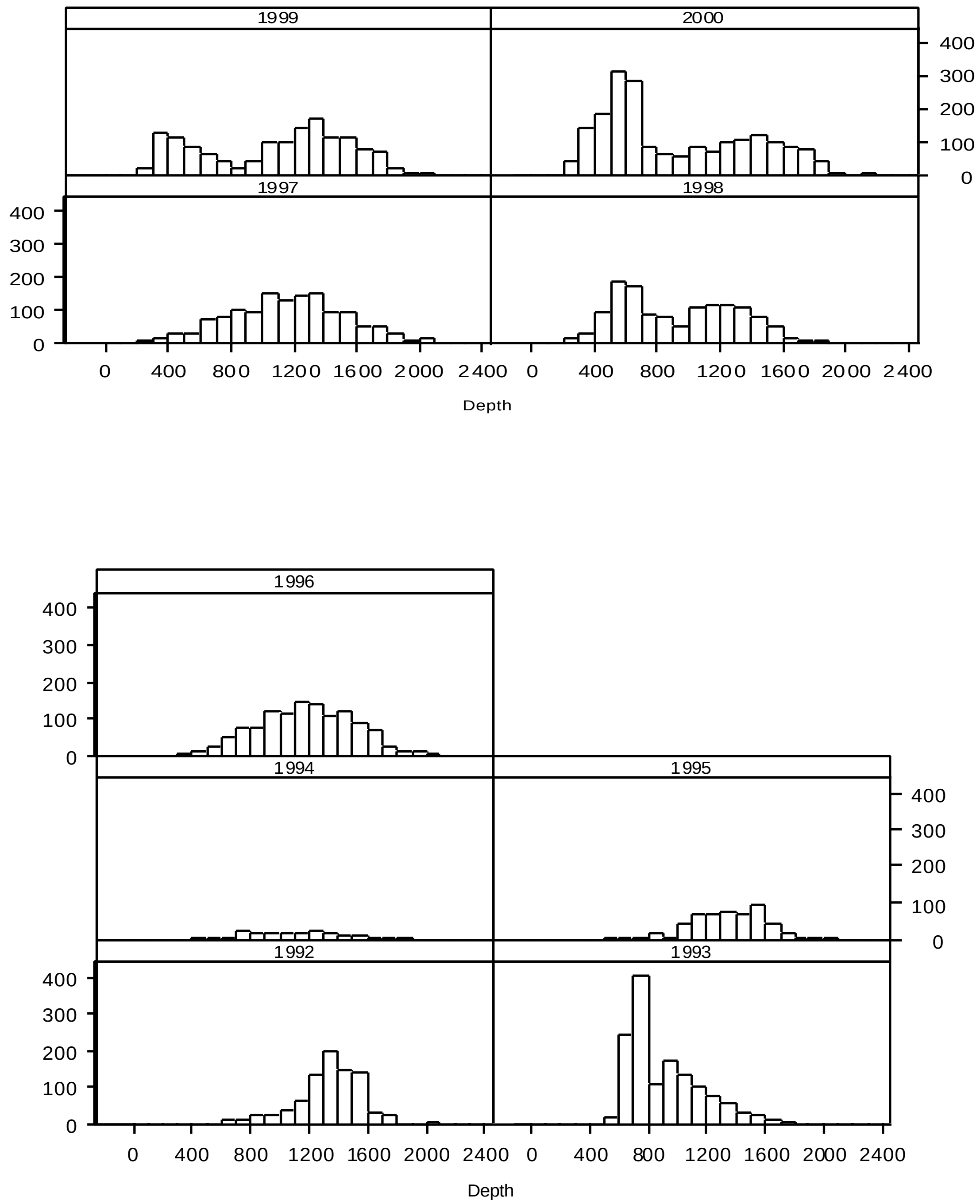


Figure 7: Histograms of depths fished by season in Subarea 48.3.

(continued)

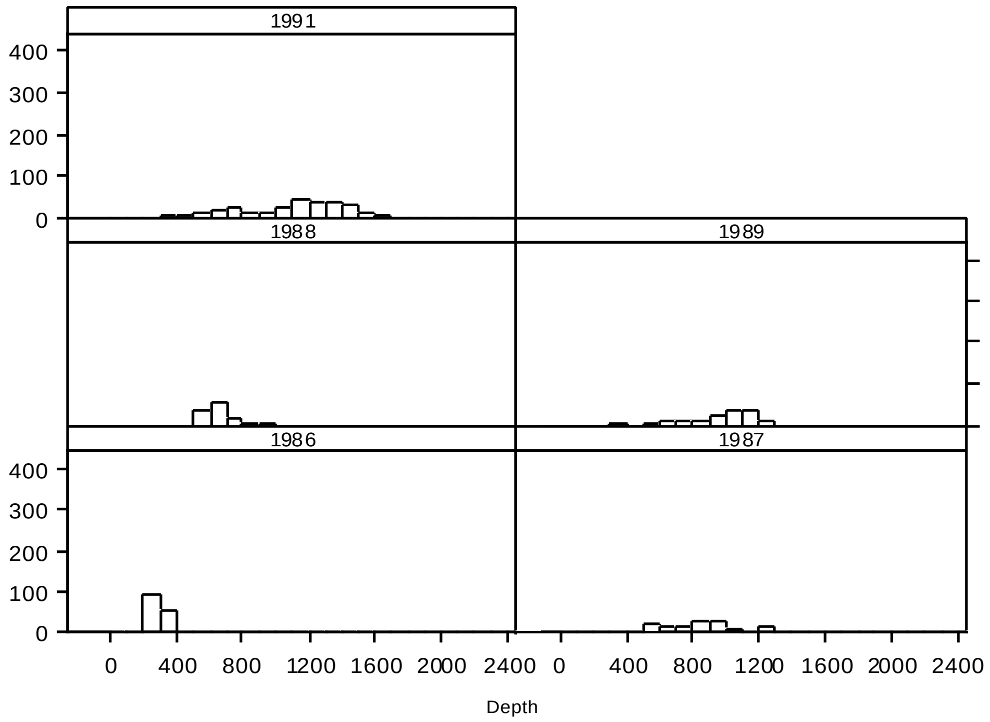


Figure 7 (continued)

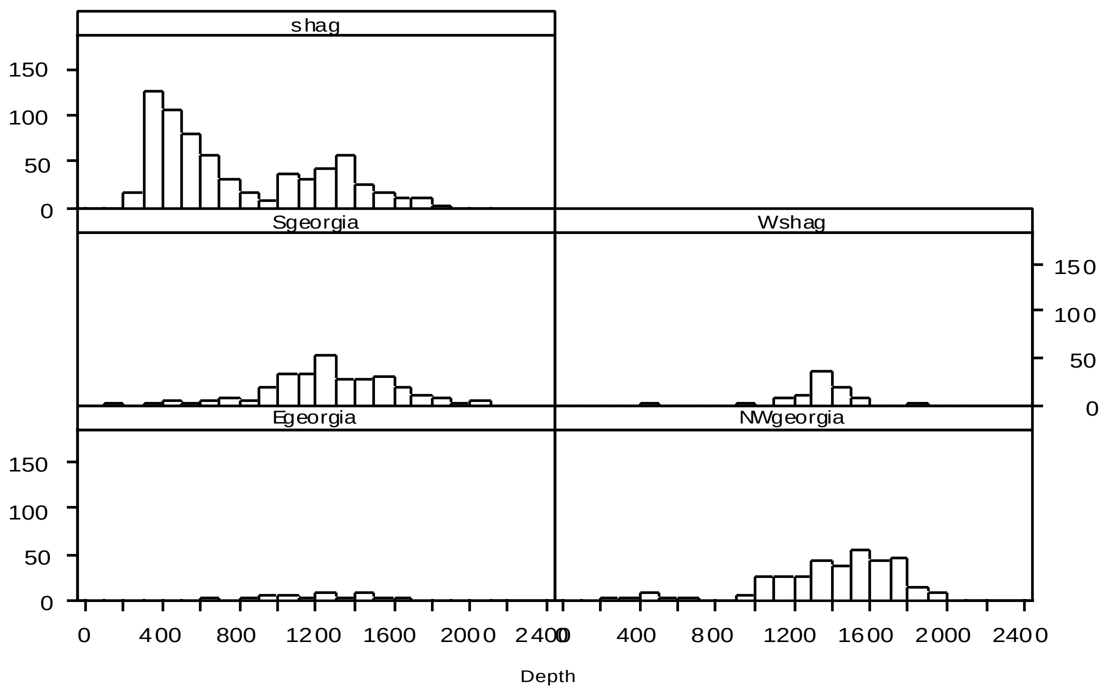


Figure 8: Histograms of depths fished during the 1998/99 season by area in Subarea 48.3.

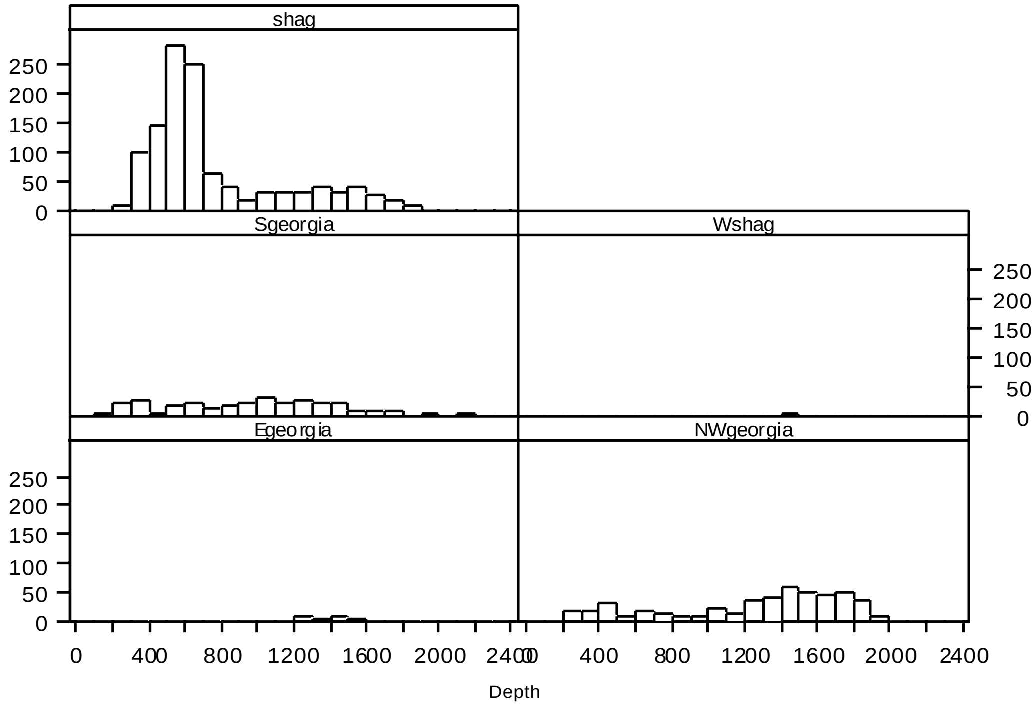


Figure 9: Histograms of depths fished during the 1999/2000 season by area in Subarea 48.3.

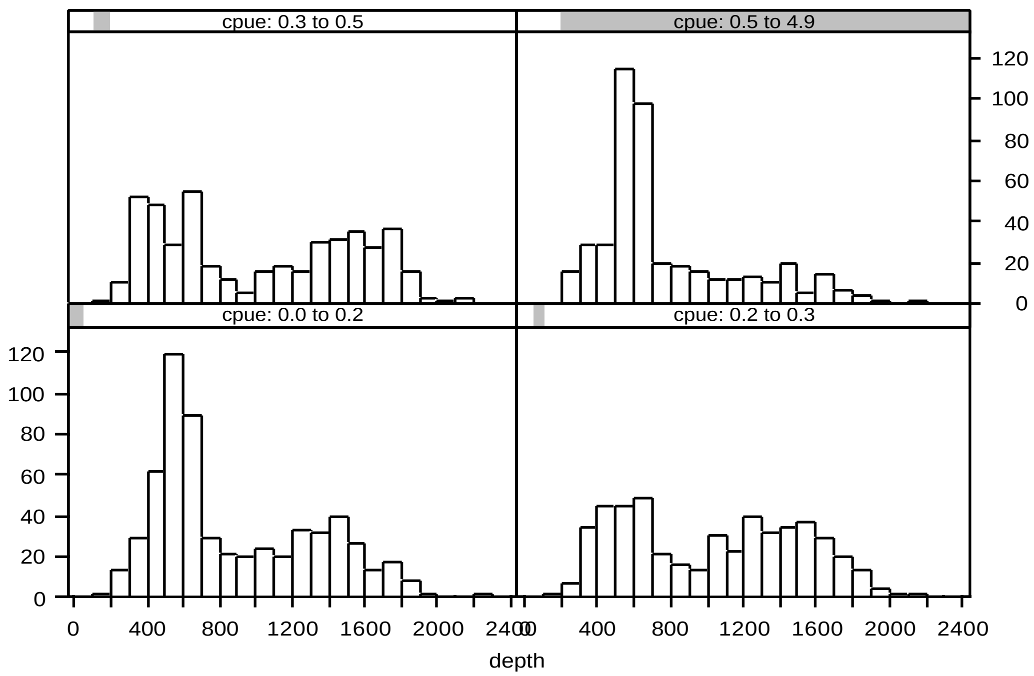


Figure 10: Histograms of depths fished during the 1999/2000 season in Subarea 48.3 for different levels of CPUE in kg/hook.

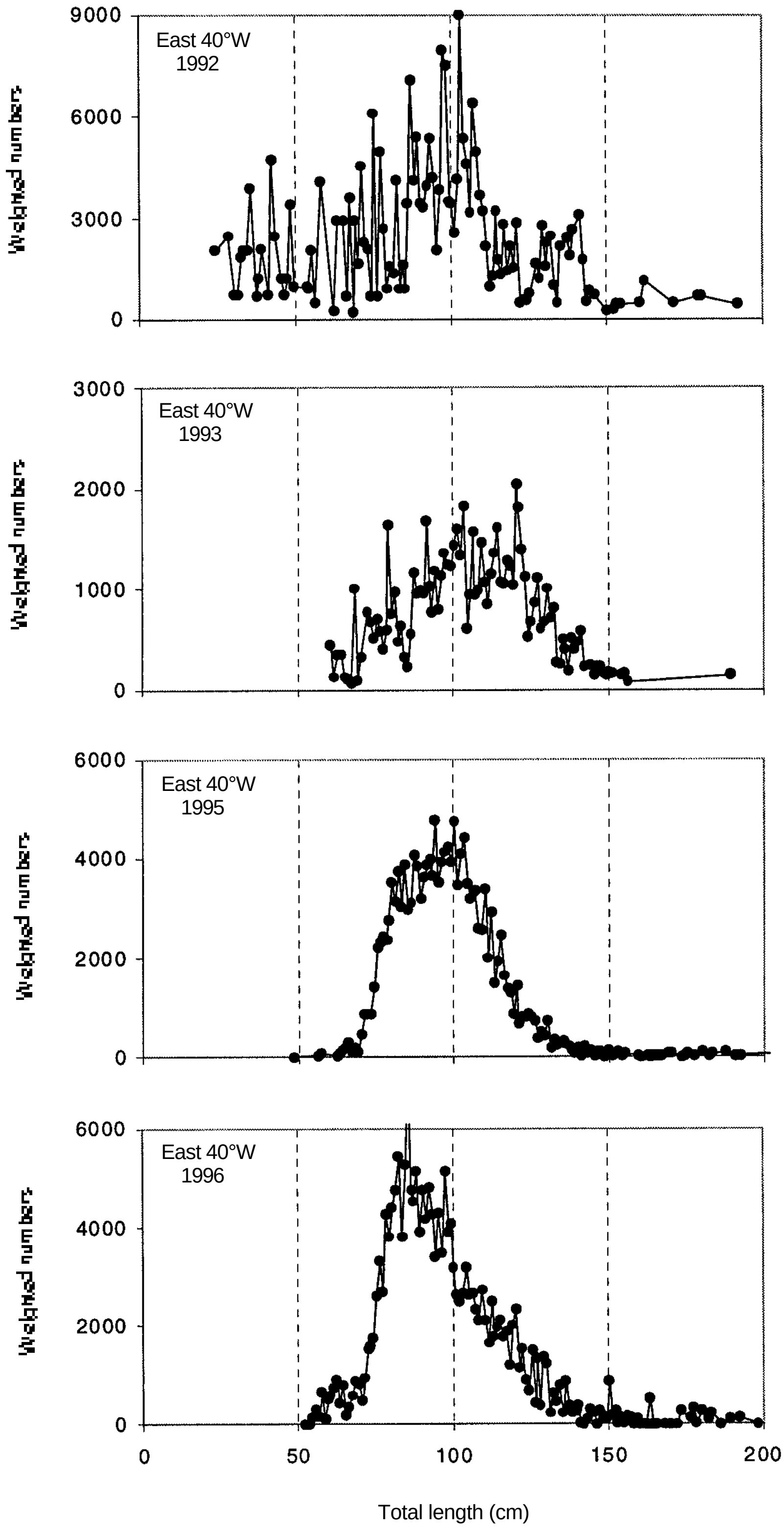


Figure 11: Catch-weighted length frequencies by season for fish taken around South Georgia.

(continued)

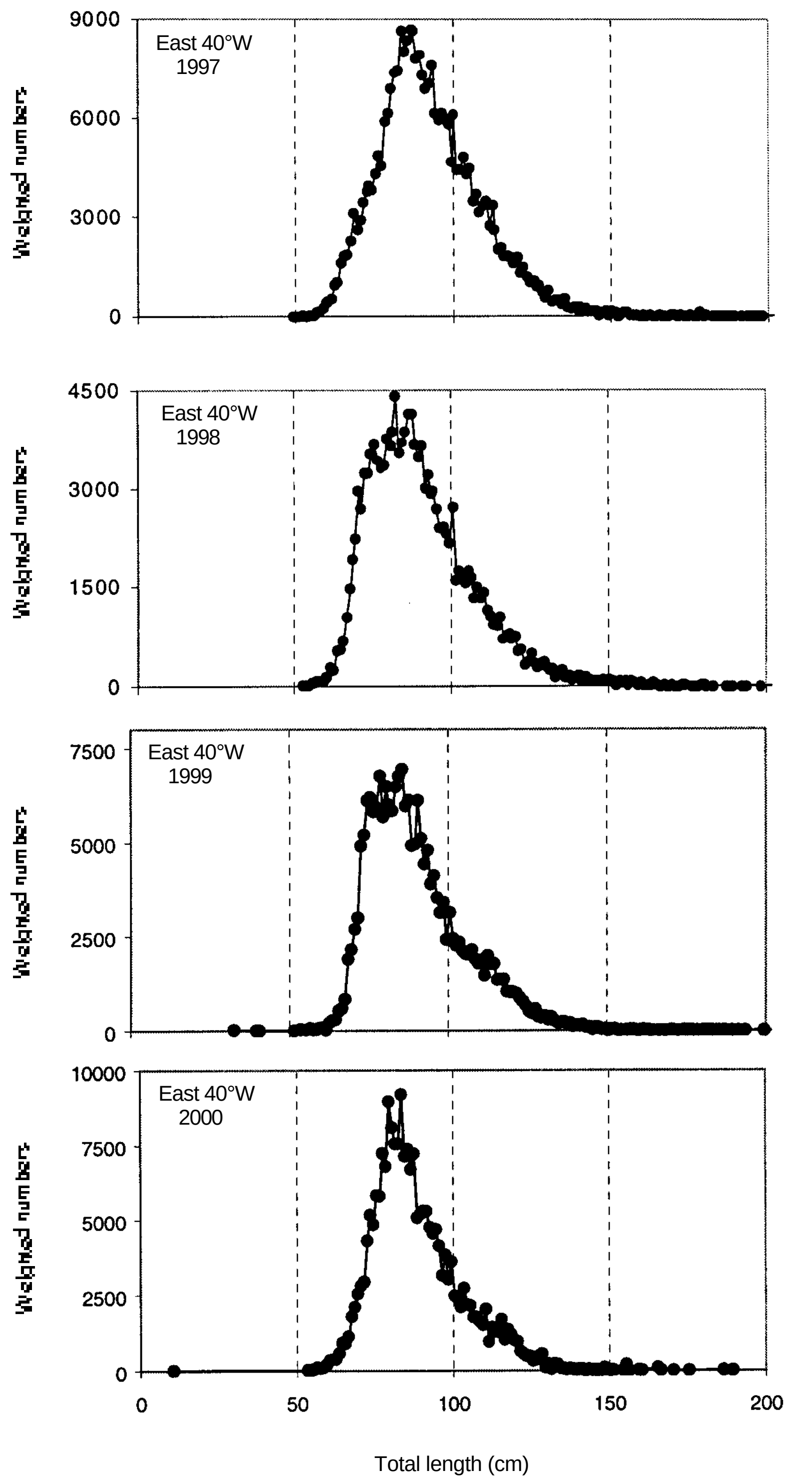


Figure 11 (continued)

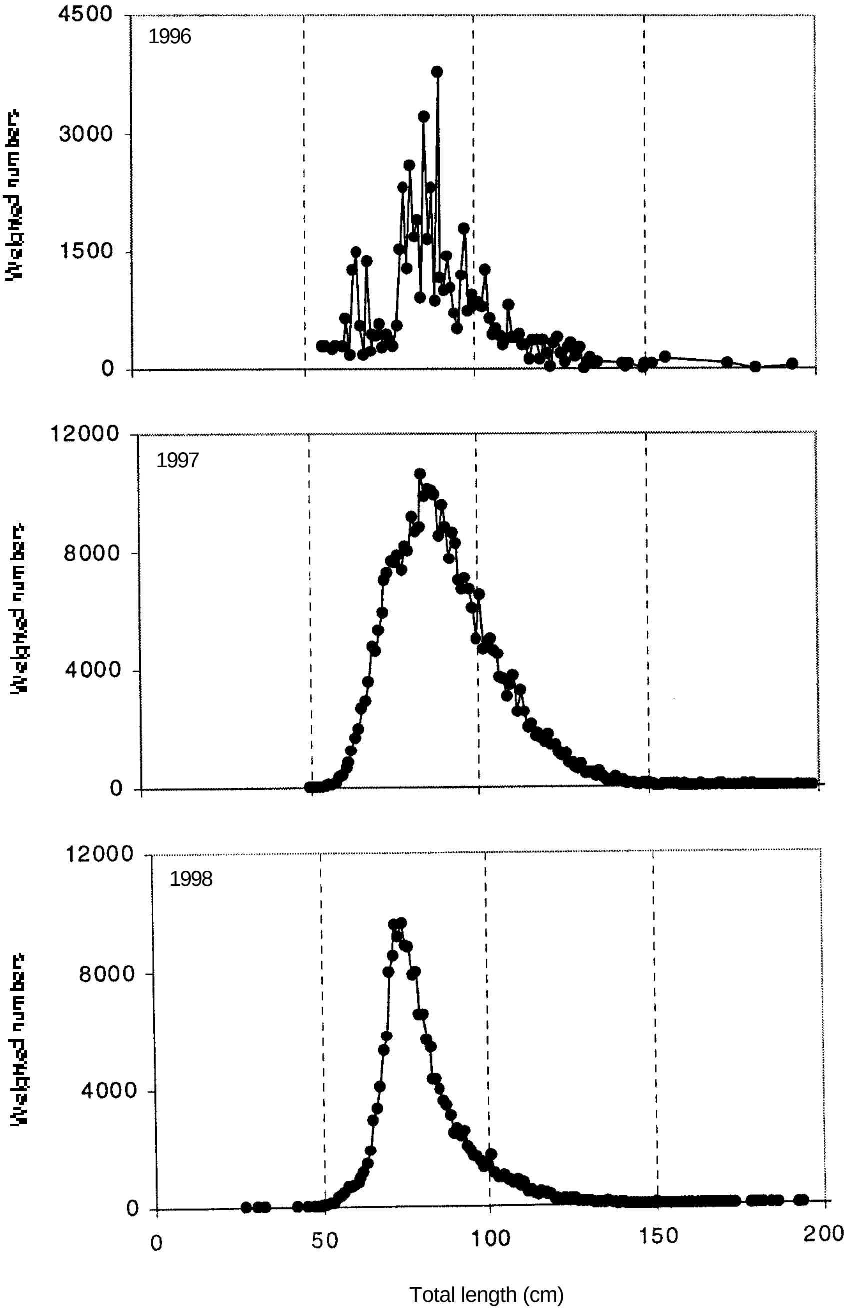


Figure 12: Catch-weighted length frequencies by season for fish taken around Shag Rocks for catches <900 m.

(continued)

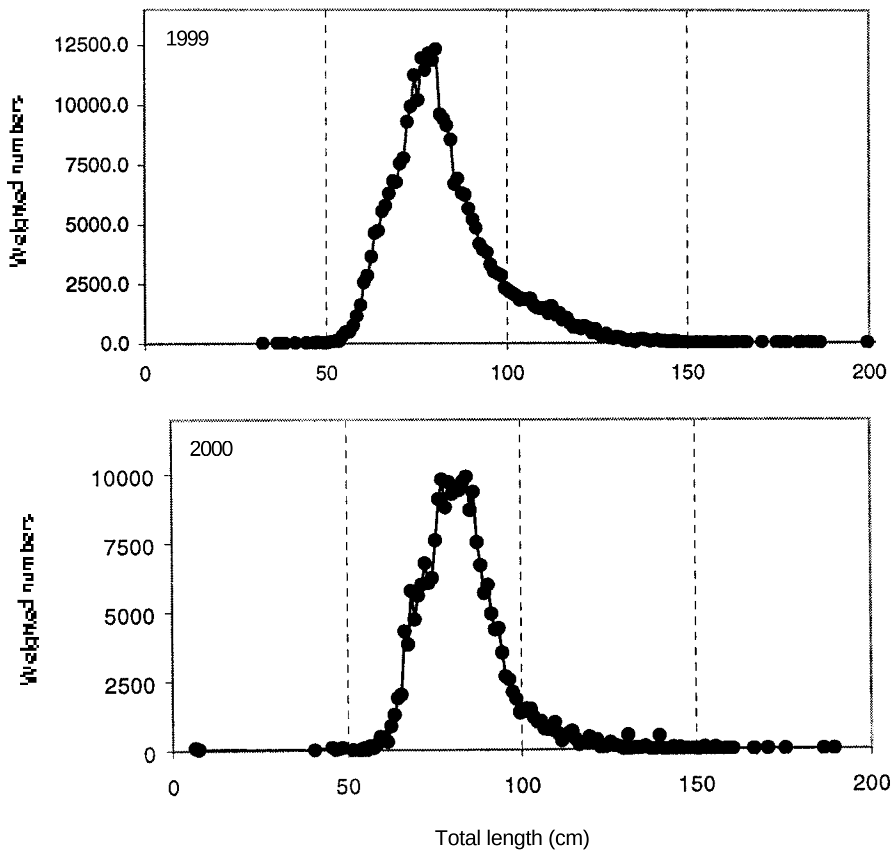


Figure 12 (continued)

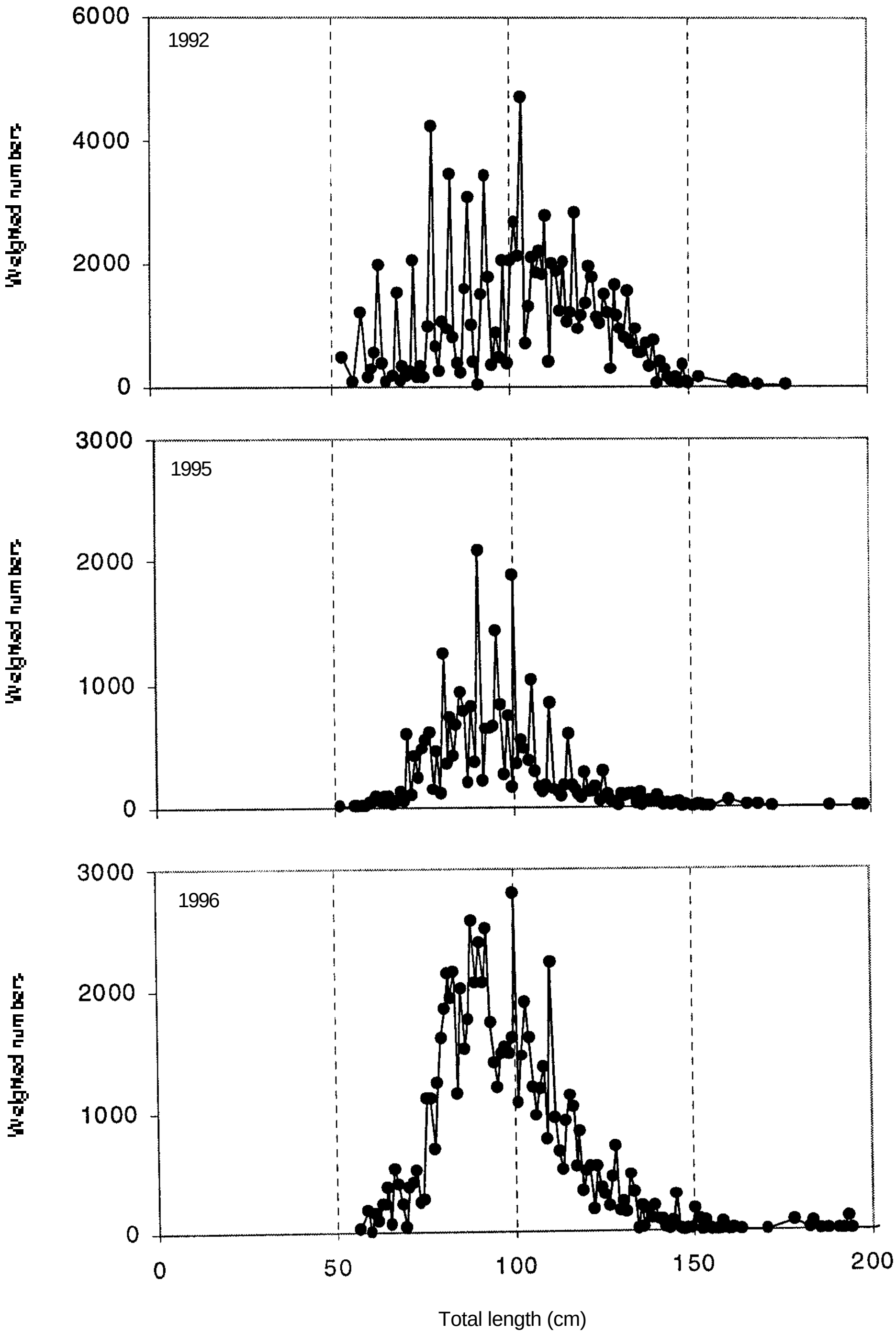


Figure 13: Catch-weighted length frequencies by season for fish taken around Shag Rocks for catches >900 m.

(continued)

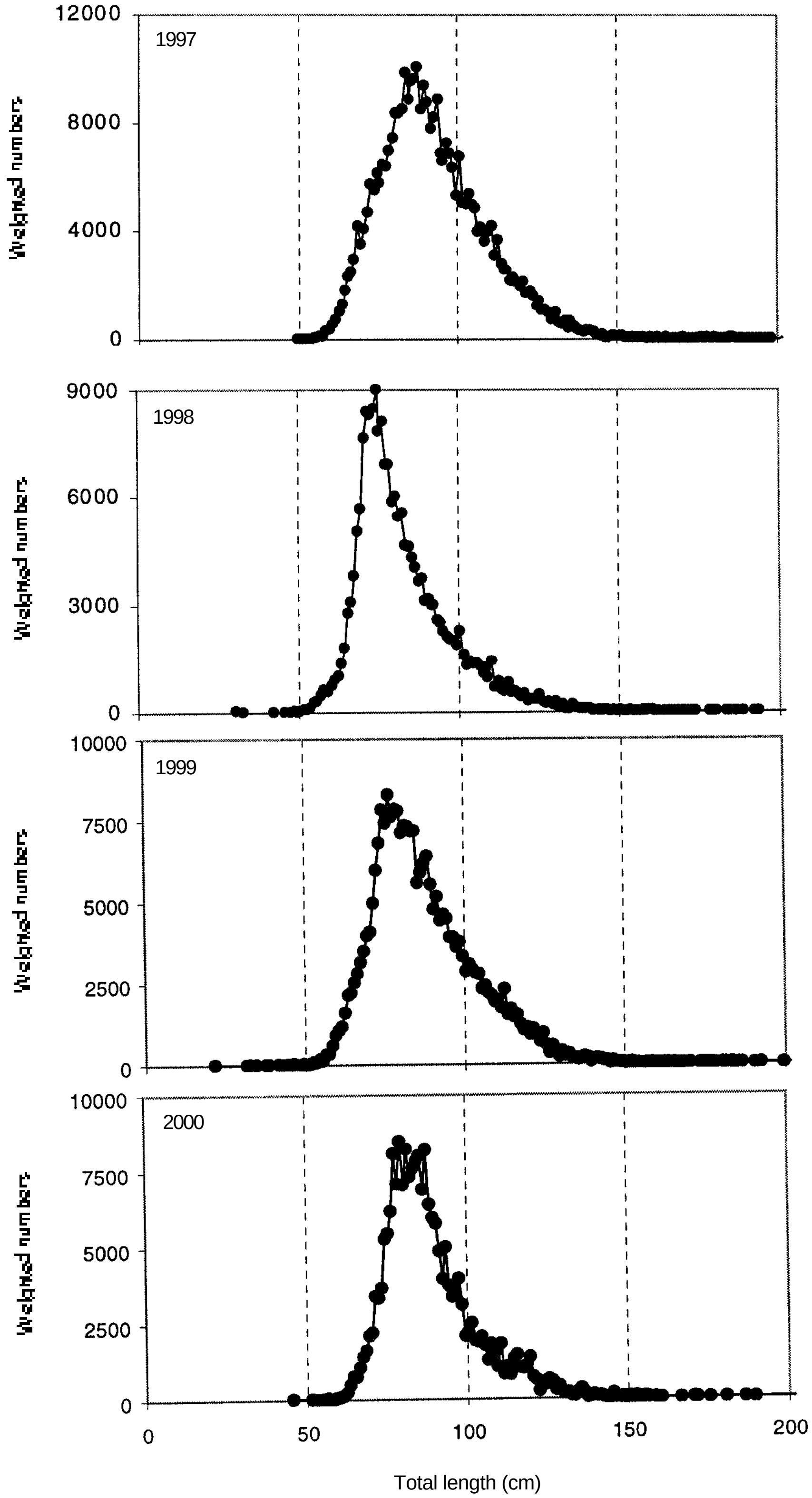


Figure 13 (continued)

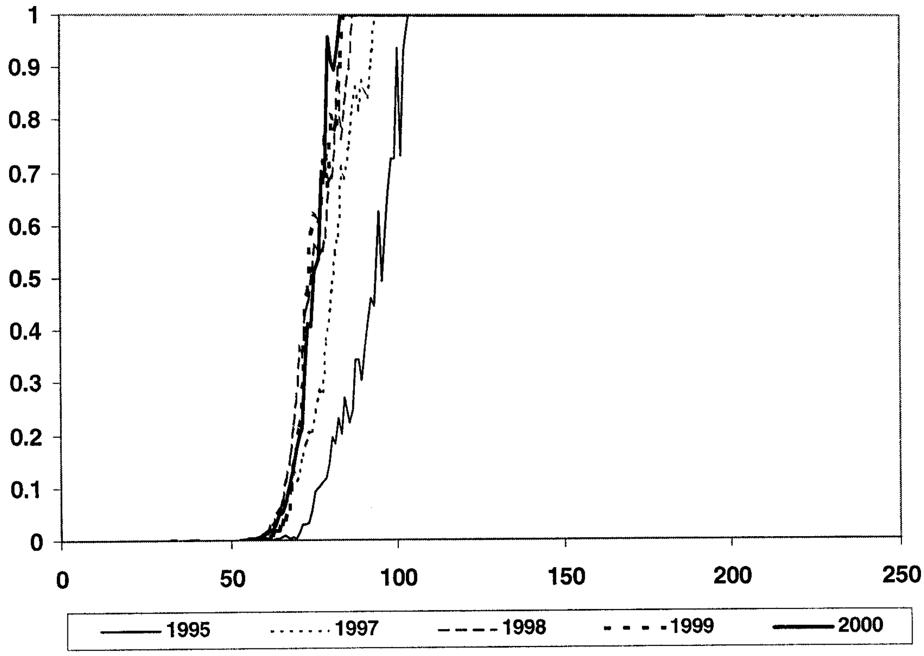


Figure 14: Selectivity curves by year for *Dissostichus eleginoides* in South Georgia (Subarea 48.3).

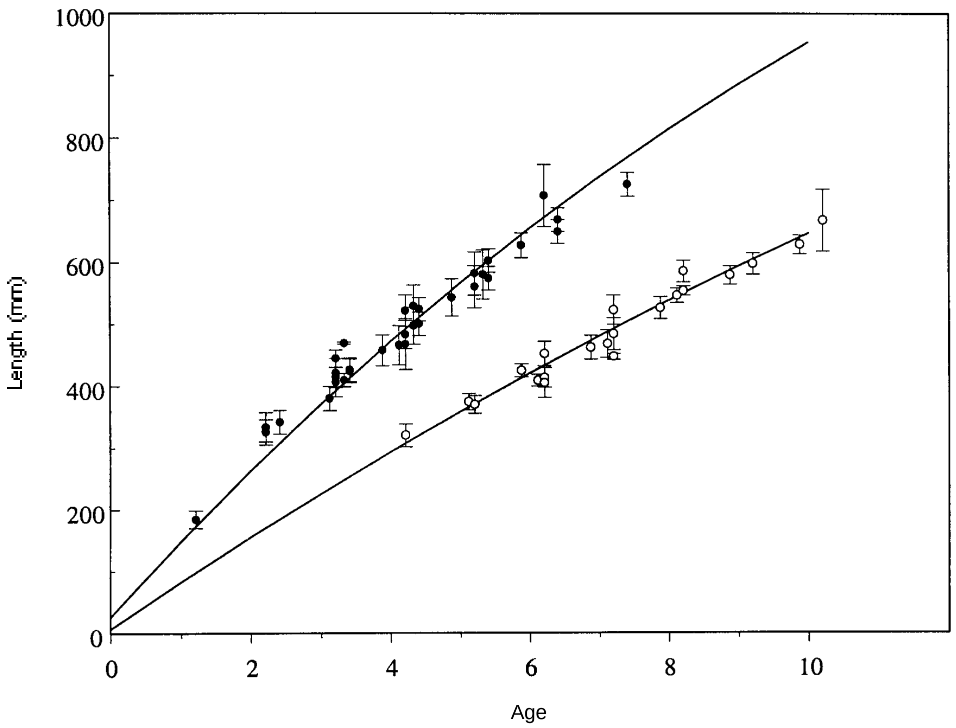


Figure 15: Mean length (± standard deviation) for cohorts from mixture analyses with the growth curves used as a guide to fit the mixture. Filled circles are results from WG-FSA-99 including the 2000 survey results analysed based on growth parameters from 1999 (top line). Open circles are from the revised mixture analyses based on von Bertalanffy k = 0.041 (bottom line).

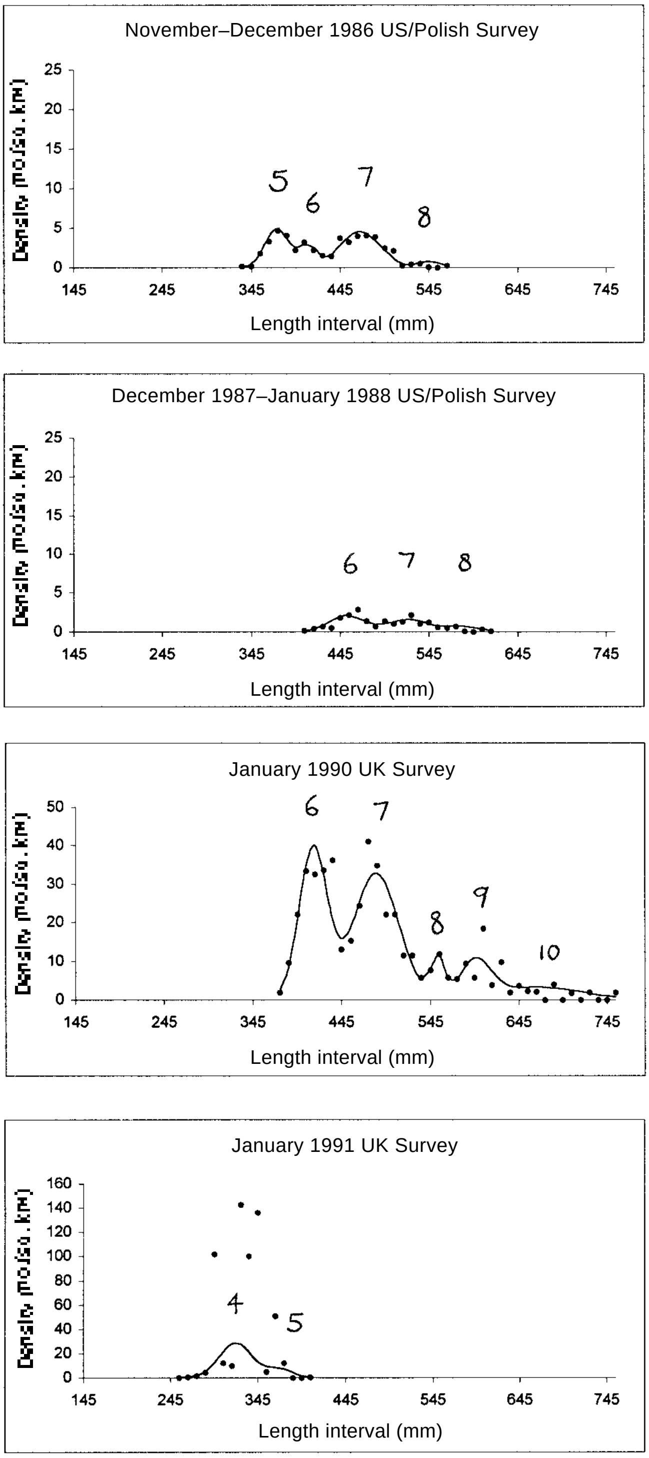


Figure 16: Plots of the observed and expected length-density data produced during the mixture analysis, using the growth rate from Heard Island (paragraph 4.132). Numbers superimposed on the plots indicate nominal ages assigned to each mixture component.

(continued)

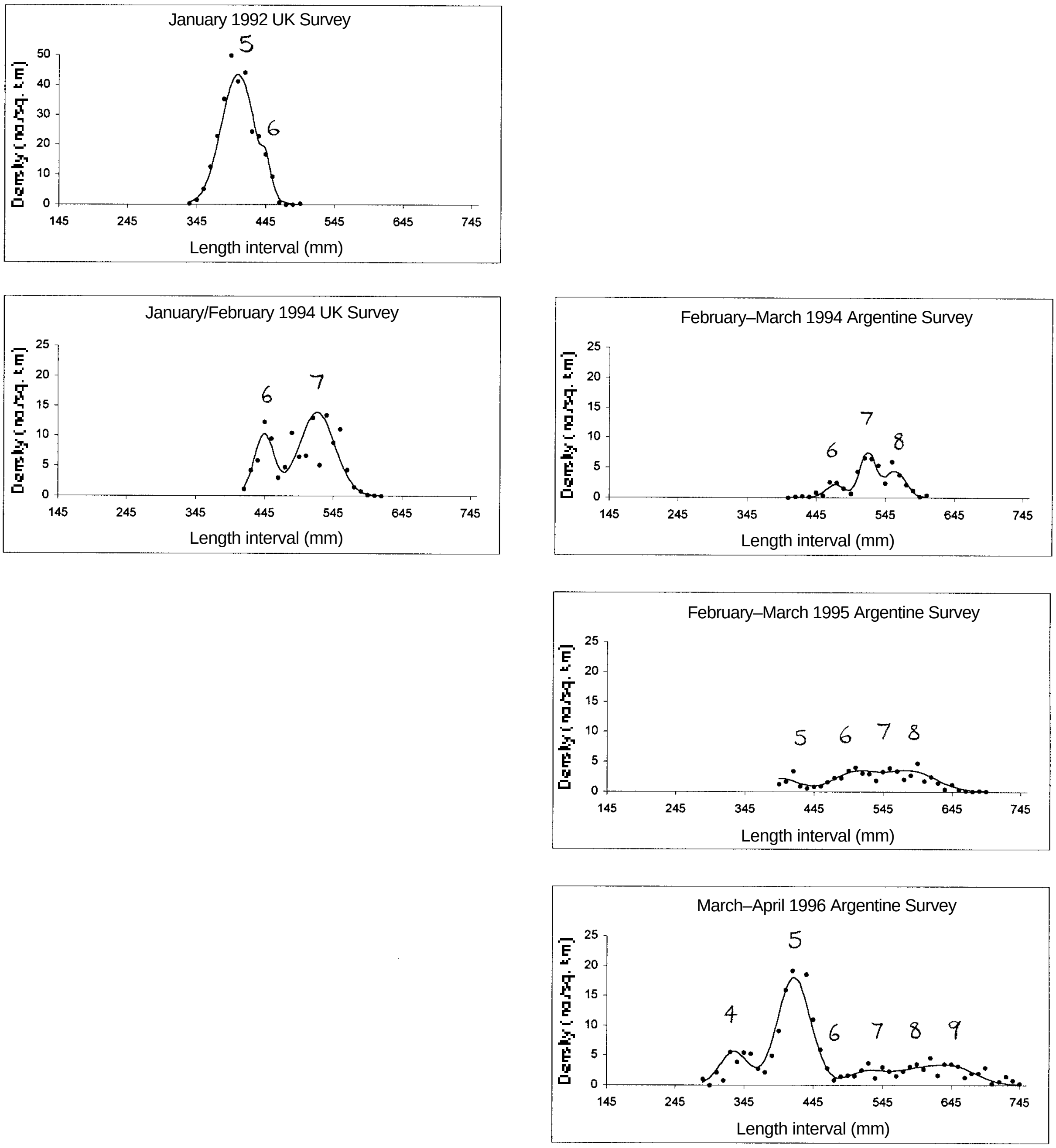


Figure 16 (continued)

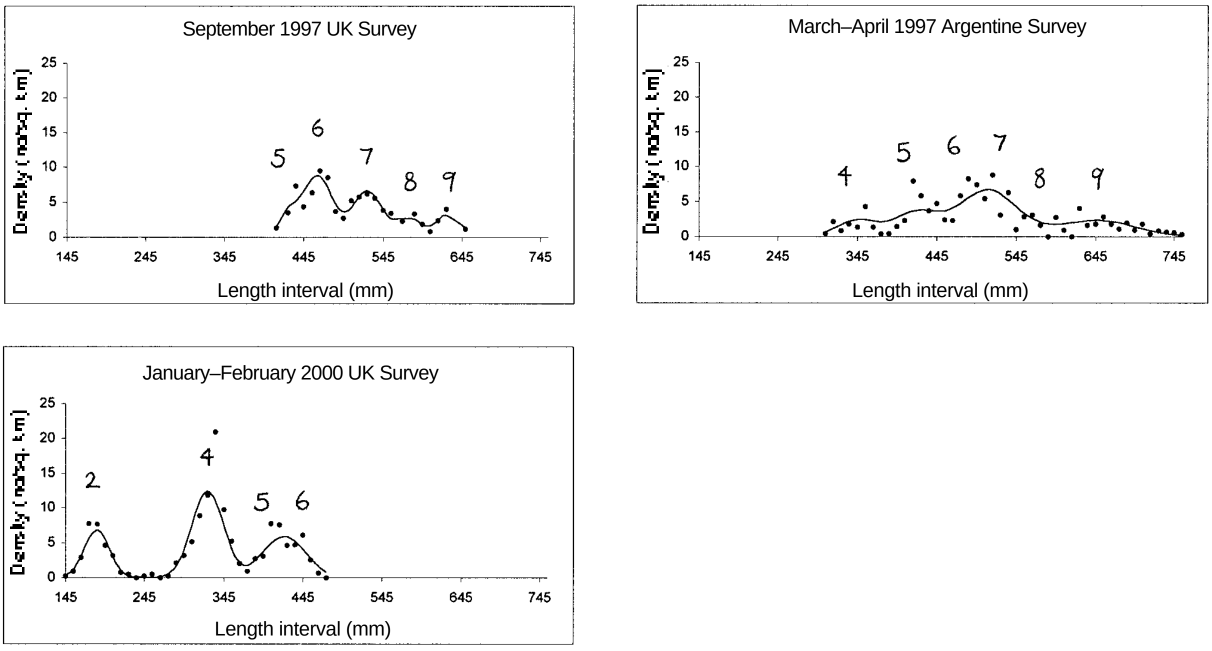


Figure 16 (continued)

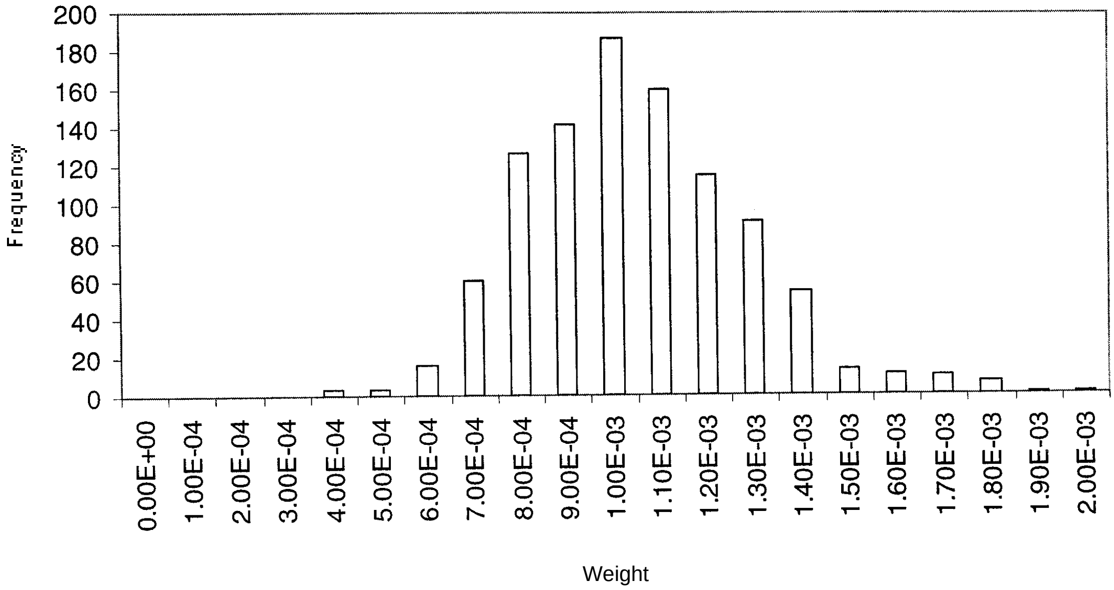


Figure 17: Histogram of estimated weights for Subarea 48.3 GYM trajectories.

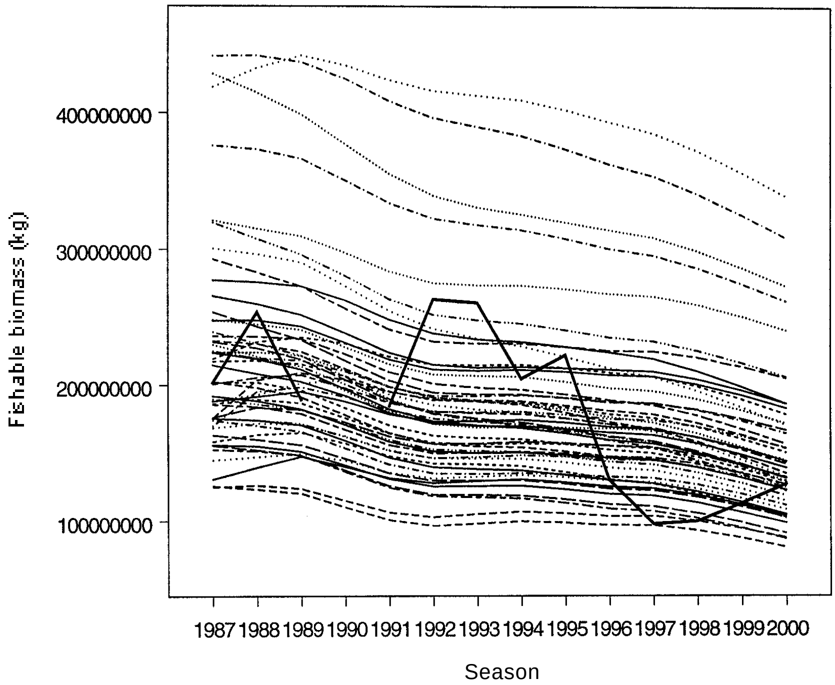


Figure 18: The 50 highest weighted trajectories of fishable biomass and scaled CPUE in Subarea 48.3 GYM analysis.

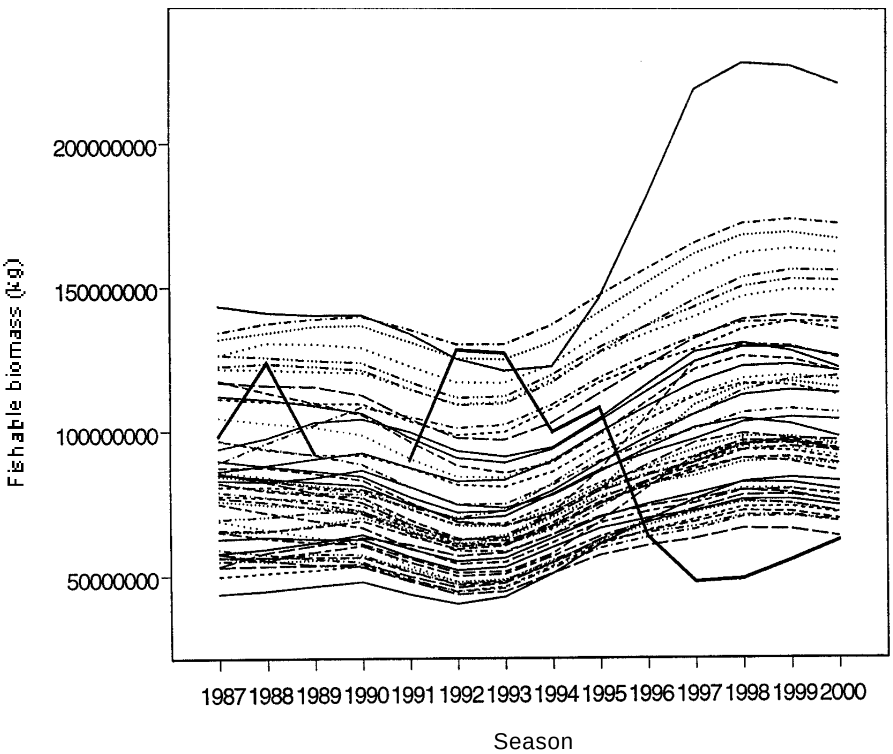


Figure 19: The 50 lowest weighted trajectories of fishable biomass and scaled CPUE in Subarea 48.3 GYM analysis.

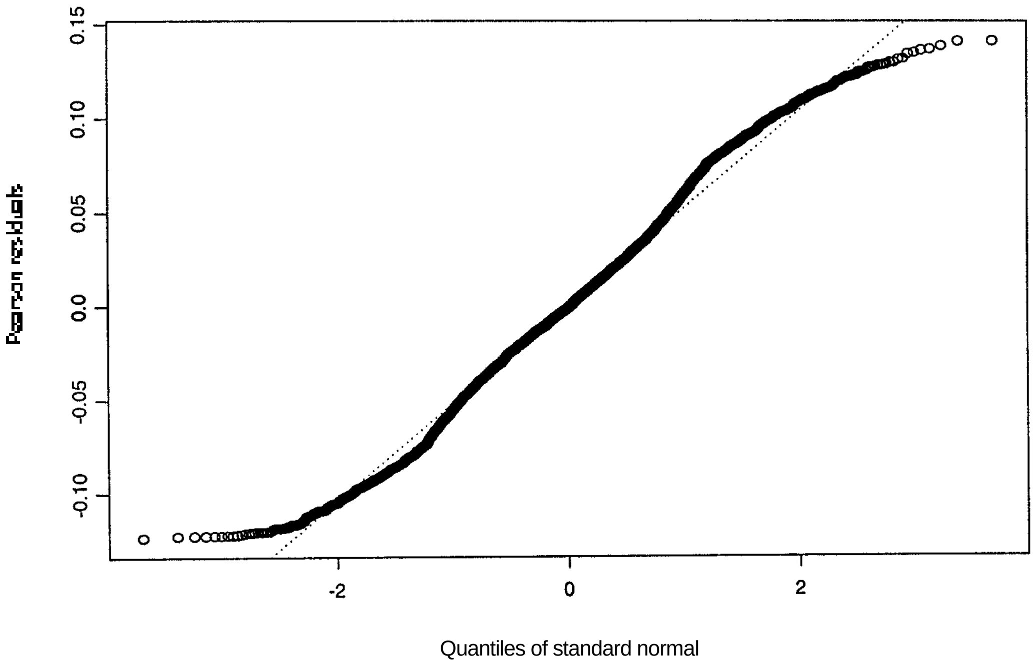


Figure 20: QQ plot of standardised residuals for the GLM fitted to CPUE values in numbers of fish/hook using data from longliners in the Kerguelen Islands.

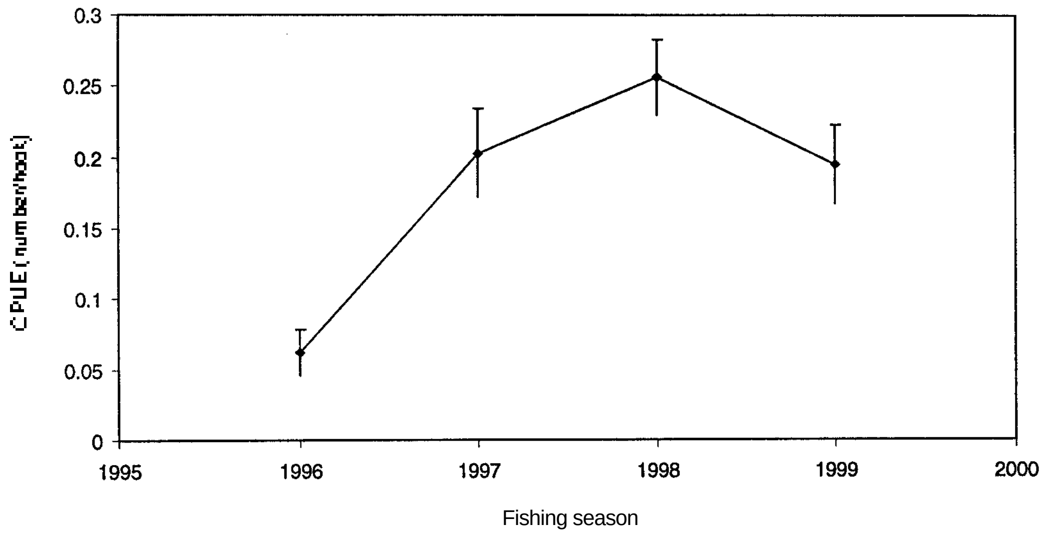


Figure 21: Standardised series of CPUE in number of fish/hook for longliners in Division 58.5.1.

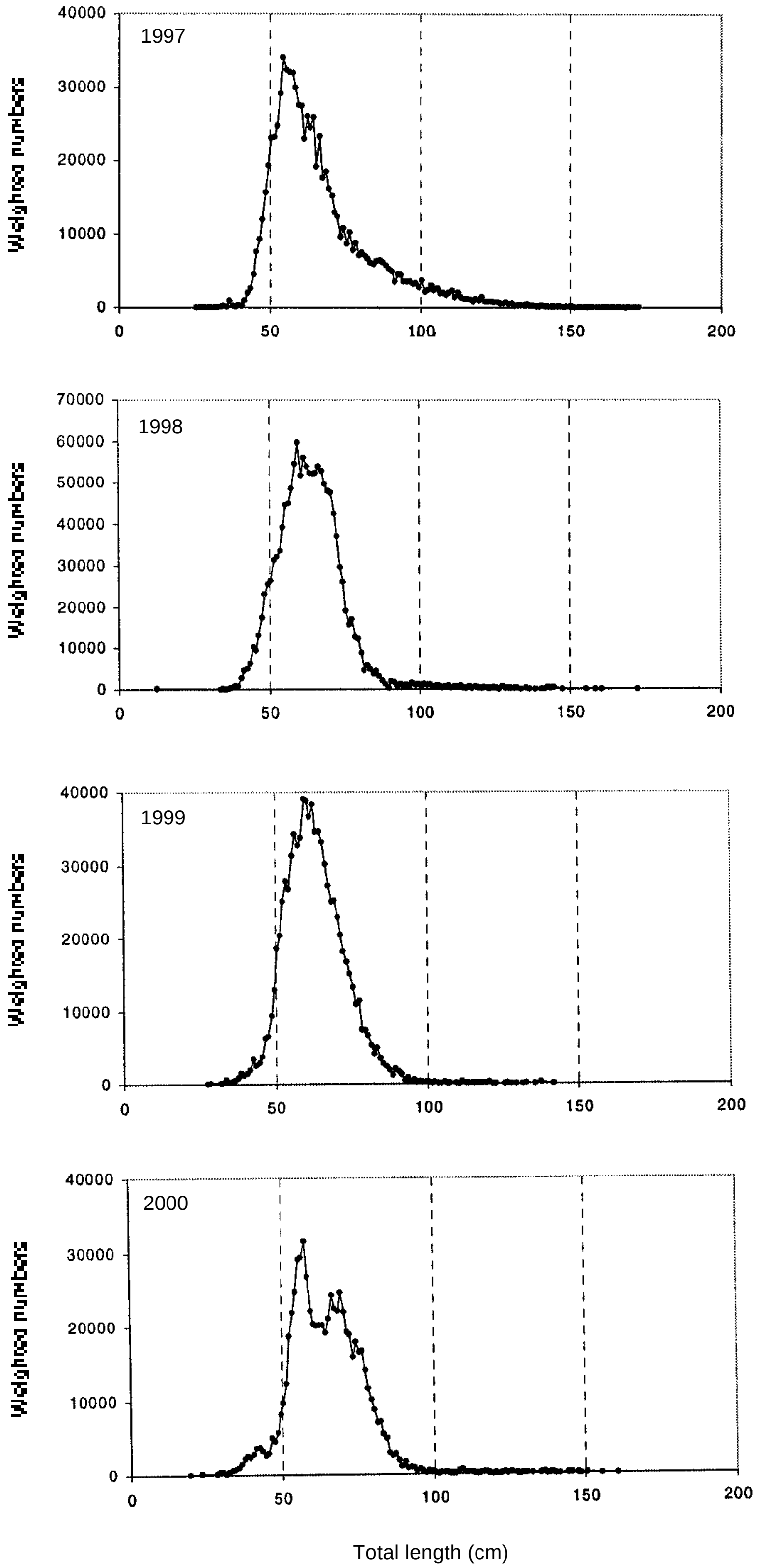


Figure 22: Catch-weighted length frequencies for *Dissostichus eleginoides* by season for fish taken around Heard Island (Division 58.5.2).

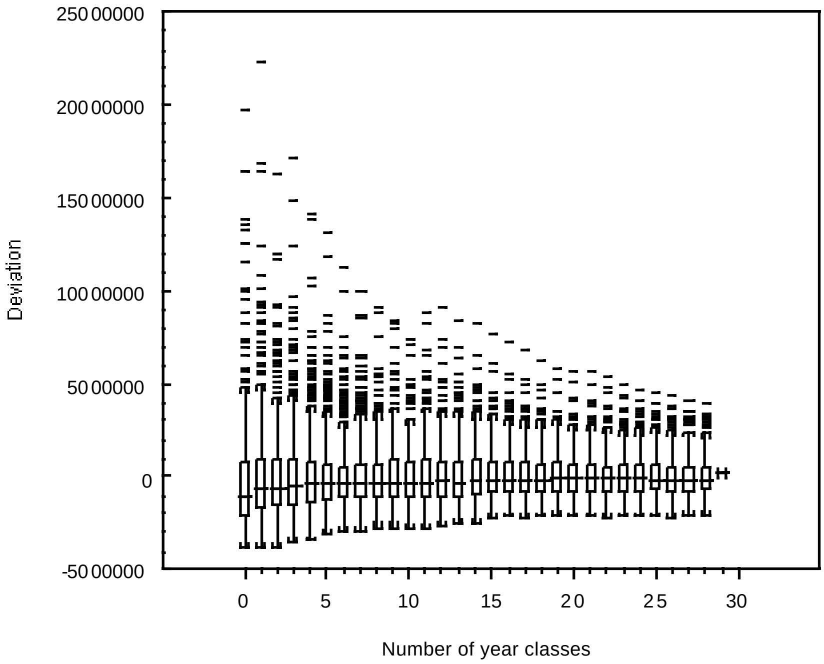


Figure 23: Box plots showing, for the number of observed year classes, the distribution of estimated mean recruitments as deviations from the population mean for 500 repeated samples from a log-normal distribution with a CV of 1.

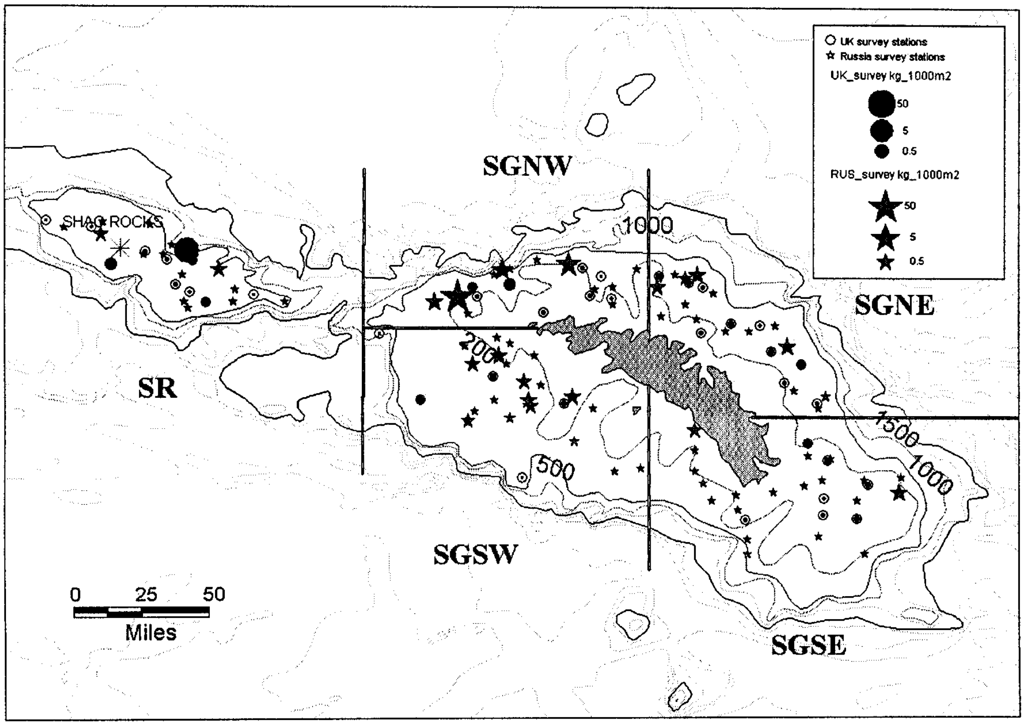
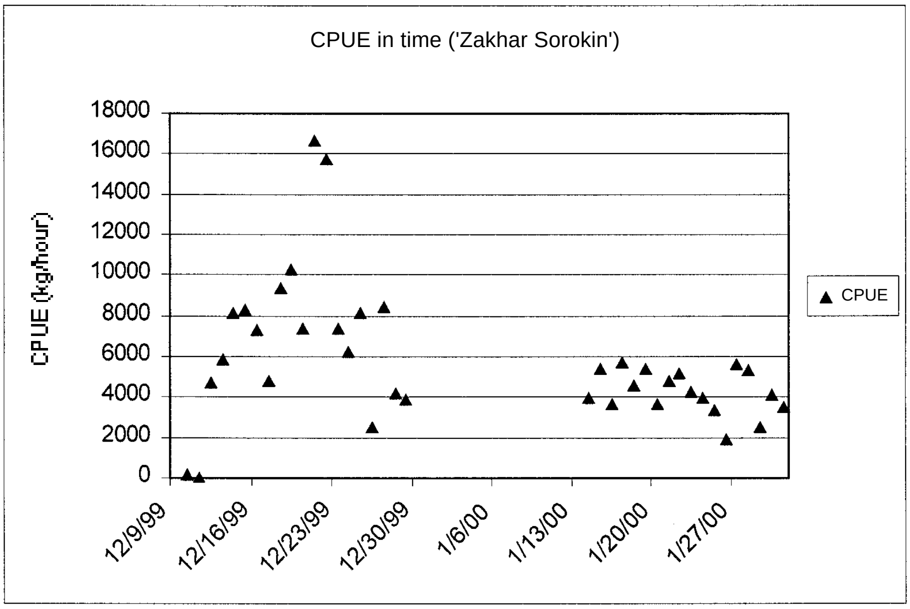


Figure 24: Location of stations sampled during the surveys conducted by Russia and the UK in Subarea 48.3 in January–February 2000.



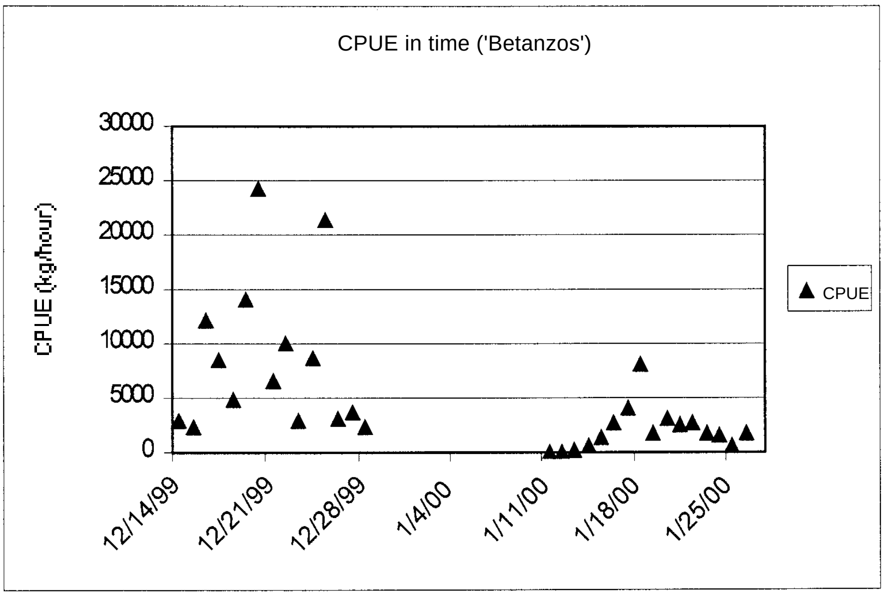


Figure 25: Graph of catch rates per hour over time for the two vessels.

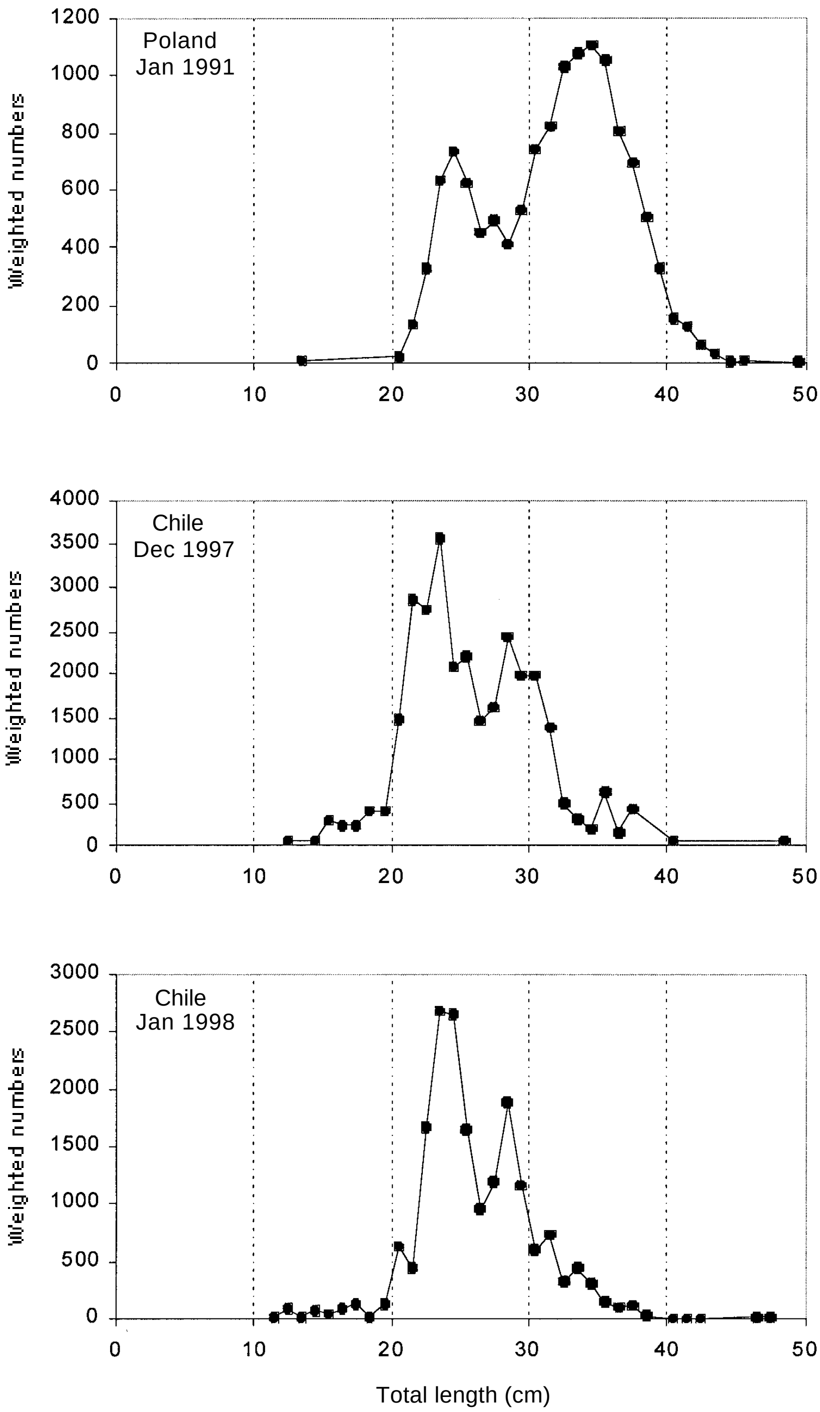


Figure 26: Catch-weighted length distributions from the commercial fishery for *C. gunnari* in the 1990/91 to 1999/2000 fishing seasons.

(continued)

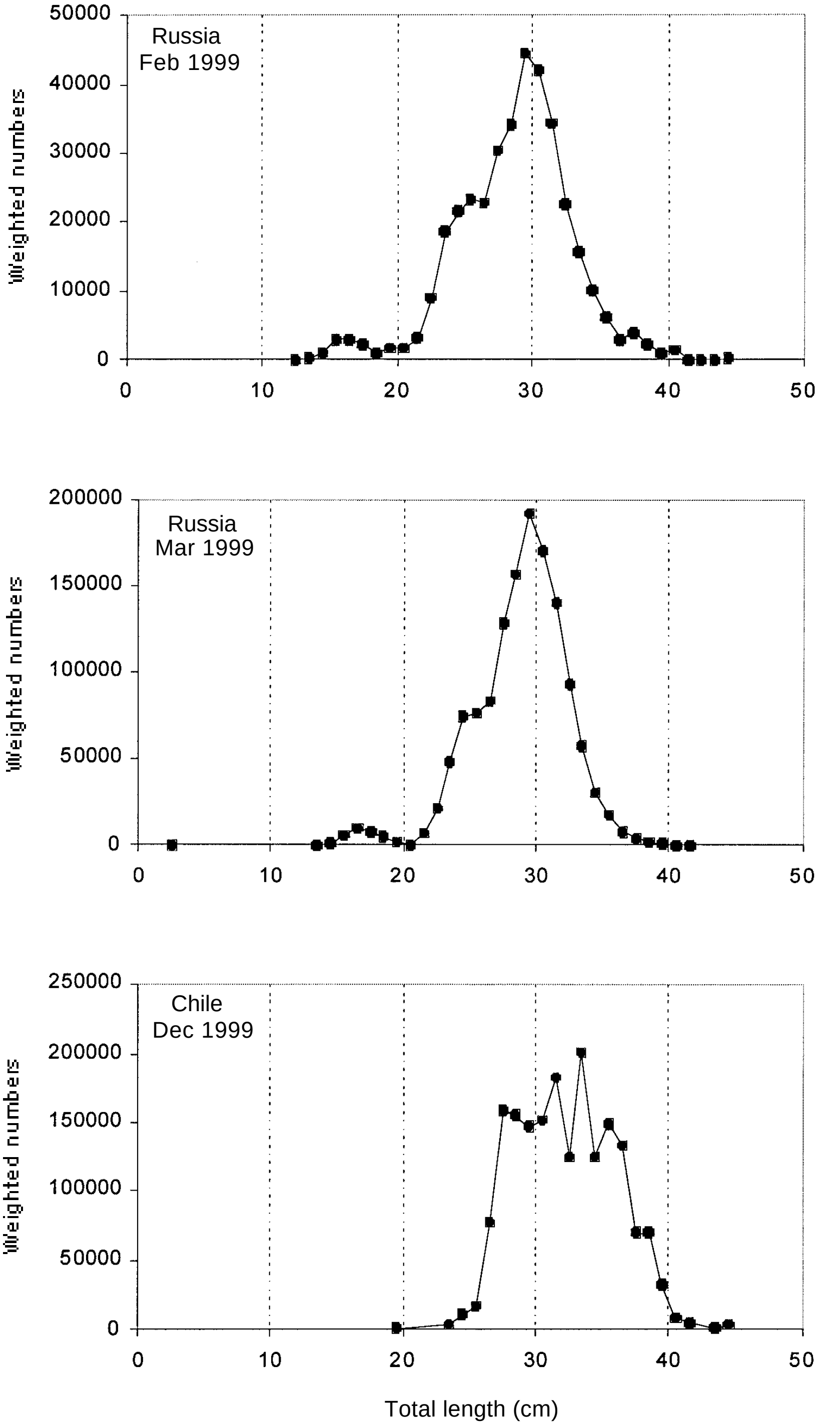
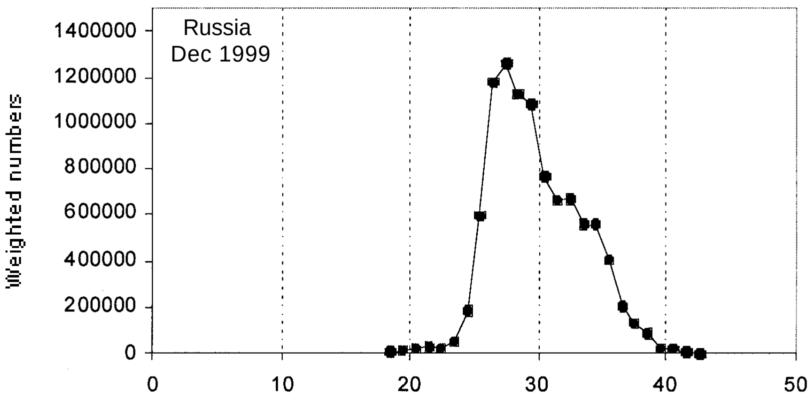
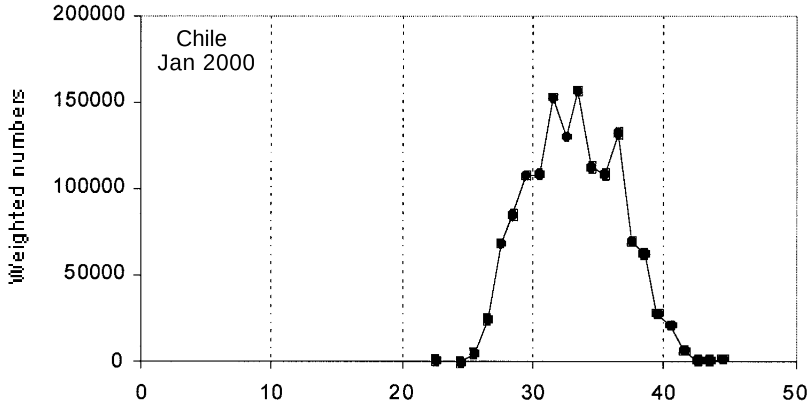


Figure 26 (continued)





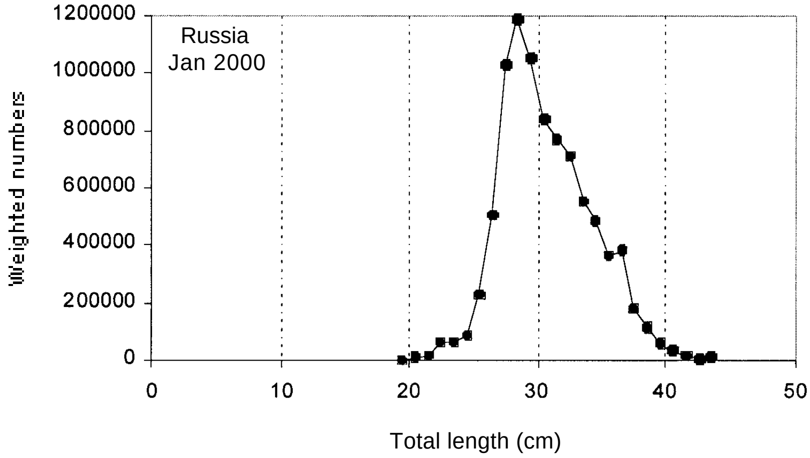
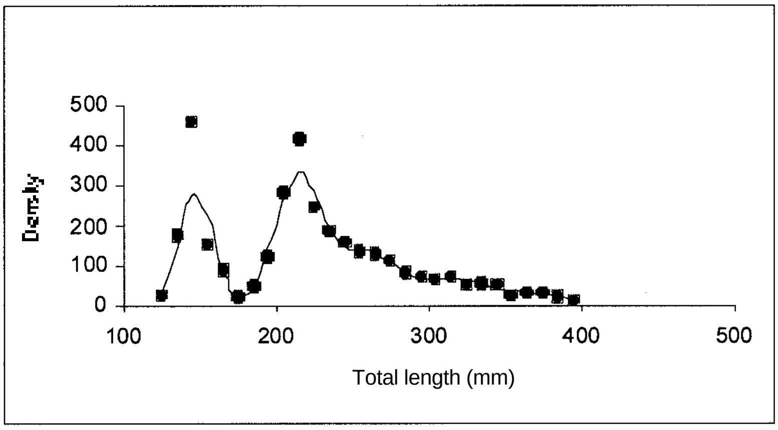
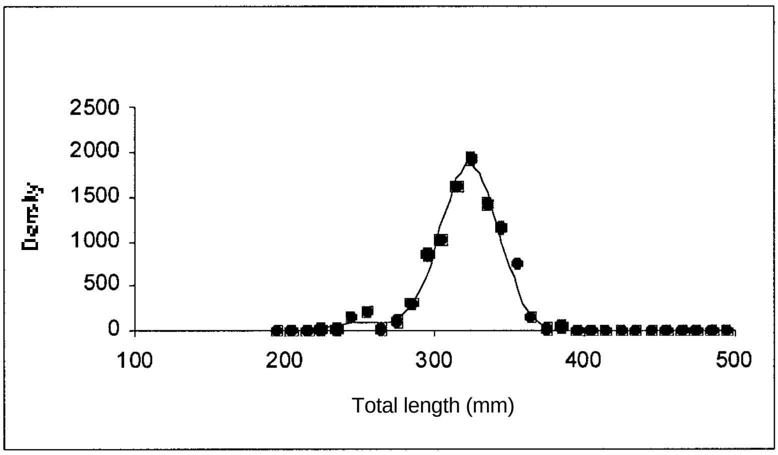


Figure 26 (continued)

(a) UK survey, South Georgia



(b) UK survey, Shag Rocks



(c) Russian survey, Subarea 48.3

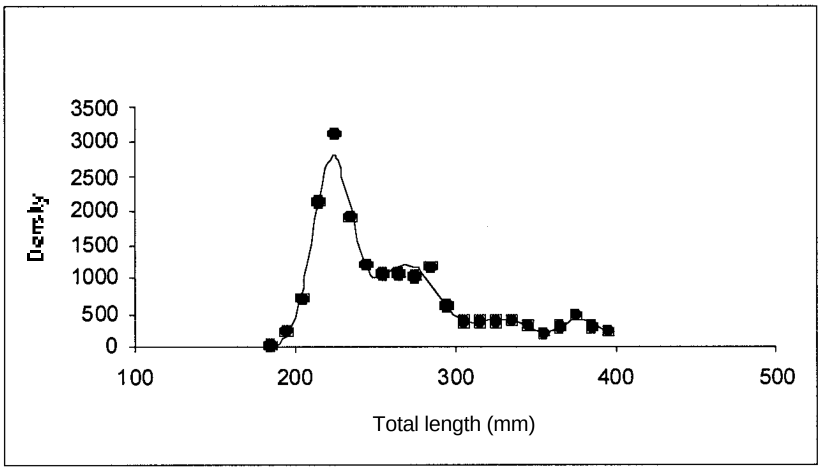


Figure 27: Observed densities at length and fitted mixtures of distributions for UK and Russian surveys during the 1999/2000 season.

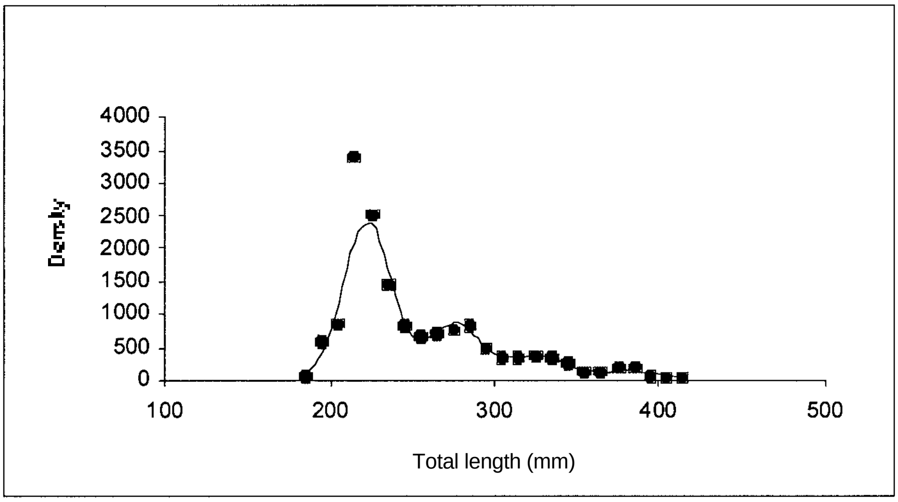


Figure 28: Observed densities at length and fitted mixtures of distributions for the combined survey dataset, Subarea 48.3.

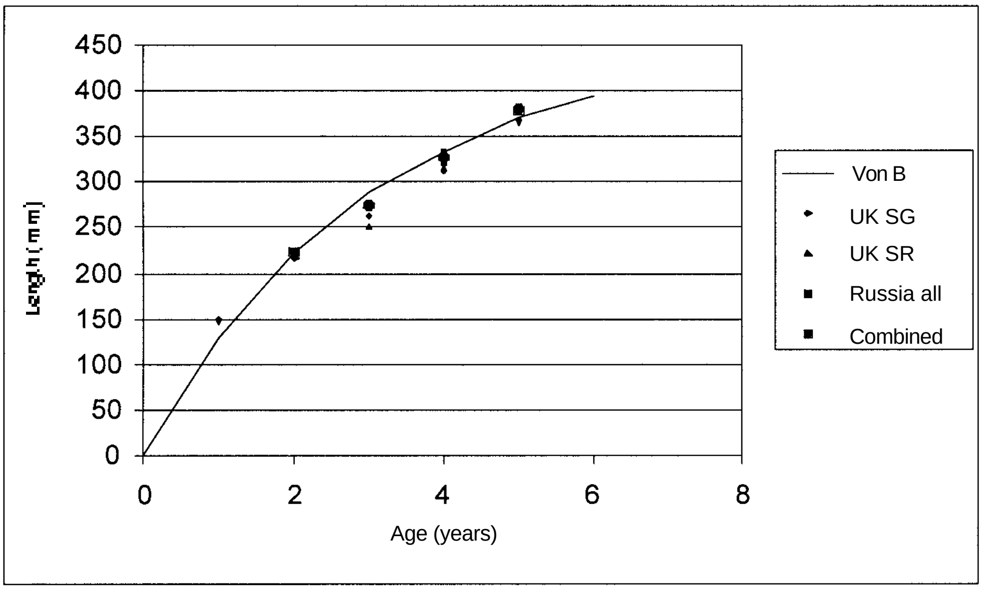


Figure 29: Comparison of means of mixture components from the CMIX analysis and the von Bertalanffy growth curve used in the short-term projection.

APPENDIX A

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 9 to 19 October 2000)

1. Opening of the Meeting

2. Organisation of the Meeting and Adoption of the Agenda

3. Review of Available Information

    3.1 Data Requirements Specified in 1999
        3.1.1 Data Inventory and Developments in the CCAMLR Database
        3.1.2 Data Entry and Validation
        3.1.3 Other

    3.2 Fisheries Information
        3.2.1 Catch, Effort, Length and Age Data Reported to CCAMLR
        3.2.2 Estimates of Catch and Effort from Illegal, Unregulated and Unreported (IUU) Fishing (Subgroup report)
        3.2.3 Catch and Effort Data for Fisheries for *Dissostichus* spp. in Waters Adjacent to the Convention Area
        3.2.4 Scientific Observer Information (Subgroup report)
        3.2.5 Research Surveys
        3.2.6 Mesh/Hook Selectivity and related Experiments affecting Catchability
        3.2.7 Conversion Factors

    3.3 Fish and Squid Biology/Demography/Ecology (Subgroup report)

    3.4 Developments in Assessment Methods (Subgroup report)

4. Assessments and Management Advice

    4.1 New and Exploratory Fisheries
        4.1.1 New Fisheries in 1999/2000
        4.1.2 Exploratory Fisheries in 1999/2000
        4.1.3 New Fisheries Notified for 2000/2001
        4.1.4 Exploratory Fisheries Notified for 2000/2001
        4.1.5 Progress Towards Assessments in New and Exploratory Fisheries
        4.1.6 Apportioning Catch Limits between Trawl and Longline Fisheries

    4.2 Assessed Fisheries
        4.2.1 *Dissostichus eleginoides* South Georgia (Subarea 48.3)
        4.2.2 *Dissostichus eleginoides* Kerguelen Islands (Division 58.5.1)
        4.2.3 *Dissostichus eleginoides* Heard Island (Division 58.5.2)
        4.2.4 *Champsocephalus gunnari* South Georgia (Subarea 48.3)
        4.2.5 *Champsocephalus gunnari* Heard Island (Division 58.5.2)

    4.3 Other Fisheries
        4.3.1 Other Finfish Fisheries
        4.3.2 Crabs
        4.3.3 Squid

4.4 General By-catch Provisions (Subgroup report)
4.5 Regulatory Framework

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

7.1 Intersessional Work of ad hoc WG-IMALF

7.2 Research into the Status of Seabirds

7.3 Incidental Mortality of Seabirds during Regulated Longline Fishing in the Convention Area
7.3.1 Data Submitted for the 1999/2000 and the Beginning of the 2000/2001 Seasons
7.3.2 Evaluation of Levels of Incidental Mortality
7.3.3 Compliance with Conservation Measure 29/XVI

7.4 Incidental Mortality of Seabirds during Unregulated Longline Fishing in the Convention Area

7.5 Incidental Mortality of Seabirds in relation to New and Exploratory Fisheries
7.5.1 Assessments of Risk in CCAMLR Subareas and Divisions
7.5.2 New and Exploratory Fisheries Operational in 1999/2000
7.5.3 New and Exploratory Fisheries Proposed for 2000/2001

7.6 Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area

7.7 Research into and Experience with Mitigating Measures

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

7.9 Advice to the Scientific Committee

8. Other Incidental Mortality

8.1 Interactions involving Marine Mammals with Longline Fishing Operations
8.2 Trawl Fishing

9. CCAMLR Website

10. Future Work

10.1 Data Requirements
10.2 Software and Analyses to be Prepared or Developed Prior to the Next Meeting
10.3 Impact of Budgetary Restraints

11. Other Business

11.1 *CCAMLR Science* and the *Science Citation Index*
11.2 *Fishery Data Manual*
11.3 Deadline for Submission of Meeting Papers
11.4 IUCN Criteria for Endangered Species

12. Adoption of the Report

13. Close of the Meeting.

APPENDIX B

LIST OF PARTICIPANTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 9 to 19 October 2000)

BAKER, Barry (Mr)	Biodiversity Group Environment Australia GPO Box 8 Canberra ACT 2601 Australia barry.baker@ea.gov.au
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APPENDIX C

LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 9 to 19 October 2000)

WG-FSA-00/1	Provisional and Annotated Provisional Agenda for the 2000 Meeting of the Working Group on Fish Stock Assessment (WG-FSA)
WG-FSA-00/2	List of participants
WG-FSA-00/3	List of documents
WG-FSA-00/4	Data and resources available to WG-FSA 2000 Secretariat
WG-FSA-00/5	Secretariat work in support of WG-FSA Secretariat
WG-FSA-00/6	Fishery information for WG-FSA-00 Secretariat
WG-FSA-00/7	United Kingdom genetic research relevant to Southern Ocean seabirds vulnerable to fisheries interactions J.P. Croxall (United Kingdom)
WG-FSA-00/8	United Kingdom research under way on Southern Ocean seabirds vulnerable to fisheries interactions J.P. Croxall (United Kingdom)
WG-FSA-00/9	France research under way on Southern Ocean seabirds vulnerable to fisheries interactions H. Weimerskirch (France)
WG-FSA-00/10	Research under way on New Zealand seabirds vulnerable to fisheries interactions J. Molloy (New Zealand)
WG-FSA-00/11	Documentation for the CCAMLR survey database and length-density analysis Secretariat
WG-FSA-00/12	Update on the CCAMLR Website Secretariat
WG-FSA-00/13	Longline fishing at Tristan da Cunha: impact on seabirds N. Glass, I. Lavarello, J.P. Glass and P.G. Ryan (South Africa) (In: *Atlantic Seabirds*, 2 (2), in press).
WG-FSA-00/14	What do we know about fish stocks in the Southern Scotia region? A review and prospects for future research K.-H. Kock (Germany) and C. Jones (USA)

WG-FSA-00/15	Preparation of identification keys for by-catch fish species Secretariat
WG-FSA-00/16	Restoration of retrospective data on *Dissostichus eleginoides* catches in Subarea 48.3 Delegations of Ukraine and Russia
WG-FSA-00/17	Brief report of national scientific observer aboard longliner *RK1* Delegation of Ukraine
WG-FSA-00/18	Summary of observations aboard trawlers operating in the Convention Area during the 1999/2000 season Secretariat
WG-FSA-00/19	Hydroacoustic observations of the vertical distribution of icefish *Champsocephalus gunnari* in the western part of the slope of the South Georgia Island in December 1999–January 2000 V.L. Senioukov (Russia)
WG-FSA-00/20	Biological features of the icefish *Champsocephalusgunnari* from commercial catches in Subarea 48.3 during the period from 8 December 1999 until 31 January 2000 V.L. Senioukov (Russia)
WG-FSA-00/21	UK groundfish survey in Subarea 48.3 (South Georgia and Shag Rocks), January 2000 I. Everson, D. Agnew, P. Bagley, M. Collins, T. Daw, R. Forster, T. Marlow, A. North (United Kingdom), J. Szlakowski (Poland), E. Van Wijk (Australia), S. Wilhelms (Germany) and C. Yau (United Kingdom)
WG-FSA-00/22	Notes on the biology of the South Georgia ray, *Raja georgiana* I. Everson, J. Kerr, C. Yau and A. Williams (United Kingdom)
WG-FSA-00/23	Fishing for toothfish using pots: results of trials undertaken around South Georgia, March–May 2000 D. Agnew, T. Daw, M. Purves and G. Pilling (United Kingdom) (*CCAMLR Science*, 8: submitted)
WG-FSA-00/24	Crab by-catch in the experimental toothfish pot fishery around South Georgia, 2000 T. Daw, D. Agnew, M. Purves, G. Pilling and C. Yau (United Kingdom) (*CCAMLR Science*, 8: submitted)
WG-FSA-00/25	Examination of the gut contents of Patagonian toothfish (*Dissostichus eleginoides*) from the toothfish pot fishery trials around South Georgia G. Pilling, T. Daw, M. Purves, D. Agnew and J. Xavier (United Kingdom)
WG-FSA-00/26	Toothfish tagging programme around South Georgia, 2000 G. Pilling, I. Everson, D. Agnew, T. Daw, R. Forster, A. North and M. Purves (United Kingdom)

WG-FSA-00/27	Spawning activity of mackerel icefish at South Georgia I. Everson, A. North (United Kingdom) and K.-H. Kock (*CCAMLR Science*, 8: submitted) (Germany)
WG-FSA-00/28	A comparison between otoliths and scales for use in estimating the age of *Dissostichus eleginoides* from South Georgia J. Ashford, C. Jones, S. Wischniowski, S. Bobko (USA) and I. Everson (United Kingdom) (*CCAMLR Science*, 8: submitted)
WG-FSA-00/29	Reducing seabird by-catch with an underwater longline setting funnel P. Ryan and B. Watkins (South Africa)
WG-FSA-00/30	Seabird by-catch in the Patagonian toothfish longline fishery at the Prince Edward Islands: 1999–2000 P. Ryan and B. Watkins (South Africa)
WG-FSA-00/31	On possibility of using acoustic method to improve quality of *Champsocephalus gunnari* biomass estimates in Subarea 48.3 S. Kasatkina (Russia) (*CCAMLR Science*, 8: submitted)
WG-FSA-00/32	Length-age composition of icefish (*Champsocephalus gunnari*, perciformes, notothenioidei, Channichthyidae) from different locations of South Georgia Island subarea Zh.A. Frolkina (Russia) (*CCAMLR Science*, 8: submitted)
WG-FSA-00/33	Standardised estimates of *D. eleginoides* catches per effort in Subarea 48.3 using information for 1985/86–1990/91 seasons P. Gasiukov (Russia) and V. Bibik (Ukraine) (*CCAMLR Science*, 8: submitted)
WG-FSA-00/34	Global status of albatrosses and Macronectes and Procellaria petrels (Source: BirdLife International. 2000. *Threatened Birds of the World*. BirdLife International/Lynx-Edicions, Barcelona.)
WG-FSA-00/35	Fishery dependent research (Extract from the Report of New Zealand on Member's Activities in the Convention Area in 1999/2000)
WG-FSA-00/36	Fish Heaven: a Monte Carlo, spatially explicit single species fishery model for the testing of parameter estimation methods I. Ball and A. Constable (Australia)
WG-FSA-00/37	A summary of observations on board longline vessels operating within the CCAMLR Convention Area Secretariat
WG-FSA-00/38	A summary of observations on compliance with Conservation Measures 29/XVI and 63/XV Secretariat

WG-FSA-00/39	Integration of CPUE data into assessments using the generalised yield model G. Kirkwood (United Kingdom) and A. Constable (Australia) (*CCAMLR Science*, 8: submitted)
WG-FSA-00/40	A survey of fish stocks in the Heard Island and McDonald Islands region in the 1999/2000 season and a comparison of the abundances of selected species with those obtained in previous surveys R. Williams, A. Constable, T. Lamb and E. van Wijk (Australia)
WG-FSA-00/41	A revision of yield and catch controls for managing the mackerel icefish (*Champsocephalus gunnari*) fishery in the vicinity of Heard Island and McDonald Islands A. Constable, R. Williams, T. Lamb and E. van Wijk (Australia)
WG-FSA-00/42	Update to recruitment series for Patagonian toothfish in the Heard Island region A. Constable, R. Williams, T. Lamb and E. van Wijk (Australia)
WG-FSA-00/43	An exact time of release and recapture stock assessment model applied to Macquarie Island Patagonian toothfish (*Dissostichus eleginoides*) G. Tuck, W. de la Mare, W. Hearn, R. Williams, A. Smith, X. He and A. Constable (Australia)
WG-FSA-00/44	Stock structure and growth in Patagonian toothfish (*Dissostichus eleginoides*) in the Southern Ocean J. Ashford, C. Jones (USA) and I. Everson (United Kingdom)
WG-FSA-00/45	On the state of *Champsocephalusgunnari* stock in Subarea 48.3 and methods of its assessment K. Shust, V. Senioukov, P. Gasiukov and A. Kozlov (Russia)
WG-FSA-00/46	Results of *D. eleginoides* stock assessment for Subarea 48.3 using a dynamic age structured production model P. Gasiukov and R. Dorovskikh (Russia)
WG-FSA-00/47	Brief information on the results of the bottom trawling survey at RV *Atlantida* in February 2000 in South Georgia subarea (48.3) P. Chernyshkov, P. Bukatin and V. Khvichya (Russia)
WG-FSA-00/48 Rev. 1	IUCN/CITES criteria for critically endangered, endangered and vulnerable species Secretariat
WG-FSA-00/49	Australian research underway on seabirds vulnerable to fisheries interactions B. Baker and R. Gales (Australia)
WG-FSA-00/50	Information received from Norway on research related to the development of artificial bait and setting devices for longlines Secretariat

WG-FSA-00/51	Distribution, biological characteristics and biomass of mackerel icefish based on the results of the trawling survey carried out at RV *Atlantida* in February 2000 Zh.A. Frolkina and P.S. Gasiukov (Russia)
WG-FSA-00/52	A method for estimating recruitment and mortality from time series of length-density data A. Constable and I. Ball (Australia) (*CCAMLR Science*, 8: submitted)
WG-FSA-00/53	Population genetics of Patagonian toothfish *Dissostichus eleginoides* and fillet identification of Patagonian toothfish and Antarctic toothfish *D. mawsoni* P. Smith and P. Gaffney (New Zealand)
WG-FSA-00/54	New information on size at maturity of *Dissostichus mawsoni* in Subarea 88.1 G. Patchell (New Zealand)
WG-FSA-00/55	The Ross Sea Antarctic toothfish (*Dissostichus mawsoni*) fishery from 1997/98 to 1999/2000 S. Hanchet and P. Horn (New Zealand)
WG-FSA-00/56	Summary of seabird and marine mammal observations during observed toothfish (*Dissostichus* spp.) longline fishing operations in CCAMLR Subareas 88.1, 1998–2000 S. Baird (New Zealand)
WG-FSA-00/57	Fishes collected during the 1999/00 exploratory fishery by New Zealand in CCAMLR Subarea 88.1 and registered in the National Fish Collection at the Museum of New Zealand Te Papa Tongarewa
WG-FSA-00/58	Factors affecting the sink rate of autoline longline fishing gear R. Blackwell, B. Bull, S. Hanchet and N. Smith (New Zealand) (*New Zealand Fisheries Assessment Report 2000/xx*)
WG-FSA-00/59	Examination of the skate by-catch from around South Georgia from one vessel in the 2000 longline toothfish season M. Endicott, D. Agnew and C. Nolan (United Kingdom)
WG-FSA-00/60	Interactions between killer whales (*Orcinus orca*) and sperms whales (*Physeter macrocephalus*) with a longline fishing vessel C.P. Nolan, G.M. Liddle and J. Elliot (United Kingdom) (*Marine Mammal Science*, 16(3): 658–664, July 2000)
WG-FSA-00/61	Review and evaluation of three mitigation measures – bird-scaring line, underwater setting and line shooter – to reduce seabird by-catch in the Norwegian longline fishery S. Løkkeborg (Norway) (ICES CM 2000/J: 10)

WG-FSA-00/62	Feasibility of video monitoring seabird interactions on small domestic tuna longliners. Delegation of New Zealand (*Conservation Advisory Science Notes*: 303, Department of Conservation, Te Papa Atawhai, New Zealand)
WG-FSA-00/63	Preliminary information on inshore demersal fish from the Danco Coast, Antarctic Peninsula, in the 1999/00 summer season R. Casaux, E. Barrera-Oro, A. Baroni and A. Ramón (Argentina)
WG-FSA-00/64	Performance assessment and performance improvement of two underwater line setting devices for avoidance of seabird interactions in pelagic longline fisheries. N. Brothers, D. Chaffey and T. Reid (Australia) (Published by the Australian Fisheries Management Authority (AFMA) through the AFMA Research Fund and Environment Australia)

Other Documents

CCAMLR-XIX/5	Notification of an exploratory longline fishery for *Dissostichus eleginoides* in CCAMLR areas Delegation of Brazil
CCAMLR-XIX/6	Notification of exploratory fisheries for *Dissostichus* spp. in the 2000/2001 season Delegation of South Africa
CCAMLR-XIX/7	Notification of Ukraine's intention to initiate exploratory fisheries for *Dissostichus eleginoides* in Division 58.4.4 Delegation of Ukraine
CCAMLR-XIX/8	Proposal for an exploratory jig fishery for squid in Subarea 48.3 in the 2000/2001 fishing seasons Delegations of the United Kingdom and the Republic of Korea
CCAMLR-XIX/9	Proposal for an extension of the CCAMLR pot fishing trial for 2000/2001 Delegation of the United Kingdom
CCAMLR-XIX/10	Notification of an exploratory fishery for *Dissostichus* spp. on Elan and BANZARE Banks (Divisions 58.4.3 and 58.4.1) and a proposed research plan Delegation of Australia
CCAMLR-XIX/11	Notification of Australia's intention to continue an exploratory fishery in Division 58.4.2 Delegation of Australia
CCAMLR-XIX/12	Notification of Argentina's intention to initiate exploratory longline fisheries for *Dissostichus* spp. in CCAMLR areas Delegation of Argentina

CCAMLR-XIX/13	Notification by France of new and exploratory fisheries in CCAMLR Statistical Area 58 during the 2000/2001 season Delegation of France
CCAMLR-XIX/14	Notification of an exploratory pot fishery for crabs in Subarea 48.3 Delegation of Uruguay
CCAMLR-XIX/15	Notification of exploratory fisheries in Subareas 88.1, 88.2, 88.3 and Division 58.4.4 Delegation of Uruguay
CCAMLR-XIX/16	Notification of an exploratory pot fishery for *Dissostichus eleginoides* in Subarea 48.3 Delegation of Uruguay
CCAMLR-XIX/17	Notification by New Zealand of its intention to continue an exploratory fishery for *Dissostichus* spp. in CCAMLR Subarea 88.1 Delegation of New Zealand
CCAMLR-XIX/19	Deadlines set by CCAMLR for the submission of information by Member countries Delegation of Chile
CCAMLR-XIX/BG/5	Implementation of conservation measures in 1999/2000 Secretariat
CCAMLR-XIX/BG/10	Report on a meeting to discuss an agreement on the conservation of southern hemisphere albatrosses and petrels Delegation of Australia
CCAMLR-XIX/BG/15	Report of the CCAMLR Observer at the Meeting on the Development of a Regional Agreement for Southern Hemisphere Albatross and Petrels under the Convention on the Conservation of Migratory Species of Wild Animals (CMS) Secretariat
CCAMLR-XIX/BG/18	US plans for fishing for crab in Subarea 48.3 in accordance with Conservation Measures 150/XVIII and 181/XVIII Delegation of the USA
CCAMLR-XIX/BG/19	Évaluation de la pêche illicite dans les eaux françaises adjacentes aux îles Kerguelen et Crozet pour la saison 1999/2000 (1er juillet 1999–30 juin 2000) – informations générales sur la zone CCAMLR 58 et tendances 2000/2001 Délégation française
SC-CAMLR-XIX/BG/1	Catches in the Convention Area in the 1999/2000 split-year Secretariat
SC-CAMLR-XIX/BG/7	Sixth conference of parties to the Convention on the Conservation of Migratory Species of Wild Animals (Somerset West, South Africa, November 1999) CCAMLR Observer (J. Cooper, South Africa)

SC-CAMLR-XIX/BG/11	The direct impact of fishing and fishery-related activities on marine life in the CCAMLR Convention Area with particular emphasis on longline fishing and its impact on albatrosses and petrels – a review Delegation of Germany
SC-CAMLR-XIX/BG/12	Albatross and petrel mortality from longline fishing: report on an international workshop held in Honolulu, Hawaii, USA, 11 and 12 May 2000 CCAMLR Observer (J. Cooper, South Africa)
SC-CAMLR-XIX/BG/13	Report to SC-CAMLR on the expert consultation on illegal, unreported and unregulated fishing Sydney, Australia, 15–19 May 2000 Presented by the Chairman of the Scientific Committee
WG-EMM-00/8	Changes in the diet of the South Georgia shag *Phalacrocorax georgianus* at the South Orkney Islands along four consecutive years R. Casaux and A. Ramón (Argentina)
WG-EMM-00/9	Fish in the diet of breeding Antarctic shags *Phalacrocorax bransfieldensis* at four colonies in the Danco Coast, Antarctic Peninsula R. Casaux, A. Baroni and E. Barrera-Oro (Argentina)
WG-EMM-00/16	A statistical assessment of the status and trends of Antarctic and sub-Antarctic seabirds Prepared for the SCAR Bird Biology Subcommittee and SC-CAMLR Working draft as of June 2000 E.J. Woehler (Australia), J. Cooper (South Africa), J.P. Croxall (United Kingdom), W.R. Fraser (USA), G.L. Kooyman (USA), G.D. Miller (South Africa), D.C. Nel (South Africa), D.L Patterson (USA), H.-U. Peter (Germany), C.A. Ribic (USA), K. Salwicka (USA), W.Z. Trivelpiece (USA) and H. Weimerskirch (France)

APPENDIX D

INTERSESSIONAL WORK PLAN FOR AD HOC WG-IMALF

INTERSESSIONAL WORK PLAN FOR AD HOC WG-IMALF FOR 2000/01

The Secretariat will coordinate the intersessional work of the IMALF group. An interim review of work will be conducted in June 2001 and advised to ad hoc WG-IMALF at the time of WG-EMM (July 2001). The outcome of the intersessional work will be reviewed in August/September 2001 and reported to WG-FSA in October 2001.

	Task/Topic	Paragraphs of WG-FSA Report	Action[1]	Start/ Completion Deadlines	Action
1.	**Planning and coordination of work:**				
1.1	Circulation of materials on IMALF matters as contained in reports of current meetings of CCAMLR.	Standing request		Dec 2000	Circulate all relevant sections of CCAMLR-XIX to IMALF group members, and technical coordinators and (via them) to scientific observers.
1.2	Circulation of papers submitted to WG-FSA on IMALF matters.	Standing request		Dec 2000	Circulate the list of papers submitted to WG-FSA on IMALF matters and advise that copies of papers may be provided on request. Circulate the papers requested.
1.3	Acknowledgement of work of technical coordinators and scientific observers.	Standing request		Dec 2000	Commend technical coordinators and all observers for their effort in the 1999/2000 fishing season.
1.4	Review observer reports (seabird interactions).	Standing request	J. Molloy (NZ)	As available	Provide on receipt copies of required section of reports for review to a member nominated by IMALF.
1.5	Review of new and exploratory fishery proposals.	New request	B. Baker	At submission deadline	Transmit hard copies of applications to Baker to prepare initial draft of IMALF table.
1.6	Membership of WG-IMALF.	7.4	Members	Nov 2000/ as required	Request to nominate new members to IMALF as required. Request all Members to send their representatives to the WG-FSA meeting.
1.7	Education and training of fishing companies and fishermen on issues of incidental mortality of seabirds.	Standing request	Technical coordinators	Dec 2000/ Aug 2001	Urge Members to improve education and training of fishers on issues of incidental mortality of seabirds via technical coordinator; report to IMALF-2001.

[1] In addition to Science officer.

(continued)

	Task/Topic	Paragraphs of WG-FSA Report	Action[1]	Start/ Completion Deadlines	Action
1.8	Protection for observers on board against adverse weather conditions.	Standing request	Technical coordinators	Dec 2000	Request technical coordinators to ask vessel owners and captains to provide as much protection as possible for observers against adverse weather conditions.
1.9	Awareness of CCAMLR conservation measures in force.	Standing request	Technical coordinators	Dec 2000/ Aug 2001	Request feedback information from technical coordinators.
1.10	The use by scientific observers of the book *Identification of Seabirds of the Southern Ocean.*	New request	Technical coordinators	Nov 2000/ Sep 2001	Request reports, collate responses for IMALF-2001.
1.11	Submission of scientific observers data from the 2000/2001 fisheries.	Standing request	Technical coordinators	Dec 2000/ as required	Liaise with technical coordinators, as necessary, on data submission for the 2000/2001 season.
2.	**Members' research and development activities:**				
2.1	Update information on national research programs into status and foraging ecology of albatrosses, giant petrels and white-chinned petrels including, in particular, research on foraging ranges.	7.10, 7.11	Members, IMALF members, R. Gales (Australia)	Jul–Sep 2001	Develop a standard format for the submission of information and request, as appropriate, for consideration at IMALF-2001. Dr Gales/Science officer to coordinate and report to IMALF-2001. Request to SCAR members via its Secretariat.
2.2	Acquire reports on research on genetic profiles of albatrosses, giant petrels and white-chinned petrels.	7.14, 7.15	Members, IMALF members	Sep 2001	Request IMALF members in Australia, New Zealand, South Africa, France, UK to assist in provision of information. Need to get response from USA. Request to SCAR members via its Secretariat.
2.3	Risk assessment of seabird by-catch in the Convention Area.	Standing request	IMALF members	Nov 2000/ Sep 2001	Further work as appropriate to update the BG for the Scientific Committee. Circulate any new tabled papers relating to seabird-at-sea distributions to Mr Baker, Dr Croxall and Dr Gales – and to other WG-IMALF members as requested.

(continued)

	Task/Topic	Paragraphs of WG-FSA Report	Action[1]	Start/ Completion Deadlines	Action
2.4	Information on the development and use of fisheries-related methods of the avoidance of incidental mortality of seabirds. In particular, information is sought on the following: • seabird capture rates in relation to artificial bait, snood line and mainline colour, bait depth and sink rates; • optimum configuration of line-weighting regimes and equipment; • automated methods for adding and removing weights to and from the line; • line-setting devices for autoline vessels; and • underwater longline setting devices.	Standing request	Members, IMALF members, Technical coordinators	Nov 2000/ Sep 2001	Request information, collate responses for IMALF-2001.
2.5	Feasibility of using video recording of line-hauling operations for observations on seabird incidental catch.	Standing request (see 7.132, 7.133)	Technical coordinators	Nov 2000/ Sep 2001	Request reports, collate responses for IMALF-2001. Circulate New Zealand document.
2.6	Tests of/experiences with paired streamer lines and boom-and-bridle arrangements.	7.124, 7.139	USA; New Zealand; Members	Sep 2001	Report to IMALF 2001.
2.7	Investigate light-level definition devices.	7.141	Members	Sep 2001	Report to IMALF/FSA 2001.
2.8	Line-weighting experiments on autoliners.	7.95–7.98, 7.148	New Zealand; other Members as appropriate	Sep 2001	Report to IMALF 2001.
2.9	Experiences with revised requirements for line weighting for Spanish system vessels.	7.147	Members	Sep 2001	Report to IMALF 2001.
2.10	Information/paper relevant to assessment of appropriate seabird by-catch levels for longline fisheries.	7.21–7.23	Members, especially attendees at IFF	Sep 2001	Report to IMALF 2001.

(continued)

	Task/Topic	Paragraphs of WG-FSA Report	Action[1]	Start/ Completion Deadlines	Action
2.11	Collation of demographic data on relevant albatross and petrel species; transmission of summary data to WG-EMM-2001.	SC-CAMLR-XIX, 4.14	Members	Complete by 30 June 2001	Report to WG-EMM 2001
2.12	Relationship of IUU seabird by-catch rates to sizes and trends of relevant populations; additional monitoring requirements.	SC-CAMLR-XIX, 4.29	Members	Sep 2001	Report to IMALF 2001
3.	**Information from outside the Convention Area:**				
3.1	Information on longline fishing effort in the Southern Ocean to the north of the Convention waters.	Standing request	Members, non-Contracting Parties, international organisations	Sep 2001	Request information intersessionally from those Members known to be licensing fishing in areas adjacent to CCAMLR (e.g. Argentina, Brazil, Chile, UK [in respect of Falkland/Malvinas Islands and Tristan da Cunha], South Africa, Uruguay, New Zealand, Australia); review situation at IMALF-2001. Request information from other parties (Members and Non-contracting Parties; international organisations) known to be fishing, or collecting data on fishing in areas adjacent to the Convention Area.
3.2	Information on incidental mortality outside the Convention Area of seabirds breeding within the area.	Standing request	IMALF members	Sep 2001	Repeat request to all IMALF members, especially to those mentioned under item 3.1 above; review at IMALF 2001.
3.3	Implementation of provisions of Conservation Measure 29/XVI in fisheries adjacent to the CCAMLR Convention Area.	Standing request	Members, non-Contracting Parties, int. organisations	Sep 2001/ as required	Request information on use/implementation of provisions of Conservation Measure 29/XVI, as under item 3.1 above; review responses at IMALF-2001.
3.4	Reports on effectiveness of use of mitigating measures outside Convention Area.	Standing request	IMALF members	Sep 2001	
3.5	Request information on the current requirements for the use of measures to mitigate by-catch of seabirds on Japanese longline fishing vessels.	7.106 and SC-CAMLR-XIX, 4.35		Sep 2001	Request information from Japan.

(continued)

	Task/Topic	Paragraphs of WG-FSA Report	Action[1]	Start/ Completion Deadlines	Action
4.	**Cooperation with international organisations:**				
4.1	Participation at the 2001 meeting of CCSBT ERSWG; invite CCSBT to attend WG-FSA.	Standing request	CCSBT Secretariat	As required	Invite and nominate observers as decided by the Scientific Committee.
4.2	Cooperation with ICCAT and IOTC on specific issues regarding incidental mortality of seabirds.	Standing request	CCAMLR observers	Sep 2001	Remind CCAMLR observers of desired feedback on IMALF matters.
4.3	Develop National Plan of Action in respect of FAO IPOA–Seabirds.	7.169	Members	Sep 2001/ as required	Provide report on progress to IMALF for information and consideration.
4.4	Albatross and petrel agreement under CMS.	7.177	South Africa	Mar–Apr 2001	Feedback to IMALF on outcome of forthcoming meeting.
4.5	International Fishers' Forum.	7.179–7.181	New Zealand	Jan 2001	Feedback to IMALF on outcome of meeting.
4.6	IUCN Red List: Seabirds.	7.16		Jan 2001	Obtain BirdLife International (2000), circulate to IMALF members and table for Scientific Committee 2001 results of assessments of threatened and near-threatened albatross, *Macronectes* and *Procellaria* species.
5.	**Data acquisition and analysis:**				
5.1	Preliminary analyses of data from the current fishing season.	Standing request	Technical coordinators	Sep–Oct 2001	Standing request: summarise and analyse current year data at a level adequate to undertake a preliminary assessment at IMALF-2001.
5.2	Acquisition of EEZ data.	Standing request (see 7.45, 7.46) (see also SC-CAMLR-XIX, 4.21, 4.22)	France	Nov 2000/ Sep 2001	Request France to submit reports and data logbooks prepared by national observers for the current and past fishing seasons.
5.3	Analysis of seabird incidental mortality data for EEZ in Subareas 58.6/58.7.	Standing request	South Africa	Nov 2000/ Sep 2001	Request South Africa to undertake analysis and report to IMALF-2001.

(continued)

	Task/Topic	Paragraphs of WG-FSA Report	Action[1]	Start/ Completion Deadlines	Action
6.	**Scientific Observers Manual:**				
6.1	Preliminary analysis of data from 2000/2001 fisheries.	Standing request	SODA	IMALF meeting	Produce draft tables equivalent to Tables 48 to 55 and 60 of WG-FSA 2000 report.
6.2	Review codes for seabird species.	?	IMALF Members	Apr 2001	Secretariat to provide revised list, using updated FAO codes and indicate any anomalies and/or species requiring codes.
6.3	Analysis of hook observation data to provide advice on minimum requirements for scientific observers.	7.30		Sep 2001	Report to IMALF 2001.

1 In addition to Science officer.

INSTRUCTIONS AND EXAMPLE FORM
FOR REPORTING SIGHTINGS OF VESSELS

INSTRUCTIONS AND EXAMPLE FORM FOR REPORTING SIGHTINGS OF VESSELS

1. Vessel name, call sign and flag are to be obtained from what is seen on the vessel or from radio contact with the vessel (the source of this information must be reported).

2. Distinguishing markings: state whether the name and port of registration of the vessel was visible or not. Record hull and superstructure colours, number of masts, position of bridge and funnel length etc.

3. Type of vessel: describe the type of vessel and gear sighted (e.g. longliner, trawler, factory ship, carrier ship).

4. Position: record the coordinates of the initial sighting of the vessel, including the CCAMLR area/subarea/division.

5. Activity of sighted vessel: record the time of the sighting, activity of the vessel at that time and heading (degrees). Record whether the vessel was fishing, setting fishing gear, trawling, hauling or other activities. Space is available for up to five sightings of the same vessel, if more space is needed complete this section on the back of the form or on a separate sheet of paper. Record presence/absence of a streamer line.

6. Record of sighting: indicate if the sighting of the vessel was recorded on video or with photographs (record where documents have been deposited under comments).

7. Comments: indicate the direction in which the vessel was steaming. Summarise any radio conversation that took place. Record level of seabird and marine mammal activity.

8. Diagram of vessel: draw the profile of the vessel, indicating any distinguishing markings that could be used for identification.

EXAMPLE FORM

SIGHTINGS OF FISHING VESSELS REPORTED BY SCIENTIFIC OBSERVERS

Vessel name: ________________ Call sign: __________________________ Flag: ___________________

Distinguishing markings: ____

____

Type of vessel (e.g. longliner, trawler): ________________________________

Initial position: Latitude _________________________ Longitude (East/West) _______________________

CCAMLR area, subarea, division: __________________________

Contact/sighting (tick appropriate box): [Visual] [Radar] [Radio Traffic]

Radio contact made with the vessel: [Yes] [No]

Time and activity (e.g. fishing, steaming) of sighted vessel:

Date:	___	Time:	___: ___	Activity:	______	Tori Line:	____	Direction:	____	Position:	______
Date:	___	Time:	___: ___	Activity:	______	Tori Line:	____	Direction:	____	Position:	______
Date:	___	Time:	___: ___	Activity:	______	Tori Line:	____	Direction:	____	Position:	______
Date:	___	Time:	___: ___	Activity:	______	Tori Line:	____	Direction:	____	Position:	______
Date:	___	Time:	___: ___	Activity:	______	Tori Line:	____	Direction:	____	Position:	______

Record of sightings (e.g. by photograph or video): ____

Comments: ____

____

____

____

Sketch of vessel, indicating distinguishing structures, profile, masts and markings.

Continue on a separate sheet if necessary.

LIST OF TASKS IDENTIFIED BY THE SCIENTIFIC COMMITTEE

SPECIFIC TASKS IDENTIFIED BY THE SCIENTIFIC COMMITTEE FOR THE 2000/01 INTERSESSIONAL PERIOD

	Task	Reference to Paragraphs in SC-CAMLR-XIX	Key Person(s) Involved	Deadline
	Fisheries Information			
1.	Collect and provide information from the krill fishery on past and current market prices for krill products, breakdown of catches by product type, conversion factors for krill products and on krill fishing strategies.	3.6 (see also list of tasks agreed by WG-EMM)	Members	Request – February Remind – June
2.	Re-issue a draft questionnaire on krill fishing strategies.	3.6	Secretariat	January
3.	Complete the questionnaire on krill fishing strategies.	3.6	Members	January
4.	Arrange intersessional work of a subgroup on conversion factors for krill products.	2.9	I. Everson (Subgroup Convener), D. Miller, S. Nicol	May-June
5.	Revise the presentation to the Commission and Scientific Committee of catch data.	(see CCAMR-XIX, 4.10–4.11)	Secretariat	One month before each meeting
6.	Process all fisheries information received and submit for consideration at meetings of the Scientific Committee and its working groups.		Secretariat	One month before each meeting
7.	Estimate the level of IUU fishing in the Convention Area based on, in particular, data derived from the Catch Documentation Scheme for *Dissostichus* spp.	2.19	Members, Secretariat	August-September
	Scheme of International Scientific Observation			
8.	Consult with Technical Coordinators on research priorities and difficulties experienced in the completion of observers duties, including the longline random-sampling design.	See list of tasks agreed by WG-FSA	Technical Coordinators, Secretariat	August-September
9.	Arrange intersessional work of subgroups of WG-FSA on matters relating to the scheme.	See list of tasks agreed by WG-FSA	Conveners of subgroups	
10.	Implement decisions of Scientific Committee, WG-EMM and WG-FSA relating to the implementation of the scheme including, in particular, reporting sightings of fishing vessels.	2.24 (see also list of tasks agreed by WG-EMM and WG-FSA)	Technical Coordinators, Secretariat	Ongoing task
11.	Improve the collection of scientific information in krill fisheries by deploying national and, or, international scientific observers, following the protocols outlined in the *Scientific Observers Manual*, in krill fisheries, consistent with other CCAMLR fisheries.	3.14	Members	July

	Task	Reference to Paragraphs in SC-CAMLR-XIX	Information to be Submitted/Coordination to be Provided	Deadline
12.	Produce brief practical guide to help observers identify principal by-catch species.	5.106	Members, WG-FSA, Secretariat	Ongoing task
	Dependent Species			
13.	Implement decisions of WG-EMM and WG-FSA (including ad hoc WG-IMALF) relating to dependent species including, in particular, collation for WG-EMM of available demographic data on albatross and petrels.	4.14 (see also list of tasks agreed by WG-EMM and WG-FSA (including ad hoc WG-IMALF)	Secretariat	One month before the meetings
	Impact of Marine Debris on Marine Animals			
14.	Prepare standard reporting form for all categories of marine debris-related information.	4.58	Secretariat	February–March
15.	Prepare annual summaries of information received in a manner suitable for viewing trends across time for data for each site or source.	4.59	Secretariat	August–September Ongoing task
16.	Prepare report to CEP-IV (ATCM) on marine debris-related activities in the Convention Area.	4.73–4.75	Secretariat	April
	Harvested Species and Management under Uncertainty			
17.	Prepare a draft Fishery Plan for each fishery in the Convention Area.	7.7	Secretariat	Ongoing task
18.	Examine potential application of marine protected areas for CCAMLR purposes.	11.24	Members	Ongoing task
19.	Implement decisions of WG-EMM and WG-FSA relating to harvested species.	See list of tasks agreed by WG-EMM and WG-FSA	Secretariat	One month before each meeting
	New and Exploratory Fisheries			
20.	Apply the advance notification scheme set out in Conservation Measure 65/XII to all notifications of new and exploratory fisheries.		Members	May
21.	Submit fisheries-based research plans as approved by the Scientific Committee.		Members	July
22.	Implement decisions of WG-FSA in respect to the submission and consideration of notifications.	See list of tasks agreed by WG-FSA	Members	May
23.	Submit data from the fishery-based research activities at least one month prior to WG-FSA.		Members	August
24.	Participate, as required, in the analysis of data from the fishery-based research activities submitted at least one month prior to WG-FSA.		Conveners of WG-FSA and its subgroups, Secretariat	August–September

	Task	Reference to Paragraphs in SC-CAMLR-XIX	Information to be Submitted/Coordination to be Provided	Deadline
25.	Develop generalised fishery notification procedure.	7.16	WG-FSA	Ongoing task
	Development of the CCAMLR Website			
26.	Increase the speed of the Secretariat's connection to the internet at the time of meetings.	12.11	Secretariat	As required
27.	Implement decisions of WG-EMM and WG-FSA on the development and maintenance of the site.	See list of tasks agreed by WG-EMM and WG-FSA	Secretariat	Ongoing task
	Publications			
28.	Publish Volume 8 of *CCAMLR Science*.		Secretariat	November
29.	Publish and disseminate the synopsis to the book *Understanding CCAMLR's Approach to Management.*	12.3	Secretariat	March
30.	Publish 2000/2001 editions of standard CCAMLR publications.			As required
31.	Meet and select papers for publication in the 2002 edition of *CCAMLR Science* (Volume 9).		Editorial Board	
	Cooperation with Other International Organisations			
32.	Support and prepare, as required, background information to observers nominated by the Scientific Committee for meetings of other international organisations.	11.34	Secretariat	One month before each meeting
33.	Implement decisions of WG-EMM and WG-FSA (including ad hoc WG-IMALF) on cooperation with other international organisations.	See lists of tasks agreed by WG-EMM and WG-FSA	Conveners of WGs and their subgroups	Intersessionally
34.	Consider species of seabirds of special interest to WG-EMM to be included in five years time in the report of SCAR on seabird populations and trends.	4.89	WG-EMM	WG-EMM
35.	Submit to SCAR information required for the preparation of the paper on *The State of the Antarctic Environment Report (SAER)*.	11.4–11.8	Secretariat	January
36.	Obtain a report on the meeting of GLOBEC-IOC on the use of environmental indices in the management of pelagic fish populations.	11.32	I. Everson	June
37.	Obtain from BirdLife International copies of publications with details of assessments of birds, seals, and cetaceans according to IUCN criteria.	4.93	Secretariat	May–June
38.	Obtain information from IWC on the proposed IWC workshop, in late 2001, relating to the CCAMLR-2000 Survey.	5.19	WG-EMM Convener	May–June

	Task	Reference to Paragraphs in SC-CAMLR-XIX	Information to be Submitted/Coordination to be Provided	Deadline
39.	Invite IWC to participate in the CCAMLR-2000 workshop in 2001 and request information in respect of its plans for any future joint IWC/CCAMLR workshop.	11.28	WG-EMM Convener	January
	WG-EMM			
40.	Provid input to the work of the WG-FSA subgroup on methods.	5.18	WG-EMM participants	October
41.	Arrange and support the intersessional work of WG-EMM subgroups on CEMP-related tasks.	See list of tasks agreed by WG-EMM	Conveners of WG-EMM and its subgroups	January–July
42.	Implement tasks assigned to the Secretariat by WG-EMM as listed in its plan of intersessional activities.	See list of tasks agreed by WG-EMM	Secretariat	One month before the meeting
43.	Provide necessary materials, analysis of data and support to the meeting of WG-EMM.	See list of tasks agreed by WG-EMM	Secretariat	One month before the meeting
44.	Consider research priorities identified by WG-EMM.	See list of tasks agreed by WG-EMM	Convener of WG-EMM, Members	February
	WG-FSA			
45.	Invite participants in WG-EMM to provide input to the work of the WG-FSA subgroup on methods.	5.18	A. Constable (Subgroup Convener)	July
46.	Provide necessary materials, analysis of data and support to the meeting of WG-FSA, including the meeting of ad hoc WG-IMALF.	See list of tasks agreed by WG-FSA	Secretariat	One month before the meeting
47.	Implement tasks assigned to the Secretariat by WG-FSA as listed in its plan of intersessional activities.	See list of tasks agreed by WG-FSA	Secretariat	One month before the meeting
48.	Consider research priorities identified by WG-FSA.	See list of tasks agreed by WG-FSA	Convener of WG-FSA, Members	February
	Ad hoc WG-IMALF			
49.	Implement tasks assigned to the Secretariat by the ad hoc WG-IMALF as listed in its plan of intersessional activities.	See list of tasks agreed by WG-FSA (also IMALF tasks in Annex 5, Appendix D of this report)	Secretariat	One month before the meeting

ANNEX 8

GLOSSARY OF ACRONYMS AND ABBREVIATIONS USED IN CCAMLR REPORTS

GLOSSARY OF ACRONYMS AND ABBREVIATIONS USED IN CCAMLR REPORTS

ACC	Antarctic Circumpolar Current
ACW	Antarctic Circumpolar Wave
ADCP	Acoustic Doppler Current Profiler (mounted on the hull)
AFMA	Australian Fisheries Management Authority
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
ASOC	Antarctic and Southern Ocean Coalition
ASPA	Antarctic Specially Protected Area
ASPM	Age Structured Production Model
ATCM	Antarctic Treaty Consultative Meeting
ATCP	Antarctic Treaty Consultative Party
ATSCM	Antarctic Treaty Special Consultative Meeting
AVHRR	Advanced Very High Resolution Radiometry
BAS	British Antarctic Survey
BIOMASS	Biological Investigations of Marine Antarctic Systems and Stocks (SCAR/SCOR)
BROKE	Baseline Research on Oceanography, Krill and the Environment
CBD	Convention on Biodiversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCAMLR-2000 Survey	CCAMLR 2000 Krill Synoptic Survey of Area 48
CCAS	Convention on the Conservation of Antarctic Seals
CCSBT	Commission for the Conservation of Southern Bluefin Tuna

CCSBT-ERSWG	CCSBT Ecologically Related Species Working Group
CDS	Catch Documentation Scheme for *Dissostichus* spp.
CDW	Circumpolar Deep Water
CEMP	CCAMLR Ecosystem Monitoring Program
CEP	Committee for Environmental Protection
CF	Conversion factor
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)
CSI	Combined standardised index
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)
DCD	*Dissostichus* catch document
DPOI	Drake Passage Oscillation Index
DWBA	Distorted wave Born approximation model
EASIZ	Ecology of the Antarctic Sea-Ice Zone
ECOPATH	Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see www.ecopath.org)
ECOSIM	Software for construction and analysis of mass-balance models and feeding interactions or nutrient flow in ecosystems (see www.ecopath.org)

EEZ	Exclusive Economic Zone
EIV	Ecologically important value
ENSO	El Niño Southern Oscillation
EPOS	European *Polarstern* Study
EPROM	Erasable Programmable Read-Only Memory
FAO	Food and Agriculture 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
GTS	Greene et al., (1990) linear TS versus length relationship
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
IFF	International Fishers' Forum (New Zealand)
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
IPOA–Seabirds	FAO International Plan of Action on the Reduction of Incidental Catch of Seabirds in Longline Fisheries
IRCS	International radio call sign
ISCU	International Council of Scientific Unions
ISO	International Organization for Standardization
ISR	Integrated Study Region
IUCN	International Union for the Conservation of Nature and Natural Resources – the World Conservation Union
IUU	Illegal, Unregulated and Unreported
IWC	International Whaling Commission

IWC-IDCR	IWC International Decade of Cetacean Research
JGOFS	Joint Global Ocean Flux Studies (SCOR/IGBP)
KYM	Krill Yield Model
LADCP	Lowered Acoustic Doppler Current Profiler (lowered through the water column)
LMR	Living Marine Resources Module (GOOS)
LTER	Long-term Ecological Research (USA)
MARPOL Convention	the International Convention for the Prevention of Pollution from Ships
MBAL	Minimum biologically acceptable limits
MFTS	Multiple-frequency method for *in situ* TS measurements
MRAG	Marine Resources Assessment Group (UK)
MSY	Maximum sustainable yield
MV	Merchant vessel
MVBS	Mean volume backscattering strength
MVUE	Minimum variance unbiased estimate
NAFO	Northwest Atlantic Fisheries Organisation
NASA	National Aeronautical and Space Administration (USA)
NCAR	National Center for Atmospheric Research (USA)
NEAFC	Northeast Atlantic Fisheries Commission
nMDS	non-metric Multidimensional Scaling
NMFS	National Marine Fisheries Service (USA)
NMML	National Marine Mammal Laboratory (USA)
NOAA	National Oceanic and Atmospheric Administration (USA)
NPOA	National Plan of Action
NRT	Net registered tonnage
NSF	National Science Foundation (USA)
NSIDC	National Snow and Ice Data Center (USA)
OECD	Organisation for Economic Cooperation and Development

PBR	Permitted biological removal
PCA	Principal component analysis
PCR	Per capita recruitment
PTT	Platform transmitter terminals
RMT	Research midwater trawl
ROV	Remotely-operated vehicle
RPO	Realised potential overlap
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	SCAR Bird Biology Subcommittee
SCAR-EASIZ	Ecology of the Antarctic Sea-Ice Zone (SCAR Program)
SCAR-COMNAP	SCAR Council of Managers of National Antarctic Programs
SCAR-GOSEAC	SCAR Group of Specialists on Environmental Affairs and Conservation
SCAR-GSS	SCAR Group of Specialists on Seals
SCAR/SCOR-GOSSOE	SCAR/SCOR Group of Specialists on Southern Ocean Ecology
SCAR WG-Biology	SCAR Working Group on Biology
SC-CAMLR	Scientific Committee for CCAMLR
SC CIRC	Scientific Committee circular (CCAMLR)
SC-CMS	Scientific Committee for CMS
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
SIC	Scientist-in-Charge
SIR Algorithm	Sampling/Importance Resampling Algorithm
SO-GLOBEC	Southern Ocean GLOBEC
SOI	Southern Oscillation Index
SO-JGOFS	Southern Ocean JGOFS
SOWER	Southern Ocean Whale Ecology Research Cruises
SPA	Specially Protected Area
SPC	South Pacific Commission
SSSI	Site of Special Scientific Interest
SST	Sea-surface temperature
TDR	Time depth recorder
TEWG	Transitional Environmental Working Group
TIRIS	Texas Instruments Radio Identification System
TS	Target strength
TVG	Time varied gain
UBC	University of British Columbia (Canada)
UCDW	Upper Circumpolar Deep Water
UN	United Nations
UNCED	UN Conference on Enviroment and Development
UNEP	UN Environmental Program
UNCLOS	UN Convention on the Law of the Sea
UNIA	the 1995 UN Agreement for the Implementation of Provisions of the United Nations Convention on the Law of the Sea relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks
US AMLR	United States Antarctic Marine Living Resources Program
US LTER	United States Long-term Ecological Research
UV	Ultra-violet

VMS	Vessel monitoring system
VPA	Virtual population analysis
WAMI	CCAMLR Workshop on Assessment Methods for Icefish
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 Evaluating 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
Y2K	Year 2000