

SC-CAMLR-XVII

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

**REPORT OF THE SEVENTEENTH MEETING
OF THE SCIENTIFIC COMMITTEE**

HOBART, AUSTRALIA
26 – 30 OCTOBER, 1998

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Abstract

This document presents the adopted report of the Seventeenth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 26 to 30 October 1998. Reports of meetings and intersessional activities of subsidiary bodies of the Scientific Committee, including the Working Groups on Ecosystem Monitoring and Management and on Fish Stock Assessment, are appended.

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**REPORT OF THE SEVENTEENTH MEETING
OF THE SCIENTIFIC COMMITTEE**
(Hobart, Australia, 26 to 30 October 1998)

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 26 to 30 October 1998 at the Wrest Point Hotel, Hobart, Australia.

1.2 Representatives from the following Members attended the meeting: Argentina, Australia, Belgium, Brazil, Chile, European Community, France, Germany, India, Italy, Japan, Republic of Korea, New Zealand, Norway, Poland, Russian Federation, South Africa, Spain, Sweden, Ukraine, United Kingdom of Great Britain and Northern Ireland, United States of America and Uruguay.

1.3 The Chairman welcomed to the meeting observers from Namibia, the Antarctic and Southern Ocean Coalition (ASOC), the Food and Agricultural Organization of the United Nations (FAO), the Scientific Committee on Antarctic Research (SCAR) and the International Whaling Commission (IWC), and encouraged them to participate in the meeting as appropriate.

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

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

- Mr T. Ichii (Japan), Fishery Status and Trends;
- Dr P. Penhale (USA), Species Monitored in the CCAMLR Ecosystem Monitoring Program;
- Prof. J. Croxall (UK), Assessment of Incidental Mortality;
- Dr K. Kerry (Australia), Marine Mammal and Bird Populations;
- Dr S. Nicol (Australia), Krill Resources;
- Mr R. Williams (Australia), Fish Resources;
- Dr R. Holt (USA), Crab Resources;
- Dr I. Everson (UK), Squid Resources;
- Dr A. Constable (Australia), Timing of the Fishing Season and Ecosystem Monitoring and Management;
- Dr G. Kirkwood (UK), Management under Conditions of Uncertainty about Stock Size and Sustainable Yield;
- Mr M. Purves (South Africa) and Prof. G. Duhamel (France), New and Exploratory Fisheries;
- Prof. B. Fernholm (Sweden), Cooperation with Other Organisations; and
- Dr D. Ramm and Ms N. Slicer (Secretariat), all other matters.

Adoption of the Agenda

1.6 The Provisional Agenda had been circulated prior to the meeting. The Agenda was adopted with one amendment, the addition of 'Timing of the Fishing Season' as Subitem 5(v) (Annex 3).

Report of the Chairman

Intersessional Meetings of Working Groups

1.7 Three CCAMLR meetings were held during the intersessional period:

- (i) the Workshop on Area 48;
- (ii) the meeting of WG-EMM; and
- (iii) the meeting of WG-FSA.

1.8 On behalf of the Scientific Committee, the Chairman thanked the conveners for their significant contributions to these meetings and the Governments of USA and India for hosting the Workshop on Area 48 and WG-EMM respectively. The Chairman personally thanked Mr V. Ravindranathan (India) for his efforts and those of the local organising committee in supporting the 1998 meeting of WG-EMM.

1.9 The Chairman also commended Dr Holt for undertaking the difficult task of Convener of WG-FSA at short notice, following the resignation of Dr W. de la Mare (Australia). The Scientific Committee acknowledged the substantial contribution that Dr de la Mare had made to the assessment and management of Antarctic marine resources during his long association with CCAMLR.

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

Intersessional Activities of CCAMLR Members

1.11 The following fisheries took place under the conservation measures in force during the 1997/98 fishing season (Annex 5, Table 2):

- (i) *Euphausia superba* in Area 48;
- (ii) *Champsocephalus gunnari* in Subarea 48.3 and Division 58.5.2;
- (iii) *Dissostichus eleginoides* in Subareas 48.3, 58.6, 58.7 and Division 58.5.2; and
- (iv) *Dissostichus* spp. in Subarea 88.1.

1.12 The Scientific Committee thanked all scientific observers involved in monitoring fisheries in 1997/98 for the great deal of very good work which they had done under difficult conditions. The data and reports had contributed substantially to the analyses of CCAMLR. The Scientific Committee particularly acknowledged the efforts made by Mr M. Lewis (UK), scientific observer aboard the ill-fated longliner *Sudur Havid*, which sank while fishing in Subarea 48.3 on 6 June 1998, with the loss of 17 lives. The Scientific Committee also acknowledged the efforts of the captain and crew of the Chilean longliner *Isla Camila* and Mr P. Marshall (UK), scientific observer on board, and the captain and crew of the South African longliner *Koryo Maru 11*, who rescued the *Sudur Havid* survivors.

1.13 The Scientific Committee acknowledged with sadness the absence of Dr K.-H. Kock (Germany), a former Chairman of the Committee, due to ill health. Dr Kock was wished a full and speedy recovery.

1.14 The Chairman regrettably informed the Scientific Committee of the deaths of two prominent scientists involved in the work of CCAMLR. Dr P. Prince (UK) and Dr P. Fedoulov (Russia) had been respected members of CCAMLR working groups, and both had contributed substantially to the work of the Scientific Committee.

1.15 The Chairman also informed the Scientific Committee that Dr Croxall was recently appointed as Professor at the Universities of Durham and Birmingham.

Scientific Committee Representation at Meetings of Other International Organisations

1.16 The Scientific Committee was represented by observers at the following international meetings during the intersessional period:

- (i) SCOR Working Group 105;
- (ii) CWP;
- (iii) Globec Open Science Committee and SO-GLOBEC Steering Committee;
- (iv) FAO Consultation on By-catch in Fisheries;
- (v) SC-IWC;
- (vi) Third meeting of CCSBT-ERSWG;
- (vii) Second International Symposium on Fish Otolith Research and Application;
- (viii) XXV SCAR and associated meetings;
- (ix) GOSEAC;
- (x) SCAR VII Biology Symposium; and
- (xi) 1998 ICES Annual Science Conference.

FISHERY STATUS AND TRENDS

Krill

2.1 Reported catches of krill (*E. superba*) are shown in Tables 1 and 2.

2.2 Following a request by the Scientific Committee at its 1997 meeting (SC-CAMLR-XVI, paragraph 2.6), information obtained from FAO indicated that Poland had reported catches of 801 tonnes in 1988/89, 2 506 tonnes in 1992/93 and 74 tonnes in 1997/98 from Division 41.3.2 just to the north of the Convention Area. Additional catches of 161 tonnes in 1979/80 and 112 tonnes in 1990/91 had been reported by the former Soviet Union in the same statistical division. The Scientific Committee encouraged Members that have fished for krill in waters adjacent to the Convention Area to submit catch and effort data to the Secretariat in the CCAMLR formats.

2.3 The Scientific Committee reiterated the importance of fine-scale data and haul-by-haul data to the assessment of the krill fishery. Members were encouraged to submit all available data to the Secretariat.

2.4 The Scientific Committee noted the following plans for krill fishing during the 1998/99 season: Japan, Poland and the Republic of Korea reported that their krill fishing activities would be similar to those in the 1997/98 season (i.e. about 60 000 tonnes, 20 000 tonnes and 2 000 tonnes respectively). The UK was likely to fish at a level similar to 1997/98 (i.e. 700 tonnes). Ukraine noted its intention to fish for krill using three vessels and that the joint venture with Canada was still under discussion. Uruguay expressed an interest in the krill fishery, although no actual plans have been formulated as yet. One German company had notified its intention to commence krill fishing, but due to domestic legal issues it is unclear at present whether fishing will commence in the forthcoming season. Argentina is considering issuing a permit to fish for krill to one operator. One of the conditions of this permit will require the carrying of a scientific observer. A single US vessel, which has been issued with a permit to fish for krill, has not operated as yet. The Scientific Committee requested the Secretariat to contact Panama and China to determine their intentions to fish for krill in the forthcoming season.

2.5 The Scientific Committee noted that krill harvested by Japanese trawlers in the Convention Area waters is used mostly as feed in the aquaculture industry and bait in recreational fisheries; a small portion of the catches is also processed as food for human

consumption. The demand for krill has dropped recently due to a downturn in the Japanese economy (Annex 4, paragraph 2.7). The quality of krill for use as feed, bait or food for human consumption is judged by three attributes: greenness of the hepatopancreas, body colour and body size. Large white krill with little green in their hepatopancreas are the most valuable, and are targeted by the fishing industry. Over recent years, Japanese trawlers have extended their fishing season to autumn and winter so as to avoid catching early-season green krill and to increase their catch of white krill. This strategy also avoids unduly stockpiling large quantities of krill products in freezer stores onshore. Members were urged to provide such information to WG-EMM and the Scientific Committee.

2.6 The Scientific Committee agreed the need for information on past and current krill market information. This information would provide further insight into the fishery, for instance in an appreciation of the economic factors affecting the fishery and ultimately potential catch levels. Members were urged to provide such information to WG-EMM and the Scientific Committee.

Fish

2.7 Catches reported from the Convention Area during the 1997/98 split-year were presented in SC-CAMLR-XVII/BG/1 Rev. 2 (Tables 3 and 4). The catches include: *D. eleginoides* in Subarea 48.3 (3 258 tonnes by mostly Chile, South Africa and UK). Divisions 58.5.1 (4 741 tonnes by France and Ukraine), 58.5.2 (2 418 tonnes by Australia), Subareas 58.6 (175 tonnes by France and South Africa within their respective EEZs) and 58.7 (576 tonnes by South Africa within its EEZ); *C. gunnari* in Subarea 48.3 (6 tonnes by Chile) and Division 58.5.2 (68 tonnes by Australia); and *Dissostichus mawsoni* in Subarea 88.1 (41 tonnes by New Zealand). There was no fishing for *Electrona carlsbergi*.

2.8 The Scientific Committee drew attention to the substantial amount of unreported catches of *D. eleginoides*, in particular in the Indian Ocean sector (Area 58). The total reported catch of *D. eleginoides* from EEZs outside the CCAMLR Convention Area and from inside the CCAMLR Convention Area was 27 908 tonnes in the 1997/98 split-year (Annex 5, Table 3). Based on sightings of longliners in various subareas and divisions, their known fishing capacities, reports of some of their landings and estimates of their catch and effort, the unreported catch was estimated to be 22 415 tonnes. The total catch of *D. eleginoides* was estimated by WG-FSA to be 50 323 tonnes (Annex 5, paragraph 3.30).

2.9 In most subareas/divisions, unreported catches accounted for between 60 and 90% of the estimated total catch derived from catch and effort data. Estimates for the 1997/98 split-year of landings of unregulated catches in Mauritius and Walvis Bay, Namibia accounted for 25 503 tonnes. This is quite similar to the estimated unreported catch of 22 415 tonnes from the CCAMLR area.

2.10 The amount of unreported catch was also investigated by examining the trade statistics for *D. eleginoides*. Trade statistics for this species were available from the Japanese and US markets principally. From these reports, it was estimated that about 90% of *D. eleginoides* was exported to Japan and the USA (Annex 5, Table 10). It was estimated that at least 60 518 tonnes of *D. eleginoides* were traded in the 1997/98 split-year.

2.11 The Scientific Committee highlighted that catches (27 908 tonnes) reported from national and CCAMLR fisheries constituted less than 50% of the *D. eleginoides* trade (60 518 tonnes) during the 1997/98 split-year and that this has serious implications for yield estimates both over the short and long term (Annex 5, paragraph 3.34).

2.12 The total unreported catch of *Dissostichus* spp. in the Convention Area during 1997/98 (22 415 tonnes) was compared with an estimate of 38 000 to 42 800 tonnes in 1996/97

(SC-CAMLR-XVI, Annex 4, Appendix D, Table D.4). The observed drop in catches between the two years could not be attributed to any particular cause, although it was speculated that declining catch rates across the Indian Ocean may be a contributing factor. The Scientific Committee also recognised that action against illegal/unregulated fishing taken by various countries may also be contributing to the decline in illegal/unregulated catches.

2.13 Given that it is unlikely that unregulated fishing will cease immediately, the Scientific Committee agreed that there is a distinct possibility that *D. eleginoides* stocks will continue to be depleted to extremely low levels and that this would also be accompanied by a severe reduction of several bird species to very low levels (see also discussion under Agenda Item 4(ii)). The former, in particular, may contravene Article II.3(c) of the Convention, thereby necessitating attention to be given as to how long it would take for stocks of *D. eleginoides* to recover, and under what circumstances it could be expected to take place.

2.14 In keeping with its advice in 1997 and since unregulated fishing for *D. eleginoides* in the Indian Ocean is likely to continue at high levels in the foreseeable future, the Scientific Committee drew the Commission's attention to the fact that only effective measures to deter illegal/unregulated fishing would serve to reduce such fishing and that in the absence of these measures, unregulated fishing is expected to continue at a level consistent with economic demand. In addition and as already indicated (paragraph 2.13), ineffective control of future unregulated fishing for *D. eleginoides* is likely to compromise the long-term yield of the targeted stock.

Crabs

2.15 There was no fishery for crabs in the Convention Area in the 1997/98 season and no additional data on crabs have been reported to the Secretariat.

Squid

2.16 The Republic of Korea/UK new fishery for *Martialia hyadesi* in Subarea 48.3, produced a catch of 53 tonnes in the 1997/98 split-year (SC-CAMLR-XVII/BG/1 Rev. 2). Mr H.-C. Shin (Republic of Korea) informed the Scientific Committee that the Republic of Korea had so far no plans to undertake a squid fishery in 1998/99.

2.17 Prof. J. Beddington (UK) informed the Scientific Committee that a non-Member country has an interest in a squid fishery in Subarea 48.3 for 1998/99.

CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

Scientific Observations Conducted in the 1997/98 Fishing Season

3.1 The Scientific Committee noted that there had been no international observer coverage of krill fisheries in the Convention Area during the 1996/97 and 1997/98 fishing seasons. However, observer data have been collected on occasion, particularly from the Japanese fleet (Annex 4, paragraph 2.13). These data had made a valuable contribution to the work of WG-EMM, and the Scientific Committee expressed its appreciation of the efforts made by Japan. The Scientific Committee endorsed the ongoing need for observer data from krill fisheries, and encouraged Members to collect such data, including krill fishing vessel activity (time budget data).

3.2 International and national scientific observers had provided extensive coverage of fishing of vessels licensed by Members and targeting *Dissostichus* spp. and *C. gunnari* in the Convention Area during the 1997/98 fishing season (Annex 5, paragraph 3.42). Observer logbook data and reports were submitted for longline fisheries in Subareas 48.3, 58.6, 58.7 and 88.1, trawling in Subarea 48.3 and Division 58.5.2, and a feasibility longline survey in Subareas 48.1, 48.2 and 88.3. In addition, two observers were aboard trawlers in Division 58.5.2 at the time of the meeting. Observers had been deployed by four Member countries: Argentina in Subareas 48.1, 48.2 and 88.3; Australia in Division 58.5.2; South Africa in Subareas 48.3, 58.6, 58.7 and 88.1; and the UK in Subareas 48.3, 58.6 and 58.7 (Annex 5, Table 11). The Scientific Committee thanked all scientific observers for the substantial amount of data and information they had collected under difficult, or at times extreme, conditions (paragraph 1.12).

3.3 The Scientific Committee noted the improved quality of logbooks submitted in 1998 compared with previous years. However, with the fishing season for many fisheries ending on or after 31 August and delays in the arrival of some logbooks and reports at the Secretariat, there had been a high data entry workload immediately prior to, and during, the meeting of WG-FSA (Annex 5, paragraph 3.43). In some cases, the late submission of data had resulted in WG-FSA using either incomplete datasets or non-validated data, or both. The Scientific Committee encouraged Members to ensure that observer logbook data and reports are submitted to the Secretariat within the time specified in the Scheme of International Scientific Observation (i.e. one month after the return of the observer to home base). Problems with meeting the submission deadline should be reported at the earliest opportunity to the Secretariat by the technical coordinators (Annex 5, paragraph 3.44).

3.4 An ad hoc task group had been formed to consider comments from scientific observers about the data recording forms and procedures currently in use for observations on board longline vessels (SC-CAMLR-XVI, Annex 5, paragraphs 3.33 and 3.34). The task group has worked interessionally and collated comments and suggestions received from scientific observers. These comments were reviewed by WG-FSA, and further changes had been proposed. These included:

- (i) changes to data collection forms (Annex 5, paragraphs 3.52 to 3.57);
- (ii) collection of additional data (Annex 5, paragraphs 3.59, 3.73 to 3.76);
- (iii) concerns over methods for collecting data (Annex 5, paragraph 3.60);
- (iv) practical difficulties for observers spending long periods in exposed vantage points (Annex 5, paragraph 3.61);
- (v) need for electronic data forms (Annex 5, paragraphs 3.62 to 3.64);
- (vi) problems associated with the random sampling of fish on longlines (Annex 5, paragraphs 3.65 to 3.68);
- (vii) need for two observers aboard each vessel (Annex 5, paragraphs 3.69 and 3.70);
- (viii) awareness of fishing crews of conservation measures and the booklet *Fish the Sea Not the Sky* (Annex 5, paragraphs 3.77, 3.78 and 3.80); and
- (ix) observer training programs (Annex 5, paragraph 3.79).

3.5 The Scientific Committee noted these topics, and:

- (i) urged that scientific observers be granted adequate access to the vessels' logbooks and other relevant information (Annex 5, paragraph 3.50);

- (ii) encouraged the ad hoc task group to revise data forms (Annex 5, paragraphs 3.52 to 3.57);
- (iii) thanked Dr G. Robertson (Australia) for his offer to review the logbook forms concerning bird observations (Annex 5, paragraph 3.57);
- (iv) encouraged Members to find solutions to the practical difficulties encountered by observers working in exposed conditions (Annex 5, paragraphs 3.59 to 3.61);
- (v) endorsed the development of electronic data submission and a stand-alone database for entering data at sea (Annex 5, paragraphs 3.62 to 3.64); and
- (vi) encouraged Members to investigate work priorities and the feasibility of deploying two observers per vessel especially in light of the need to obtain as complete observations as possible both of the fishery and incidental mortality of seabirds during longlining (Annex 5, paragraphs 3.65 to 3.70).

3.6 The Scientific Committee noted that conversion factors, from processed to whole weight of *D. eleginoides*, determined by the observers were usually different from those used when calculating the catch taken by the vessel. Catch sizes calculated using available observer-determined conversion factors were estimated to be 10% greater than those reported from the vessels (Annex 5, paragraphs 3.73 and 3.74). The Scientific Committee endorsed the evaluation of a new procedure for estimating conversion factors (Annex 5, Appendix D).

3.7 The Scientific Committee acknowledged the importance of the observer logbook data and reports to the work of CCAMLR, and recognised that the wide distribution of observers amongst Member countries was central to the success of the CCAMLR Scheme of International Scientific Observation. In this respect, the Scientific Committee agreed that the ongoing refinements of the *Scientific Observers Manual* and the manual itself go a long way to ensuring that observer reports are standardised and of comparable quality.

3.8 The Scientific Committee noted with appreciation that a number of Members had instituted observer training programs to prepare observers for implementation of the tasks set out in the *Scientific Observers Manual*. However, Chile and Spain expressed their concern at being unable to deploy observers during the 1997/98 season in Subarea 48.3. Ukraine also noted its ability to provide a number of well-trained scientific observers experienced in working in the Antarctic.

3.9 The Scientific Committee indicated that the nationality of observers and their distribution amongst Members was not a scientific issue and is a matter for the Commission. The central issue was the scientific competence and performance of the observers.

Review of the Current Edition of the *Scientific Observers Manual*

3.10 The Scientific Committee noted that several changes and additions to the *Scientific Observers Manual* had been proposed by WG-FSA and the ad hoc task group. The Scientific Committee encouraged the task group to consider these modifications and, where feasible, update and distribute new logbook forms and instructions in loose-leaf format by February 1999.

3.11 In relation to discussion under this agenda item, Dr M. Naganobu (Japan) requested the deletion of improper wording relating to vessel type in paragraph 8.5 of WG-FSA's report (Annex 5) because the qualification of vessel type was not based on any scientific or rational categorisation. The Scientific Committee recognised that the description of the vessel alluded to in this particular paragraph was simply a transcript from an observer report and no clear

categorisation of trawl vessel type was intended. Dr Naganobu also pointed out that subjective descriptions of this kind could lead to misunderstanding and confusion. He reiterated his request that the reference be deleted.

3.12 In response, the Chairman of the Scientific Committee indicated that the deletion of wording from a report which had been adopted would set an unfortunate and unacceptable precedent for the Scientific Committee. Subsequent translation by the Secretariat of the observer report had indicated that the reference was less categorical than contained in paragraph 8.5 of WG-FSA's report (Annex 5) and had alluded to the vessel as being 'similar to the Japanese construction'. Therefore, he stated that it was not proper to infer any reference to a national affiliation or improper action from the above observer report. He indicated that no improper action could be attributed to the identified vessel being under Japanese flag as this also could not be proven. He further indicated that such interpretations should not be the preserve of a scientific observer and that great care should be taken to ensure that reports of vessel activities by observers were based on fact. For further discussion on the Scientific Committee's view concerning the reporting of vessel activities by scientific observers please refer to paragraphs 3.13 and 3.14.

Advice to the Commission

3.13 In response to the Commission's request for advice (CCAMLR-XVI, paragraph 8.20), the Scientific Committee considered the role of scientific observers in collecting information on illegal and unregulated fishing. It agreed that scientific observers should only report on a factual basis, and that compliance activities should be left to CCAMLR inspectors.

3.14 The Scientific Committee endorsed the concept that the activities of scientific observers should be confined to gathering information and data in support of the work of the Scientific Committee. Factual data on sighting of fishing vessels during a fishing voyage, including vessel type identification, position and activity, would provide valuable information on the amount and distribution of fishing effort of the fleet, and as such would contribute to the stock assessments. This type of data would not be expected in real time, and should be submitted to the Secretariat at the end of a voyage in the observer report.

DEPENDENT SPECIES

Species Monitored under the CCAMLR Ecosystem Monitoring Program (CEMP)

4.1 Dr Everson introduced the report of WG-EMM by noting that the work of WG-EMM was conducted in two parts: the Workshop on Area 48 and the WG-EMM meeting.

4.2 The Workshop on Area 48, convened by Dr R. Hewitt (USA), was held at the Southwest Fisheries Science Center in La Jolla, USA, from 15 to 26 June 1998. The report of the meeting is appended to the WG-EMM report (Annex 4).

4.3 Dr Everson took the opportunity to thank Dr Hewitt for his contributions to all stages of the planning and organisation of the workshop.

4.4 Dr Everson further noted that during this very successful workshop, a large number of datasets were processed and a number of complex analyses were undertaken. It was decided at the workshop that the data and indices utilised would only be made available by the Secretariat in accordance with CCAMLR's normal rules of data access. Analyses were being prepared for publication.

4.5 The main WG-EMM meeting was held from 10 to 20 August 1998 in Kochi, India. Dr Everson thanked the host country and in particular, Mr Ravindranathan and his colleagues, for their efforts which resulted in a successful, productive meeting.

4.6 Prof. Croxall noted that the WG-EMM meeting suffered from a lack of scientific expertise in the area of dependent species due to a late change in meeting dates which precluded attendance by several members. It was recommended that meeting dates, once set, should not be changed.

4.7 The terms of reference for the Workshop on Area 48 were to:

- (i) identify the extent of between-season and within-season variation in key indices of the environment, harvested species, and dependent species over past decades;
- (ii) identify coherence in the indices between sites and clarify understanding of the linkages between Subareas 48.1, 48.2 and 48.3;
- (iii) develop working hypotheses; and
- (iv) provide a summary report for consideration of the 1998 meeting of WG-EMM.

4.8 The workshop was organised around the hypothesis H_0 and an alternative, H_1 as described below:

- (i) H_0 : Subareas 48.1, 48.2 and 48.3 are discrete ecosystems and events observed in any one subarea do not reflect what is happening in other subareas; and
- (ii) H_1 : Area 48 is a homogeneous ecosystem and events observed in any one subarea reflect the entire area.

4.9 It was recognised that neither of these hypotheses was likely to be correct. However, they represent the end points of the spectrum of possibilities and thus provided a useful structure for organising the workshop.

4.10 The results of the workshop were considered under appropriate agenda items of the WG-EMM meeting rather than taking the complete report at once.

4.11 Dr Everson summarised the results of analyses of land-based predator indices from the workshop report:

- (i) most land-based predator indices showed greater coherence between species within sites than across sites (Annex 4, Appendix D, paragraphs 7.9 to 7.16);
- (ii) land-based predator indices in summer were generally coherent across Subareas 48.1, 48.2 and 48.3 (Annex 4, Appendix D, paragraphs 7.18 to 7.29):
‘good’ years: 1984/85, 1987/88, 1994/95 to 1996/97,
‘bad’ years: 1990/91 and 1993/94, particularly 1990/91;
- (iii) coherence in land-based predator indices for summer across subareas was generally more evident in good than in bad years (Annex 4, Appendix D, paragraphs 7.28 and 7.32);
- (iv) winter land-based predator indices showed less coherence across subareas and summer indices. When there was coherence, it was more consistently area-wide in winter than in summer (Annex 4, Appendix D, paragraphs 7.33 to 7.48):

‘good’ years: 1988, 1989 and 1997,
‘bad’ years: 1990 and 1994; and

- (v) there was no consistent sequence in land-based predator indices between bad winters and bad summers; that is, either can precede the others (Annex 4, Appendix D, paragraph 7.45).

4.12 Dr Everson reported that the Working Group appreciated the whale data provided by the IWC and concluded that sighting surveys of minke whales appeared to offer the best technique for censusing whales for analyses in CCAMLR.

4.13 Ms D. Thiele (IWC Observer) stated that the SC-IWC is undertaking a large retrospective analysis of Southern Ocean baleen whale sighting data. This study will be completed prior to the krill synoptic survey planned for 2000.

4.14 The Working Group reviewed SC-CAMLR-XVII/BG/2 Rev. 1 and concluded that it was no longer necessary to present this information in a paper. It was suggested that for Table 1, (Summary of Members’ CEMP activities on monitoring approved predator parameters), the Secretariat should directly pursue the submission of relevant historic data. The Working Group suggested that Tables 2 (directed research programs required to evaluate the utility of potential predator parameters) and 3 (Summary of Members’ research required to provide essential background information needed to interpret changes in monitored predator parameters) should go onto the CCAMLR website.

4.15 Prof. Croxall concurred with this assessment, but felt that Table 1 in SC-CAMLR-XVII/BG/2 Rev. 1 was a useful summary which allowed scientists to anticipate what data might become available in the future. Dr Penhale concurred, but recommended that there be a notation of the expected date of data submission. The Scientific Committee agreed that Table 1 should continue to appear as a paper and that the Secretariat should solicit information on the status of ‘in preparation’ data, including a date when these data were expected to be submitted.

4.16 Dr Everson began his presentation on the section of the WG-EMM report which dealt with CEMP standard methods by reporting that the completed, revised *CEMP Standard Methods* had been circulated in September 1997. The rest of Dr Everson’s presentation focused mainly on paragraphs which required input from the Scientific Committee.

4.17 Dr Everson observed that the Working Group found uncertainties with standard method A3 Breeding Population Size (Annex 4, paragraphs 8.5 and 8.13 to 8.15).

4.18 Dr Miller noted that his misinterpretation of the treatment of the A3 data from Marion Island may have led to unwarranted concerns.

4.19 Prof. Croxall noted that it was difficult to reconcile the text of Annex 4, paragraph 8.13 with the data in the CEMP database and with the information published in the papers tabled for CCAMLR in the last two years (WG-EMM-96/38 and 97/55). It was agreed that further (intersessional) examination of the relationship between the population sizes of the penguins in the CEMP study colonies at Marion Island and those in the overall population might be useful. Dr R. Crawford (South Africa) would be asked to investigate this and report to next year’s meeting of WG-EMM.

4.20 Accordingly, it was agreed that it was probably not appropriate to review Method A3 at present. However, it was reaffirmed that discrete colonies need to be used and that these should contain a total of 1 000 to 2 000 breeding pairs. Although the instructions in the method provide for study population sizes of as few as 100 pairs, such small samples were only envisaged to be used in exceptional circumstances.

4.21 In terms of questions relating to the representativeness of CEMP study colonies in respect of population processes and trends at larger spatial scales, the Scientific Committee agreed that Members with relevant data should be encouraged to address some of the questions set out in the WG-EMM report (Annex 4, paragraphs 8.5(i) to (iv)).

4.22 Dr Everson noted that Method A5 (duration of foraging) should be reviewed intersessionally by the Subgroup on Methods.

4.23 A new method, using aerial photography as an alternative to ground counts was presented. The Working Group recommended that the method, with minor changes, could be adopted for Adélie penguins and noted it may be applicable to, and could be tested on, other species.

4.24 Dr Everson reported that a new method which proposes to monitor changes in coastal fish populations by the analysis of the pellets of the Antarctic shag was approved for an initial five-year trial period. This method will be published and circulated to Members.

4.25 The Scientific Committee noted that the forthcoming synoptic krill survey of Area 48 in 2000 provided an important opportunity to acquire simultaneous data on the distribution and abundance of marine mammals and birds. It was agreed that this should be brought to the attention of Members.

4.26 SCAR-BBS had provided CCAMLR with advice on appropriate recording techniques for seabirds at sea, arising from a workshop on this topic, which should supersede parts of the methods developed for use during the BIOMASS FIBEX and SIBEX programs.

4.27 Further details of the recommended seabird at-sea recording methods should be sought from SCAR and/or scientists experienced in using the two methods recommended by the workshop, in order to assist participants in the B₀ survey to use appropriate methods for estimating seabird distribution and abundance.

4.28 Dr Nicol noted that seabird and cetacean observations had been successfully carried out on the 1996 krill biomass survey in Division 58.4.1. Further results of and experience gained during this survey will be presented to WG-EMM in 1999.

4.29 Dr Kerry noted that in addition to recording the aerial distribution of seabirds during the synoptic krill survey (paragraph 4.25), it would be useful to investigate the three-dimensional overlap of penguins with krill.

4.30 It was noted that methods of estimating the at-sea distribution and abundance of seabirds are to be considered by the IWC Scientific Committee at a workshop to define whale survey methods for use on the synoptic survey and for GLOBEC. It was recommended that the results of the IWC methods workshop to be held in March 1999 should be reviewed by the Working Group.

4.31 The Working Group thanked SCAR for the report of the 1996 APIS survey meeting and the report of SCAR-GSS in the same year, which were forwarded following WG-EMM's request last year.

4.32 It was noted that it is unlikely that the APIS program will produce a standard method for routine monitoring of crabeater seals before the APIS program is completed in the year 2000.

4.33 The Working Group expressed its continuing interest in the development of a suitable technique to be completed as soon as possible.

4.34 The Working Group noted that no new CEMP sites were proposed for consideration by the Working Group. It was also noted that no Protected Area Management plans had been forwarded by SCAR for consideration by the Working Group.

Assessment of Incidental Mortality

Incidental Mortality Arising from Longline Fishing

IMALF Intersessional Activities

4.35 The Scientific Committee noted the active intersessional work program of ad hoc WG-IMALF and the excellent attendance (12 members from seven countries) at the meeting held as part of WG-FSA. The request for additional members from countries involved in longline fishing and/or seabird research in the Convention Area (e.g. Norway, Ukraine, Uruguay and USA) and currently unrepresented in WG-IMALF, was noted, as was the decision that technical coordinators and the Scientific Observer Data Analyst should be ex-officio members of ad hoc WG-IMALF.

4.36 The Scientific Committee noted that WG-FSA had appointed Prof. Croxall as Convener and Mr B. Baker (Australia) as Deputy Convener of ad hoc WG-IMALF (Annex 5, paragraph 7.5).

4.37 The Scientific Committee endorsed the intention to review research programs into the status of albatrosses, giant petrels and *Procellariapetrels* at the 1999 ad hoc WG-IMALF meeting and the request to all Members to submit relevant summary data intersessionally (Annex 5, paragraph 7.8).

Data on Incidental Mortality of Seabirds during Longline Fishing in the Convention Area

4.38 The intersessional revision of 1997 data on seabird by-catch from Subareas 58.6 and 58.7 was noted (Annex 5, paragraphs 7.9 to 7.12). This showed that:

- (i) the overall catch rate (birds/thousand hooks) was estimated as 0.49 and 0.58 for day and night setting (Annex 5, paragraph 7.12 and Table 32);
- (ii) the main species killed by regulated fisheries were white-chinned petrels (66%) and grey-headed albatrosses (11%) (Annex 5, paragraph 7.11 and Table 31); and
- (iii) an estimated 696 birds were killed during night setting and 866 during day setting. This total estimated mortality of 1 562 birds is 69% greater than the observed total mortality of 923 birds (Annex 5, paragraph 7.12, Tables 33 and 34).

4.39 The Scientific Committee noted that these revised estimates include by-catch rates that would have increased last year's estimates of seabird by-catch in unregulated fisheries in these subareas.

4.40 Noting the continuing difficulties with timely data submission and validation which preclude the undertaking of comprehensive analysis of the current year's data (Annex 5, paragraphs 7.15 and 7.16), the Scientific Committee approved the suggestion that the main analysis of by-catch data should be undertaken intersessionally (Annex 5, paragraphs 7.17, 7.37 and 7.59), complemented by preliminary assessment of the current year's data at the WG-FSA meeting (Annex 5, paragraphs 7.18 and 7.19).

4.41 To allow comprehensive analysis and assessment, full details from observers on all seabird by-catch for longline fisheries in the Convention Area, and especially from the French EEZ, would be needed (Annex 5, paragraphs 7.22 to 7.24).

4.42 The 1998 results for Subareas 48.1, 48.2, 88.1 and 88.3 showed no by-catch of seabirds in these subareas (Annex 5, paragraphs 7.25 and 7.26).

4.43 The 1998 results for Subarea 48.3 were as follows:

- (i) 79 seabirds (83% white-chinned petrels, 12% black-browed albatrosses) were observed killed at an overall catch rate of 0.025 birds/thousand hooks (Annex 5, paragraphs 7.27, 7.28 and 7.33, Tables 35 and 36), compared with 712 seabirds at a catch rate of 0.23 birds/thousand hooks in 1997;
- (ii) an estimated 640 birds were killed, a substantial reduction (88% fewer) of the estimated 1997 kill of 5 755 (Annex 5, paragraph 7.34 and Table 37);
- (iii) these results represent a major improvement compared with 1997, due to the much higher levels of compliance with CCAMLR conservation measures (Annex 5, paragraphs 7.35 and 7.40); and
- (iv) the one-month delay (until 1 April) in the start of the fishing season is thought to be a major factor in reducing bird by-catch in 1998 (Annex 5, paragraph 7.36).

4.44 The 1998 results for Subareas 58.6 (outside the French EEZ) and 58.7 were as follows:

- (i) 498 seabirds of five species (mainly white-chinned petrels (96%)) were observed killed with an average catch rate of 0.117 birds/thousand hooks (Annex 5, paragraph 7.42, Tables 38 and 39), compared with 834 seabirds at a catch rate of 0.52 birds/thousand hooks in 1997;
- (ii) seabird by-catch rates were considerably reduced compared with 1997; this was probably because of improved compliance with Conservation Measure 29/XVI, especially with respect to night setting and use of streamer lines (though the 5 n miles fishing exclusion zone around the Prince Edward Islands may have contributed) (Annex 5, paragraphs 7.51 and 7.52);
- (iii) important factors associated with higher rates of seabird by-catch were daytime setting (though reduced three-fold from last year), high winds, proximity to breeding island, vessel and time of year (Annex 5, paragraphs 7.45 to 7.50 and Figure 10);
- (iv) by-catch occurred mainly during summer, peaking during February to mid-March, the chick-rearing period of white-chinned petrels (Annex 5, paragraph 7.45 and Figure 11); and
- (v) WG-FSA had endorsed the suggestion that the fishery in Subarea 58.7 should be closed from February to mid-March during the chick-rearing period of white-chinned petrels (Annex 5, paragraph 7.55).

4.45 Mr Purves noted that the forthcoming South African fishing plan will take the advice in paragraph 4.44(v) into account but there are strong local views that a sustained fishing presence in the area is needed to combat illegal fishing. Prof. Duhamel supported this view.

4.46 The Scientific Committee noted that, in the Convention Area overall, based on data available to WG-FSA:

- (i) there had been a substantial reduction (by 90% in Subarea 48.3 and about 50% in Subareas 58.6 and 58.7) in seabird by-catch in the regulated fisheries in the Convention Area in 1997/98;
- (ii) this was in part attributable to greater compliance with the mitigating measures set out in Conservation Measure 29/XVI and to the later commencement of the fishing season in most areas in 1997/98 than in preceding years; and
- (iii) that the highest by-catch rates recorded were for sets commenced in daytime and for those undertaken during February and March in Subareas 58.6 and 58.7 and in April in Subarea 48.3.

Compliance with Conservation Measure 29/XVI

4.47 The Scientific Committee noted the advice of WG-FSA that:

- (i) no vessels were in compliance in respect of line weighting, for the second successive year (Annex 5, paragraph 7.63 and Figure 12);
- (ii) improvement in the prevalence of night setting, compared with 1997, occurred in all subareas (Annex 5, paragraph 7.64);
- (iii) despite some improvements since 1997 (principally relating to retaining offal during the haul), many vessels are still discharging offal during the haul on the same side as line hauling (Annex 5, paragraph 7.65); and
- (iv) streamer lines were used on more vessels than last year, but most streamer lines do not meet CCAMLR specifications (Annex 5, paragraphs 7.67 to 7.70 and Table 40).

Assessment of Potential Levels of By-catch of Seabirds in the Convention Area due to Unregulated Longline Fishing

4.48 The Scientific Committee noted that WG-FSA had estimated this in an identical fashion to last year, using the 1997 by-catch rates from the regulated fishery, rather than the much lower 1998 values, to characterise the performance of unregulated vessels. On this basis, the estimate of potential seabird by-catch for 1998 (taken exclusively in the Indian Ocean sector) was between 50 000 and 89 000 seabirds (Annex 5, Tables 41 and 42), potentially comprising 31 000 to 56 000 white-chinned petrels, 11 000 to 20 000 albatrosses and 2 000 to 4 000 giant petrels. This compares with estimated values for 1997 of 31 000 to 111 000 seabirds.

4.49 The Scientific Committee accepted the conclusion of WG-FSA that these levels of mortality would be unsustainable for the populations of these species breeding within the Convention Area in the southern Indian Ocean, and drew this to the attention of the Commission.

4.50 Therefore the Scientific Committee recommended that the Commission take the most stringent measures possible to combat unregulated fishing in the Convention Area.

Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area

4.51 The Scientific Committee noted that:

- (i) information on seabird by-catch outside the Convention Area, especially the extensive data provided by Australia and New Zealand, continued to indicate that substantial by-catch occurs of species and populations breeding within the Convention Area (Annex 5, paragraphs 7.122 to 7.134); and
- (ii) new information on fishing effort and on bird by-catch by Taiwanese pelagic longliners for tuna in the Southern Ocean (north of the Convention Area) had been acquired and that further dialogue was recommended (Annex 5, paragraph 7.135).

Effectiveness of Mitigation Measures

4.52 The review of new information relating to methods for mitigating seabird by-catch in longline fisheries was welcomed by the Scientific Committee. It endorsed the advice relating to:

- (i) offal discharge, including bait spillage and vessel reconfiguration, particularly the reaffirmation (SC-CAMLR-XVI, paragraph 4.52(iii)) that vessels discharging offal during the haul on the same side as the line hauling site should no longer be allowed to fish in the Convention Area and drew this especially to the attention of those involved in licensing of vessels to fish in national EEZs (Annex 5, paragraphs 7.139 to 7.144);
- (ii) the importance of adequate line weighting as potentially the most effective of existing mitigating measures (Annex 5, paragraph 7.150), the need to develop more efficient methods to weight lines and the high priority of research on effects of line sink rates (Annex 5, paragraph 7.168);
- (iii) the potential need to add a provision to Conservation Measure 29/XVI governing the use of line floats (Annex 5, paragraph 7.152);
- (iv) the need to investigate the use of line-setting devices (Annex 5, paragraph 7.154);
- (v) the development and testing of underwater setting tubes by Australia, New Zealand, Norway and South Africa, which was noted and encouraged (Annex 5, paragraphs 7.161 to 7.163); and
- (vi) the need for research into artificial bait, gear colour and bait-taking behaviour of seabirds (Annex 5, paragraphs 7.166 and 7.167).

4.53 Participants in the ad hoc WG-IMALF and WG-FSA meetings indicated that the detailed discussion of mitigating measures this year had been made possible by the high quality of the data provided by observers and by the presence at the meeting of scientists with much practical experience of fishing operations on board longline vessels.

4.54 It was especially noted that WG-FSA advised that line weighting is potentially a very effective mitigating measure. Indeed, achieving rapid sinking of the baited longline is probably the measure which offers at present the best opportunity substantially to reduce, if not eliminate, seabird by-catch in longline fisheries. If an appropriate weighting and spacing regime can be used, no seabirds should be caught, even in daytime sets (Annex 5, paragraph 7.150).

4.55 Prof. C. Moreno (Chile) advised of a forthcoming collaborative research project between Chile and Australia to be undertaken in southern Chile. This will include research relevant to albatross–fishery interactions, especially in relation to longline sink rates, and albatross at-sea distribution in relation to the distribution of fishing effort. Members encouraged Australia and Chile in these initiatives, noting the importance of such information for an important area for which few data are currently available.

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

4.56 Last year the Commission requested the Secretariat to arrange for comments on the draft of the FAO International Plan of Action on the Reduction of Incidental Catch of Seabirds in Longline Fisheries (IPOA) from ad hoc WG-IMALF (SC-CAMLR-XVII/BG/5) to be forwarded to FAO in time for consideration at the FAO Consultation, to be held in Rome from 26 to 30 October 1998 (CCAMLR-XVI, paragraph 12.4). In accordance with FAO's timetable, the revised International Plan of Action will then be submitted for adoption at the next meeting of the FAO Committee on Fisheries (COFI), to be held in February 1999.

4.57 In consultation with the Chairman of the Scientific Committee it was decided that, taking into account the timing of various CCAMLR meetings, it would be possible to arrange for the intersessional comments of ad hoc WG-IMALF to be considered at WG-FSA and then sent to FAO. After intersessional consultation with members of the Scientific Committee, Mr J. Cooper (South Africa) was nominated as CCAMLR observer at the FAO Consultation. The ad hoc WG-IMALF comments and additional observations in the IPOA were approved by WG-FSA (WG-FSA-98/34 Rev. 2, Appendix) and sent to FAO with Mr Cooper.

4.58 It was hoped that Mr Cooper would be able to submit a summary report on the October consultation in time to be considered by the Scientific Committee at its 1998 meeting. In any case, the Scientific Committee endorsed the comments on the FAO IPOA in the appendix to WG-FSA-98/34 Rev. 2 and drew them to the attention of the Commission.

4.59 The Scientific Committee commended Australia on its Threat Abatement Plan, the objective of which is to reduce seabird by-catch in all fishing areas, seasons and fisheries within the AFZ to be achieved within the five-year life of the plan. The ultimate aim of the threat abatement process is to achieve a zero by-catch of seabirds, especially threatened albatross and petrel species, in longline fisheries. It was noted that the Threat Abatement Plan contained many elements which might be used in developing other national and regional agreements, especially that proposed for southern hemisphere albatrosses under the CMS. The Scientific Committee noted the prospect of a meeting in Chile to begin developing this agreement.

New and Exploratory Fisheries Proposed in 1998

4.60 Last year in response to concerns 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 (SC-CAMLR-XVI, Annex 5, paragraph 7.118), advice was requested on known and potential interactions with seabirds, relating to the:

- (i) timing of fishing seasons;
- (ii) need to restrict fishing to night time; and
- (iii) magnitude of general potential risk of by-catch of albatrosses and petrels.

4.61 Last year the Working Group undertook the first comprehensive assessment on this basis. It assessed new and exploratory fisheries for most subareas and divisions of the

Convention Area. For comparison, it also undertook assessments of areas with established longline fisheries (Subarea 48.3 and Division 58.5.1) (SC-CAMLR-XVI, Annex 5, paragraphs 7.126 and 7.127).

4.62 This year most statistical subdivisions of the Convention Area, including all with proposals for new and exploratory fisheries, were reassessed in terms of risk of by-catch of species and groups of seabirds at risk (Annex 5, paragraphs 7.101 to 7.116 and Figure 13).

4.63 In broad terms, the assessments and reassessments made this year, and the resulting advice, differ very little from those prepared and agreed last year for the same areas. The only areas assessed for the first time this year were Subarea 48.5 and Division 58.4.2 (Annex 5, paragraph 7.103). There were only two new features of the assessments this year:

- (i) consideration of the potential for longline fishing in an area, as deduced from inspection of bathymetric maps of the area in question (Annex 5, paragraph 7.114); and
- (ii) areas which had been, or were being, considered as subdivided in respect of fishery assessments (e.g. Subareas 88.1 and 48.6) were therefore also assessed for seabird risk in relation to the subdivisions (Annex 5, paragraph 7.114).

4.64 The Scientific Committee noted that, in respect of this year's proposals (full details of assessments and advice appear in Annex 5, paragraph 7.116), potential conflict between proposed longline fishing seasons and advice on seasons closed to longline fishing to protect seabirds was, in essence:

- (i) minor for Division 58.4.4 (Spain and South Africa), Subareas 58.6 (South Africa) and 58.7 (South Africa);
- (ii) substantial for Divisions 58.4.3 (France), 58.4.4 (France), Subareas 58.6 (France) and 58.7 (France); and
- (iii) uncertain for Division 58.4.4 (Uruguay).

4.65 Relevant information from the proposals for new and exploratory fisheries (especially in relation to fishing seasons) and the advice from the IMALF section of WG-FSA are summarised in Table 5.

4.66 In addition, WG-FSA had provided detailed advice in respect of the New Zealand request for a variation from Conservation Measure 29/XVI for exploratory fishing in Subarea 88.1, south of 65°S (Annex 5, paragraphs 7.117 to 7.119).

4.67 The Scientific Committee endorsed the New Zealand request (Annex 5, paragraph 7.117), subject to:

- (i) the use of the variation of a minimum sink rate of 0.3 m/s, as described in Annex 5, paragraphs 7.117 and 7.118;
- (ii) all other elements of Conservation Measure 29/XVI remaining in force; and
- (iii) fishing ceasing if significant bird by-catch occurs.

4.68 Dr A. Baker (New Zealand) indicated that the level of bird by-catch deemed to be significant would be a very low number (e.g. 10 or less) and based on the bird mortalities directly observed by the scientific observer. If the limit is reached, the use of the variation for the purpose of the experiment will cease and the vessels will revert in full to the provision of Conservation Measure 29/XVI.

4.69 The Scientific Committee noted that the variation from Conservation Measure 29/XVI and the limit on bird mortality is only for the purpose of allowing the experiment with line weighting to proceed with the ultimate aim of introducing measures which will reduce bird mortality to zero. They do not constitute precedents for longline fishing operations in other years, seasons or areas.

4.70 The Scientific Committee agreed that with the exception of the variation agreed above for Subarea 88.1 (south of 65°S), Conservation Measure 29/XVI should be retained in full for longline fisheries in all parts of the Convention Area (Annex 5, paragraph 7.169).

Approaches to Eliminating Seabird By-catch in Longline Fisheries in the Convention Area

4.71 The Scientific Committee welcomed and endorsed the WG-FSA review of policies and practices (involving seabird and fish research, fishing gear development, education and legislation) which it believed essential to progressing and resolving this issue (paragraph 7.189). It drew to the attention of the Commission the recommendations for:

- (i) sustained development of underwater setting, as the likely medium- to long-term solution (Annex 5, paragraph 7.190);
- (ii) enhanced work to develop line weighting regimes to ensure sink rates that will preclude seabirds accessing baits (Annex 5, paragraph 7.191) and the implications of this for exemption from other mitigating measures (Annex 5, paragraph 7.192);
- (iii) improving compliance with the existing suite of mitigation measures (Annex 5, paragraph 7.193);
- (iv) improved training and education of fishing companies, vessel captains, fishing masters, crew, scientific observers and technical coordinators (Annex 5, paragraph 7.194);
- (v) development of a range of national and international plans of action, e.g. those under FAO, CMS and the Australian Threat Abatement Plan (Annex 5, paragraph 7.196); and
- (vi) action relating to improved regulation of high seas fishing (especially through harmonisation of management measures) with CCAMLR encouraging Members (and other countries fishing in the Convention Area) to ratify and promote entry into force of instruments such as 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 (UNIA), FAO Compliance Agreement and Code of Conduct for Responsible Fisheries (Annex 5, paragraph 7.197).

4.72 The observer from ASOC expressed appreciation for the work which scientists and governments have undertaken to resolve the critical problem of incidental seabird mortality. However, ASOC still has grave concerns regarding the level of seabird by-catch that has been associated with longline activity in the Convention Area. It is ASOC's view that the existing problem is greatly exacerbated by the fact that actual levels of incidental mortality are unknown and existing figures are likely to significantly under-represent the true extent of the problem, and thus the ecological implications of present incidental seabird mortality levels. It can be argued that extinction remains a very real possibility for several populations of albatrosses. Therefore ASOC believes that it is vital that recommendations for effective by-catch prevention measures be forwarded to the Commission by the Scientific Committee in the strongest of

terms. Bearing in mind that the overwhelming majority of seabird deaths occur in the illegal and unregulated fishery, these measures must involve actions by Member States, e.g. port and market controls, that will effectively bring an end to these illegal and unregulated activities. ASOC notes the success of the enforcement activities taken by some governments in reducing levels of illegal activities within their EEZs and urges all states to devote more resources to effective enforcement. Finally, ASOC would like to see continued progress with respect to the development of a broader range of measures to prevent seabird mortality, taking into account the ecological, seasonal and environmental conditions which increase the likelihood of seabird by-catch.

4.73 In respect of entanglement in longlines of animals other than birds, the only report is of a single seal killed in Subarea 48.2 (Annex 5, paragraph 8.1).

Incidental Mortality in Trawl Fisheries

4.74 Only a single report, of a grey-headed albatross killed in collision with a trawl warp line (Annex 5, paragraph 8.3), was received this year. There was no evidence of vessels fishing with net monitor cables in contravention of Conservation Measure 30/X (Annex 5, paragraph 8.2).

Marine Debris

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

4.76 The UK undertook surveys of entanglement of Antarctic fur seals (*Arctocephalus gazella*) at Bird Island, South Georgia (SC-CAMLR-XVII/BG/11) for the eighth consecutive winter (1997) and tenth consecutive summer (1997/98). In winter, seven seals were observed entangled, 40% of the number in 1995. Usually most (75%) entanglements were of adult females. Packaging bands (57%), synthetic fishing line (14%) and fishing net (14%) were the main entangling materials. In summer, 13 seals were recorded entangled, the lowest total to date. Most animals involved were juveniles; the overall severity of injury was the lowest yet recorded. The proportion of entanglements in synthetic line (8%) was much less than in recent years, with fishing net (38%) and especially packaging bands (54%) considerably increased. Overall however, the level of entanglement recorded was the lowest since the study started 10 years ago.

4.77 In 1997/98, the UK undertook the second systematic annual survey of entanglement of Antarctic fur seals at Signy Island, South Orkney Islands (SC-CAMLR-XVII/BG/12). Six seals, all juvenile males, were reported entangled; this is half the number in the previous year, possibly due to the prolonged presence of sea-ice in the area. Entanglement was mainly in fishing net (83%) but also in packaging bands (17%), the reverse of the situation at Bird Island (14% and 57% respectively). Severe injury was being caused to 67% of animals at Signy Island (none at Bird Island). The reduction in entanglement in general and in packaging bands in particular, is encouraging. However, this may have been as much due to environmental conditions in 1997/98 as to improved waste disposal practice.

4.78 In 1997/98, the fifth year of standardised recording of man-made debris associated with seabirds at Bird Island, South Georgia (SC-CAMLR-XVI/BG/10), there was a marked increase in ingested and regurgitated plastic items reported for albatrosses. The total of 41 items was more than twice the previous highest total (in 1993/94). Ingested plastics were also reported for giant petrels and white-chinned petrels. Fishing gear was reported in association with

grey-headed albatrosses (seven squid jigs), black-browed albatrosses (two hooks and line, one squid jig) and wandering albatrosses (25 hooks and/or line). These levels are similar to or higher than most previous years, especially for squid jigs. This may suggest increased squid fishing activity in the area around, or adjacent to, South Georgia. Overall, the impact on birds at their breeding colonies remains a cause of concern.

4.79 Pollutants found in association with seabirds at sub-Antarctic Marion Island for the period May 1996 to April 1998 are reported in CCAMLR-XVII/BG/26. Standardised searches and incidental finds show a large increase between the 1996/97 and the 1997/98 field seasons. Fishing gear increased at a rate 10-times higher than other (non-fishing) pollutants over this period. Sixty rope nooses used for suspending toothfish in blastfreezers and 23 toothfish hooks were found. All the rope nooses, and 19 of the hooks were found during the second year. This increase in fishing gear from 1996/97 to 1997/98 is interesting in view of the fact that the large influx of vessels fishing illegally for *D. eleginoides* in waters around the Prince Edward Islands occurred during the 1996/97 season. Prior to this study, three southern bluefin tuna hooks had been found at Marion Island between 1992 and 1996. Three seabirds (a southern giant petrel, a northern giant petrel and a sub-Antarctic skua) were found entangled in fishing gear, while five seabird carcasses (three wandering albatross chicks, one white-chinned petrel chick and a southern giant petrel adult) were found with ingested fishing gear.

4.80 Dr Miller indicated that a similar survey at Prince Edward Islands was planned in the next couple of years to compare levels of debris at a strict nature reserve with those on Marion Island.

4.81 Prof. D. Torres (Chile) indicated that CCAMLR-XVII/BG/27 reports two Antarctic fur seals seen entangled at Cape Shirreff in 1997/98. One animal, a juvenile male, was entangled in a packaging band from which it was released.

4.82 Prof. Duhamel noted that a substantial increase in debris, especially fishing hooks, has been recorded around the nests of wandering albatrosses on Possession Island, Crozet Islands (CCAMLR-XVII/BG/41).

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

4.84 The Scientific Committee noted that the relatively frequent reports of entanglements in packaging bands are not necessarily evidence of failure by vessels of Members of CCAMLR to comply with Conservation Measure 63/XV, as the bands could well derive from vessels engaged in illegal or unregulated fishing. However, it was noted that observers reported the presence of packaging bands on two vessels in the Convention Area in 1997/98 (Annex 5, Table 14).

4.85 The Scientific Committee drew to the attention of the Commission that there may be quite extensive amounts of gear lost from longline vessels which are currently unreported to CCAMLR. Such gear has considerable potential for entanglement of marine mammals and birds. This problem is likely to be more acute in the unregulated fishery, exacerbated by occasional instances of large-scale gear loss, when complete longlines are abandoned in order that vessels may evade capture.

Marine Mammal and Bird Populations

4.86 The Scientific Committee at its Sixth Meeting (SC-CAMLR-VI, paragraphs 8.6 and 8.7), agreed to periodically review the status of all marine mammal and bird populations in the Antarctic, with particular attention to identifying those species whose populations have

experienced or are currently experiencing a significant change in abundance. SCAR-GSS, SCAR-BBS and the IWC were asked in 1995 to again provide appropriate information (SC-CAMLR-XIV, paragraph 3.70).

4.87 The report from SCAR-BBS, prepared in August 1996, was tabled as requested at the 1996 meeting of the Scientific Committee which recognised the vast amount of work involved in preparing the review and expressed its appreciation for the work of SCAR-BBS (SC-CAMLR-XV, paragraph 3.80).

4.88 Although the report of SCAR-BBS (SC-CAMLR-XV/BG/29) was available to WG-EMM at its 1997 meeting, substantial discussion was deferred to the 1998 meeting so that it could be discussed alongside the report of SCAR-GSS (SC-CAMLR-XVI, paragraph 4.91) when presented.

4.89 It was noted that the report of SCAR-GSS (paragraph 4.31) was available for the 1998 meeting of WG-EMM. The Scientific Committee thanked SCAR-GSS for this report.

4.90 Discussions of the reports of both SCAR-GSS and SCAR-BBS at the 1998 meeting of WG-EMM were limited on this occasion due to the absence of appropriate bird and seal biologists.

4.91 In respect of the report of SCAR-BBS (SC-CAMLR-XV/BG/29), the WG-EMM report had suggested that it contained data of questionable reliability and outdated information and recommended that its utility should be considered by the Scientific Committee in the light of the data submitted to CEMP. However, Dr Everson indicated that the original comments of the working group may have been based on a misunderstanding.

4.92 Dr Everson expressed his view that WG-EMM participants at the 1998 meeting did not properly recognise the value of this status and trends report. The report addressed bird populations at the broad Southern Ocean scale and provides information far beyond the basic krill-centred system currently under consideration by WG-EMM.

4.93 Prof. Croxall reaffirmed that the SCAR-BBS review, which had been prepared by 21 scientists from 13 countries, considered data for some 24 species for about 80 locations, and gave comprehensive advice on the status and trends of Antarctic and sub-Antarctic seabirds that could not be derived from existing CEMP data.

4.94 It was noted that the next review of status and trends of Antarctic seals and seabirds should be presented in the year 2000 (SC-CAMLR-XVI, paragraph 4.96).

4.95 Prof. Croxall reported that preparations for the next review of the status and trends of Antarctic and sub-Antarctic seabirds were well advanced. In order to take account of the request to undertake statistical analysis of trends in seabird populations in the Convention Area, SCAR-BBS had decided to hold a special workshop, involving the holders of long-term data together with other seabird experts and statisticians.

4.96 This workshop will be hosted by the Montana State University, USA from 17 to 21 May 1999. Contributions to the funding for this workshop have already been provided by the US National Science Foundation and SCAR and are being sought from CCAMLR at this meeting, as was indicated last year (SC-CAMLR-XVI, paragraph 4.96).

4.97 Prof. Torres noted that SCAR-GSS will meet prior to the year 2000 meeting of SCAR. The 1998 report from the meeting in Concepción, Chile, will be made available to WG-EMM, possibly next year.

4.98 The Scientific Committee welcomed these initiatives and looked forward to receiving reports from SCAR in due course.

4.99 Several bird species forage within the CCAMLR area although breeding outside it (e.g. Annex 5, paragraph 7.7) and it was hoped that these species will be included in the review.

4.100 Three other seabird research papers tabled by New Zealand (SC-CAMLR-XVII/BG/8, BG/9 and BG/13) provide additional data on populations. These papers were provided in response to CCAMLR's request for information on national programs investigating the status of albatrosses, giant petrels and white-chinned petrels (SC-CAMLR-XVI, Annex 5, paragraphs 7.18 and 7.20)

HARVESTED SPECIES

Krill Resources

Report of WG-EMM

Distribution and Standing Stock

5.1 The Scientific Committee noted the results of the Workshop on Area 48 regarding distribution and standing stock of krill which suggested that there was considerable concordance in recruitment indices between Subareas 48.1, 48.2 and 48.3, implying that large-scale phenomena were likely to be influencing population dynamics in this region (Annex 4, paragraphs 4.1 to 4.12).

Recruitment and Mortality

5.2 The Scientific Committee noted the detailed considerations of recruitment indices for krill and the reasons for the change in terminology from 'proportional recruitment' to 'per capita recruitment'. It was agreed that this change was appropriate (Annex 4, paragraphs 4.1 to 4.38).

5.3 The Working Group had conducted some analyses which demonstrated that there may be errors in either the current estimates of mortality (M) or in estimates of per capita recruitment and the Scientific Committee agreed that work needs to be done to resolve the observed discrepancies. Particular emphasis should be placed on the key questions raised in paragraph 4.38 of the Working Group's report (Annex 4) and the aim of this work is to determine how to utilise length-density data from restricted areas in estimating large-scale trends in absolute recruitment.

Area 48 Synoptic Survey

5.4 The Scientific Committee noted the progress made with the design and planning for the Area 48 synoptic krill survey which has as its primary objective an improved estimate of B_0 , the pre-exploitation biomass. The survey will be conducted in January 2000 (Annex 4, paragraphs 9.49 to 9.90).

5.5 The survey design as currently configured utilises three vessels which will sail along parallel transects that are considered representative of the entire survey area. Should other vessels become available, they would conduct extra transects interleaved within the survey area.

5.6 The core measurements on the survey would be:

- (i) krill acoustic data collected using a Simrad EK500 scientific echosounder on transect;
- (ii) krill length-frequency data collected using an RMT8 net (or equivalent); and
- (iii) physical oceanographic data collected using a CTD to 1 000 m.

The net sampling and the CTD data would be collected at stations at midday and midnight.

5.7 Additional sampling was encouraged but should not compromise the collection of the core data. Consideration should be given to the incorporation of observations on seabirds and marine mammals using standard techniques, such as outlined in paragraphs 4.27 and 4.30, however, the Scientific Committee was aware of possible restrictions on the number of berths on the participating vessels.

5.8 Participants were encouraged to carry out their own standard regional studies either prior to or after the synoptic survey so that the wide spatial coverage of the survey could be linked to the temporal sequence of the regional surveys.

5.9 Vessels from three Member nations, Japan, UK and USA are likely to participate in the survey and the Scientific Committee requested that these Members confirm their ability to arrive at South Georgia in the first week of January 2000 to start the first calibration.

5.10 Brazil and the Republic of Korea have expressed some interest in participating in the survey with well-equipped research vessels. It was noted that Peru may also have some interest, and the Scientific Committee asked Dr E. Fanta (Brazil) to seek further information. Additionally, scientists from the Ukraine with particular expertise in krill biology, hydroacoustics and oceanology would be interested in participating in the survey on vessels of other nations.

5.11 The Scientific Committee agreed that any countries wishing to participate in the survey should notify the coordinator of the survey (Dr J. Watkins, UK) no later than 15 March 1999. Drs Hewitt, Naganobu and Watkins have agreed to be coordinators for their nations' survey plans.

5.12 The tasks of the survey coordinator are to: convene a planning workshop (to be held in mid- to late March 1999), to coordinate cruise plans and preparations, to serve as at-sea coordinator, to ensure the data are supplied to CCAMLR and to participants, to organise a post-survey data analysis workshop and to coordinate report generation.

5.13 The Scientific Committee agreed that the core datasets should be analysed at a workshop attended by all survey participants as soon as possible after the survey and in advance of the 2000 meeting of WG-EMM. There was also agreement that the initial dissemination and publication of these core results of the survey should take place as a joint undertaking by the participants.

5.14 The CCAMLR Data Centre would be the depository of all core data and consequently appropriate data storage formats would need to be addressed prior to the survey.

Data Requirements

5.15 The Scientific Committee endorsed the list of data requirements relating to krill set out in the Working Group's report (Annex 4, paragraphs 12.2(i) to (vii), (ix), (x) and 12.3(ii), (iii) and (x)).

Precautionary Catch Limits and Advice to the Commission

5.16 The Scientific Committee noted that there is insufficient new information to warrant a reassessment of the precautionary catch limits for krill. Also, it acknowledged that continued progress in developing a general model of krill dynamics in Area 48 arising from the Workshop on Area 48 would, in the near future, contribute to an evaluation of a subdivision of the precautionary catch limit in this area (Annex 4, paragraph 8.1).

5.17 The Scientific Committee noted that no new management measures were proposed by WG-EMM (Annex 4, paragraph 8.21).

Fish Resources

Background Matters to Assessments

5.18 For the purposes of stock assessments during WG-FSA, estimates of total catches (including illegal, unreported and unregulated catches) during the current fishing season, i.e. from the end of the last CCAMLR meeting until the present, were used. The Scientific Committee endorsed the view of WG-FSA that these figures were more appropriate inputs to assessment models than the split-year catches reported in paragraphs 2.7 and 2.8 and Tables 3 and 4.

5.19 The estimates of total catches of *D. eleginoides* taken during the 1997/98 fishing season are detailed in Annex 5, paragraphs 3.20 to 3.38 and Table 8, and those for *C. gunnari* are summarised in Annex 5, paragraph 3.14. These data are summarised in Table 6.

5.20 The Scientific Committee recommended that for future meetings, the Secretariat prepare catch statistics for the period of the preceding fishing season, as well as those for the split-year.

Database Data Entry and Validation

5.21 A large number of computer-based datasets are maintained by the Secretariat to support the work of CCAMLR. A long-term aim is to move all datasets into formats supported by a database management system, and to document each dataset in the Secretariat's Dataset User Guide. As part of this long-term integration of datasets, the Secretariat is developing an intranet.

5.22 All the available fishery and observer data for the 1997/98 split-year, and earlier years, have been entered and validated. However, as in previous years, some datasets have only recently been submitted, and these were being processed in order of priority, as detailed in Annex 5, paragraph 3.4. Some data for 1997/98 were either overdue or in the process of being submitted, and these were not available at the time of the WG-FSA meeting.

5.23 The Secretariat was also tasked with the transfer of all available survey data to the newly-designed survey database. Participants were encouraged to either submit or resubmit recent survey data and supporting documentation to the Secretariat so that these data could be used in future analyses of the Working Group (Annex 5, paragraph 3.7).

Estimates of Seabed Area

5.24 At last year's meeting, WG-FSA used estimates of seabed area within two fishing depth ranges as the basis for estimating the amount of potentially suitable substrate available to *Dissostichus* spp. in regions where new and exploratory fisheries had been proposed. This year, estimates of seabed areas by depth strata were revised. The estimates contained mean depths of 2 x 2 minute grid squares. In addition, fishing depth ranges for Subarea 88.1 were calculated south of 72°S, whereas last year data in this area were not available. Seabed under permanent ice cover was excluded from the analysis of the southern region of Subarea 88.1 (Annex 5, paragraphs 3.8 to 3.12). The Scientific Committee endorsed the recommendation of WG-FSA for Members to continue to collect detailed bathymetric data and to submit these to the Secretariat so as to develop a high resolution bathymetry dataset which could be used to further the knowledge of species' habitat.

Research Surveys

5.25 Several research cruises were conducted in the Convention Area during the 1997/98 season, and are detailed in Annex 5, paragraphs 3.82 to 3.86. These included trawl surveys by the USA in Subarea 48.1 and Australia in Division 58.5.2, and longline research surveys by Spain in Subarea 48.6 and Division 58.4.4 and Chile in Subareas 48.1, 48.2 and 48.3. The Scientific Committee noted the value of these research efforts for assessments. Information obtained during the longline surveys by Spain and Chile had made a valuable contribution to the knowledge of *Dissostichus* spp. in regions where new and exploratory fisheries had been proposed.

Resumption of Closed or Lapsed Fisheries

5.26 The Scientific Committee noted the discussion in WG-FSA concerning the need for development of a formal procedure for dealing with closed or lapsed fisheries (Annex 5, paragraphs 3.88 to 3.92). The Scientific Committee agreed that a fishery could be considered to lapse when an assessment is no longer current. After this time, such a fishery would be required to submit new information on which a satisfactory assessment can be made before continuing or, in the absence of such information, the fishery would revert to a new fishery. To this end, the Scientific Committee requested that WG-FSA consider how to provide a period of currency along with assessments and recommendations it makes to the Scientific Committee. In this context, it also asked WG-FSA to consider how often a fishery needs to be assessed or reviewed. For example, the assessment of long-term annual yield for myctophids in Subarea 48.3 is now four years old. The Scientific Committee asked that WG-FSA examine how often assessments of long-term annual yield using the GYM need to be reviewed.

General Scheme

5.27 The submission by the European Community of a discussion paper (CCAMLR-XVII/18) on a unified regulatory framework for CCAMLR based on stages of

fishery development was welcomed by WG-FSA (Annex 5, paragraphs 3.93 to 3.95). This was viewed as an important initiative, and WG-FSA endorsed the need to develop a framework of this type. The Working Group also agreed with the sentiments expressed in the final paragraph of this document, which indicated that development of such a framework will take some time, and that Conservation Measures 31/X and 65/XII should remain in force until a replacement scheme is adopted.

5.28 In addition, the Scientific Committee stressed that the transition from a developing to an established fishery should only occur when WG-FSA has been able to conduct a stock assessment confirming that the fishery is sustainable according to the decision rules set by the Commission. The Scientific Committee also endorsed the importance of adequate prior notification by Members intending to commence fishing in new or lapsed fisheries.

Fish Biology, Demography and Ecology

5.29 Characteristics of the biology and demography of fish species are presented in Annex 5, paragraphs 3.96 to 3.136. Important points are considered below.

5.30 *Dissostichus* spp. identification, especially distinction between *D. eleginoides* and *D. mawsoni* is discussed, and biological characteristics of both species are provided.

5.31 Areas of overlap of the two *Dissostichus* species were discussed at WG-FSA (Annex 5, paragraphs 3.100 to 3.103). For the purpose of the assessment, the delineation between *D. eleginoides* and *D. mawsoni* was as illustrated in Annex 5, Figure 1.

5.32 Several studies were reviewed which reported on attempts to age *D. eleginoides*. These used annuli on otoliths and scales and radiocarbon dating. WG-FSA agreed that further work was needed to validate ageing methods to determine the time scale of annulus formation for scales and that Members should report their findings on the use of scales and otoliths for age determination to the next meeting of WG-FSA. Several studies investigated fecundity, maturity, and stock structure of *Dissostichus* spp. Significant findings included that *D. eleginoides* probably spawn in late July/August and maybe in April/May in Subarea 48.3. Tagging studies at Macquarie Island indicated that only one fish out of a total of 469 recaptures was recaptured outside the ground at which it was released, and that preliminary genetic studies indicated that fish from locations only 40 n miles apart appeared to have significantly different DNA sequences. However, during the meeting a report was received that a *D. eleginoides* tagged in the Falklands/Malvinas area was recaptured close to Coquimbo in Chile, a distance of several thousand kilometres from its initial tagging location.

5.33 The Scientific Committee agreed that further studies on stock delimitations are required, and information on this subject is urgently required to resolve the problem of management units discussed below (paragraphs 5.37 and 5.39).

5.34 The exploratory longline fishery undertaken in Subarea 88.1 by New Zealand provided information on *D. mawsoni* distribution, diet and growth. Similar work was undertaken by Chile in Subareas 48.1, 48.2 and 88.3.

5.35 Information concerning the biology of *C. gunnari* and several other species included a revised biomass estimate and length-frequency data for *C. gunnari* in Subarea 48.1, and abundance of several species inferred by studies using trammel nets over a 15-year study.

Developments in Assessment Methods

5.36 A new user guide to the GYM was provided at WG-FSA along with recent updates to the model. The GYM was validated with only two minor errors being identified. Members were encouraged to conduct further evaluations and the Secretariat was tasked with establishing a register of tests conducted on the GYM. The Scientific Committee thanked Dr Constable for providing the guide and Drs Ramm and Constable for validation of the GYM, thus making it straightforward to use by many participants at the meetings. Versions on a CD-ROM are available for participants to evaluate in their own institutes. A proposal for recording the status of assessment methods and associated computer programs used by CCAMLR was discussed at WG-FSA. Members were encouraged to participate in validation of programs not yet validated and the Secretariat was tasked with establishing a central repository of programs used by CCAMLR and information on the tests conducted as part of their validation.

Consideration of Management Areas and Stock Boundaries for *Dissostichus* spp.

5.37 Preliminary findings of genetic and tagging studies on *D. eleginoides* near Macquarie Island, and analyses of seabed areas within the fishing depth range of 500 to 1 800 m had led WG-FSA to consider the possibility that discrete stocks of *Dissostichus* spp. may occur over smaller spatial scales than the management areas currently used by CCAMLR (SC-CAMLR-XVII/BG/4, paragraphs 3.151 to 3.154). Given this possibility, the most precautionary approach was to assume that discrete stocks of *Dissostichus* spp. may occur over small spatial scales. The Working Group had identified two types of spatial scale: the geographic area over which stocks were assessed (assessment unit) and the geographic area over which stocks were managed (management unit).

5.38 The Scientific Committee noted that the assessment of yields in new and exploratory fisheries notified for 1998/99 had used statistical subareas or divisions as the assessment units. This had been the same approach as used in 1997. The Scientific Committee also noted that WG-FSA had tentatively identified smaller management units based on the analyses of seabed areas within the fishing depth range of 500 to 1 800 m (SC-CAMLR-XVII/BG/4, Table 15, Figure 1). Management units within and outside EEZ boundaries had been determined taking into account the new fisheries notified by France, and the exploratory fisheries notified by South Africa.

5.39 The Scientific Committee considered that the Commission may wish to look at these management units as a basis for allocating effort in new and exploratory fisheries, and in areas where longliners and trawlers may both target the same species. Such management areas could also be used to ascertain preferred fishing grounds in future notifications of new and exploratory fisheries. The Scientific Committee sought guidance from the Commission on whether this matter should be taken forward, and explored in further detail, especially in the Indian Ocean sector of the Convention Area.

Assessments and Management Advice

Dissostichus eleginoides

Methods Applied to the Assessment of *D. eleginoides*

5.40 The Scientific Committee noted that, as during previous meetings of WG-FSA, the assessment of *D. eleginoides* at the 1998 meeting comprised three main areas of data analysis:

- (i) standardisation and assessment of CPUE data;
- (ii) determination of long-term annual yields using the GYM; and
- (iii) analysis of length data to investigate trends in size at capture.

The application of these methods is discussed in Annex 5, paragraphs 4.86 to 4.90.

5.41 The Scientific Committee agreed that the use of assessment models such as the GYM has been very valuable in assessing precautionary catch limits for fisheries in several statistical areas for which little information is available. In some areas there now exists a dataset on CPUE covering a number of years that would allow the use of conventional depletion-based assessment techniques such as the de Lury method. The use of historical recruitment data with the GYM is appropriate when data are limited, but when there is a clear trend in CPUE, traditional assessment methods may give more information on the status of the stock. Such analyses have the potential to be used as an alternative method for assessing short-term replacement yields.

5.42 The Scientific Committee recommended that the Secretariat should acquire appropriate software for conducting a variety of depletion analyses in time for the next meeting of WG-FSA. At its next meeting, WG-FSA should examine how the GYM and depletion-based methods could be used to estimate both short- and long-term annual yields.

South Georgia (Subarea 48.3)

Standardisation of CPUE

5.43 The Scientific Committee noted the GLM analyses undertaken by WG-FSA, which included revised information from previous fishing seasons as well as new information from the 1997/98 fishing season.

5.44 The Scientific Committee endorsed the use of only winter CPUEs in the GLM analyses, because they provide a better overlap between vessels of different nationalities throughout the fishing season (Annex 5, paragraph 4.93).

5.45 Details of applying the GLM analyses are provided in Annex 5, paragraphs 4.94 to 4.103. The Scientific Committee shared the concern of WG-FSA that the CPUE indices, both in terms of kilograms and numbers of fish per hook, showed a consistent declining trend since 1994 (Annex 5, Figures 4 and 5).

Determination of Long-term Annual Yield using the GYM

5.46 Details of the assessment methods and input parameters for the GYM undertaken by WG-FSA are given in Annex 5, paragraphs 4.104 to 4.107 and Table 17.

5.47 During the Scientific Committee meeting it was realised that out-of-date input parameters were used in this analysis. The model was rerun using the updated input parameters as per SC-CAMLR-XVI, Annex 5, Table 18, and repeated here in Table 7. The yield at which there is a probability of 0.1 of falling below 0.2 of the median pre-exploitation spawning biomass level over 35 years was 3 616 tonnes. The median escapement for this level of catch was 0.52.

5.48 This was the second year running in which errors in the analyses undertaken by WG-FSA have been identified by the Scientific Committee. The Scientific Committee agreed that this underlined the importance of maintaining well-documented assessment histories for each stock.

Comparison of the GYM Output with the CPUE Trend shown by the GLM

5.49 Last year, WG-FSA had noted that the trends in median biomass predicted from the GYM indicated a smaller decline than that indicated by the GLM analyses of CPUE. The new GLM analyses of CPUE data conducted this year had indicated a continued decline in CPUE between 1997 and 1998.

5.50 In an attempt to compare results of the CPUE analyses with those of the GYM, WG-FSA had used the GYM to examine the effects of the time series of observed recruitments and the catch history on the status of the spawning stock. Preliminary results indicated that the decline in CPUE may be the result of a series of low recruitments in the early 1980s (Annex 5, paragraphs 4.108 to 4.110).

5.51 Prof. Beddington noted that there was no inherent inconsistency between the results of the CPUE analysis and those of the GYM. The GYM makes a large number of runs in a stochastic projection procedure. Some of these runs may be consistent with the CPUE trend and some may not.

5.52 The Scientific Committee noted that the stronger cohorts in the latter part of the recruitment history in SC-CAMLR-XVI, Annex 5, Table 17 will enter the fishery over the next few years. As this occurs, the effects may be seen in an upturn in the CPUE trend. Given that there are data on recruitment over 14 years and CPUE data over a period of seven years, the use of a depletion model for assessing yields, as discussed in paragraphs 5.41 and 5.42, should be investigated.

Trends in Size at Capture

5.53 The Scientific Committee noted WG-FSA's preliminary analysis of catch-weighted length-frequency data and endorsed the recommendation that the routines for extracting catch-weighted length-frequency data developed by the Secretariat prior to the 1998 meeting be further developed in the intersessional period.

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

5.54 The estimate of yield from the GYM was 3 616 tonnes. This was similar to the result obtained at last year's meeting (3 540 tonnes).

5.55 According to the analysis of available data for the most recent season the CPUE has continued to decline from 1997 to 1998. Preliminary analysis using the GYM indicated that the decline in CPUE may be the result of a series of low recruitments in the early 1980s. However, the Scientific Committee considered that the catch limit for the 1998/99 season should be less than the 3 616 tonnes indicated by the GYM in order to maintain a degree of caution appropriate to the results of the CPUE analysis.

5.56 The Scientific Committee reiterated its advice from last year that the following points can be taken into consideration in setting a catch limit for the 1998/99 season:

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

5.57 The Scientific Committee observed that the new analytical techniques it has suggested be applied to this stock next year (paragraph 5.41) may allow a more accurate estimate of the stock status to be made.

South Sandwich Islands (Subarea 48.4)

5.58 Despite a catch limit of 28 tonnes last season, no fishing in this subarea was reported to the Commission during the 1997/98 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)

5.59 The Scientific Committee recommended that Conservation Measure 128/XVI be carried forward for the 1998/99 season. It 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.

Kerguelen Islands (Division 58.5.1)

Standardisation of CPUE for the Trawl Fishery

5.60 WG-FSA used a GLM to standardise an updated series of CPUE data from the trawl fishery for *D. eleginoides* in Division 58.5.1 (Annex 5, paragraphs 4.121 to 4.126). This GLM analysis followed the approach used at the Working Group's last meeting.

5.61 Adjusted, standardised CPUE decreased between 1990/91 and 1993/94 but have been relatively stable since then (Annex 5, Figure 8). Nevertheless, the standardised CPUE index for the 1997/98 split-year is the lowest on record.

5.62 The Working Group viewed the declining trend in standardised catch rates with concern and noted that the trend in nominal catch rates demonstrated a more precipitous decline in CPUE during the early part of the time series (Annex 5, Figure 8). Further concern was expressed over the apparent increase in the percentage of hauls with small catches (Annex 5, Table 23).

Longline CPUE

5.63 Although the total catch in the longline fishery in Division 58.5.1 during the 1997/98 season was 1 118 tonnes, it was not possible to undertake an analysis of longline CPUE data at this year's meeting because haul-by-haul data were only available for the most recent season (Annex 5, paragraph 4.127).

5.64 Standardised CPUE analysis using the GLM has been applied to both longline and trawl fisheries, but these have not been compared. The Scientific Committee recommended that interpretation of CPUE as an abundance index should be evaluated by WG-FSA.

Determination of Long-term Annual Yields using the GYM

5.65 The GYM was used to assess long-term annual yield in Division 58.5.1. Recruitments were prorated from the estimate for Subarea 48.3. Parameters adopted from Subarea 48.3 and the catch history, including unreported catches (paragraph 5.19), were used in the projection (Annex 5, paragraphs 4.128, 4.129 and Table 24). The Scientific Committee agreed to rerun this assessment based on the updated recruitment parameters for Subarea 48.3 (paragraph 5.47).

5.66 The estimated long-term annual yield was 6 997 tonnes. WG-FSA noted that this yield is higher than most years in the catch history, except for 1992, 1997 and 1998. Given this potentially high yield, the Scientific Committee endorsed WG-FSA's advice that verification of recruitment at this level to this division is necessary.

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

5.67 The declining trend in CPUE in the trawl fishery demonstrated by the GLM analysis confirms previous studies of this stock. Reduction of the French catch limit (from the 1996 season onwards) shows concern for the management of the fishery in the French EEZ.

5.68 The French authorities have allocated a catch limit for trawling for the 1998/99 season (1 September 1998 to 31 August 1999). A maximum of 3 400 tonnes applies for two vessels only in the whole area, including a 1 000-tonne limit in the eastern sector.

5.69 The longlining catch limit in the western sector has already been established up to the end of 1998 (October to December). A catch limit of 500 tonnes applies for two foreign (Ukrainian) vessels only. The total value for the 1998/99 season in this sector will not exceed the value of the long-term sustainable yield estimated at the 1994 meeting (1 400 tonnes).

5.70 A catch limit of 1 100 tonnes will apply for the 1998/99 season for one French longliner in the eastern sector outside the area fished by trawlers.

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

5.72 Effective management of this fishery, in common with other subareas in the Indian Ocean sector, will be severely compromised as long as illegal catches continue.

Heard and McDonald Islands (Division 58.5.2)

5.73 The catch limit of *D. eleginoides* in Division 58.5.2 for the 1997/98 season was 3 700 tonnes for the period 8 November 1997 to the end of the Commission meeting in 1998. The catch reported for this division by the time of the Working Group meeting was 3 264 tonnes. This was expected to increase to 3 700 tonnes by the end of the Commission meeting.

Determination of Long-term Annual Yields using the GYM

5.74 The analysis undertaken at last year's meeting was updated using the latest version of the GYM, incorporating total reported catches for the 1997/98 fishing season. The unreported catch in the 1996/97 fishing season was revised and the upper estimate of unreported catch for the 1997/98 season was used. The future long-term annual yield at which the median escapement is 0.5 was 3 690 tonnes for the upper estimate of catch, provided that high levels of unreported catches do not continue (Annex 5, paragraphs 4.137 to 4.140 and Table 17).

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

5.75 The Scientific Committee recommended that the catch limit for Division 58.5.2 in the 1998/99 season should be revised to 3 690 tonnes, representing the annual yield estimate from the GYM, assuming removals in 1997/98 were equal to the reported catches plus the upper estimate of unreported catches.

5.76 The analysis resulting in this recommendation assumed that total removals of fish in 1998/99 and future seasons are reduced to the level of 3 690 tonnes.

5.77 The Scientific Committee noted that estimates of unreported catches in Division 58.5.2 in the 1997/98 season were less than 20% of those estimated for the previous fishing season. It was nevertheless reiterated that there will be a much greater effect on the catch limit in future years if the level of removals continues to exceed catch limits.

Crozet Islands and Prince Edward Islands (Subareas 58.6 and 58.7)

5.78 The catch reported for these subareas in 1997/98 comprised 88 tonnes caught inside the Crozet Islands EEZ (Subarea 58.6) and 814 tonnes from inside the Prince Edward Islands EEZ (140 tonnes from Subarea 58.6 and 674 tonnes from Subarea 58.7). One tonne was reported for the exploratory fisheries conducted in accordance with Conservation Measures 141/XVI and 142/XVI, which set catch limits of 658 tonnes and 312 tonnes for Subareas 58.6 and 58.7 respectively.

5.79 The fishery in the Crozet Islands EEZ took place only in November 1997. A total of 77 sets were made in 12 small-scale units (0.5° x 1° square). No new analysis of the data was undertaken.

5.80 The estimated longlining yields from the GYM were 8 874 tonnes in Subarea 58.6 and 1 529 tonnes in Subarea 58.7. These assumed removals from the 1997/98 season of 1 994 tonnes and 1 574 tonnes for the two subareas respectively. Given these potentially high yields, the Scientific Committee endorsed WG-FSA's concern that the verification of recruitment to these subareas is necessary (Annex 5, paragraphs 4.147 and 4.148). The Scientific Committee agreed to rerun the GYM assessment based on the updated recruitment parameters for Subarea 48.3 (paragraph 5.47).

Standardisation of CPUE for the Prince Edward Islands (Subarea 58.7)

5.81 The GLM was used to standardise an updated series of CPUE data from the longline fishery for *D. eleginoides* around the Prince Edward Islands. This GLM analysis followed the approach that was used at the Working Group's last meeting (Annex 5, paragraphs 4.149 to 4.153).

5.82 Standardised catch per unit effort has decreased substantially between 1996 and 1998. The major drop in CPUE between 1996 and 1997 occurred over a period in which WG-FSA has estimated substantial unreported catches were taken from this region.

5.83 The Scientific Committee noted that the GYM estimates for Subareas 58.6 and 58.7 need to be treated with particular caution for a number of reasons:

- (i) unreported catches in these areas may be underestimated because of the amount of unreported catch that could not be attributed to specific areas. This is especially important considering the high level of these catches and the dramatic decline in CPUE;
- (ii) the fishable ground straddles the boundary between Subareas 58.6 and 58.7, which could result in incorrect allocation of unreported catch between these subareas; and
- (iii) recruitments to these areas remain unknown.

5.84 Because of this, the Scientific Committee felt that a direct estimate of recruitment, e.g. from a trawl survey, is essential in order to make a proper assessment for Subareas 58.6 and 58.7.

Management Advice for *D. eleginoides* (Subareas 58.6 and 58.7)

5.85 The Scientific Committee recalled its advice for Subareas 58.6 and 58.7 from last year that the total estimated catch, including the unreported component, has represented a substantial proportion of the estimated median unexploited biomass from the GYM.

5.86 This information, coupled with the major decline in the CPUE index since 1996 suggests that the estimate of annual yield provided by the GYM for the purposes of the new and exploratory fisheries for Subarea 58.7 (Annex 5, Table 19) should be viewed with considerable caution.

5.87 The extent to which the standardised CPUE data for the Prince Edward Islands EEZ are relevant to the situation in Subarea 58.6 is uncertain. However, the Scientific Committee agreed that in view of the history of unregulated catch and the decline in CPUE indicated at last year's meeting, the annual yield estimate calculated for the purpose of new and exploratory fisheries for Subarea 58.6 should also be treated with caution.

5.88 Advice on new and exploratory fisheries notified for Subareas 58.6 and 58.7 is provided in paragraphs 9.19 to 9.26 and 9.29.

5.89 The Scientific Committee noted that estimates of unreported catches in these areas in the 1997/98 season were less than 15% of those estimated for the previous fishing season. It was nevertheless reiterated that there will be a much greater effect on the catch limit in future years if the level of removals continues to exceed the estimated yield.

Champscephalus gunnari

South Georgia (Subarea 48.3)

Commercial Catch

5.90 Although the commercial fishery for *C. gunnari* around South Georgia (Subarea 48.3) was open from the end of the Commission meeting in November 1997 until 1 April 1998 and a catch limit of 4 520 tonnes had been set, only one vessel took part in this fishery. The vessel fished for 10 days between 25 December 1997 and 5 January 1998 catching 5.04 tonnes of *C. gunnari* out of a total catch of 5.25 tonnes. 67% of the catch was taken in just two hauls, confirming the patchy distribution of this species around South Georgia.

5.91 The Scientific Committee discussed the extent to which the poor catches were due to a low standing stock of the target species, or the inexperience of the fishing master in locating fishable concentrations of *C. gunnari*, and/or the very low level of fishing effort applied. It was concluded that the results of the limited fishing in 1997/98 did not provide a reliable indication of the current viability of the fishery or of stock status.

Assessment at this Meeting

5.92 The catch limit for the 1997/98 season of 4 520 tonnes was derived from a short-term cohort projection performed at last year's meeting. This was based on a biomass estimate from a UK trawl survey in September 1997. In view of the extremely low catches and the lack of a new survey, an assessment of yield over the period 1998/99 and 1999/2000 was performed, using the same short-term projection method as used last year (SC-CAMLR-XVI, Annex 5, paragraphs 4.202 to 4.208). Analysis with the GYM was not carried out this year because the survey results used last year were still considered current. The projected short-term yield estimates were 4 840 tonnes for the 1998/99 season and 3 650 tonnes for the 1999/2000 season. The estimate of yield for the 1998/99 season was higher than that estimated at last year's meeting (4 140 tonnes), owing to the negligible catch (about 5 tonnes) in 1997/98 (Annex 5, paragraphs 4.162 and 4.163).

5.93 Dr E. Marschoff (Argentina) noted that the inexperience of the captain in catching *C. gunnari* was a consequence of the long period that the fishery has not been operating, but does not mean that the vessel was inefficient at catching this species. This is an ad hoc hypothesis that does not satisfactorily explain the poor catches. Dr Marschoff also stated that fish have been consistently of small size both in recent surveys and in the commercial fishery, suggesting the existence of unrecorded ecological interactions, and for this reason the fishery should be closed.

5.94 Other Members noted that the fishery usually depends on fish aged 3 and 4 and that the 1997 survey showed the presence of fish aged 2 to 6 years, and that year classes 2 to 4 were very abundant (SC-CAMLR-XVI, Annex 5, Table 24). In addition, the yields estimated from the short-term projections were based on the lower 95% confidence bound of the survey, and hence were conservative estimates of yield (Annex 5, paragraph 4.166).

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

5.95 Most Members agreed that the management of the fishery for *C. gunnari* in Subarea 48.3 during the 1998/99 season should be similar to that in force last season. The total catch limit should be revised to 4 840 tonnes in accordance with this year's short-term yield calculations.

5.96 Dr Marschoff noted that the low catch rates in this fishery and the high percentage of small fish taken indicate that the stock remains at a low level. While further research is needed on the causes of this situation the stock should be afforded maximum protection by closing the fishery.

5.97 In response, other Members recalled that the yields estimated from the short-term projections were based on the lower 95% confidence bound of the 1997 UK trawl survey, and that therefore they constituted conservative estimates of yield.

Kerguelen Islands (Division 58.5.1)

5.98 No commercial fishing for *C. gunnari* took place in this division during the 1997/98 season. During the 1998/99 season, France intends to conduct a full survey on *C. gunnari* to assess the abundance using the same method as in the 1997 survey. No commercial fishing for this species is envisaged in 1998/99. If the presence of a strong year 2+ cohort is confirmed in 1998/99, fishing may take place on this species in the 1999/2000 season.

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

5.99 The Scientific Committee supported the French plan to conduct a pre-recruit survey in the 1998/99 season and looked forward to seeing the analysis of the results at the next meeting.

Heard and McDonald Islands (Division 58.5.2)

Commercial Catch

5.100 The catch limit agreed by the Commission for the 1997/98 season was 900 tonnes to be taken on the Heard Plateau area only. Two vessels took part in this fishery. *C. gunnari* was targeted sporadically between mid-May and September 1998, as commercial demand required, while the vessels were engaged in their principal fishery for *D. eleginoides*. A total of 115.2 tonnes was caught up to 24 September 1998.

5.101 Between 29 May and 4 June 1998, one vessel conducted a random-stratified trawl survey for *C. gunnari* on Heard Island Plateau and Shell Bank, similar to that conducted in August 1997. Compared to the previous survey, fish were much more concentrated on Gunnari Ridge, and densities were very low over the remainder of Heard Island Plateau. Densities on Shell Bank were much lower than in the previous year.

Assessment of Yield

5.102 An assessment of *C. gunnari* in the Heard Island Plateau area was made using the same short-term annual yield method as used last year. Estimates of yield for Shell Bank were not made because of the very low abundance of this population. The assessment was updated to include an estimate of catches taken since the survey was conducted (Annex 5, paragraphs 4.175 to 4.177). This resulted in a combined catch over two years of 1 984 tonnes, comprising 1 160 tonnes in the first year and 824 tonnes in the second year.

5.103 Unlike the previous three years the age 2 cohort in 1998 is very weak and is expected to contribute little to the biomass in the coming years. Unless a new recruitment class enters the fishery by the year 2000, catch limits may need to be set by some other method, and be maintained thereafter unless a further survey demonstrates that abundant cohorts are recruited. The Scientific Committee recommended that WG-FSA investigate what assessment techniques are appropriate for such a case.

5.104 Although the estimate of biomass on Heard Island Plateau is lower than in the survey of the previous year, the calculated yield is higher. This results from the fact that the fish in the 1998 survey were mostly concentrated in one area, and so the biomass estimate had a low variance and the lower 95% confidence limit of the estimate, which is used in the yield calculation, was consequently higher than in the previous year (Annex 5, Table 26).

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

5.105 The Scientific Committee agreed that the management of the fishery for *C. gunnari* on the Heard Island Plateau part of Division 58.5.2 during the 1998/99 season should be similar to that in force last season. The total catch limit should be revised to 1 160 tonnes in accordance with this year's short-term yield calculations. The Scientific Committee agreed that no fishing should be undertaken on Shell Bank.

Assessment of Other Fish Species and *Dissostichus* spp.
in Pacific Ocean Sector (Subarea 88.3)

Antarctic Peninsula (Subarea 48.1) – *Notothenia rossii*,
Gobionotothen gibberifrons, *Chaenocephalus aceratus*,
Chionodraco rastrospinosus, *Lepidonotothen larseni*,
Lepidonotothen squamifrons and *Champscephalus gunnari*

5.106 Finfish stocks in the Antarctic Peninsula region (Subarea 48.1) have been exploited from 1978/79 to 1988/89 with most of the commercial harvesting taking place in the first two years of the fishery. Given the substantial decline in biomass of the target species in the fishery, *C. gunnari* and *N. rossii*, by the mid-1980s, Subarea 48.1 was closed for finfishing from the 1989/90 season onwards.

5.107 A random-stratified bottom trawl survey was carried out in two regions of Subarea 48.1. Estimates of standing total stock biomass for eight species of finfish were made. Biomass estimates for most species were still less than the 1987 survey estimates; indicating that stock of fish in this area have not recovered since the early fishery. This was supported by results from the Chilean feasibility longlining effort in Subarea 48.1. Total catch was low (<1 tonne) and CPUE was also very low (<0.1 kg/hook) (Annex 5, paragraphs 4.179 to 4.186).

Management Advice

5.108 There appears to be little prospect for a substantial fishery given the low biomass estimates for the 1997/98 season and some of the uncertainties associated with the decline in biomass compared to 1987. The Scientific Committee therefore recommended that Conservation Measure 72/XII should remain in force for the species considered in this section until future surveys indicate an increase in fish biomass in the subarea.

5.109 In view of the low catch rates in the exploratory *Dissostichus* spp. fishery, the Scientific Committee recommends that fishing for *Dissostichus* spp. should be prohibited in this area.

South Orkney Islands (Subarea 48.2)

5.110 Total catch from the Chilean feasibility longlining survey in Subarea 48.2 for three days during March 1998 was low (<1 tonne) and CPUE was lower than the minimum established by the Commission of 0.1 kg/hook to initiate a commercial fishery (Annex 5, paragraph 4.189).

Management Advice

5.111 In the absence of new information on stocks in this subarea, the Scientific Committee noted that fisheries in Subarea 48.2 should remain closed in accordance with Conservation Measure 73/XII. In view of the low catch rates in the exploratory *Dissostichus* spp. fishery the Scientific Committee also recommends that fishing for *Dissostichus* spp. should be prohibited in this area.

Antarctic Coastal Area of Division 58.4.1 and Division 58.4.2

5.112 No new information was available to the Working Group to undertake any assessment on the stocks in these divisions.

Pacific Ocean Sector (Subarea 88.3)

5.113 The Chilean feasibility longlining survey carried out in Subarea 88.3 for 10 days during February 1998 indicated that catch was low (<1 tonne) and CPUE was lower than the minimum established by the Commission of 0.1 kg/hook required to establish a commercial fishery (Annex 5, paragraph 4.199).

Management Advice for *Dissostichus* spp. (Subarea 88.3)

5.114 In view of the low catch rates in the feasibility survey of *Dissostichus* spp. in Subarea 88.3, the Scientific Committee recommended that fishing for *Dissostichus* spp. should be prohibited in that subarea.

By-catch Provisions

5.115 The Scientific Committee noted the recommendation of WG-FSA to retain the two main principles for by-catch species (Annex 5, paragraph 4.202). The current by-catch provision specifies actions required when the by-catch in any one haul is greater than 100 kg and exceeds 5% of all fish by weight (e.g. Conservation Measure 130/XVI, paragraph 11). It was noted that this provision may limit exploratory fishing on some *Dissostichus* spp. grounds. The Scientific Committee discussed the extent to which the existing by-catch provisions of

conservation measures need to be revised in order to allow exploratory fishing to proceed in a reasonable manner. It was agreed that any such change should nevertheless ensure that exploratory fisheries continue to be undertaken in the spirit of Conservation Measure 65/XII, and retain the level of control on the size and distribution of by-catch inferred by the existing provisions. The Scientific Committee agreed that the scheme set out in the following subparagraphs would be a reasonable way to proceed:

- (i) for any species for which there is no explicit by-catch limit held under a conservation measure, the by-catch limit should be set at 50 tonnes;
- (ii) when the catch of a single by-catch species (as defined in conservation measures) in an individual set or haul exceeds 2 tonnes, the vessel shall move to another fishing location at least 5 n miles distant, in accordance with the existing provision; and
- (iii) in statistical areas where the aggregate catch limits for target species are less than 1 000 tonnes, the catch of a single by-catch species should be no more than 5% by weight of the aggregate catch limit.

This last provision was added in recognition of the fact that 50 tonnes represents a high proportion of the catch in some statistical areas where the sum of all catch limits for target species is low.

5.116 While these may operate as a general approach to by-catch species, the Scientific Committee noted that, in Subarea 88.1, the by-catch of *Macrourus carinatus* can be up to 15% in areas near to suitable fishing grounds (Annex 5, paragraph 4.52). It also noted that this species is widespread in Subarea 88.1. The Scientific Committee requested WG-FSA to review at its next meeting any information available on by-catch species in order to assess their potential yield in this area.

By-catch Species in Subarea 48.3

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

5.117 No new information was available on *C. aceratus*, *P. georgianus*, *G. gibberifrons*, *N. rossii*, *P. brevicauda guntheri* and *L. squamifrons* in Subarea 48.3.

Assessments of By-catch in Division 58.5.2

5.118 WG-FSA used estimates of recruitment parameters for two by-catch species, *C. rhinoceratus* and *L. squamifrons*, in Division 58.5.2 to complete assessments using the GYM in the same manner as is undertaken for *D. eleginoides* (Annex 5, paragraphs 4.204 to 4.206). The estimates of long-term annual yield for *C. rhinoceratus* and *L. squamifrons* are 150 tonnes and 78 tonnes respectively. The Scientific Committee agreed that these estimates are more reliable than those for last year because they are now based on recruitment estimates from the area in which fishing takes place.

Management Advice

5.119 The Scientific Committee agreed that the mixed strategy for protecting by-catch species should be retained as a general policy.

5.120 The Scientific Committee reiterated its advice from previous years concerning the by-catch species in Subarea 48.3 and therefore recommended that Conservation Measures 3/IV and 95/XIV remain in force and that Conservation Measure 127/XVI be extended to the 1998/99 season.

5.121 The Scientific Committee recommended that the catch limit in Division 58.5.2 for *C. rhinoceratus* should be 150 tonnes, and that for *L. squamifrons* should be 80 tonnes. Because of their low long-term annual yields, however, it is still advisable to retain the 2-tonne limitation on individual hauls in Conservation Measures 130/XVI and 131/XVI to avoid directed fishing on these species.

5.122 The Scientific Committee drew attention to the fact that the yield for *L. squamifrons* has been rounded from 78 to 80 tonnes. The Scientific Committee felt that using exact results from the assessments implies a spurious precision. It realised, however, that a set of rules is required governing rounding of results and requests that WG-FSA consider this matter at its next meeting.

5.123 The Scientific Committee recommended that for any by-catch species for which there is no explicit catch limit, that the scheme set out in paragraph 5.115 be applied.

Research Surveys

Simulation Studies

5.124 Drs P. Gasiukov (Russia) and Marschoff reported on progress made on the study of the influence of spatial correlation in the estimates of the *C. gunnari* stock (SC-CAMLR-XVI, Annex 4, paragraph 6.2). Preliminary results indicate that the correlation between stations of the order of 10 km apart is small enough to treat them as uncorrelated. The work will continue in the intersessional period.

Recent and Proposed Surveys

Recent Surveys

5.125 Four recent surveys were undertaken in the Convention Area during 1997/98 covering Subareas 48.1, 48.2, 48.6 and 88.3 and Divisions 58.4.4 and 58.5.2. These surveys were carried out by Australia, Chile, Spain and USA (Annex 5, paragraphs 6.2 to 6.6). Results have been used in assessments completed for the respective areas.

Proposed Surveys

5.126 Plans to conduct research surveys have been received from Australia (Division 58.5.2), France (Division 58.5.1) and the USA (Subareas 48.1 and 48.2) and are described in Annex 5, paragraphs 6.7 and 6.8.

Future Work

Elasmobranch By-catch

5.127 The Scientific Committee reviewed the need to study elasmobranch by-catch in the light of discussions initiated at CCAMLR-XVI between Mr R. Shotton (FAO Observer) and Drs Miller and Ramm. Mr Shotton had outlined a FAO initiative to review the elasmobranch by-catch in world fisheries, and to present findings at a meeting in October 1998. As part of this review, FAO had expressed interest in a baseline study of elasmobranch by-catch in the Southern Ocean.

5.128 Mr Shotton expressed disappointment that little was done to study a group of species that ranked seventh of the 14 taxa in terms of weight landed from the CCAMLR area, is very widely distributed, and is an important by-catch in many fisheries.

5.129 The Scientific Committee appreciated the offer from FAO and wished to draw attention to the potentially serious problem of the levels of catch of this group about which little is known. At present the Scientific Committee is not aware of the availability and quality of relevant data held by Members.

5.130 WG-FSA, however, had confirmed the long-term need to document and assess, in general, by-catch in fisheries within the Convention Area, and to collect information which would allow the assessment of stocks of species caught as by-catch. Several steps were envisaged as provided in Annex 5, paragraphs 9.2 and 9.3 (see also paragraphs 7.9 and 7.10).

Fishery Data Manual

5.131 The Scientific Committee supported the Secretariat's proposal to publish and update the data reporting requirements for CCAMLR fisheries in a loose-leaf format as detailed in WG-FSA-98/12 and further discussed by WG-FSA (Annex 5, paragraphs 9.4 to 9.6).

Workshop on *Champscephalus gunnari*

5.132 Last year, the Working Group had identified a high-priority need for further developments of long-term management strategies for *C. gunnari*. This was endorsed by the Scientific Committee and a workshop was planned in association with the 1998 meeting of WG-FSA. The terms of reference of the workshop were prepared. The meeting was not held because necessary papers and information were not available in time for the meeting. Because of high-priority needs for work on *D. eleginoides*, the Scientific Committee endorsed the assessment of WG-FSA that the workshop should be postponed until after 1999 (Annex 5, paragraphs 9.7 to 9.10).

5.133 The Scientific Committee encouraged Members to continue to collect and submit data on *C. gunnari* to maximise the productivity of the workshop.

High-priority Intersessional Work on *Dissostichus* spp.

5.134 In the course of this year's assessments WG-FSA identified high-priority areas for future work on *Dissostichus* spp. The Scientific Committee agreed that this work should be

afforded higher priority to that on *C. gunnari* given the state of fisheries for *Dissostichus* spp. and the low catches of *C. gunnari* reported in recent years. The principal areas of work identified in Annex 5, paragraph 9.11 were:

- (i) consider the currency of assessments for both *D. eleginoides*, as well as other species;
- (ii) subject to the advice of the Scientific Committee and the Commission, define a start date for fisheries for *Dissostichus* spp. and review the 35-year period of which stock trajectories are projected with the GYM, especially in terms of reconciling the outputs of the GYM and information derived from CPUE;
- (iii) identify stocks and define their home ranges;
- (iv) analysis and interpretation of CPUE data;
- (v) develop and validate growth models for *D. eleginoides* and *D. mawsoni* in different parts of their range;
- (vi) obtain recruitment data for areas for which none are currently available;
- (vii) derive recruitment indices from mixture analyses and analysis of their sensitivity to expected outcomes from growth and mortality functions; and
- (viii) define ways of apportioning assessments in areas where both trawling and longlining may occur.

5.135 The Scientific Committee noted that task (vii) will require the reporting or re-reporting of survey data to the Secretariat in order that they may be analysed in accordance with current standard methods before the next meeting of WG-FSA.

5.136 Recognising the high-priority need for further work on *Dissostichus* spp., WG-FSA examined the idea of holding a thematic session during its 1999 meeting. If such a session was feasible, then key new work on *Dissostichus* spp. could be reviewed during the meeting, and would alleviate the need for a workshop prior to the meeting. The success of the thematic session would hinge on the success of intersessional activities and the ability to report findings in papers focused on key elements of the assessments.

Other Work During the Intersessional Period

5.137 The Scientific Committee supported the recommendation of WG-FSA that the role of subgroup coordinators at this year's meeting be extended to the intersessional period, and that these people be tasked with coordinating the relevant and high-priority aspects of the work identified at the meeting. WG-FSA concluded that such an approach was likely to ensure the success of the thematic session. The Convener of the Working Group and Chairman of the Scientific Committee in consultation with Working Group members, appointed coordinators for the following activities:

- (i) compilation of catch data (from regulated and unregulated fishing activities) (Mr Purves and Prof. Duhamel);
- (ii) review of observer reports and information (Dr Balguerías);
- (iii) review and summarise new and exploratory fisheries activities and notifications (Secretariat);

- (iv) assessment of *D. eleginoides* in established, new and exploratory fisheries (Drs Constable, Parkes, Agnew, Moreno, Marschoff and Ramm);
- (v) assessment of *C. gunnari* (Drs Constable, Parkes, Agnew, Moreno, Marschoff and Ramm);
- (vi) review, and where necessary assess, the biology and demography of species considered by the Working Group (Dr Everson); and
- (vii) compilation of data necessary for ad hoc WG-IMALF activities (Secretariat).

5.138 The work of these coordinators will be triggered by the arrival of the data necessary for them to address the various topics identified.

5.139 The Working Group identified a number of tasks which should be carried out by participants and the Secretariat during the intersessional period. These tasks are summarised in Annex 5, paragraphs 9.16 to 9.20.

Convener of WG-FSA

5.140 The Scientific Committee expressed its gratitude to Dr Holt for so ably convening this year's meeting of WG-FSA at short notice after the resignation of Dr de la Mare.

5.141 The Scientific Committee discussed the recommendation of WG-FSA concerning the convenership of the meetings for 1999 and 2000. The nomination of Mr Williams as the next Convener of WG-FSA was proposed by Dr Holt, seconded by Prof. Moreno and agreed by the Scientific Committee.

5.142 The Scientific Committee congratulated Mr Williams on his appointment.

Crab Resources

5.143 No vessels have fished for crabs in Subarea 48.3 since January 1996, and no vessels have expressed an interest in participating in this fishery during the 1998/99 crab fishing season (SC-CAMLR-XVI, Annex 5, paragraphs 4.226 and 4.227).

5.144 The Scientific Committee endorsed WG-FSA's view that it was not necessary to conduct an assessment of the crab stock in Subarea 48.3 (Annex 5, paragraph 4.195) and noted that Conservation Measures 90/XV and 126/XVI were in force for the 1996/97 and 1997/98 crab fishing seasons.

5.145 The Scientific Committee noted that, currently, the crab fishery is not considered commercially viable (SC-CAMLR-XVI, Annex 5, paragraph 4.227). At present, the viability of the fishery is related to various economic factors rather than to stock abundance, and the Scientific Committee agreed that the fishery could become commercially viable in the future. In this regard, the Scientific Committee endorsed WG-FSA's view that a conservative management scheme as contained in Conservation Measure 126/XVI is still appropriate for this fishery (Annex 5, paragraph 4.196).

5.146 The Scientific Committee further noted that Conservation Measure 90/XV expired after the 1997/98 crab fishing season. The Scientific Committee, recognising the great utility of the experimental harvest regime set out in Conservation Measure 90/XV in providing useful information for developing an assessment of the target species, reiterated the view expressed at

its 1996 meeting that Conservation Measure 90/XV should remain in force, but that if new vessels were to enter the fishery, the Commission might wish to revise Phase 2 in the light of the comments made in paragraph 4.183 of the 1996 report (SC-CAMLR-XV, Annex 5).

Squid Resources

5.147 A notification of the intention to conduct an exploratory fishery for the squid *M. hyadesi* in Subarea 48.3 by the Republic of Korea and the UK during the 1997/98 season had been approved under Conservation Measure 145/XVI. No fishing had been carried out since the 1997 Commission meeting. No new information had been presented to WG-FSA, WG-EMM or the Scientific Committee.

5.148 The scientific basis on which both the notification and the current conservation measure were based has not changed. WG-FSA, WG-EMM and SC-CAMLR had had detailed discussions on the subject of a squid fishery in 1997 (SC-CAMLR-XVI, Annex 5, paragraphs 4.2 to 4.6; SC-CAMLR-XVI, Annex 4, paragraphs 6.83 to 6.87; SC-CAMLR-XVI, paragraphs 9.15 to 9.18). The catch limit is considered to be precautionary, since it is only 1% of a conservative estimate of annual predator consumption (SC-CAMLR-XV, paragraph 8.3).

5.149 The Scientific Committee recommended that a conservative management scheme as contained in Conservation Measure 145/XVI is still appropriate for this fishery.

Timing of the CCAMLR Fishing Year: Technical Considerations of the Feasibility of a Change in Timing of the Annual Season

5.150 The Scientific Committee considered the current timing of the annual fishing season which begins immediately following the Commission meeting and concludes at the end of the Commission meeting in the following year. The Scientific Committee recognises that the requirement for Members to licence vessels to fish in the Convention Area results in a period immediately following CCAMLR when fishing cannot take place. This is because licences based on the recently decided conservation measures need to be issued in a manner consistent with domestic legislative requirements.

5.151 The Scientific Committee considered whether there are any technical difficulties in moving the start and end of the annual season for finfish to, say, the end of November, and for any interim measures that may be necessary to facilitate the transition to a new season, such as adding an additional month to the first year of operation. This would enable 12 months of fishing activity when there is no biological reason to have a closed season and to retain the requirement that regulations come into force as close to the end of the Commission meeting as possible while enabling the issue of licences within a reasonable time.

5.152 The Scientific Committee provides advice to the Commission on the most recent data and analyses available from its Working Groups and, in some cases, from other sources. This advice is unlikely to be affected by a change in season by approximately one month. Currently, WG-FSA (including ad hoc WG-IMALF) concludes its work two weeks before the end of the season and uses data from the fishery up to the end of September in the current year. An additional three to four weeks is unlikely to affect the current assessments, particularly as many are now based on assessments of long-term annual yield or, in the case of *C. gunnari*, include projections over two years based on recent surveys.

ECOSYSTEM MONITORING AND MANAGEMENT (REPORT OF WG-EMM)

Environment

6.1 The Scientific Committee noted the analyses of environmental parameters undertaken by WG-EMM (Annex 4, paragraphs 6.1 to 6.10) and, in particular, the results concerning trends in environmental factors in Area 48 (Annex 4, paragraph 6.1):

- (i) global ocean/atmosphere signals were evident in indices of the physical environment (sea-surface temperature (SST), air temperature, sea-level pressure, sea-ice extent etc.);
- (ii) approximately four-year periodicity was evident in SST and the Antarctic Circumpolar Wave;
- (iii) precession of SST anomalies across Scotia Sea was consistent with the FRAM advective transport model, suggesting transport of four to eight months between the Antarctic Peninsula and South Georgia;
- (iv) global/atmospheric signals showed strongest coherence with South Georgia, weaker coherence with the Antarctic Peninsula and the South Orkneys implying different local influences; and
- (v) a warming trend over the last seven years was apparent in the surface temperature data only at the Antarctic Peninsula and the South Orkneys.

CEMP Indices for Environmental Variables

6.2 The Scientific Committee recalled its deliberations on indices of environmental variables last year (SC-CAMLR-XVI, paragraphs 6.11 to 6.13) and welcomed the revised F2 (sea-ice) and F5 (SST) methods accepted by WG-EMM this year (Annex 4, paragraphs 9.39 to 9.46). These standard methods are now available for use in monitoring these parameters.

6.3 The Scientific Committee thanked South Africa, Russia, New Zealand, USA (Long Term Ecological Research program) and Australia (Australian Antarctic Division) for their contributions on long-term ice (F1 index), weather (F3 index) and snow (F4 index) observations at CEMP sites (Annex 4, paragraphs 9.47 and 9.48). The Scientific Committee noted that, not only were these Members the only ones to respond directly to the Scientific Committee circular in the intersessional period, they were also the major contributors of these data to CEMP. Others are known to have not responded because they did not have any data to contribute. Consequently, the Scientific Committee asked the Secretariat to proceed with the development of draft methods for the next meeting of WG-EMM using the data and methods now available.

Ecosystem Analysis

6.4 The Scientific Committee welcomed the continued development of Composite Standardised Indices (CSI) and noted that further development will require care in the choice of parameters to include in a CSI, including consideration of the correlation between indices, the time and space scales integrated by them, and the weighting factors that might be applicable (Annex 4, paragraphs 7.1 to 7.4).

6.5 The Scientific Committee also noted that these indices and other multivariate approaches are providing the means, at least in a preliminary way, by which results of CEMP can be used in assessing the status of the ecosystem. To this end, the Scientific Committee noted the two objectives for ecosystem analysis considered by WG-EMM (Annex 4, paragraph 7.6):

- (i) understanding the autecological properties of species, and the interactions between ecosystem components; and
- (ii) identifying predictive/operational models from which management advice can be derived.

6.6 The Scientific Committee endorsed the continued work of WG-EMM in developing further the multivariate approaches, including especially the exploration of the sensitivity of such analyses to the CSIs used.

Generalised Yield Model and Krill Yield Model

6.7 The Scientific Committee noted that the GYM is now available for general use (paragraph 5.36; Annex 4, paragraphs 7.9 and 7.10) and encouraged Members to undertake further testing of the program in the context of estimating yields for krill before its use in the assessments following the Area 48 synoptic survey. The Scientific Committee agreed that a high priority should be given to documenting and archiving the krill yield model so that it can be retained for cross-validation or for estimating yields should the need arise in the future (Annex 4, paragraph 7.11).

Krill-based Interactions

6.8 The Scientific Committee noted the general discussion on the coherence between results on temporal trends in krill abundance in different parts of the Scotia Sea and, in particular, the conclusions from the Workshop on Area 48 (Annex 4, paragraphs 7.12 to 7.18) that:

- (i) proportional recruitment above an index value of approximately 0.3 was correlated with sea-ice extent in the Antarctic Peninsula;
- (ii) krill density at South Georgia was associated with regional sea-ice and summer Southern Oscillation Index, in particular the low krill density, low sea-ice years of 1990/91 and 1993/94. In contrast, krill density at the Antarctic Peninsula was not associated with indices of physical variability; and
- (iii) land-based and pelagic predator indices in Subarea 48.3 were correlated with summer krill densities but were also influenced independently by physical factors. In contrast, land-based predator indices in Subarea 48.1 were not correlated with krill or physical indices.

6.9 The Scientific Committee welcomed the discussion concerning the models of krill recruitment and looked forward to the development of a predictive model of krill recruitment based on variation in environmental parameters (Annex 4, paragraphs 7.19 and 7.20).

6.10 The Scientific Committee noted the discussions concerning the interaction of krill with plankton (Annex 4, paragraphs 7.22 to 7.26), fisheries (Annex 4, paragraphs 7.27 to 7.29) and predators (Annex 4, paragraphs 7.30 and 7.31).

6.11 The Scientific Committee considered that the two indices currently available for examining the potential localised effects of krill fishing on predators, the Schroeder index and the Agnew–Phegan model, need to be further evaluated by statistical experts before asking the Secretariat to begin analysing the performance of these models. It noted that these two approaches monitor different components of the fishery–krill–predator interaction. The Schroeder index monitors the geographic overlap of the foraging range of predators and fishing while the Agnew–Phegan index compares the relative consumption of krill by the fishery with the consumption of krill by predators. The Scientific Committee noted that a means of combining these indices, i.e. combining the degree of overlap in range of consumption with the magnitudes of consumption, may be a useful index to CCAMLR. Consequently, the Scientific Committee requests such work be submitted to WG-EMM for review as soon as practicable.

6.12 In addition, the Scientific Committee noted that other initiatives need further development in order to address issues relating to the potential localised effects of krill fishing on predators. These include:

- (i) improving estimates of krill consumption by predators at appropriate spatial and temporal scales;
- (ii) further development of existing models addressing predator–krill interactions (especially Mangel and Switzer, 1998) and functional relationships between predators and prey (e.g. Butterworth and Thomson, 1995); and
- (iii) continuing investigation of the consequences of various types of conservation measure associated with precautionary approaches to management in these situations (e.g. SC-CAMLR-XII, paragraph 6.57). This will require a fresh dialogue with fishers to determine the manner in which fishing practices may be varied in local areas important to predators (SC-CAMLR-XII, paragraphs 6.65 to 6.69; CCAMLR-XII, paragraphs 8.39 to 8.45).

Fish- and Squid-based Interactions

6.13 The Scientific Committee noted the discussion concerning fish- and squid-based interactions (Annex 4, paragraphs 7.32 and 7.33).

Assessment of the Status of the Ecosystem

6.14 The Scientific Committee welcomed the progress made at the Workshop on Area 48 and the recent WG-EMM meeting in developing the tools (CSI and multivariate indices) for carrying out an ecosystem assessment and methods for presenting such an assessment (Annex 4, paragraphs 8.2 to 8.20). It noted that these methods are still being developed and require further work to fully understand how to interpret them (Annex 4, paragraph 8.20).

6.15 The Scientific Committee endorsed the development of the diagrammatic presentation of summaries of these data (Annex 4, Tables 1 to 5). Each parameter is represented as a bar graph of standardised normal deviates over time. In this way wide deviations from the norm as well as trends can be clearly seen. Additionally, some of the parameters have a five-year running mean alongside the graph to indicate general trends in the dataset.

6.16 The Scientific Committee noted that some of the interpretations and inferences in the WG-EMM report should be viewed with caution, especially where reference to correlations (e.g. Annex 4, paragraph 8.7), relationships between population size and breeding success (e.g. Annex 4, paragraphs 8.8 and 8.9) and conclusions in relation to the proximate causes of

population changes (e.g. Annex 4, paragraphs 8.8 and 8.16) are concerned. Greater use of CSI indices should improve future interpretations. In addition, the completeness of knowledge available to interpreters of these diagrams can affect their conclusions. For example, the rapid increase and subsequent decrease of gentoo penguins in Subarea 48.3 attributed by WG-EMM to migrations in relation to krill abundance (Annex 4, paragraph 8.11) had been analysed in considerable detail, especially in relation to deferred breeding in and after years of low krill availability, by Croxall and Rothery (1995). The Scientific Committee agreed that more rigorous methods for assessing trends portrayed in these diagrams need to be developed. It also agreed that WG-EMM should maintain assessment histories for each area, which would include details of published works explaining trends in these indices or associated factors. These would be very useful in order to help ensure that the absence of experts from particular meetings of the Working Group in the future would not prevent correct interpretation of these indices.

6.17 The Scientific Committee endorsed the program of work for further developing these methods by WG-EMM (in particular Annex 4, paragraphs 8.17(ii) and (iii) and 8.18) and, in particular, the Scientific Committee agreed that the properties of all CEMP parameters need to be understood in order to ensure that they are able to be interpreted correctly. It was noted that duplication of existing work should be avoided and that, where possible, previous work (e.g. the Workshop on Area 48) should be used as the basis for developing the assessment methods in WG-EMM.

6.18 The Scientific Committee recognised that the interpretation of some indices will be influenced by the spatial and temporal scales of sampling. As a first step to addressing this issue, the Scientific Committee requested that WG-EMM investigate the utility of presenting the annual trends in CSIs according to two times of the year, summer and winter, and two spatial scales, small (local) and large scale.

The Ecosystem Approach as Applied in Other Parts of the World

6.19 The Scientific Committee welcomed the introduction of this agenda item to the work of WG-EMM by Dr Everson and endorsed the aims to ensure that ideas and practices that are currently used elsewhere in the world can be considered for incorporation into the CCAMLR program and to ensure that the scientific work undertaken by CCAMLR receives consideration by other organisations, thus improving the awareness of its activities.

6.20 Mr Shotton offered the cooperation and support of FAO to hold an international meeting on the ecosystem approach to management and how various national and international bodies incorporate this approach into management of fisheries. He noted that FAO recognises CCAMLR has considerable expertise in this area, which could form the basis of such a meeting. The Scientific Committee welcomed this offer and asked that WG-EMM consider whether such a meeting would be possible soon after 2000. It also noted that the 1999 ICES/SCOR Symposium on Ecosystem Effects of Fishing should address ecosystem management issues.

Organisation of Future Meetings and Work of WG-EMM

6.21 The Scientific Committee noted the consideration given by WG-EMM to the organisation of future meetings, particularly the merits of having a major theme associated with the next meeting in order to minimise costs associated with meetings of specialists (Annex 4, paragraphs 13.2 to 13.7). It was noted that the work of WG-EMM will be concentrated on the Area 48 synoptic survey through planning in 1999 and analysis in 2000. Consequently,

additional themes may not be possible in the near future. Workshops provide another opportunity to bring together specialists on outstanding items of work requiring concentrated work.

6.22 The Scientific Committee noted the membership of two subgroups of WG-EMM established by the former WG-CEMP to carry out intersessional work (Annex 4, paragraphs 13.8 and 13.9):

- (i) designation and protection of CEMP sites: Drs Penhale and Kerry, Prof. Torres and Dr P. Wilson (New Zealand); and
- (ii) practical aspects of standard monitoring methods: Drs I. Boyd (UK), W. Trivelpiece (USA), V. Siegel (Germany), E. Murphy (UK) and Constable.

6.23 These subgroups are not exclusive and can involve others interested in participating in their work. The Scientific Committee agreed that Dr Fanta should be added to the subgroup dealing with the designation and protection of CEMP sites. The Scientific Committee agreed that the issue of membership of subgroups could be considered as a part of the agenda of WG-EMM in order that the work and membership of those groups can remain under review.

Interactions between WG-EMM and WG-FSA

6.24 The Scientific Committee noted the extensive work undertaken by the Secretariat to establish a comprehensive database on fish by-catch in the krill fishery (Annex 5, paragraphs 5.5 to 5.8). It was noted that WG-FSA was still unable to provide a clear indication of the likely impact of krill harvesting on larval and juvenile fish but that the Working Group reiterated the view that even a relatively low incidence of larval/juvenile fish in krill catches could result in a substantial impact on future abundance of key species in some areas. Scientific observations of krill fishing vessels, dialogue with fishers and sampling of blocks of frozen whole krill once landed would facilitate further assessment of this issue (Annex 5, paragraphs 5.9 to 5.12). Also, the Scientific Committee noted that studies on the distribution and abundance of larval/juvenile fish during the 1999/2000 synoptic survey for krill being planned by WG-EMM would be useful in this regard.

Convenership of WG-EMM

6.25 The Scientific Committee thanked Dr Everson for four excellent years as Convener of WG-EMM as well as his previous roles as Chairman of the Scientific Committee and Convener of WG-FSA, and expressed its appreciation to Dr Everson for agreeing to undertake a fifth and last year as Convener.

MANAGEMENT UNDER CONDITIONS OF UNCERTAINTY ABOUT STOCK SIZE AND SUSTAINABLE YIELD

7.1 One of the areas that the Commission had indicated last year that the Scientific Committee should focus on under this agenda item was the interrelationship between the different stages of development of fisheries (CCAMLR-XVI, paragraphs 10.1 to 10.3). This topic had been discussed by the Scientific Committee last year (SC-CAMLR-XVI, paragraphs 5.150 to 5.152 and 7.1 to 7.5), and it was considered further at this meeting by WG-FSA (Annex 5, paragraphs 3.88 to 3.95), with discussions focusing in part around CCAMLR-XVII/18.

7.2 In relation to fisheries that had lapsed for reasons not related to conservation concerns, and for which a stock assessment had been conducted previously by the Scientific Committee, WG-FSA had noted that an unresolved issue was the currency of the previous assessment (i.e. for how long did the assessment remain valid). This issue needs to be considered further by the Scientific Committee (paragraph 5.26; Annex 5, paragraphs 3.89 to 3.91).

7.3 The submission by the European Community of a discussion paper on a unified regulatory framework for CCAMLR based on stages of fishery development (CCAMLR-XVII/18) was widely welcomed by the Scientific Committee. This was viewed as an important initiative, and the Scientific Committee endorsed the need to develop such a framework. The Scientific Committee also agreed that the development of such a framework will take some time, and that Conservation Measures 31/X and 65/XII should remain in force until a replacement scheme is adopted.

7.4 In addition to the above points relating to the recommencement of closed or lapsed fisheries, discussion of this paper centred around scientific criteria for transitions between the other categories of fisheries. Of particular importance was the transition from a developing to an established fishery. From a scientific point of view, this should only occur when the Scientific Committee has been able to conduct a stock assessment confirming that the fishery is sustainable according to the decision rules set by the Commission. This was the intent of the Conservation Measure 65/XII in relation to exploratory fisheries, particularly in respect of the need to continue to classify a fishery as exploratory until such time as sufficient information as set out in paragraph 1(ii) of the conservation measure is available. The Scientific Committee agreed that it is important that any new framework should retain this requirement. The opinion was expressed that this would be more consistent with the application of a precautionary approach, especially since the proposed framework made it possible to transfer directly to established fishery status immediately following notification.

7.5 The prominence given in the discussion paper to the need for prior notification was strongly endorsed by the Scientific Committee.

7.6 When estimating yield levels for new and exploratory fisheries for *D. eleginoides*, once again in the absence of direct estimates of recruitment for a particular area, it has been necessary in a number of cases to extrapolate recruitment and stock discreteness levels from those estimated in different areas (SC-CAMLR-XVI, paragraph 7.9). This procedure introduces an additional degree of uncertainty to estimated yields that can only be eliminated when research surveys have been conducted to estimate recruitment or biomass in each area for which yields are to be calculated (paragraph 9.28).

7.7 The development of a long-term management strategy for *C. gunnari* remains a high-priority item of future work for the Scientific Committee. However, at this meeting a number of urgent topics relating to the assessment of *D. eleginoides* were identified (Annex 5, paragraph 9.11). These were felt by the Scientific Committee to be of higher immediate priority than the conducting of the planned Workshop on *C. gunnari* (Annex 5, paragraphs 9.7 to 9.10), which it therefore recommended be postponed until after 1999.

7.8 Last year, the Scientific Committee had discussed the possible need for a change to the boundary between Subareas 58.6 and 58.7. In its discussion on stock boundaries this year, WG-FSA had concluded it would be preferable if *Dissostichus* spp. stocks were managed using geographical units that normally were smaller than the statistical areas currently used (Annex 5, paragraphs 3.151 to 3.154). Annex 5, Figure 1 illustrates such management units. If this approach is taken, the need to change the boundary between Subareas 58.6 and 58.7 is removed (paragraphs 5.37 to 5.39).

7.9 The Scientific Committee recognised that it did not have good knowledge of the levels of by-catch in many parts of the Convention Area or of its potential effects on stocks of the by-catch species. It noted, however, that a number of the by-catch species, especially

elasmobranchs, were known to be particularly vulnerable to overfishing. This issue is discussed in paragraphs 5.127 to 5.130. For these and other potentially vulnerable species, much of the data are still being collected. In such circumstances, it is important that by-catch regulations be balanced. On the one hand, they should aim to ensure that the catches of by-catch species are not sufficiently large as to threaten the sustainability of stocks of those species. However, on the other hand they should not be so restrictive as to encourage dumping of the by-catch species, with a consequent loss of valuable information. Prof. Moreno also noted that for elasmobranchs, there was an urgent need for better taxonomic keys to enable more accurate recording of by-catch data at the species level (Annex 5, paragraph 9.3).

7.10 Given the proposed changes to by-catch provisions recommended by the Scientific Committee this year (paragraph 5.115), it was agreed that WG-FSA should be asked to consider the effectiveness of by-catch regulations at its next meeting in the light of observer information collected during the year. WG-FSA should also be asked to consider appropriate ways in which by-catches on longlines can be quantified.

7.11 A new source of uncertainty in assessments and management of *Dissostichus* spp. identified at this meeting was in the conversion factors used to estimate green weight from processed catch weight. This is discussed in paragraph 3.6.

SCIENTIFIC RESEARCH EXEMPTIONS

8.1 The Scientific Committee noted the five notifications under Conservation Measure 64/XII of scientific research surveys planned for the 1998/99 intersessional period (CCAMLR-XVII/BG/4, Table 5):

- (i) France (*La Curieuse*) in Division 58.5.1 during winter 1999 (mesopelagic fish);
- (ii) UK (*James Clark Ross*) in Subarea 48.3 in January 1999 (krill);
- (iii) USA (*Laurence M. Gould*) in Subarea 48.1 in March to July 1999 (plankton and various Antarctic fish);
- (iv) USA (*Nathaniel B. Palmer*) in Subarea 48.1 in May and June 1999 (krill, silverfish and zooplankton); and
- (v) USA (*Yuzhmorgeologiya*) in Subareas 48.1 and 48.2 in February to March 1999 (finfish).

8.2 In addition, Australia had notified of its intention to conduct a pre-recruitment survey for *C. gunnari* between May and August 1999 in the Heard Island Plateau and Shell Bank areas of Division 58.5.2, and to take approximately 20 kg of *E. superba* in Divisions 58.4.1 and 58.4.2 during 1998/99 (CCAMLR-XVII/MA/6). Argentina also indicated its intention to conduct a finfish survey in Subarea 48.3 (CCAMLR-XVII/MA/17).

8.3 The Scientific Committee noted that the estimated total catch for each survey notified for 1998/99 is expected to be less than 50 tonnes.

NEW AND EXPLORATORY FISHERIES

New Fisheries in 1997/98

9.1 There were seven conservation measures relating to new fisheries in force during the 1997/98 season, but fishing was conducted under the terms of only three of these measures. Summary information on the seven new fisheries during 1997/98 is contained in CCAMLR-XVII/BG/4 Rev. 1. Data received by the Secretariat in relation to these fisheries were summarised in Annex 5, Table 2.

9.2 Throughout this section, a split-year is the statistical reporting period which runs from 1 July in one year through to 30 June in the following year. Fishing seasons do not necessarily align with split-years, although catch data are frequently summarised by split-year. For new and exploratory fisheries, the seasons are explicitly set out in individual conservation measures.

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

9.3 Chile conducted a prospecting longline cruise to determine the feasibility of new fisheries in these areas. The cruise was conducted during February and March 1998; results from the cruise were reported in SC-CAMLR-XVII/BG/7 Rev. 1. It was concluded that new fisheries in Subareas 48.1, 48.2 and 88.3 would not be feasible, and commercial-scale fishing operations were not conducted in these three subareas.

New Fisheries for *Dissostichus* spp. in Subareas 48.6 and 88.2 and Divisions 58.4.3 and 58.4.4

9.4 New fisheries for *Dissostichus* spp. for 1997/98 had been notified by South Africa in Subarea 48.6 and Divisions 58.4.3 and 58.4.4, by Norway in Subarea 48.6, by Ukraine in Division 58.4.4 and by New Zealand in Subarea 88.2. None of these new fisheries took place.

Exploratory Fisheries in 1997/98

9.5 Five conservation measures relating to exploratory fisheries were in force during 1997/98; fishing was conducted under the terms of four of these measures. Summary information on all five exploratory fisheries is contained in CCAMLR-XVII/BG/4 Rev. 1.

Exploratory Longline Fisheries for *D. eleginoides* in Subareas 58.6 and 58.7 outside EEZs

9.6 The exploratory fisheries for *D. eleginoides* notified by Ukraine and Russia in Subareas 58.6 and 58.7 outside EEZs during 1997/98 did not take place.

9.7 South African vessels did, however, conduct exploratory fishing operations for *D. eleginoides* in Subareas 58.6 and 58.7 outside the EEZs during 1997/98. One vessel fished in each subarea and the total catch in these areas was about 1 tonne.

Exploratory Longline Fisheries for
Dissostichus spp. in Subarea 88.1

9.8 In Subarea 88.1, one vessel from New Zealand conducted exploratory fishing operations from 21 February to 25 March 1998. All fishing was conducted south of 65°S. Fishing was carried out over 30 fine-scale rectangles and a total of 41 tonnes was taken. *D. eleginoides* was recorded much further south than previously reported with a 7.5-kg fish caught at 73°S. *D. mawsoni* was present throughout the region, extending as far north as 65°S. *Dissostichus* spp. were present in 97% of the fine-scale rectangles, indicating these species are present over wide areas of Subarea 88.1.

Exploratory Trawl Fishery for
Dissostichus spp. in Division 58.4.3

9.9 Australia notified the Commission of its intent to conduct an exploratory trawl fishery in Division 58.4.3 during 1997/98. No fishing did, however, take place.

Exploratory Jig Fishery for *M. hyadesi* in Subarea 48.3

9.10 Although the UK and the Republic of Korea notified the Commission of their intentions to conduct an exploratory squid fishery in Subarea 48.3, no vessels fished under the terms of Conservation Measure 145/XVI after 8 November 1997.

New Fisheries Notified for 1998/99

9.11 New fisheries notifications for 1998/99 were summarised in Annex 5, Table 16. All new fisheries notifications were for subareas and divisions that had been new fisheries in 1997/98 but where no fishing had occurred. The checklist approach, developed at the previous meeting of WG-FSA, was used again to aid its discussions of new fisheries notifications for 1998/99.

New Longline Fisheries for *Dissostichus* spp.
in Subarea 48.6 and Division 58.4.4 (South Africa)

9.12 South Africa submitted a notification (CCAMLR-XVII/10) for new fisheries for *Dissostichus* spp. in Subarea 48.6 and Division 58.4.4.

9.13 The notification was essentially a restatement of the intentions that South Africa made at the last meeting of the Commission. The South African notification addresses all the requirements of Conservation Measure 31/X and the points in SC-CAMLR-XV, paragraph 8.17. The South African notification was the only notification received for a new fishery in Subarea 48.6. France, Spain and Uruguay have also submitted notifications for new fisheries in Division 58.4.4.

9.14 The South African notification contained a description of a 'sliding scale' for biological sampling. According to the notification, biological sampling will be dependent on catch levels. The Scientific Committee considered that such an approach might be useful for providing guidance to observers and agreed that, if such a sampling scheme is conducted, South African scientists should advise on the advantages and disadvantages of such a scheme.

New Longline Fisheries for *D. eleginoides*
in Division 58.4.4 (Spain and Uruguay)

9.15 Spain submitted a notification (CCAMLR-XVII/12) for an exploratory fishery for *D. eleginoides* in Division 58.4.4. It was noted that although the Spanish notification was titled ‘Notification of Spain’s intention to initiate an exploratory fishery,’ the notification should actually be for a new fishery under the definition in Conservation Measure 31/X. As such it was agreed to evaluate the notification as one for a new fishery. The Spanish notification addresses all the requirements of Conservation Measure 31/X and the points in SC-CAMLR-XV, paragraph 8.17.

9.16 It was noted that the notification by Spain did not include any information on position verification. It was confirmed by Mr L. López Abellán (Spain) that the vessels would be equipped with VMS, and unfortunately this information had been omitted from the notification.

9.17 Uruguay also submitted a notification (CCAMLR-XVII/19) for a new fishery for *D. eleginoides* in Division 58.4.4. The Uruguayan notification addresses all the requirements of Conservation Measure 31/X and the points in SC-CAMLR-XV, paragraph 8.17.

9.18 The Scientific Committee noted that some notifications were submitted after the deadlines set out in Conservation Measure 31/X, paragraph 2, but that these were still evaluated. It was further noted that the purpose of these deadlines was to have enough time at hand for the review process. Regarding this aspect the Scientific Committee seeks the guidance of the Commission as to how late submissions of fishery notifications should be handled in the future.

New Trawl and Longline Fisheries for *D. eleginoides*
in Subareas 58.6 and 58.7 outside EEZs and
Divisions 58.4.3 and 58.4.4 (France)

9.19 France submitted a notification (CCAMLR-XVII/9 Rev. 1) for new fisheries for *D. eleginoides* in Subareas 58.6 and 58.7 and Divisions 58.4.3, 58.4.4, 58.5.1 and 58.5.2 (outside EEZs). The notification was for both longline and trawl fisheries. Prof. Duhamel clarified that the notification no longer applied for Divisions 58.5.1 and 58.5.2. As such, the Scientific Committee only considered the notification in respect of Subareas 58.6 and 58.7 and Divisions 58.4.3 and 58.4.4 (outside EEZs). The French notification addresses all the requirements of Conservation Measure 31/X and the points in SC-CAMLR-XV, paragraph 8.17.

9.20 The French notification overlaps many other notifications. South Africa, Spain and Uruguay also submitted notifications for new fisheries in Division 58.4.4. South Africa submitted notifications for exploratory fisheries in Subareas 58.6 and 58.7 (outside EEZs) and Australia submitted a notification for an exploratory fishery in Division 58.4.3. The Scientific Committee viewed the overlap between the French notification and the notifications by other Members with some concern because there could be trawl fisheries and longline fisheries simultaneously operating in the same area.

9.21 Currently, separate assessments are conducted for longline and trawl fisheries by WG-FSA. It is expected that WG-FSA will be able to provide mixed-fishery assessments next year. To conduct such assessments using the GYM, it would be necessary to have an estimate of the proportion of the total fishing effort (or catch) that would be expended (or caught) by each gear type. The Scientific Committee noted that such an estimation might require an allocation of total effort between longline and trawl fisheries. In this regard, the Scientific Committee agreed that the Commission needs to provide advice on issues of allocation between competing gear types operating in the same area.

9.22 In resolving the problem the Scientific Committee noted that it was unable to provide yield estimates for a mixed fishery at this stage. A series of assessments were, however, given for either a longline or a trawl fishery in these areas. This was done under the assumption that only one of these gear types would be used and in this respect the assessments should be considered as very separate entities and not additive. The Scientific Committee considered that the maximum catch for a statistical area should be no more than the yield estimated for longlining, as this is greater than the yield for trawling in this case. Also, the catch for the trawl component of the mixed fishery should be no greater than the yield estimated for the trawl fishery. The Scientific Committee agreed that the yield for the respective gear types should be discounted in some way when the other gear type is also being used in the same management area but could not determine a suitable scientific method for achieving this at this meeting.

9.23 Again, in relation to the French notification, the Scientific Committee noted the advice of WG-FSA (Annex 5, paragraph 4.33) that new trawl fisheries are not required to distribute fishing effort over a wide area and that 100-tonne catch limits for fine-scale rectangles should be applied to new trawl fisheries, as they are for new longline fisheries.

9.24 While the general principle of distributing effort in new fisheries should be retained in order that localised depletions do not occur, the Scientific Committee agreed that this restriction may have different ramifications for the operation of trawl fisheries. The Scientific Committee agreed that the recommendation of WG-FSA be carried forward to the Commission, but requested that WG-FSA review at its next meeting the spatial extent of local populations. Such a review should be aimed at providing advice as to how catch and effort should be distributed in fine-scale rectangles in order that the depletion of local stocks is unlikely to occur as a result of new or exploratory fisheries.

9.25 It was noted that France's notification was that fishing operations would be conducted during the whole 1998/99 season. The implications of a year-long fishery on incidental mortality of seabirds are discussed in Annex 5, paragraph 7.116. Prof. Duhamel clarified that France would follow the Commission's direction with respect to the length of the fishing season, but noted that a year-long fishery would make it easier to monitor unregulated fishing in the Convention Area. If there is substantial unregulated fishing during a closed season, incidental mortality to seabirds could be increased. Prof. Duhamel also noted his concern that fishing only in winter would cause all catches to be taken during the *D. eleginoides* spawning season.

9.26 The Scientific Committee also noted that the French notification stated that an observer working under CCAMLR's International Scheme of Scientific Observation would 'possibly' be on board each vessel participating in the new fisheries. Prof. Duhamel clarified that a CCAMLR observer would definitely be on board each vessel participating in the new fisheries. There will also be a French observer on board each vessel.

Exploratory Fisheries Notified for 1998/99

9.27 Exploratory fisheries notifications for 1998/99 are listed in Annex 5, Table 16. All three notifications for exploratory fisheries in 1998/99 were for fisheries that were also in the exploratory stage during 1997/98. None of the fisheries that were considered to be new fisheries at the last meeting of the Commission have been notified as exploratory for the coming season.

9.28 In the preamble to Conservation Measure 65/XII, the Commission had agreed that exploratory fishing should not be allowed to expand faster than the acquisition of information necessary to ensure that the fishery can and will be conducted in accordance with the principles set forth in Article II. A vital element in ensuring this is the ability of the Scientific Committee to conduct stock assessments. For *Dissostichus* spp., the GYM assessment method currently

used by WG-FSA requires estimates of recruitment. For longline fisheries for *Dissostichus* spp., the Scientific Committee has in the past been unable to assess the status of the stocks using data from longline fishing only. The Scientific Committee agreed that conducting research surveys was an essential element of the precautionary development of exploratory fisheries. The Scientific Committee therefore recommended that research surveys to estimate biomass be included at the very early stages of the development of new and exploratory fisheries for *Dissostichus* spp. In this context, the Scientific Committee welcomed the inclusion of plans for the early conduct of research surveys in the notification by Australia.

Exploratory Longline Fisheries for *Dissostichus* spp.
in Subareas 58.6 and 58.7 (South Africa)

9.29 South Africa submitted a notification (CCAMLR-XVII/14) for exploratory fisheries for *Dissostichus* spp. in Subareas 58.6 and 58.7 (outside EEZs). The South African notification for exploratory fisheries in Subareas 58.6 and 58.7 (outside EEZs) coincides with notifications by France for new longline and trawl fisheries in these subareas.

Exploratory Trawl Fisheries for *Dissostichus* spp.
in Divisions 58.4.1 and 58.4.3 (Australia)

9.30 Australia submitted a notification (CCAMLR-XVII/11) for exploratory trawl fisheries for *Dissostichus* spp. in Divisions 58.4.1 and 58.4.3. The Australian notification for an exploratory trawl fishery in Division 58.4.1 does not overlap with notifications from other Members. The notification for an exploratory trawl fishery in Division 58.4.3 coincides with a notification by France for a longline fishery in this division.

9.31 The Scientific Committee noted that the Australian notification is essentially the same as the notification made at the last meeting of the Commission and applies only to Elan and BANZARE Banks. It was felt that it should be brought to the attention of the Commission that during 1997/98 exploratory trawling on these banks was supposed to be conducted under the terms of Conservation Measure 144/XVI. Conservation Measure 144/XVI was clearly intended to permit exploratory fishing over the entirety of both banks, but a large portion of BANZARE Bank is included in Division 58.4.1 and this division was closed to directed fishing for *Dissostichus* spp. under the terms of Conservation Measure 120/XVI. Thus, the Australian notification is a resubmission that includes notification of intention to fish in a small portion of Division 58.4.1 (that portion covering BANZARE Bank).

Exploratory Longline Fishery for *Dissostichus* spp.
in Subarea 88.1 (New Zealand)

9.32 New Zealand submitted a notification (CCAMLR-XVII/13 Rev. 1) for an exploratory fishery for *Dissostichus* spp. in Subarea 88.1. New Zealand's notification lays out a scheme for determining catch limits in fine-scale rectangles based on decision rules related to initial catch rates. Under the scheme, catch limits for fine-scale rectangles are increased when initial catch rates are high. The Scientific Committee noted that similar schemes for determining catch limits in fine-scale rectangles had previously been suggested by South Africa (CCAMLR-XVI/8 Rev. 1) and New Zealand (CCAMLR-XVI/17). The Scientific Committee agreed that, in principle, there might be some merit in setting catch limits for fine-scale rectangles based on decision rules related to initial catch rates. However, the Scientific Committee had some difficulty with the scheme outlined in New Zealand's notification. The Scientific Committee recognised that the decision rules outlined in New Zealand's notification are based on

information about *D. eleginoides* catch rates from the Falkland/Malvinas Islands. This could be problematic because the decision rules in Subarea 88.1 should also be based on information about catch rates of *D. mawsoni*. The Scientific Committee determined that a detailed analysis of catch rates of *D. mawsoni* could not be undertaken at this meeting. In this regard, the Scientific Committee reiterated its decision last year that it could consider the adaptive approach further if a paper considering further development of it was submitted for the Scientific Committee's consideration at its next meeting (SC-CAMLR-XVI, Annex 5, paragraph 4.81).

9.33 Dr K. Sullivan (New Zealand) undertook to have the necessary analyses completed for consideration at next year's WG-FSA and Scientific Committee meetings.

9.34 Due to the exploratory nature of the fishery in Subarea 88.1 a significant by-catch of *M. carinatus* (9.48 tonnes; 17% of the total catch; 23% of the *Dissostichus* spp. catch) was caught. In this regard, the New Zealand notification proposed a 200-tonne by-catch limit for *Macrourus* spp. in Subarea 88.1. The Scientific Committee could not determine whether a by-catch limit of 200 tonnes would be appropriate for *Macrourus* spp. as there is almost no information on these fish (see also paragraphs 5.115 and 5.116).

9.35 New Zealand's notification indicated that the 1997/98 fishing season in Subarea 88.1 was severely restricted by the presence of ice, both icebergs and sea-ice. The 1997/98 fishing season in Subarea 88.1 began in the late austral summer, and, due to the rapid growth northwards of the ice shelf in mid-March, there was only a four-week period that could be fished within the Ross Sea. In this regard, the New Zealand notification proposed that the 1998/99 fishing season start on 15 December 1998. The Scientific Committee considered this proposal in relation to its impacts on incidental mortality of seabirds (paragraphs 4.66 to 4.70).

9.36 The Scientific Committee noted that notifications for new and exploratory fisheries were submitted in a standardised format making analyses easier than in previous years. The Scientific Committee further recommended that this standardised approach be followed for future notifications.

Calculation of Precautionary Catch Levels

9.37 Precautionary catch limits for new and exploratory fisheries were calculated by WG-FSA by extrapolation using parameters from the assessments of estimated yields for *D. eleginoides* in Subarea 48.3 for longlining and Division 58.5.2 for trawling. The Working Group calculated precautionary catch limits for new and exploratory fisheries with the GYM. The calculations involved five main components.

- (i) Estimates of mean recruitment in each area under consideration were obtained by proportional adjustments for fishable seabed areas. For longline fisheries the adjustments used the relative areas of seabed between 600 and 1 800 m. For trawl fisheries, the depth range used was 500 to 1 500 m.
- (ii) Other biological and fishery parameters were set equal to the values most appropriate for the area under consideration. For most areas, this meant using parameters from assessments for Subarea 48.3 for longline fisheries, or those for Division 58.5.2 for trawl fisheries.
- (iii) The recent catch history for each area under consideration was updated to include the most recent information on regulated and unregulated catches.
- (iv) The GYM was run for each area under consideration to determine potential long-term annual yield.

- (v) A discounting of these yields was considered in order to account for the uncertainty of extrapolating parameters for *D. eleginoides* to previously unfished or lightly fished areas.

9.38 WG-FSA had considerable discussion about which seabed area values would be most appropriate for calculating the precautionary catch limits. This discussion is summarised in Annex 5, paragraphs 3.151 to 3.154 and paragraphs 4.62 to 4.64. The Scientific Committee endorsed the use of seabed areas to estimate adjusted mean recruitments as provided in Annex 5, Table 15. The Scientific Committee also endorsed the plans of WG-FSA to undertake further work on stock boundaries.

9.39 The Scientific Committee endorsed the methods for estimating yield used by WG-FSA (Annex 5, paragraphs 4.57 to 4.72). It noted the oversight in the parameters for recruitment in Subarea 48.3 (paragraph 5.47) and agreed to rerun the GYM calculations for new and exploratory longline fisheries that were based on these parameters. These results are presented in Table 7.

9.40 The Scientific Committee reiterated a statement made by WG-FSA expressing concern that the available knowledge about *D. mawsoni* was much less than that for *D. eleginoides*. This implied that precautionary catch levels calculated would be more uncertain for *D. mawsoni* than for *D. eleginoides*. In these circumstances, it may be appropriate for a greater discount factor for uncertainty to be applied for *D. mawsoni*. The discount factor used for *D. eleginoides* was 0.45, matching the factor used by the Commission for calculating precautionary catch limits during the last two years. The discount factor used for *D. mawsoni* was 0.30.

9.41 The Scientific Committee emphasised that there is no scientific basis for selecting a particular value for any discount factor.

9.42 The precautionary yields, according to these discounted factors, are presented in Table 8. The Scientific Committee reiterated last year's account of the intrinsic uncertainties involved in the calculation of precautionary yields and noted that the results in Tables 7 and 8 must be interpreted with considerable caution. These intrinsic uncertainties were:

- (i) the values calculated for precautionary catch limits should not be taken to imply that such quantities of fish would actually be available for capture;
- (ii) the calculation procedure relies explicitly on extrapolation from assessments of existing fisheries to new and exploratory fisheries in previously unfished or lightly fished areas. In particular, it makes the assumption that the recruitment rate per unit area of fishable seabed is the same across all areas;
- (iii) there is greater uncertainty associated with the calculations for *D. mawsoni*, and the discount factors used are arbitrary; and
- (iv) the estimates of unreported catches are uncertain.

9.43 Despite these uncertainties, the Scientific Committee agreed that the methods used to calculate precautionary catch limits were the best available given existing information.

Management Advice

9.44 The Scientific Committee recommended that the precautionary yield estimates given in Table 7 for *D. eleginoides* and *D. mawsoni* be used when calculating catch limits for the new and exploratory fisheries operating during 1998/99 but that these should be discounted to allow for uncertainties in these input parameters, such as in Table 8.

9.45 The Scientific Committee agreed that mixed fisheries require careful consideration because estimated yields for single trawl and longline fisheries cannot be added together to derive a total yield of *D. eleginoides* from a management area. If in the course of a season only one method of fishing is undertaken, then the yield assessed for that method of fishing can be applied. However, a mixture of trawl and longline fishing presents a special problem because these methods fish different parts of the stock. This means that the total catch from a mixed fishery should be less than the highest yield, which in this case is the longline yield. The Scientific Committee recognised that in a mixed fishery the yield for the trawl fishery should be discounted by some proportion if a longline fishery is present and that the yield for the longline fishery should be discounted by some proportion if a trawl fishery is present. An example could be that the catch limit for trawling be set as the proportion of total effort (or some other allocation) given to trawling multiplied by the estimate of yield for trawling. Similarly, the catch limit for longlining could be the proportion of total effort (or some other allocation) given to longlining multiplied by the estimate of yield for longlining.

9.46 The Scientific Committee agreed that advice could not be given this year on how to apportion catches in a mixed fishery other than that discussed above. The Scientific Committee recommended that notifications of new or exploratory fisheries should include the minimum viable catch and, where possible, which management units/areas the fishery will be located in. This information can then be used by WG-FSA to advise on long-term annual yields for each method in a mixed fishery. The Scientific Committee requested guidance from the Commission on how yields should be divided between different types of fisheries.

9.47 The Scientific Committee agreed with the view put forward by WG-FSA that new trawl fisheries should be required to distribute fishing effort over a wide area and that 100-tonne catch limits for fine-scale rectangles should also apply to new trawl fisheries. These limitations already apply to longline fisheries. This will be reviewed by WG-FSA next year.

9.48 The Scientific Committee recommended that research surveys to estimate biomass be included at the very early stages of the development of new and exploratory fisheries for *Dissostichus* spp. In this regard, the Scientific Committee noted that in the past it has been unable to assess the status of *Dissostichus* spp. stocks using data from longline fishing only.

9.49 The Scientific Committee noted the recommendation of WG-FSA to retain the two main principles for by-catch species (Annex 5, paragraph 4.202). It was further agreed that there should be by-catch limitations on exploratory longline fisheries that are similar to those currently in force for exploratory trawl fisheries. The principle of by-catch limitations should be to require that longliners move to other fishing locations when there is a relatively high by-catch on any one haul. By-catch limitations should be operationally flexible and simple to understand. The Scientific Committee agreed that the scheme set out in paragraph 5.115 would be a reasonable way to proceed.

9.50 Management advice stemming from consideration of seabird by-catches in new and exploratory fisheries is given in paragraphs 4.60 to 4.70.

DATA MANAGEMENT

Intersessional Work

10.1 Last year, the Scientific Committee agreed that Dr Ramm (Data Manager) should submit a regular status report to the Scientific Committee on progress in the management of CCAMLR data (SC-CAMLR-XVI, paragraph 10.14). The status report was specifically aimed at addressing the measures taken to maintain the integrity of the CCAMLR database (SC-CAMLR-XVI, paragraph 10.13(i)).

10.2 Dr Ramm reported on these measures and, more generally, on the work undertaken by the Secretariat's Data Management group since last year's meeting (SC-CAMLR-XVII/BG/6). These activities included the work of Mr N. Williams (Computer Systems Officer) and Mr E. Appleyard (Scientific Observer Data Analyst), Ms N. Slicer (part-time Data Management Assistant) and Mrs L. Millar (part-time Data Entry Specialist). The group had also received support from Mr D. O'Connor (short-term contract programmer) from February to April to assist with the development of programs associated with CEMP indices, fishery data entry, and the generation of tables for the *Statistical Bulletin*, and from May to early October to assist with the development of the CCAMLR website.

10.3 The increasing needs of the Commission and Scientific Committee had led to increases in the quantity of data processed and managed by the Secretariat. The amount of data processed is doubling approximately every three years. Recent increases were attributed largely to the submission of haul-by-haul data from longline fisheries and data collected under the CCAMLR Scheme of International Scientific Observation.

10.4 A major role of Data Management was to ensure that the integrity of the data was maintained, and this was achieved by:

- (i) developing the CCAMLR database so that it continued to meet the evolving needs of the Commission and Scientific Committee;
- (ii) maintaining the primary database system (SQL Server) at a high level of efficiency so as to take advantage of recent developments in database software and computer hardware;
- (iii) safeguarding the CCAMLR database against changes which may compromise the integrity of historical data; and
- (iv) maintaining a high level of security for accessing and using CCAMLR data.

10.5 Another major role of Data Management was to support the analyses of the Commission and Scientific Committee. This involved close collaboration with participating scientists, and the exchange of data, information and computer programs. The Scientific Committee noted that this exchange could only operate effectively if both parties used compatible software and, specifically, if the Secretariat maintained an up-to-date suite of software.

10.6 As with the CCAMLR database, maintaining the integrity of routine analyses was a continuous process which was achieved by:

- (i) developing the routine analyses so that these continue to meet the evolving needs of the Commission and Scientific Committee; and
- (ii) updating existing routines (e.g. CEMP indices, routines for generating tables in the *Statistical Bulletin*) so that these continue to operate correctly as the CCAMLR database evolves.

10.7 The report (SC-CAMLR-XVII/BG/6) also highlighted the activities of the Data Management group during the intersessional period. Details of the work in support of WG-EMM and WG-FSA had been presented to these working groups in a summarised format (WG-EMM-98/23 and WG-FSA-98/5) and in related meeting papers. The highlights included:

- (i) validation of the GYM;
- (ii) monitoring fisheries under the conservation measures in force;
- (iii) developing the method for analysing bathymetry data;

- (iv) developing the routine analyses of CEMP data and indices;
- (v) producing Volume 10 of the *Statistical Bulletin*, covering the split-years 1987/88 to 1996/97; and
- (vi) developing the CCAMLR website.

10.8 The Scientific Committee endorsed the tasks allocated to the Secretariat by the Working Groups during the forthcoming intersessional period (Annex 4, paragraphs 12.2 to 12.4 and 12.6; Annex 5, paragraphs 9.16 to 9.20). These tasks included the transfer of survey data to the newly designed database, and the correction of problems and errors identified by Drs Gasiukov and Everson (Annex 5, paragraphs 3.6 and 3.7).

Coordinating Working Party on Fisheries Statistics (CWP)

10.9 The Scientific Committee discussed a proposal for Dr Ramm to participate in the Eighteenth Session of CWP, scheduled in Luxembourg from 6 to 9 July 1999. The provisional agenda of that meeting (CCAMLR-XVII/BG/9, Appendix 2) included consideration of STATLANT issues (item 8), statistical implications of the precautionary approach (item 12), and elasmobranch statistics (item 13).

10.10 The Scientific Committee considered that participation at this meeting would promote:

- (i) development of methods for collecting fishery data, including statistics on elasmobranchs;
- (ii) exchange of trade data including information on commodity classification and foreign landings and transshipping;
- (iii) exchange of data on landings and fleet and fishery statistics;
- (iv) exchange of information on the methods for collecting fishery and by-catch data, including observer programs and VMS; and
- (v) links with regional fishery agencies.

10.11 The Scientific Committee noted that some links were already established, and that some of the information on the trade of *Dissostichus* spp. used during the recent meeting of WG-FSA had been provided by FAO.

10.12 The Scientific Committee encouraged and supported Dr Ramm's participation at the CWP meeting, and provided guidance for the development of papers on CCAMLR's contribution to the meeting. Specifically, under item 12 of the provisional agenda, the Scientific Committee was interested about progress in the ecosystem approach to resource management, and:

- (i) how far advanced other agencies were in data submission protocols and analyses; and
- (ii) how other agencies derived management advice from ecosystem analyses.

10.13 The Scientific Committee proposed that, if possible, item 12 of the provisional agenda should be aimed at defining the types of data that were required to facilitate the ecosystem approach to resource management.

10.14 The Scientific Committee endorsed the allocation of funds to support Dr Ramm's participation at the CWP meeting.

CCAMLR Website

10.15 At the Sixteenth Meeting of CCAMLR, the Commission had agreed that the objective of the CCAMLR website would be to provide a framework for organising, presenting and delivering information to Members, related organisations and the general public (CCAMLR-XVI, paragraph 4.25; see also SC-CAMLR-XVI, paragraph 10.8). The information was to be delivered at two levels:

- (i) general information and some published material would be available to Members and the general public via open-access webpages; and
- (ii) detailed information, meeting business and selected datasets would be restricted to meeting participants and approved users via password-protected webpages.

10.16 The Scientific Committee noted that the Secretariat had begun work on the website. Sections of the website were developed and some webpages were made available to participants at the 1998 meetings of WG-EMM and WG-FSA. In early October, selected webpages containing general information were released for preview by the Commission. The website homepage (<http://www.ccamlr.org>) was language neutral, and it is intended to present information and documents in all four languages of the Commission (CCAMLR-XVII/BG/23).

10.17 The Scientific Committee agreed that effective use of the website would:

- (i) enhance the work of Members, both intersessionally and during meetings, by expediting the exchange of material and facilitating communication and the decision-making processes as the website will allow immediate access to CCAMLR's bibliography, meeting papers, reports, publications, maps, data requirements, and summary data;
- (ii) allow the immediate viewing by Members of specific information as and when it is received by the Secretariat;
- (iii) provide a further option for the dissemination of publications, including booklets and educational material which, in comparison with the production and dissemination of paper-based publications, will be relatively inexpensive and will immediately reach a worldwide audience; documents can also be posted on the website in a specific format for downloading and printing as required; and
- (iv) allow the general public, including students, to access general information about CCAMLR; the timely presentation of information on the website will allow a better informed and more focused debate of CCAMLR matters.

10.18 The Scientific Committee noted that working group participants who had accessed the website prior to the meeting of WG-EMM had found that the webpages had been well structured and presented, and had provided valuable information prior to the meeting. WG-EMM had found that the website had the potential to grow into a very useful tool which would facilitate the exchange of information and expedite decision-making (Annex 4, paragraph 13.13).

10.19 In addition, Dr Everson advised that the website would be valuable in drawing public awareness to the work of CEMP and increase the awareness of the program. At a broader scale, the website would facilitate the exchange of information between agencies within the Antarctic Treaty System.

10.20 Dr Naganobu pointed out the importance of a security system and the Scientific Committee discussed the various levels of security afforded to the website. Dr Ramm explained that the guiding principle used in developing the security system for the website was that information and documents on the website were afforded a level of security equivalent to those already in place within the Secretariat and at CCAMLR meetings. For example, open access would be given to published documents such as the *Statistical Bulletin* which are already in the public arena. In contrast, access to meeting papers which were currently provided as hard copies would be restricted to meeting participants.

10.21 The Scientific Committee agreed that the proposed use of passwords to restrict access to parts of the webpages containing detailed information (paragraph 10.15(ii)) would provide adequate protection to CCAMLR information not in the public domain. It was agreed that the security of such information should be kept under constant review.

10.22 The Scientific Committee agreed that the development of the website must proceed as an important task alongside the other urgent data management priorities for the intersessional period, and endorsed the recommendations made by WG-EMM in that regard (Annex 4, paragraphs 13.14 to 13.16). In addition, Dr Ramm was asked to investigate ways of linking the website to other agencies within the Antarctic Treaty System, and to those of Members of the Joint Committee on Antarctic Data Management.

COOPERATION WITH OTHER ORGANISATIONS

Reports of Observers from International Organisations

SCAR

11.1 The Scientific Committee noted with pleasure the presence of Dr Fanta as Observer from SCAR at this meeting and believed that it would facilitate collaboration between SCAR and CCAMLR.

11.2 Dr Fanta presented a report on the Tenth Meeting of SCAR's Group of Specialists on Environmental Affairs and Conservation (GOSEAC), held in Basel, Switzerland, in September 1998 (SC-CAMLR/XVII/BG/21). The main points of interest to CCAMLR are listed below.

- (i) The introduction of non-native species in the Antarctic may interfere with the local biota and SCAR recommended that such introductions be reported and monitored; 'zero' tolerance was not seen as a practical solution.
- (ii) Methods for environmental monitoring for the detection of impacts caused by human activity in the area included chemical, behavioural, physiological and biochemical methods. Individual variability and natural fluctuations at populational level, as well as the lack of enough baseline data were seen as limiting factors in the interpretation of the results. The influence of activities outside the Treaty area, mainly related to fisheries activities was also noticed. A close collaboration with WG-EMM was identified as important.
- (iii) Codes of conduct developed to protect bird and seal populations or individuals from the effects of human presence should be developed within a precautionary perspective in the absence of adequate scientific data.
- (iv) Management plans were seen as useful tools to avoid or minimise impacts of human activity in the Treaty area.

- (v) A potential increase in the interest of commercial exploitation of biological resources other than fisheries (mainly for pharmaceutical purposes) was identified and SCAR recommended that CCAMLR remains attentive with respect to marine organisms.

IWC

11.3 The Observer from IWC, Ms D. Thiele had reported on the plans to have IWC observers conduct whale sightings during the CCAMLR synoptic krill survey in Area 48 (paragraphs 4.13 and 4.30).

FAO

11.4 The Observer from FAO, Mr Shotton, deferred presentation of his report (CCAMLR-XVII/BG/44) to the meeting of the Commission. The Scientific Committee recalled that issues regarding the occurrence of elasmobranch in the by-catch of fisheries within the Convention Area had been discussed (paragraphs 5.127 to 5.130).

ASOC

11.5 The Scientific Committee noted the report of the Observer from ASOC, Ms C. Mormorunni (CCAMLR-XVII/BG/48). The main points of interest to CCAMLR are listed below.

- (i) The illegal and unregulated fishing for *Dissostichus* spp. threatened to severely undermine CCAMLR's progress towards precautionary management and the conservation of Antarctica's marine living resources. The uncertainty surrounding the level of illegal and unregulated catch had introduced an uncertainty into the assessments which significantly undermined their reliability and viability, as well as the fishery's projected impacts on dependent and associated species, and the greater marine environment. ASOC believed that Members had no other choice but to set zero catch limits for *D. eleginoides* until the illegal and unregulated fishery was brought under control.
- (ii) The incidental seabird mortality was exacerbated by the illegal and unregulated fishery and the levels reported by ad hoc WG-IMALF (Annex 5, section 7) indicated that urgent action was needed to eliminate all incidental seabird mortality.
- (iii) ASOC recalled the paper on Marine Protected Areas (MPA) tabled by the IUCN observer at CCAMLR-XVI. ASOC encouraged CCAMLR to consider this powerful conservation and management tool, and specifically how it may be immediately applied within the Convention Area.
- (iv) ASOC reminded the Scientific Committee that decisions taken this year will demonstrate to the broader international community whether CCAMLR is in fact able to carry out its mission and ensure the protection and conservation of the Antarctic marine environment.

SCOR, CCSBT, ICES, IOC and IATTC

11.6 No observers from these organisations presented a report at the meeting.

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

SCAR Subcommittee on Evolutionary Biology of Antarctic Organisms

11.7 The Scientific Committee noted the report of the CCAMLR observer at the SCAR Subcommittee on Evolutionary Biology of Antarctic Organisms, Dr Fanta, (SC-CAMLR-XVII/BG/22). The main points of interest to CCAMLR are listed below.

- (i) The preliminary announcement of the Workshop on Evolutionary Biology of Antarctic Organisms, to be held in Brazil from 12 to 15 May 1999.
- (ii) The main purpose of the workshop will be to obtain a view of the state of the art of adaptation, gene flow, evolution, biodiversity and new techniques for the development of a proposal for a future integrated, multinational, multidisciplinary research program within SCAR.
- (iii) As many of the proposed themes are of direct interest to CCAMLR, the subcommittee wishes to invite a member of the Scientific Committee to attend the meeting and actively participate in the discussions of aims, trends and needs of research.

SCAR Group of Specialists on Seals

11.8 The Scientific Committee noted the report of the CCAMLR observer to SCAR-GSS, Prof. Torres (SC-CAMLR-XVII/BG/15). The main points of interest to CCAMLR are listed below.

- (i) At the recent meeting at the Universidad de Concepción (Chile) in July 1998 the SCAR-GSS elected a new chairman, Dr J. Bengtson (USA), and Secretary, Dr I. Boyd (UK).
- (ii) The group reviewed information on the status and population trends of all species of Antarctic pinnipeds. During its last meeting in 1996, SCAR-GSS had prepared a five-year review of information to CCAMLR. These tables were updated. The next five-year update of pinniped status and trends will be prepared by SCAR-GSS during its next meeting and sent to CCAMLR by October 2000, incorporating the recent results of the circumpolar survey of pack-ice seals (APIS).
- (iii) It was agreed to send to CCAMLR a set of documents of the APIS Program, in time for the meeting of WG-EMM, as a basis for developing a standard method for surveying pack-ice seals.
- (iv) SCAR-GSS was informed about the decision of WG-EMM to standardise colour codes of tags placed on fur seals to make the locations of taggings obvious on resighting. This was of particular interest to SCAR-GSS since it attempts to maintain an Antarctic seal tagging and marking database at the National Marine

Mammal Laboratory in Seattle, USA. Considering the colour codes suggested by WG-EMM, it was noted that the recommended procedure was to have the male and female portion of the individual tags in separate colours. SCAR-GSS felt that this recommendation might create identification problems in the future, because of colour fading and the difficulty of being able to read only one side of the tag during resighting efforts.

- (v) Another matter of interest to CCAMLR related to the finding of plastic particles in seal scats, which suggest that bioaccumulation of such particles may be taking place in the Antarctic marine ecosystem. Monitoring these particles for abundance, distribution and species involved might constitute an interesting research topic. If so, the fecal samples necessary to be collected for useful information is more than 100.
- (vi) To improve information flow between SCAR-GSS and CCAMLR, more rapid exchange of documents was suggested, and SCAR-GSS asked the CCAMLR and SCAR observers to assist with this task.

11.9 Dr Penhale advised that the USA had approved the APIS program for the 1999/2000 season.

SCAR Subcommittee on Bird Biology

11.10 Prof. Croxall reported on the meeting of SCAR-BBS, the executive summary of which was tabled as SC-CAMLR-XVII/BG/24. The main points of interest to CCAMLR are listed below.

- (i) The latest report from the Central Data Bank for Antarctic Bird Banding (CDB) based at the University of Cape Town, South Africa covering years 1987 to 1996.
- (ii) The production of annual lists of Antarctic and sub-Antarctic publications on birds for publication in *Marine Ornithology*.
- (iii) The intention to publish the report of an intersessional survey of penguin marking activities supporting earlier concerns of the sometimes deleterious effects of flipper bands on penguins; some progress with the design of new flipper bands for penguins, including the use of plastic materials, has been made.
- (iv) Publication of the report of the Penguin Conservation Assessment and Management Plan Workshop held in Cape Town, South Africa, in September 1996 which proposed classification under IUCN's Red List Categories of threat for rockhopper and royal penguins as vulnerable, and for macaroni as near-threatened. SCAR-BBS considered research requirements for each species in the light of activities undertaken in the last two years. A need for continued research, including population surveys, was identified for all three species.
- (v) The status and trends of the Antarctic and sub-Antarctic seabirds document, tabled at the subcommittee's last meeting and subsequently submitted to CCAMLR, is now in press with *Marine Ornithology*.
- (vi) The SCAR-BBS intention to undertake reviews of bird populations (including trends) in Protected Areas to contribute to the strategic assessment of Antarctic Protected Areas.

- (vii) The planned undertaking of an Important Bird Areas (IBA) study of the Antarctic Continent, using the internationally-agreed criteria which are being applied in studies underway for all other continents. Such a study entails the identification, using objective criteria, of a network of sites critical for the long-term viability of bird populations, enabling the adequacy of the existing Protected Areas system to be reviewed in terms of their birds, and recommendations made for new protected areas.
- (viii) The proposal to establish a computerised and on-line site-specific database on breeding distribution and abundance of Antarctic and sub-Antarctic birds, hosted by the Australian Antarctic Data Centre (AADC). The database would be accessible under the proposed home page for the subcommittee on the SCAR WG-Biology website.
- (ix) The approval by WG-Biology of the recommendation of the ad hoc Working Group on Seabirds at Sea Methodology Workshop in 1996. For future international coordinated projects within the Southern Ocean that wish to determine the quantitative abundance (density) of seabirds at sea, a method that incorporates bird flux through the survey area should be used in preference to the BIOMASS protocol. At present, two methods involving bird flux are available, and the method used is dependent on the objectives of the seabird project. The Vector method has the advantage of including all birds in the transect for density calculations, resulting in greater detail in quantitative analyses. The Snapshot method accepts some loss of quantitative detail for uncommon species, with the advantage of being less labour intensive (i.e. fewer observers required). Irrespective of the method chosen, a 300-m transect width and basic time unit of 10 minutes (or an alternative that can be analysed in 10-minute periods) are recommended for consistency and compatibility with historical datasets.

11.11 The Scientific Committee was informed that the 1998 SCAR meeting adopted four recommendations referring to seabirds which occur in the Convention Area. These concerned:

- (i) submission of bird banding data (Rec XXV-Biol 8);
- (ii) requirements to submit comprehensive data on the use of implanted transponder tags in penguins to the SCAR Central Data Bank for Antarctic Bird Banding (Rec XXV-Biol 9);
- (iii) the priority for research on threatened and near-threatened penguin species, viz rockhopper, royal and macaroni penguins (Rec XXV-Biol 10); and
- (iv) encouraging research on seabird populations at risk from longline fisheries, and on related initiatives for developing and using improved mitigating measures, especially in South American waters where least resources have hitherto been available for such work; and that CCAMLR be informed on such research and its results (Rec XXV-Biol 11).

SCAR WG-Biology

11.12 The Scientific Committee noted the report of the CCAMLR observer to SCAR WG-Biology (Prof. Fernholm), SC-CAMLR-XVII/BG/20. The main points of interest to CCAMLR are listed below.

- (i) The working group supported the development of a coordinated protected area system (Rec XXV-Biol 3).

- (ii) The management plans for SSSI Nos 8 and 34, Western Shore of Admiralty Bay, and Lions Rump, King George Island, were endorsed (Rec XXV-Biol 12).
- (iii) Four general principles that WG-Biology considered important for its future work:
 - (a) to establish programs with coordinated multidisciplinary aims and activities;
 - (b) to ensure that biological programs are designed which include clear links to and/or collaboration with existing and potential SCAR research on global change;
 - (c) to ensure that biological programs are designed which have links to and/or collaboration with international research programs being undertaken under the auspices of bodies other than SCAR (e.g. SCOR, CCAMLR); and
 - (d) to develop within SCAR's biological research programs the potential for effective research on topics and issues relating to environmental protection, conservation and management (and to develop efficient mechanisms for transmitting the results of such research to the necessary bodies within the Antarctic Treaty System concerning environmental matters).
- (iv) The working group recommended the appointment of Dr Fanta as the observer to the CCAMLR Scientific Committee (Rec XXV-Biol 13).
- (v) The Working Group planned to have its next meeting in association with SCAR XXVI in Japan, 2000.
- (vi) The Working Group elected as a new chairman Y. Le Maho (France).

SCAR VII International Biology Symposium

11.13 The Scientific Committee noted the report of the CCAMLR observer to SCAR VII International Biology Symposium, Dr Penhale, who introduced SC-CAMLR-XVII/BG/23 and indicated that its purpose was to draw attention to papers of interest to the Scientific Committee. Proceedings will be published in about one year.

SCOR

11.14 The meeting of WG-105 (the Impact of World Fisheries Harvests on the Stability and Diversity of Marine Ecosystems) was held in Hobart in January 1998. Dr Constable was the CCAMLR observer at that meeting. As agreed at SC-CAMLR-XVI, a draft copy of the book *Understanding CCAMLR's Approach to Management* had been submitted to the meeting.

ATCM

11.15 The Scientific Committee noted the Executive Secretary's report of the XXII ATCM (CCAMLR-XVII/BG/18). The definitions of marine protected areas which had been proposed and endorsed by the Scientific Committee had now been accepted. Six resolutions had been adopted, including 'Antarctic Data Management' and 'ATCM Homepage'.

SO-GLOBEC

11.16 The Scientific Committee noted the recent work of SO-GLOBEC as outlined in Annex 4, paragraphs 9.92 to 9.96. A poster outlining progress in SO-GLOBEC was presented.

ICES

11.17 The Scientific Committee noted the annual report from ICES (SC-CAMLR-XVII/BG/17) which had been submitted by the CCAMLR Observer, Ms I. Lutchman (UK).

11.18 Dr Miller will be the CCAMLR observer to the ICES meeting in November. Should Dr Miller be unable to attend then Dr Sullivan would be CCAMLR observer.

CWP

11.19 The Scientific Committee noted the Data Manager's report from the intersessional meeting of CWP (CCAMLR-XVII/BG/9). This report had been discussed under 'Data Management' (paragraphs 10.9 to 10.14).

IWC

11.20 The Scientific Committee noted the observer's report (CCAMLR-XVII/BG/47), and recalled earlier discussions regarding the collaboration between IWC and CCAMLR, and in particular plans underway in regard to the synoptic survey (paragraphs 4.13 and 4.30).

11.21 The Chairman of the Scientific Committee was tasked with contacting Dr S. Reilly, and seeking direct feedback on the future activities of the liaison group between IWC and the Scientific Committee (SC-CAMLR-XVI, paragraph 11.13).

CCSBT, ICCAT and IATTC

11.22 The Scientific Committee noted the CCSBT Observer's report (SC-CAMLR-XVII/BG/4). The information provided in this report had been considered during the recent meetings of WG-FSA (Annex 5, paragraph 7.186). It also noted the ICCAT Observer's report (CCAMLR-XVII/BG/46) and the IATTC Observer's report (CCAMLR-XVII/BG/35).

Second International Symposium on Fish Otolith Research and Application

11.23 Dr Everson reported that the Second International Symposium on Fish Otolith Research and Application held in Bergen, Norway, from 20 to 25 June 1998 had been a great success. A large number of papers had been presented on all aspects of otolith research and applications.

Of particular relevance to CCAMLR are studies on age validation and stock identity. Dr Everson stated that he was unsure of the planned timetable for publication of the proceedings.

Future Cooperation

11.24 The Scientific Committee noted that WG-EMM considered a number of international meetings which were of relevance to its work (Annex 4, paragraphs 9.91 to 9.100).

- (i) SO-GLOBEC Steering Committee had drafted a Science Plan for its program from 1999 onwards and looks for cooperation with CCAMLR and IWC.
- (ii) A Symposium of ICES/SCOR, 'Ecosystems Effects of Fishing', would be held from 16 to 19 March 1999 in Montpellier, France, and the subject matter is considered to be of interest to the Scientific Committee. Dr Constable had been invited by the organising committee to coordinate the development of a keynote paper, in conjunction with colleagues from the Scientific Committee. It was recommended that past and current conveners involved in the development of the ecosystem approach and still involved in CCAMLR, together with the Chairman of the Scientific Committee and the former and current Data Managers, Drs Agnew and Ramm, would assist with this task.
- (iii) An international workshop on interannual variability in the Southern Ocean will be held at the British Antarctic Survey, Cambridge, UK, from 2 to 7 August 1999.

11.25 The Scientific Committee nominated the following observers to meetings in 1998/99:

- (i) 31st Session of the IOC Executive Council, 17 to 27 November 1998, Paris, France – no observer;
- (ii) First Session of the IOTC Scientific Committee, 7 and 8 December 1998, Victoria, Seychelles – Australia (Mr J. Barrington);
- (iii) International Conference on Integrated Fisheries Monitoring, 1 to 5 February 1999, Sydney, Australia – Dr Miller and/or Dr Agnew;
- (iv) 1999 Meeting of the IWC Scientific Committee, 3 to 15 May 1999, Grenada, West Indies – possibly Dr Kock;
- (v) Committee for the Environmental Protection, ATCM, May 1999, Lima, Peru – Dr Miller;
- (vi) SCAR-BBS Workshop, May 1999, Montana, USA – Prof. Croxall;
- (vii) Eighteenth Session of CWP, 6 to 9 July 1999, Luxembourg – Dr Ramm;
- (viii) Krill Symposium, 23 to 27 August 1999, Santa Cruz, USA – Dr Nicol;
- (ix) Workshop on the Interannual Variability in the Southern Ocean, August 1999, Cambridge, UK – Dr E. Murphy or J. Priddle;
- (x) CMS, 10 to 16 November 1999, Cape Town, South Africa – Mr Cooper;
- (xi) ICES, venue and date to be determined – Ms Lutchman;

- (xii) XIth Meeting of GOSEAC, July 1999, venue to be confirmed – Dr Fanta; and
- (xiii) SCAR Workshop on Evolutionary Biology of Antarctic Organisms, 12 to 15 May 1999, Curitiba, Brazil – Drs P. Rodhouse (UK) and G. Carvalho (Brazil).

11.26 The Scientific Committee agreed that all observers invited to meetings of the Scientific Committee and working groups in 1998 should be invited to attend the meetings in 1999.

Cooperation with the Convention on Biological Diversity

11.27 Last year, the Scientific Committee noted that CCAMLR should keep under review developments within the Convention on Biological Diversity (CBD) as these may affect participation of CCAMLR and its Members in various programs related to biodiversity (SC-CAMLR-XVI, paragraphs 11.25 and 11.26).

11.28 The Secretariat has informed CBD of CCAMLR's work in relation to albatross conservation and has drawn CBD's attention to the interactions between albatrosses and longline fisheries as an example of harmful biological consequences caused by anthropogenic effects (SC-CAMLR-XVI, paragraphs 7.31 and 7.32).

11.29 Copies of the Secretariat correspondence with CBD on the matters mentioned above are given in SC-CAMLR-XVII/BG/14.

PUBLICATIONS

12.1 The fifth edition of *CCAMLR Science* had been published just prior to CCAMLR-XVII. The Scientific Committee thanked Dr Sabourenkov (Editor) and his production team, Ms G. Tanner (Production Editor), Mrs R. Marazas, Ms G. von Bertouch and Mr B. Denholm, for their efforts in producing this volume.

12.2 The following documents were also published during 1998:

- (i) *CCAMLR Scientific Abstracts* covering abstracts of papers presented in 1997;
- (ii) *Statistical Bulletin*, Volume 10 (1988–1997);
- (iii) revised version of the *Scientific Observers Manual*;
- (iv) flier and stickers for *Fish the Sea Not the Sky*; and
- (v) a placard and mini-poster on the problem of marine debris in Antarctic waters.

12.3 The Scientific Committee considered an offer to publish short reviews of the scientific highlights from CCAMLR's work in the journal *Reviews in Fish Biology and Fisheries* (RFBF) (SC-CAMLR-XVII/BG/19). The Scientific Committee endorsed WG-FSA's views that the publication of short reviews of CCAMLR's work in a highly-cited scientific journal was attractive, and would promote CCAMLR's work to the broader scientific community. However, the Scientific Committee agreed that there should be no binding agreement to publish highlights annually. Possible topics for review would include the application of the GYM and CCAMLR's approach to management. The Chairman of the Scientific Committee was tasked with preparing a reply to Prof. T. Pitcher, founding editor of RFBF.

12.4 The Scientific Committee also recognised the need to augment the profile of *CCAMLR Science* within the scientific community. The journal was presently covered by *Aquatic Science and Fisheries Abstracts* and was included in *Current Antarctic Literature* (formerly *Antarctic Bibliography*). However, *CCAMLR Science* was not listed in *Current Contents* and did not have a scientific citation index.

12.5 The Scientific Committee was aware that journals not listed in *Current Contents* were not afforded full credibility within many scientific funding agencies. This may result in scientists publishing CCAMLR-related work elsewhere. Dr Sabourenkov was tasked with investigating the feasibility of listing *CCAMLR Science* in *Current Contents* and establishing a link to *Science Citations Index* for ranking with other science journals.

12.6 The Scientific Committee noted that whilst copies of *CCAMLR Science* may be considered for dissemination through the CCAMLR website, the hard copy format of the journal was essential to maintain the integrity of *CCAMLR Science* and the high calibre of papers submitted for publication.

12.7 The Scientific Committee discussed the status of the book *Understanding CCAMLR's Approach to Management*. The Secretariat had worked with the authors in 1998 to finalise the English text, and translation to a draft stage had been completed.

12.8 The Scientific Committee noted that the book had evolved beyond the initial concept of producing a brief (20 pages) brochure summarising the work of the Scientific Committee for the benefit of the Commission.

12.9 The options for the publication of the book were outlined in CCAMLR-XVII/7, and were to:

- (i) have the document published independently;
- (ii) have the document published by the Secretariat; and
- (iii) publish the document on the website.

12.10 Dr Everson presented an alternate option of publishing the complete document in *CCAMLR Science* and also arranging an extended reprint run. In addition, he suggested that a separate synopsis of the document may be produced to fulfil the original aims of the document, to provide a succinct summary of how the Scientific Committee produces its scientific advice and how this advice is used in the taking of management decisions by the Commission.

12.11 The Scientific Committee concluded that the document should be published on the CCAMLR website in all four languages, and in a hard copy form (300 copies) similar to that used for the conservation measures. A synopsis of the document should also be written and produced in all four languages to summarise CCAMLR's approach to management. This synopsis would be produced in a format similar to that of the pamphlet outlining the principles of CEMP. As originally envisaged, the documents will require technical editing and translation and the synopsis will need to be written by a scientific writer. The Scientific Committee agreed that this work should be done as soon as possible.

12.12 The Scientific Committee agreed with this approach, and tasked the Science Officer to coordinate a scientific editing committee comprising the Chairman of the Scientific Committee, the conveners of the working groups, other interested members of the Scientific Committee, and a contracted professional editor. It was requested that the contract editor be able to work in close geographic proximity to the Chairman of the Scientific Committee or one of the conveners.

12.13 The Scientific Committee tasked the committee to revise the document prior to publication, and precis the information contained in the document and produce a brief (20 pages) publication summarising the work of the Scientific Committee for the benefit of the Commission.

12.14 The Scientific Committee agreed that the group be given remit to operate within the A\$25 000 allocated to this publication in 1999 so as to ensure the high quality of the documents, and produce a professional publication aimed at the Commission. All publications should be produced in the four languages of the Commission.

SCIENTIFIC COMMITTEE ACTIVITIES DURING THE 1998/99 INTERSESSIONAL PERIOD

13.1 The following Scientific Committee activities are planned for the 1998/99 intersessional period:

- (i) meeting of WG-EMM;
- (ii) Second Symposium on Krill; and
- (iii) meeting of WG-FSA.

13.2 Mr López Abellán extended an invitation to hold the WG-EMM meeting at the Spanish Institute of Oceanography in Tenerife, during the second half of July 1999. The Scientific Committee thanked Mr López Abellán for his kind offer, and the Government of Spain for offering to host the meeting.

13.3 The Second Symposium of Krill will be held in Santa Cruz (USA) from 23 to 27 August 1999.

13.4 The meeting of WG-FSA was scheduled to be held at the Secretariat's headquarters from 11 to 20 October 1999.

13.5 The Scientific Committee decided to postpone the Workshop on *C. gunnari* until a time after 1999 (paragraph 5.132).

13.6 The Scientific Committee discussed the procedure developed by the Chairman and conveners of working groups to allocate and track intersessional tasks (SC-CAMLR-XVII/BG/25). Activities during the 1997/98 intersessional period were reviewed. The majority of the tasks given to the Secretariat, including most of those afforded a high priority, had been completed. This had reflected the efficient and thorough support that the Secretariat had provided to the Scientific Committee and its working groups.

13.7 All of the tasks which had not been completed were either ongoing, or were awaiting input from Members. The Scientific Committee identified these tasks.

Scheme of International Scientific Observation:

- (i) preparation of data entry programs – ongoing (SC-CAMLR-XVI, Annex 5, paragraph 10.11);

Harvested species:

- (ii) indices of local krill availability – input from Members (SC-CAMLR-XVI, Annex 4, paragraph 3.20);
- (iii) species discrimination in acoustic surveys – input from Members (SC-CAMLR-XVI, Annex 4, paragraph 8.18);
- (iv) data logging from acoustic surveys – ongoing (SC-CAMLR-XVI, Annex 4, paragraph 8.23);
- (v) scale and otolith collections and age-length keys for *Dissostichus* spp. – ongoing (SC-CAMLR-XVI, paragraph 5.48);
- (vi) acoustic database for fish and krill – ongoing (SC-CAMLR-XVI, paragraph 5.156);
- (vii) research survey format – ongoing (SC-CAMLR-XVI, paragraph 5.157);

- (viii) electronic data submission – ongoing (SC-CAMLR-XVI, Annex 5, paragraph 10.11);
- (ix) data extraction query for weighted length frequencies – ongoing (SC-CAMLR-XVI, Annex 5, paragraph 4.163);

Incidental mortality arising from longline fishing:

- (x) request information on French program for monitoring albatross and petrel populations – input from Member (SC-CAMLR-XVI, paragraph 4.40);
- (xi) reports on incidental mortality of seabirds outside the Convention Area – input from Members, particularly from South America (SC-CAMLR-XVI, Annex 5, paragraph 7.99);
- (xii) information on South African longline fishery for hake – input from Member (SC-CAMLR-XVI, Annex 5, paragraph 7.102);
- (xiii) information on use of artificial bait – input from Mustad (SC-CAMLR-XVI, Annex 5, paragraph 7.139);
- (xiv) studies and information on artificial bait – ongoing by Members (SC-CAMLR-XVI, Annex 5, paragraph 7.140);
- (xv) experience with underwater setting – ongoing by Members (SC-CAMLR-XVI, paragraph 4.66);

Dependent species:

- (xvi) investigate availability of data on Antarctic petrels – being considered by Members (SC-CAMLR-XVI, paragraph 4.4);
- (xvii) develop software on monitoring at-sea behaviour – ongoing and part of planning process for the synoptic survey (SC-CAMLR-XVI, Annex 4, paragraph 8.69);
- (xviii) update CEMP data – ongoing (SC-CAMLR-XVI, paragraph 6.6);
- (xix) requests for Members’ suggestions for analysis of IWC data – input from Members (SC-CAMLR-XVI, Annex 4, paragraph 8.134);

CCAMLR Data Management:

- (xx) staged approach to updating databases – ongoing (SC-CAMLR-XVI, paragraph 10.3); and
- (xxi) forecasting data entry resource requirements – ongoing and input from Members (SC-CAMLR-XVI, paragraph 10.15).

13.8 The Scientific Committee agreed that the procedure developed by the Chairman and conveners of working groups had allowed the Scientific Committee to:

- (i) focus on issues of priority, and track tasks allocated to the Secretariat and Members;
- (ii) document these tasks; and
- (iii) evaluate its own performance, and the allocation of resources.

13.9 Dr Everson added that it had been gratifying to see the work of the Scientific Committee evolve in this manner, and indicated ways of facilitating the review process in future years. He had found the format used for reporting the Secretariat's work in support of WG-EMM very useful (WG-EMM-98/23). That format included details of the actions taken, and references to meeting papers and other information related to these actions. A similar format had been used to report work in support of WG-FSA (WG-FSA-98/5).

13.10 The Scientific Committee agreed that the reporting format should include for each task identified:

- (i) a brief description;
- (ii) reference to the relevant paragraph(s) in the report;
- (iii) a list of the actions taken, with dates;
- (iv) a list of what information was obtained as a result of those actions, with dates; and
- (v) the current status of the task.

13.11 The Scientific Committee endorsed the following tasks for the 1998/99 intersessional period:

- (i) all of the outstanding or ongoing tasks identified in paragraph 13.7;
- (ii) the tasks identified by WG-EMM (Annex 4, paragraphs 12.2 to 12.7); and
- (iii) the tasks identified by WG-FSA (Annex 5, paragraphs 9.16 to 9.20).

13.12 In addition, the Secretariat was requested to transfer these tasks to the format identified in paragraph 13.10, distribute the listing to all members of the Scientific Committee and working groups at the earliest time possible after these meetings, and append the list to the final version of the Scientific Committee report (Annex 6).

13.13 The Scientific Committee reported that the Secretariat had provided excellent support at the meeting of WG-EMM in Kochi, India, and thanked Mrs L. Bleathman, Drs Ramm and Sabourenkov, and Ms G. Tanner for their dedication and very professional work. Dr Everson recalled that Dr Sabourenkov had prepared a job plan for his work during the meeting of WG-EMM which had proven useful, and had highlighted the large amount of work done during the meeting.

13.14 It was also noted that the Data Management group, including Mr Appleyard, Mrs Millar, Ms Slicer and Mr Williams had been instrumental in ensuring that the large amount of data was available at the right place and at the right time during the meeting of WG-FSA.

13.15 The Scientific Committee commended all of the staff at the Secretariat for the substantial amount of work of a diverse nature they had done in support of the Scientific Committee and its working groups during the past year, and for their professional approach to producing the reports under intense time pressures.

13.16 The Scientific Committee was aware that a number of pressure points at key times and in specific areas within the Secretariat support of the Scientific Committee and working group activity had emerged over recent meetings, and endorsed the views expressed at WG-FSA that:

- (i) the Scientific Committee and working groups should, wherever possible, facilitate the work of the Secretariat by submitting rapporteur reports in electronic format; and
- (ii) the Secretariat should maintain its pro-active approach to its resources and keep under review the re-allocation of existing resources, or the addition of resources, to spread the workload and relieve pressure points.

Both these suggestions were seen as improving the efficiency of the Scientific Committee's work and the Committee's interactions with the Secretariat in key areas.

BUDGET FOR 1999 AND FORECAST BUDGET FOR 2000

14.1 The Scientific Committee considered its budget for 1999 and 2000, and discussed the:

- (i) allocation of funds for the Workshop on *C. gunnari*;
- (ii) revised cost of producing the working group reports; and
- (iii) participation by the Data Manager at the Eighteenth Session of CWP in 1999, the synoptic survey planning workshop in 1999, and the workshop to analyse data from the synoptic survey in 2000.

14.2 The Scientific Committee agreed that:

- (i) funding for the Workshop on *C. gunnari* would be carried over to 2000;
- (ii) the cost of producing the working group reports be revised in line with expenditure incurred in 1998; and
- (iii) the Data Manager should participate at the Eighteenth Session of CWP in 1999 and the workshop to analyse data from the synoptic survey in 2000, but his participation was not required at the synoptic survey planning workshop in 1999.

14.3 The Scientific Committee reviewed the current practice of providing 12 copies of its annual report to Members free of charge. The Scientific Committee considered the option of producing an electronic version of the annual report which would be suited to dissemination via the website. This electronic version would include hyperlinks between the table of contents and the text of the report, and between table and figure references and the actual tables and figures. The report would also be divided into small computer files, so as to allow selective, and rapid, downloading of sections of the report.

14.4 The Scientific Committee was informed that the difference between the costs of production and dissemination of a hard copy of the report and those for producing an electronic version were:

- (i) cost of printing and postage for the hard copy; and
- (ii) cost of formatting for the electronic version.

14.5 The Scientific Committee noted that the costs of producing and disseminating four free hard copies of the report and developing the electronic version was equivalent (i.e. break even) to the costs of producing and disseminating 12 hard copies. In the context of the 12 copies of the report currently distributed free of charge to Members, producing and disseminating only two hard copies of the report to Members, and developing the electronic version, would result in an annual saving of approximately A\$5 000.

14.6 The Scientific Committee concluded that there was no clear cut off point with regard to the number of copies issued to Members free of charge each year. However, the required number would be, at minimum, five copies per Member per year. This should be reviewed by the Scientific Committee at its next meeting in the light of experience in the forthcoming year and following analysis of the utilisation of the website.

14.7 The budget of the Scientific Committee for 1999, and the forecast budget for 2000, as agreed by the Scientific Committee is summarised in Table 9.

ADVICE TO SCOI AND SCAF

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

ELECTION OF CHAIRMAN OF THE SCIENTIFIC COMMITTEE

16.1 Dr Siegel nominated Dr Miller for a second term as Chairman of Scientific Committee. This nomination was seconded by Dr K. Shust (Russia). No further nominations were received, and Dr Miller was unanimously elected as Chairman of the Scientific Committee for 1999 and 2000. The Scientific Committee congratulated Dr Miller on his re-appointment. Dr Miller thanked the Scientific Committee for their vote of confidence and indicated that he very much valued the support and friendship of all the Committee's members. He hoped that he would be able to serve the Scientific Committee well during his second term.

NEXT MEETING

17.1 The next meeting of the Scientific Committee would be held in the current venue from 25 to 29 October 1999.

OTHER BUSINESS

18.1 Dr Everson reported he had been informed by Dr S. Kim (Republic of Korea) that the Subgroup on International Coordination plans to continue the coordination of work to be undertaken in the Peninsula area during summer 1999/2000. Data collection activities will include acoustic surveys, net sampling and oceanographic studies. Activities will be conducted by Japan, the Republic of Korea and USA around the South Shetland Islands from December 1999 to February 2000. Efforts will be made to use the same methodologies as used by participants in the synoptic survey. It is expected these results will complement the synoptic survey objectives and activities included under SO-GLOBEC. The Scientific Committee thanked Dr Kim for his role in coordinating the activities of this subgroup.

18.2 Dr Everson informed the Scientific Committee that the annual symposium for the year 2000 of the Fisheries Society of the British Isles would be held in Cambridge, UK, and that the theme is 'Biology of Polar Fish'. The program is still being prepared, but it is anticipated that, subject to demand, there will be sessions on harvested species. He agreed to include all participants at WG-FSA on the mailing list for information.

18.3 Concern was expressed at certain aspects of the conduct of Scientific Committee business, in particular the time taken up by items relating to 'housekeeping' and 'networking', often at the expense of allowing more time for substantial discussion of the main agenda items from which advice to the Commission needs to be formulated.

18.4 In particular, tabled documents for the Scientific Committee are often unclear as to whether (or what) action or advice is required from the Scientific Committee and/or whether they are simply for information. If the former, the proposed actions/advice needed should be clearly identified; if the latter, a summary paragraph should be provided which can be taken directly into the report of the meeting.

18.5 It was proposed that, wherever possible, papers tabled for the Scientific Committee should be taken as read. Consideration would be limited, at least initially, to matters indicated in the papers as requiring action or advice from the Scientific Committee.

18.6 To this end:

- (i) the reports of the working groups of the Scientific Committee should have a section on 'Advice to the Scientific Committee' (carefully and thoroughly)

cross-referenced to the appropriate paragraphs of supporting text) at the end of each part of their reports. Initial discussion by the Scientific Committee would be confined to consideration of these sections;

- (ii) other papers tabled for consideration would, by means of an executive summary, abstract or highlighted appropriate text, indicate those elements of their content to which Scientific Committee attention is directed; and
- (iii) all reports from observers (whether to or from CCAMLR) shall have similar summaries or highlighted items. These elements of each document shall be collated by the Secretariat on the opening day of the Scientific Committee meeting into a summary document, which will be the main item considered by the Scientific Committee under the relevant agenda item.

ADOPTION OF THE REPORT

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

CLOSE OF THE MEETING

20.1 On behalf of the Scientific Committee, Dr Everson thanked the Chairman for his contribution to the work of the Committee, and for successfully leading it through the difficult tasks it had encountered over the past year. The meeting had been very productive, and the Scientific Committee looked forward with pleasure and high hopes to Dr Miller's renewed term as Chairman.

20.2 Dr Miller thanked the rapporteurs listed in paragraph 1.5 who had worked very hard and under serious time constraints. He also thanked the other members of the Scientific Committee for their contribution to the meeting. He thanked Drs Ramm and Sabourenkov, Ms Marazas, Slicer and Tanner, Mr Appleyard and Mr Williams, the translators and the other staff of the Secretariat for their dedicated work in support of the activities of the Scientific Committee. In particular, the Scientific Committee had appreciated Mrs B. Graham (French translation team) who had worked under the trying circumstance of the recent loss of her father. Dr Miller also acknowledged the hard work of the interpreters and the sound technicians.

20.3 The Chairman then closed the meeting.

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- Mangel, M. and P.V. Switzer. 1998. A model at the level of the foraging trip for the indirect effects of krill (*Euphausia superba*) fisheries on krill predators. *Ecological Modelling*, 105: 235–256.

Table 1: Total krill catch (in tonnes) in the 1997/98 split-year by area and country. The catch for the 1996/97 split-year is indicated in brackets.

Subarea/Division	Japan		Poland		Ukraine
48.1	34 430	(37 480)	13 883	(13 498)	(0)
48.2	6 673	(98)		(0)	(0)
48.3	22 130	(21 220)	1 429	(5 658)	(4 246)
Total	63 233	(58 798)	15 312	(19 156)	(4 246)

Subarea/Division	UK		Republic of Korea		Total	
48.1	634	(308)	890	(0)	49 837	(51 286)
48.2					6 673	(98)
48.3			733	(0)	24 292	(31 124)
Total	634	(308)	1 623	(0)	80 802	(82 508)

Table 2: National krill catches (in tonnes) since the 1989/90 split-year based on STATLANT returns.

Country	Split-year ¹								
	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
Chile	4 500	3 679	6 065	3 261	3 834				
Germany	396								
Japan	62 187	67 582	74 325	59 272	62 322	60 303	60 546	58 798	63 233 ³
Latvia					71				
Republic of Korea	4 039	1 210	519						1 623
Panama						141	495		
Poland	1 275	9 571	8 607	15 909	7 915	9 384	20 610	19 156	15 312
USSR ²	302 376	275 495							
Russia			151 725	4 249	965				
South Africa					2				
Ukraine			61 719	6 083	8 852	48 884	20 056	4 246	
UK								308	634
Total	374 773	357 537	302 960	88 774	83 961	118 712	101 707	82 508	80 802

¹ The Antarctic split-year begins on 1 July and ends on 30 June.

² Although the formal date for the dissolution of the USSR was 1 January 1992, for comparative purposes statistics are compiled here for Russia and Ukraine separately for the complete split-year, i.e. 1 July 1991 to 30 June 1992.

³ Advised by Japan during the meeting.

Table 3: Total finfish catch (in tonnes) in the 1997/98 split-year by area and country. The catch for the 1996/97 split-year is indicated in brackets.

Subarea/ Division	Australia	Chile	France	Japan	Republic of Korea	New Zealand
48.1		1 (0)				
48.2		<1 (0)				
48.3		1490 (1275)		76 (0)	177 (425)	
58.5.1			3775 (3674)	(0)		
58.5.2	2495 (1057)					
58.6			104 (0)	(334)		
58.7						
88.1						54 (0)
88.3		<1				
Total	2495 (1057)	1491 (1275)	3879 (3674)	76 (334)	177 (425)	54 (0)

Subarea/ Division	South Africa	Spain	Ukraine	UK	Uruguay	Total
48.1						1 (0)
48.2						<1 (0)
48.3	507	199 (291)		595 (403)	262 (0)	3306 (2394)
58.5.1			997 (1007)			4772 (4681)
58.5.2						2495 (1057)
58.6	89 (122)					193 (456)
58.7	598 (1974)					598 (1974)
88.1						54 (0)
88.3						<1 (0)
Total	1194 (2096)	199 (291)	997 (1007)	595 (403)	262 (0)	11419 (10562)

Table 4: National finfish catches (in tonnes) since the 1989/90 split-year based on STATLANT returns.

Country	Split-year ¹								
	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
Argentina					9	867	107		
Australia			4		2			1 057	2 495
Bulgaria			114	220	70	177			
Chile			2 917	2 125	150	1 894	3 092	1 275	1 491
France	579	1 576	1 589	826	4 211	4 173	3 673	3 674	3 879
Japan							263	334	76
Republic of Korea					143	420	381	425	177
New Zealand									54
Poland	523	41							
Russia	1 453		48 589	281	265	11	102		
Spain		35						291	199
South Africa								2 096	1 194
Ukraine	3 530		11 265	2 346	942	5 473	1 003	1 007	997
UK	61	9	10		6			403	595
USA							184		
USSR ²	46 092	97 240							
Uruguay									262
Total	52 238	98 901	64 488	5 798	5 798	13 015	8 805	10 562	11 419

¹ and ² Refer to footnotes in Table 2.

Table 5: Fishing seasons and conservation measures relating to notifications for new and exploratory fisheries for *Dissostichus* spp. during the 1998/99 fishing season.

Subarea/ Division	Country	Gear	New	Exploratory	VMS	CMs to Apply	Proposed Fishing Season	WG-FSA Ref.	Advice in Regard to Seabird By-catch			
									CM 29/XVI	Area Risk Category ⁷	Fishing Season Closure	WG-FSA Ref.
48.6	South Africa	Longline				29/XVI, 133/XVI	1 Mar–31 Aug (North of 60°S), 15 Feb–15 Oct (South of 60°S)	4.17		2	-	7.116(i)
58.4.1	Australia ¹	Trawl				30/X	?	4.44	-	na	-	-
58.4.3	France	Longline				29/XVI, 133/XVI	All year	4.28		3	Sept–April	7.116(iii)
58.4.4	Australia ¹	Trawl				30/X	?	4.44	-	na	-	-
	France	Longline				29/XVI, 133/XVI	All year	4.28		3	Sept–April	7.116(iv)
	France	Trawl				29/XVI	All year	4.28	-	na	-	-
	Spain	Longline			6	29/XVI	1 Apr–31 Aug	4.22		3	Sept–April	7.116(iv)
	South Africa ¹	Longline				29/XVI, 133/XVI	1 Apr–31 Aug	4.17		3	Sept–April	7.116(iv)
58.6	Uruguay	Longline			2	29/XVI, 133/XVI	? ³	4.25		3	Sept–April	7.116(iv)
	France	Longline				29/XVI, 133/XVI	All year	4.28		5	Sept–April	7.116(vii)
	France South Africa ¹	Trawl Longline				29/XVI, 133/XVI	All year ? ³	4.28 4.22	-	na 5	- Sept–April	- 7.116(vii)
58.7	France	Longline				29/XVI, 133/XVI	All year	4.28		5	Sept–April	7.116(viii)
	South Africa ¹	Longline				29/XVI, 133/XVI	? ³	4.42		5	Sept–April	7.116(viii)
88.1	New Zealand ¹	Longline				29/XVI ⁴	15 Dec–31 Aug	4.47	4	3,2 ⁵	-	7.116(ix)

¹ Denotes fisheries for both *D. eleginoides* and *D. mawsoni*

² Application states 'will be considered'

³ To be defined at the forthcoming meeting of the Commission

⁴ With variation in respect of daytime setting south of 65°S (paragraphs 4.66 to 4.70)

⁵ 3 in northern part, 2 in southern part

⁶ Accidentally omitted in the original proposal (paragraph 9.16)

⁷ As defined in Annex 5, paragraph 7.112, where 1 is the lowest category of risk and 5 the highest

Table 6: Total estimated removals of *D. eleginoides*, *D. mawsoni* and *C. gunnari* by statistical area for the 1997/98 fishing season.

Subarea/Division	<i>D. eleginoides</i> and <i>D. mawsoni</i>			<i>C. gunnari</i>
	CCAMLR Reported Catch	Estimated Unreported Catch	Estimated Total Catch	CCAMLR Reported Catch
48.3	3 328	0	3 328	5
58.5.1	4 741	11 825	16 566	0
58.5.2	3 264	520–3 500	3 784–6 764	115
58.6	229	1 765	1 994	0
58.7	674	900	1 574	0
88.1	41	0	41	0

Table 7: Results of the GYM runs undertaken during the Scientific Committee meeting for *Dissostichus eleginoides* in Subarea 48.3, Division 58.5.2, Subarea 58.7 and Division 58.5.1 and for areas for which notification was received for new and/or exploratory fisheries for *Dissostichus* spp. These results use the new seabed areas in Annex 5, Table 15. These runs use revised recruitment parameters for Subarea 48.3 and other longline assessments. E – *Dissostichus eleginoides*, M – *Dissostichus mawsoni*.

Subarea/Division	Method	Species	Seabed Areas	Catch History			Recruitments ²		Yield Estimates		Outside EEZ	
				1996	1997	1998	Longline	Pooled	Escapement	Depletion	Escapement	Depletion
48.3	Longline	E	66 633	see Annex 5, Table 17			14.243		3 780	3 616		
58.5.2	Trawl	E	93 430	see Annex 5, Table 17			14.585		3 692	4 044		
							Prorated Recruitments					
58.5.1	Longline	E	124 428	see Annex 5, Table 24			14.844		6 997	7 161		
58.6	Longline	E	71 295	9 531	19 233	1 994	14.287		8 874	13 005	3 456	5 064
58.6	Trawl		31 520				13.498		2 342	2 398	640	656
58.7	Longline	E	12 655	6 137	6 951	1 574	12.558		1 529	1 611	61	64
58.7	Trawl		6 896				11.979		491	405	5	4
88.1	North of 65°S	Longline	E	10 838			12.403		603	730		
88.1	South of 65°S	Longline	M	227 069		39	15.445		6 700	11 055		
Pooled 1		Longline	E	202 824 ¹			15.332	1	11 345	15 305		
48.6	North of 60°S	Longline	E	28 070				1	1 570	2 118		
58.4.3		Longline	E	96 844				1	5 417	7 308	5 246	7 077
58.4.4		Longline	E	22 743				1	1 272	1 716		
Pooled 2		Trawl		80 606			14.437	2	3 246	3 600		
58.4.1		Trawl		14 401				2	580	643		
58.4.3		Trawl		48 897				2	1 969	2 184	1 969	2 184
58.4.4		Trawl		17 308				2	697	773		
Pooled 3		Longline	M	332 123 ¹			15.825	3	9 760	14 494		
48.6	South of 60°S	Longline	M	56 146				3	1 650	2 450		

¹ Other areas were included in these runs but only the estimates pertinent to new and exploratory fisheries are presented in this table.

² Mean of log_e recruitment function

Table 8: Discounted yields for new and exploratory fisheries – 0.45 was applied to estimates of yield for *D. eleginoides* and 0.3 to estimates for *D. mawsoni* contained in Table 7.

Subarea/Division		Method	<i>D. eleginoides</i>		<i>D. mawsoni</i> 0.30	
			Total Area 0.45	Outside EEZ 0.45		
48.6	North of 60°S	Longline	707		495	
48.6	South of 60°S	Longline				
58.6*		Longline	3 993	1 555		
58.6*		Trawl	1 054	288		
58.7*		Longline	688	27		
58.7*		Trawl	182	2		
58.4.1		Trawl	261			
58.4.3		Longline	2 438	2 361		
58.4.3		Trawl	886	886		
58.4.4		Longline	572			
58.4.4		Trawl	314			
88.1	North of 65°S	Longline	271			
88.1	South of 65°S	Longline				2 010

* These total yields do not apply to the current notifications for new and exploratory fisheries.

Table 9: Scientific Committee budget for 1999 and forecast budget for 2000.

1998 Budget		1999	2000 (forecast)
	Working Group on Fish Stock Assessment		
	Meeting		
13 200	Preparation and Secretariat support	16 700	16 800
21 400	Report completion and translation	<u>26 800</u>	<u>27 000</u>
<u>7 000</u>	Increased report costs		
41 600		43 500	43 800
3 000	Workshop on <i>C. gunnari</i>	0	3 000
	Working Group on Ecosystem Monitoring and Management		
	Meeting		
19 300	Preparation and Secretariat support	19 900	20 100
<u>24 300</u>	Report completion and translation	<u>24 900</u>	<u>25 100</u>
43 600		44 800	45 200
7 000	Support of International Krill Symposium	4 500	0
0	Support of SCAR Bird Assessment	5 000	0
	Travel for Scientific Committee Program		
40 100	WG-EMM meeting (freight, flights and subsistence)	42 700	44 000
	Workshop on Area 48 (2000 Krill Assessment)		
3 500	Data Manager travel	0	3 600
4 400	Secretarial support	0	0
<u>3 800</u>	Report costs	<u>8 200</u>	<u>10 000</u>
11 700		8 200	13 600
<u>1 100</u>	Contingency	<u>1 100</u>	<u>1 100</u>
A\$148 100	Total	A\$149 800	A\$150 700

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OF THE SCIENTIFIC COMMITTEE**

AGENDA FOR THE SEVENTEENTH MEETING OF THE SCIENTIFIC COMMITTEE

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 - (ii) Report of the Chairman
 - (iii) Preliminary Consideration of the Scientific Committee Budget
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 1997/98 Fishing Season
 - (ii) Review of the Current Edition of the *Scientific Observers Manual*
 - (iii) Advice to the Commission
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 - (i) Species Monitored under the CCAMLR Ecosystem Monitoring Program (CEMP)
 - (a) Report of WG-EMM
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 - (ii) Assessment of Incidental Mortality
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- 6. Ecosystem Monitoring and Management
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- 9. New and Exploratory Fisheries
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- 19. Adoption of the Report of the Seventeenth Meeting of the Scientific Committee
- 20. Close of the Meeting

**REPORT OF THE WORKING GROUP ON
ECOSYSTEM MONITORING AND MANAGEMENT**

(Kochi, India, 10 to 20 August 1998)

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**REPORT OF THE WORKING GROUP ON
ECOSYSTEM MONITORING AND MANAGEMENT**
(Kochi, India, 10 to 20 August 1998)

INTRODUCTION

Opening of the Meeting

1.1 The fourth meeting of WG-EMM was held in Kochi, Kerala, India, from 10 to 20 August 1998.

1.2 In his welcoming address, Dr A.E. Muthunayagam, Secretary to the Government of India, Department of Ocean Development, New Delhi, outlined India's Antarctic Research Program and the importance of oceans and their sustained utilisation. The Honourable Minister for Fisheries, Government of Kerala, Sh. T.K. Ramakrishnan, described regional concerns about the exploitation of fishery resources and the environment, and the efforts underway to establish sustainable utilisation and conserve the marine resources. Sh. G. Eden, Honourable Member of Parliament, and Dr S. Paul, Honourable Member of Legislative Assembly of Kerala, extended their welcome to participants.

1.3 His Excellency, Justice (Retd) Sukhdev Singh Kang, Governor of Kerala, officially opened the meeting by welcoming all participants and expressing his hopes for fruitful scientific discussions. On behalf of the Working Group, the Convener, Dr I. Everson, thanked His Excellency, Justice (Retd) Sukhdev Singh Kang, the Government of India and, in particular, the Department of Ocean Development for the good wishes extended in the opening addresses to the meeting and also for hosting the meeting. Dr Everson noted that the CCAMLR management regime was dependent on the provision of sound scientific advice. Accordingly, he was pleased to welcome so many scientists from a large proportion of Member countries, many from the host country, India, to the meeting. Sh. V. Ravindranathan, Director of the Department of Ocean Development, gave a vote of thanks.

Adoption of the Agenda and Organisation of the Meeting

1.4 The Provisional Agenda was introduced and discussed. No changes were proposed and 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 Drs D. Agnew (UK), A. Constable (Australia), R. Hewitt (USA), R. Holt (USA), P. Penhale (USA), D. Ramm (Data Manager) and E. Sabourenkov (Science Officer), J. Watkins (UK) and P. Wilson (New Zealand). It was decided that item 9.5 of the agenda, 'Plans for a Synoptic Krill Survey in Area 48' would first be discussed in a subgroup. Drs Hewitt, Holt and Watkins were asked to set up the subgroup and report back to the Working Group on its findings.

FISHERIES INFORMATION

Catches Status and Trends

2.1 The spatial distribution of catches from the krill fishery during the split-year 1996/97 (July 1996 to June 1997) was presented (WG-EMM-98/7 Rev. 1). The fishery targeted krill

near the South Shetland Islands (Subarea 48.1) in all months except August and September 1996. Near South Georgia (Subarea 48.3), traditionally a winter fishery, it operated during July to September 1996 and in June 1997. Near the South Orkney Islands fishing took place in December 1996. The total reported catch of krill taken in 1996/97 was 83 919 tonnes.

2.2 The krill catches reported to the Secretariat by August 1998 indicated that four Members fished for krill during 1997/98, all in Area 48: Japan (63 413 tonnes); Korea (1 621 tonnes); Poland (15 312 tonnes) and the UK (634 tonnes). No fishing was reported from Areas 58 and 88. The total catch of krill reported at the time of the meeting was 80 980 tonnes.

2.3 Dr Ramm had sought information on catches of krill taken in FAO Division 41.3.2 from Members fishing in the northern sector of Subarea 48.1. He had also searched the FAO FISHSTAT database. This search confirmed the reported catches taken in Division 41.3.2 by Poland in 1988/89 (801 tonnes) and 1992/93 (2 506 tonnes) and reported in the *Statistical Bulletin*, and additional catches taken by the former Soviet Union in 1979/80 (161 tonnes) and Russia in 1990/91 (112 tonnes). Further, Poland submitted monthly catch and effort reports for krill fishing in Division 41.3.2 during 1997/98 (total catch 74 tonnes). The Working Group encouraged Members that have fished, or plan to fish, for krill in waters adjacent to the Convention Area to submit catch and effort data to the Secretariat in the CCAMLR formats.

2.4 The Working Group noted that STATLANT data for the past season would soon be submitted to the Secretariat. The Working Group reiterated the importance of fine-scale data and haul-by-haul data in the assessment of the krill fishery and its interactions with the ecosystem. Members were encouraged to submit all available data to the Secretariat.

2.5 In regard to plans to fish for krill during the split-year 1998/99, Mr T. Inoue (Japan) advised that Japan planned to continue fishing at the same level of about 60 000 tonnes of krill taken by four trawlers. Dr S. Kim (Republic of Korea) reported that the Republic of Korea planned to continue fishing at the same level of about 2 000 tonnes. Dr Agnew reported that fishing for krill by UK vessels in 1998/99 was likely to be at a level similar to 1997/98. For the moment, UK fishing for krill has been restricted to summer and winter periods, and is linked to the spring and autumn squid fisheries around the Falkland/Malvinas Islands. Dr Holt advised that a permit to take krill had been issued by the USA to one operator, and fishing may begin in September. Information in WG-EMM-98/13 indicated that Ukraine planned to renew krill fishing in the future. Dr K. Shust (Russia) advised that the present economic situation in Russia prevented Russian trawlers from operating in the krill fishery.

2.6 The Working Group had no further information on the proposed joint Ukraine/Canada fishing venture using two vessels (SC-CAMLR-XVI, paragraph 2.3). The Secretariat was requested to contact both countries, and seek further information on fishing activities which may have taken place during 1997/98 or were intended in 1998/99. The Secretariat was also asked to contact Uruguay, Panama and China to determine their intentions to fish for krill in CCAMLR waters.

Harvesting Strategies

2.7 Mr Inoue explained that krill harvested by Japanese trawlers in CCAMLR waters is used mostly as feed in the aquaculture industry and bait in recreational fisheries; a small proportion of the catches is also processed as food for human consumption. The demand for krill has dropped recently due to the severe downturn in the regional economy.

2.8 The quality of krill for use as feed, bait or food for human consumption is judged by three attributes: greenness of the hepatopancreas, body colour and body size. Large white krill with little green in their hepatopancreas are the most valuable, and are targeted by the fishing

industry. Over recent years, Japanese trawlers have extended their fishing season to autumn and winter so as to avoid catching early season green krill, increase their catch of white krill, and avoid unduly large stocks of krill products in freezer stores onshore.

2.9 The Working Group discussed the need for information on past and current market prices for krill. This information would provide further insight into the fishery, for instance in an appreciation of the economic factors affecting this fishery.

2.10 The results of biochemical analyses of krill harvested during the First Indian Antarctic Krill Expedition were presented (WG-EMM-98/39 and 98/42). These results not only indicated the biochemical composition of krill, but also showed the effects of processing on the moisture content, fluoride content, and autolytic properties of krill taken during fishing operations.

2.11 Krill, processed aboard, were also subject to trials in post-harvest processing. A variety of frozen, dried, canned and marinated products had been evaluated (WG-EMM-98/40). Fluoride in the processed products was reduced to 1–15 ppm. Tests on the use of krill as an additive to food products for human consumption yielded variable results (WG-EMM-98/41), some of which reduced the acceptability of such products (e.g. as a consequence of a characteristic or bitter taste).

2.12 The Working Group noted that these results were important since they provide the first descriptions of krill biochemistry, product type and product scope for a number of years. Furthermore, some of the information presented in the above papers (WG-EMM-98/39 and 98/42) may have important application in the production and updating of energetic models for krill-dependent predators. The Working Group therefore encouraged publication of the Indian data as well as a comparison of these data with earlier work on krill biochemistry and energetics (e.g. Grantham, 1977; Clarke and Morris, 1983; Budzinski et al., 1985).

Observer Scheme

2.13 The Working Group noted that there had been no international observer coverage of the krill fleet in 1996/97 and 1997/98. Consequently, observer data, including time-budget data, for this period were not available. The Working Group reiterated the need for observer data and encouraged Members to collect such data and submit these to the Secretariat. Observer-type data have been collected from the Japanese fleet as part of the Japanese research program, and reported in WG-EMM-98/33.

MEETINGS DURING THE INTERSESSIONAL PERIOD

Report of the Workshop on Area 48

3.1 The Convener of the workshop, Dr Hewitt, introduced the Report of the Workshop on Area 48 to the meeting (WG-EMM-98/16). The workshop was held at the Southwest Fisheries Science Center in La Jolla, USA, from 15 to 26 June 1998. The terms of reference were:

- (i) identify the extent of between-season and within-season variation in key indices of the environment, harvested species, and dependent species over past decades;
- (ii) identify coherence in the indices between sites and clarify understanding of the linkages between Subareas 48.1, 48.2 and 48.3;
- (iii) develop working hypotheses; and
- (iv) provide a summary report for consideration of the 1998 meeting of WG-EMM.

3.2 The workshop was organised around the hypothesis H_0 and an alternative, H_1 as described below:

- (i) H_0 : Subareas 48.1, 48.2 and 48.3 are discrete ecosystems and events observed in any one subarea do not reflect what is happening in other subareas; and
- (ii) H_1 : area is a homogenous ecosystem and events observed in any one subarea reflect the entire area.

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

3.4 As findings and recommendations contained in the report relate to a number of topics discussed by WG-EMM, it was decided that the report would be considered in detail by section during discussions under subsequent agenda items.

3.5 The Working Group congratulated Dr Hewitt on a very successful workshop during which a large number of datasets were processed and a number of complex analyses undertaken. It was noted that Dr Hewitt was involved not only in the conduct of the workshop, but he had taken an active role in all stages of its organisation beginning with initial correspondence with potential contributors of data and the conduct of initial analyses.

3.6 The Working Group recommended that, as with previous scientific workshops, the report should be appended to the Working Group report and published in the bound volume of the report of the 1998 meeting of the Scientific Committee.

3.7 During discussions of this issue it was also noted that the Report of the Workshop on Area 48 (Appendix D) did not contain a number of background data and indices which were used by the workshop. It had been decided at the workshop that this information would only be made available by the Secretariat in accordance with CCAMLR's normal rules of data access (see Appendix D, paragraph 2.11).

HARVESTED SPECIES

Distribution and Standing Stock

4.1 Under this agenda item the following papers were considered to contain relevant information: WG-EMM-98/18, 98/30, 98/36, 98/13, 98/32, 98/51, 98/33, WS-Area48-98/11, WG-EMM-98/12 and 98/50, and these will be discussed in the following paragraphs.

4.2 WG-EMM-98/18 discussed the occurrence of Antarctic krill concentrations in the vicinity of the South Shetland Islands during a cruise in the austral summer of 1990/91. From early to mid-summer krill density increased and showed distinct offshore–inshore differences in abundance. In mid-summer acoustically determined krill density was low in the oceanic zone (8 g/m²), higher in the slope frontal zone (36 g/m²) and highest along the shelf break in the inshore zone (131 g/m²).

4.3 Working in the same area as the previous paper, WG-EMM-98/30 presented a recalculation of krill biomass using the Polish FIBEX acoustic data so that it would be comparable with the recalculation of other FIBEX datasets presented by Trathan et al. (1992). The new results indicated that the acoustic krill density for stratum 1 (an area of the Drake Passage northwest of the South Shetland Islands) was 3.0 g/m² (CV 44.1%), while the acoustic density for stratum 2 (within the Bransfield Strait) was 76.6 g/m² (CV 33.2%).

4.4 WG-EMM-98/36 presented an acoustic krill density estimate (0.6 g/m^2) for the infrequently surveyed area between 60° – 61°S and 34° – 40°E (Area 58) collected by the Indian Antarctic expedition in January 1996. Comparisons within the paper with other survey results indicated that the krill density in that area was low.

4.5 WG-EMM-98/13 presented estimates of larval density of krill for Subarea 48.2. North and east of the South Orkney Islands the average density was $\sim 30\,000$ individuals/ m^2 . In comparison with data from other years the abundance of larvae in 1997 was extremely high.

4.6 WG-EMM-98/32 presented estimates of three large surveys to estimate distribution and abundance of krill between the Antarctic Peninsula and South Georgia in 1983/84, 1984/85 and 1987/88. The mean biomass estimated from Isaacs-Kidd Midwater Trawls (IKMT) for the whole region was relatively constant on the three cruises (76.5 g/1 000 m^3 in January–March 1984, $101.7 \text{ g/1 000 m}^3$ in October–December 1984 and $101.4 \text{ g/1 000 m}^3$ in January–March 1988). In marked contrast there were significant changes in the quantity of krill observed in individual subareas. This was most obvious in Subarea 48.3 where krill densities of less than 1.5 g/1 000 m^3 were observed around South Georgia in 1984 while this had increased dramatically to $147.5 \text{ g/1 000 m}^3$ in 1988. In contrast, densities in Subareas 48.1 and 48.2 were smaller in 1988 than in 1984, this was particularly marked for Subarea 48.1 where the density in 1988 was approximately one-third of the density seen at the end of 1984.

4.7 WG-EMM-98/51 presented acoustic estimates of krill density obtained at South Georgia (Subarea 48.3) for 11 austral summers between 1981 and 1998. Krill abundance fluctuated widely from year to year over this time period, ranging from ~ 2 to $\sim 150 \text{ g/m}^2$. In 1981/82, 1990/91 and 1993/94 there were particularly low abundances of krill. For five of the summers between 1990 and 1998 separate density estimates for the northeastern and northwestern ends of South Georgia were calculated. In four of these years the density was higher at the eastern end of the island.

4.8 WS-Area48-98/11 presented a comparison of acoustic krill densities around South Georgia (Subarea 48.3) and Elephant Island (Subarea 48.1) for seven summers between 1981 and 1997. The magnitude of abundance and the between-year gradients of change of abundance were similar at each site; e.g. very low densities of krill were found at both sites in 1991 and 1994. There was no apparent lag in changes in abundance at each site suggesting that densities of krill at both locations were linked and may be impacted by the same gross physical and biological factors acting over the same temporal and spatial scales.

4.9 WG-EMM-98/12 presented a summary of the results obtained by YugNIRO during the period from 1977 to 1990 for an area between 60° and 80°E in the Indian Ocean (Sodruzhestva Sea, Area 58). Results from monitoring the krill biomass revealed two main periods of differing krill abundance. During the period from 1977 to 1984 the krill density was high (15 – 20 g/m^2), while from 1985 until 1988 the density was lower (1 – 5 g/m^2), in the last two years (1989–1990) the density increased but the values were lower than those seen at the beginning of the data series.

4.10 WG-EMM-98/50 presented updated krill density estimates obtained from standardised scientific net hauls for the Elephant Island region (Subarea 48.1) for the period from 1977 to 1998. The density estimate for 1997/98 was $59 \text{ krill/1 000 m}^3$. This was substantially less than the values that had been obtained in 1995/96 and 1996/97 (120 and $213 \text{ krill/1 000 m}^3$ respectively) and was seen as a possible return to the lower values found in the period from 1990 to 1994.

4.11 In Subarea 48.1, both net and acoustic density data were available for the period 1981 to 1997 (Appendix D, paragraph 4.7). Changes in density from year to year occurred in the same direction for both datasets. Note, however, that the absolute relationship between the two density estimates was not constant, and that major changes were observed around 1985/86 and 1992/93.

Population Structure, Recruitment, Growth and Production

4.12 Dr Hewitt presented a summary of the analyses on krill population structure and recruitment indices which were carried out at the Workshop on Area 48 (Appendix D, paragraphs 4.8 to 4.18).

- (i) Proportional recruitment indices at Elephant Island were low in 1988/89, 1989/90, 1991/92, 1993/94, 1995/96 and 1996/97. They were high in 1979/80, 1980/81, 1981/82, 1987/88, 1990/91 and 1994/95.
- (ii) Proportional recruitment indices at South Georgia were low in the same years they were low at Elephant Island. Proportional recruitment was high in South Georgia in 1994/95. Note, however, that no estimates of recruitment were available for 1979/80, 1980/81, 1981/82, 1987/88 and 1990/91.
- (iii) Absolute recruitment at Elephant Island was highest in 1979/80, 1980/81 and 1981/82. It was relatively low in 1987/88, 1990/91 and 1994/95.
- (iv) Krill length frequencies at Elephant Island and South Georgia were most similar in 1989/90, 1992/93 and 1996/97. They were more different in 1993/94 and 1997/98.
- (v) Krill predators at South Georgia shifted their diet from large- to medium-size krill as the summer progressed in 1990/91 and 1993/94 but not during intervening years.

4.13 In addition Dr Hewitt presented a summary of the krill fishery data analysed as part of the Workshop on Area 48 (Appendix D, paragraphs 4.20 to 4.27).

- (i) CPUE was calculated for fishing areas near Elephant Island, Livingston Island, South Orkneys, western end of South Georgia and eastern end of South Georgia.
- (ii) CPUE at Livingston Island and Elephant Island were similar from 1982/83 through until 1992/93. The CPUE in the Livingston Island area has been low since 1992/93.
- (iii) Low CPUE for the winter fishery at South Georgia occurred at the eastern end of the island in 1991 and 1993 while it was low at the western end of the island in 1991 and 1994.

4.14 The Working Group reiterated the conclusion of the Workshop on Area 48, that there was considerable concordance between proportional recruitment indices in Subareas 48.1 and 48.3, implying that large-scale phenomena were likely to be influencing population dynamics in both regions.

4.15 Under this section of the agenda the Working Group considered the following papers: WG-EMM-98/13, 98/18, 98/33, 98/37, 98/50, WS-Area48-98/15 and Appendix D. Important points of relevance to the Working Group are summarised as follows.

4.16 WG-EMM-98/18 presented data on the krill population structure on the western side of the Antarctic Peninsula in 1990/91. The characteristic general pattern of increasing size and maturity with distance offshore was observed. Mature krill in spawning condition (44–55 mm) were found only offshore and in the frontal zone while small krill (24–33 mm) were restricted to the inshore zone.

4.17 WG-EMM-98/13 presented data on the general population structure in Subarea 48.2 in March 1997. In this year up to half the population were in the size range of 39 to 47 mm

(3+ year class), no juveniles (1+ year class) were observed and only 5 to 10% of the population were in the 2+ year class. In contrast, near Elephant Island (Subarea 48.1), 5% of the krill were juvenile, 30% were in year class 2+ and 30% were in year class 3+.

4.18 WG-EMM-98/37 presented data on the population structure of krill sampled during the January and February 1996 in Area 58 (57°–61°S and 30°–40°E). The observed length frequency distribution was bimodal with a mode at 19–20 mm and at 53–54 mm. Very few krill were found in between these two size groups implying that in this area at least two year classes were missing.

4.19 WG-EMM-98/33 presented a large and comprehensive dataset on proportional recruitment indices derived from Japanese fisheries data in Area 48 between 1980 and 1997. The results for the R2 values derived from the fishery data in Subarea 48.1 showed significant correlations with the R1 and R2 proportional recruitment indices derived from scientific surveys (Siegel et al., 1998). In contrast R1 values derived from the fishery did not show significant correlations with the scientific data; this could have been due to net selectivity and/or incomplete coverage of the areas where 1+ year class krill tend to occur. R1 and R2 recruitment indices from the fishery data were not significantly correlated. In Subarea 48.1 recruitment peaks were observed in 1980/81, 1981/82, 1987/88 and 1994/95. In Subarea 48.2 recruitment peaks were seen in 1980/81, 1981/82, 1990/91 and 1994/95. While in Subarea 48.3 recruitment peaks were observed in 1988/89, 1989/90, 1993/94 and 1994/95.

4.20 It was emphasised that some caution was required when using recruitment indices from fishery data because of net selectivity and the area covered by the commercial fishery. Nevertheless, the Working Group recognised this as an extremely valuable contribution and was very pleased to see such a comprehensive review of data collected from the commercial fishery.

4.21 WS-Area48-98/15 presented data on krill population structure derived from krill eaten by three predator species at South Georgia (Subarea 48.3) for the summers from 1991 to 1997. A comparison of krill sampled by nets and predators revealed similar length-frequency distributions when comparing nets with samples from Antarctic fur seals and macaroni penguins combined. The length-frequency distribution of krill within a season was most variable in 1990/91 and 1993/94, both years of low krill biomass at South Georgia. In both these years large krill dominated in the diet of fur seals and macaroni penguins during December but were completely replaced by small krill by February. The mean length of krill in March showed a regular increase from 1991 to 1993, fell to a minimum in 1994 and thereafter increased steadily until 1997. It is suggested that years of high mean krill length reflect the failure of small krill to recruit to the South Georgia population, producing a period of low krill biomass the following year.

4.22 The Working Group recognised that while individual predators may show some selectivity (e.g. in some years fur seals showed clear selectivity for large krill), this was less apparent when the three predator species were combined. It was difficult to weight the contributions of the different predators. The results of the changes of recruitment indices through the season had potential implications for the timing of surveys to assess recruitment. It was also recognised that the predators may not be sampling the same krill populations as the surveys.

4.23 WG-EMM-98/50 presented the updated time series of recruitment indices for the Elephant Island region (Subarea 48.1) derived from scientific net sampling. This paper confirmed that after the high proportional and absolute recruitment shown by the 1994/95 year class, the values for the 1995/96 and 1996/97 year classes were showing a downwards trend.

4.24 It was noted that the small krill observed in the Indian Ocean sector (WG-EMM-98/37) implied success of the 1994/95 year class, which is the same year class that was successful in Area 48. However, the Working Group felt that it was premature to accept that such an observation implied concordance in recruitment between these two areas.

Detailed Consideration of Recruitment Indices

4.25 The Workshop on Area 48 used two indices of recruitment in its work, proportional and absolute recruitment. Estimates of proportional recruitment (R1) are derived from mixture analyses (i.e. the proportion of individuals in a given year that fall within the year 1 age class) and are used to determine absolute recruitment in that year (see paragraph 4.29).

4.26 The Workshop on Area 48 used this estimate of proportional recruitment backdated to the previous year as an index of the reproductive performance of krill in respective subareas. This was done in an attempt to understand whether variation in reproductive performance in krill coincided with variation observed in key environmental or predator parameters. The Working Group noted that the terminology needed to be refined so that notions of reproductive performance would not be confused with methods for calculating absolute recruitment in a given year. To this end, the Working Group agreed that 'Per Capita Recruitment' (PCR) encapsulates the meaning desired in discussions about affects of the environment on krill reproductive output and larval survival.

4.27 The Working Group examined methods for determining PCR. It noted that the proportion of R1 in the stock at a specific time does not provide an indicator of reproductive success because it does not refer to the reproductive stock in the previous year. For this reason, an index of reproductive success needs to include a measure of recruits from one year and a measure of the spawning stock from the previous year. A potential method for estimating PCR was discussed under item 9 in paragraphs 9.6 to 9.12.

4.28 Last year, the Working Group noted progress on assessing krill recruitment and indicated that a priority task was to develop a reliable predictor of krill recruitment and to determine its statistical properties so that it can be used in assessments (SC-CAMLR-XVI, Annex 4, paragraph 3.27). Also, the Working Group noted the need to understand whether small-scale estimates of recruitment based on restricted surveys reflected more global trends (SC-CAMLR-XVI, Annex 4, paragraph 3.28).

4.29 These questions were raised again following the assessments undertaken by the Workshop on Area 48. In particular, the Working Group noted that the estimates of recruitment (based on proportions of R1 combined with the estimates of krill density), when considered in combination with the estimate of $M = 0.8$ (Siegel, 1991; but note that estimates of M may vary from year to year and that Butterworth et al. (1994) integrated over a range of $M = 0.4-1.0$ in the calculations of a precautionary yield for krill), did not seem to be sufficient to sustain the populations of krill despite the apparent abundance of krill to predators in many years. The Working Group undertook some preliminary analyses using the results from Subarea 48.1 in an attempt to reconcile the recruitment estimates and M .

4.30 For clarification, the proportion of one-year-olds, R1, in any year, y , is

$$R1_y = \frac{N_{1,y}}{\sum_{a=1}^n N_{a,y}}$$

where $N_{a,y}$ is the number at age a in year y , and there are n ages. In addition, some analyses are based on recruits at age 2 rather than age 1. In this case, the formula of the proportion of two-year-olds, R2, in any year, y , is

$$R2_y = \frac{N_{2,y}}{\sum_{a=2}^n N_{a,y}}$$

These formulae apply to the year of capture, y . In the Workshop on Area 48, these values were related to the year class, which is $y-1$ and $y-2$ for $R1$ and $R2$ respectively.

4.31 The problem identified above can be examined, in the first instance, using a model of a closed krill population considered to be in equilibrium. In this case, the number of krill in one year, N_{t+1} , should be equal to the number of krill in the previous year, N_t . In this case, losses to mortality should equal recruitment, R . Thus,

$$R1 = \frac{R}{N} = 1 - e^{-M}$$

The current estimate of M is 0.8. Thus, the average replacement recruitment required for a sustainable population would require $R1 = 0.55$. However, $R1$ has been observed to be consistently below this value at about 0.1 during the late 1980s and early 1990s (see Figure 1). Under a scenario of equilibrium, M would need to be approximately 0.11, which is considerably different from the current estimate.

4.32 The Working Group recognised that this calculation does not account for variable recruitment or sampling variability. Two analyses were undertaken using measures of absolute recruitment to solve for a constant M , where absolute recruitment was considered to be

$$R_y = D_y R1_y$$

and D_y is the density of krill in the current year, y (see Siegel et al. 1998 for discussion). Values of D_y and $R1$ are taken from WG-EMM-98/50 and the values of D_y are the bootstrap estimates of density from net surveys.

4.33 The first was an age-structured population projection with six age classes using the absolute recruitments and solving for M by minimising the sums of squared differences between the expected and observed numbers in each year. In this model, the missing values in estimates of $R1$ and the absolute densities were interpolated. The estimate of M was 0.584. A projection of the stock based on this estimate of M is shown together with the estimates of absolute density in Figure 1.

4.34 The second method used only the available data to estimate M and accounts for uncertainty in both the estimates of $R1$ and absolute density. It minimised the error in M from a series of equations of differences between the expected density from the previous year projected to the current year and the estimate of adult animals from the current year

$$D_y \cdot (1 - R1) - D_{y-1} \cdot e^{-M} = 0$$

The series of equations included only those years for which data were available. The estimate of M in this case was 0.603. The estimates of total density for each year are overlaid on Figure 1 where the density in a year was the projected density of adults from the previous year plus the density of recruits estimated for that year from $R1$ and the total recorded density.

4.35 The results of both these methods estimated M to be less than the current estimate of 0.8. Figure 1 shows that the values of M derived from these methods provide projection results that are close to the estimates of density in the years prior to 1992 but, following that year, the difference between observed and estimated densities becomes greater, particularly in the most recent years from 1996. This result suggests that the observed recovery of the density of krill in Subarea 48.1 following 1994 could not be attributed to recruitment alone.

4.36 The Working Group considered that the discrepancies between estimates of M and between observed and expected estimates of density using these analyses could have arisen, *inter alia*, from:

- (i) the current estimates of recruitment are correct and the model for M needs revision, e.g. the estimate of a constant M over all post-recruit year classes may need to be revised or the model may need to account for interannual variability in M;
- (ii) the estimate of the proportion of recruitment is representative of the whole population but the estimates of density vary in their representativeness of the population, (e.g. arising from interannual variability in advection); and
- (iii) the estimates of proportional recruitment (R1) may be incorrect, arising from spatial variability in the distribution of different age classes and/or different residence times of those age classes in the survey area, or as a result of interannual variability in growth rate which may affect the interpretation of the length-density data.

4.37 The Working Group noted that work needs to be undertaken to determine the reasons for the discrepancies. It also noted that the Workshop on Area 48 had made considerable progress in allowing these questions to surface and to provide some direction for pursuing them. The Working Group agreed that the results of the Workshop on Area 48 need to be carried forward interessionally with the aim to determine how to utilise length-density data from restricted areas in estimating large-scale trends in absolute recruitment. In particular, the following questions were highlighted for further developmental work:

- (i) What model/s of recruitment can be applied to local stocks in different subareas?
 - (a) Are local stocks independent?
 - (b) How important are immigration and emigration to the dynamics of local stocks?
 - (c) Does the local stock have a single origin or multiple origins? If so, is the demography of krill the same in each of these stocks? What are the relative inputs of the different source stocks?
 - (d) Does the pattern of immigration or emigration vary between cohorts or between locations or times?
- (ii) How does intra-annual variability in krill distribution affect estimates of recruitment?
 - (a) Does sampling have to occur throughout a season or is a single time appropriate?
- (iii) How should sampling be stratified in space to ensure a representative sample from the local stock is obtained?
 - (a) What methods can be applied to ensure that small-scale surveys can be used to understand trends over large-scale areas?
- (iv) How sensitive is the method for estimating R1 to variation in growth, mortality and recruitment rates?

DEPENDENT SPECIES

CEMP Indices

5.1 Dr Ramm presented a summary of the anomalies and trends in CEMP indices (WG-EMM-98/4 Rev. 2). New data for indicator species in the 1997/98 season were included where available; sea-ice data were available to December 1997 and sea-surface temperatures (SST) were available to March 1998. Information on missing values were also presented, as requested at last year's meeting. The Working Group recognised that missing values may occur as a result of technical or logistical constraints, however, some missing values arise as a result of an absence of the properties to be measured. The Working Group noted that a methodology needs to be developed that can incorporate these latter missing values in assessments of anomalies.

Studies on Distribution and Population Dynamics

General

5.2 Analyses of land-based predator indices from the Workshop on Area 48 (Appendix D, paragraph 9.4) show that:

- (i) most land-based predator indices showed greater coherence between species within sites than across sites (Appendix D, paragraphs 7.9 to 7.16);
- (ii) land-based predator indices in summer were generally coherent across Subareas 48.1, 48.2 and 48.3 (Appendix D, paragraphs 7.18 to 7.29):

‘good’ years: 1984/85, 1987/88, 1988/89, 1994/95 to 1996/97;
‘bad’ years: 1990/91 and 1993/94, particularly 1990/91.

- (iii) coherence in land-based predator indices for summer across subareas was generally more evident in good than in bad years (Appendix D, paragraphs 7.28 and 7.32);
- (iv) winter land-based predator indices show less coherence across subareas than summer indices. When there was coherence:

‘good’ years: 1977, 1988 and 1989;
‘bad’ years: 1990 and 1994

it was more consistently area-wide than in summer (Appendix D, paragraphs 7.33 to 7.48); and

- (v) there was no consistent sequence in land-based predator indices between bad winters and bad summers; that is, either can precede the other (Appendix D, paragraph 7.45).

Antarctic Fur Seals

5.3 The Working Group thanked SCAR for the report on status and trends in Antarctic seals (WG-EMM-98/8 and 98/27) but noted that some of the data are now well out of date. The utility of such data being solicited from SCAR is discussed further in paragraph 5.5.

5.4 WG-EMM-98/17 reported a population decline of Antarctic fur seals at Cape Shirreff during 1997. This followed six years of annual increases in the number of seals at this site, although pup growth rates in 1997 were within the historical norm (WS-Area48-98/18). The Working Group suggested that these results could be attributed to a number of possible causes, including density-dependent factors and/or environmental linkages. However, it agreed that a single annual decline in population numbers may not necessarily indicate the beginning of a population decline of Antarctic fur seals at Cape Shirreff and that more research is required.

Birds

5.5 The status and trends of Antarctic and sub-Antarctic seabirds (SC-CAMLR-XV/BG/29) were discussed by the Working Group. The document, through necessity, contains data of questionable reliability and is dated. The Working Group recognised that SC-CAMLR-XV/BG/29 had been produced in response to a request for information from SCAR-BBS. Given that data on bird population status and trends are annually submitted to the CEMP database, the question of the potential utility of data from SCAR at five-yearly intervals should be referred to SC-CAMLR for consideration.

5.6 Foraging trip duration in male and female macaroni penguins at Bouvet Island (WG-EMM-98/23) indicated that female, not male penguins may provide superior data on foraging. This needs to be reviewed intersessionally in relation to information from South Georgia. The Working Group expressed interest in the future of this study as it was monitoring a species known to feed on krill but present in an area for which there is little information. Diet composition studies would also be of interest in addressing the issue of prey switching – also it is known that fish are eaten in the early part of the season; krill are eaten later on. In addition, knowledge of meal size in relation to foraging trip duration would give some indication of feeding efficiency.

5.7 Diet and foraging effort of Adélie penguins in relation to pack-ice conditions in the southern Ross Sea (WG-EMM-98/15) reconfirmed the importance of *Pleuragramma antarcticum* and *Euphausiacrystallorophias* in the diet delivered to chicks by provisioning parents on Ross Island and showed that successful foraging during the chick-rearing phase appears to depend on the proximity of pack-ice to nesting colonies. The Working Group expressed interest in this paper for modelling purposes.

Whales

5.8 According to the whale data provided by the IWC (WS-Area48-98/21) for which the Working Group expressed thanks to Dr S. Reilly (Observer, IWC), sighting surveys of minke whales appeared to offer the best technique for censusing whales for analyses in CCAMLR.

Other Information

5.9 WG-EMM-98/49 describes the US AMLR 1997/98 field season, and of note is that this season was the first at Cape Shirreff after shifting base from Seal Island. The Working Group welcomed the news from Dr Holt that the Admiralty Bay dataset would soon be available to CCAMLR.

5.10 The Working Group reviewed SC-CAMLR-XVII/BG/2 and considered that it was no longer necessary to present this information in a paper. Instead, it was suggested that for Table 1 (summary of Members' CEMP activities on monitoring approved predator parameters)

the Secretariat directly pursue the submission of relevant historic data. The Working Group suggested Table 2 (directed research programs required to evaluate the utility of potential predator parameters) should go onto the CCAMLR website and also recommended that the Scientific Committee ensure a standard approach, if possible, for this sort of data across both WG-EMM and WG-FSA.

ENVIRONMENT

6.1 Participants at the Workshop on Area 48 emphasised the following results (Appendix D, paragraph 9.2):

- (i) global ocean/atmosphere signals were evident in indices of the physical environment (SSTs, air temperatures, difference in sea-level pressure across Drake Passage (DPOI, Drake Passage Oscillation Index), sea-ice extent derived for Area 48) (Appendix D, paragraphs 3.16 to 3.22);
- (ii) approximately four-year periodicity was evident in SST and with the Antarctic Circumpolar Wave (ACW) described by White and Petersen (1994) (Appendix D, paragraphs 3.23 to 3.28);
- (iii) precession of SST anomalies across Scotia Sea was consistent with the FRAM advective transport model, suggesting transport times of four to eight months between the Antarctic Peninsula and South Georgia (Appendix D, paragraphs 3.29 to 3.37);
- (iv) global ocean/atmospheric signals showed strongest coherence with South Georgia, weaker coherence with the Antarctic Peninsula and the South Orkneys implying different local influences (such as Weddell Sea) (Appendix D, paragraphs 3.31, 3.32 and 3.36); and
- (v) a warming trend over the last seven years was apparent in the surface temperature data only at the Antarctic Peninsula and the South Orkneys (Appendix D, paragraphs 3.26 and 3.28).

6.2 Table 4 of WG-EMM-98/4 presents sea-ice indices updated to include 1998 data. The Working Group expressed appreciation to the Secretariat for providing the new information but also questioned whether the data were being utilised in analyses. However, it was recognised that several key participants, who might utilise the information, were not in attendance at the meeting and it was decided to defer the issue until the next meeting of the Working Group.

6.3 WG-EMM-98/12 presented an overview of 30 years of oceanographic monitoring by YugNIRO in the Indian Sector of the Antarctic waters, especially in the waters of the Kerguelen Archipelago, Ob and Lena Banks, and the Sodruzhestva and Cosmonauts Seas. Major investigations included the distribution of water masses, position of fronts, current flows, gyre formation and thermocline locations.

6.4 The large amount of data collected in this area over a long time period was noted. It was recognised that much of the data might be useful in furthering the work of the Working Group and participants were encouraged to define specific data needs to address specific problems. The authors could then be encouraged to provide appropriate data.

6.5 WG-EMM-98/14 reported a program to provide fisheries users with information pertaining to current and monthly environmental conditions. Information in the form of maps is derived using SST satellite data. Although current maps are not prepared for Antarctic waters, the authors suggest similar data could be obtained and provided for areas of interest to the

Working Group. It was suggested that it would be important to know how fishers utilised these data. It was also recognised that data of this type might be used to investigate how predators respond to certain environmental factors both within and among years.

6.6 WG-EMM-98/15 investigated pack-ice at three sites in the Ross Sea from 1994/95 to 1996/97. Sea-ice was extensive and persistent in 1994/95 compared to the other two years; it was least extensive in 1996/97.

6.7 WG-EMM-98/31 used satellite microwave observations to report on daily transition of polynyas in the Ross Sea from 1978 to 1994. A typical polynya existed in the inner area of the Ross Sea in November of each year. The shape of the polynyas changed remarkably in several days. They usually opened to the northern oceanic water in late December.

6.8 It was suggested that it would be of interest to standardise methods used to investigate polynya dynamics which would allow comparisons to other variables across years, etc. It also would be useful to develop some spatial index to determine variability in the characteristics of polynyas.

6.9 WS-Area48-98/10 reported that high levels of autocorrelation were evident in the SST anomalies around South Georgia (Subarea 48.3) with periodicity evident at a lag period of four years. To the north of the island significant autocorrelation was also evident at a lag period of one year. Cross-correlation analyses with indices describing the El Niño areas of the Pacific indicated that temperature fluctuations at South Georgia reflected temperature fluctuations in the Pacific. This link was separated temporally with the Pacific preceding South Georgia by almost three years. High levels of intra-annual variability at South Georgia were observed and the Principal Component Analysis (PCA) indicated that seasonal differences between winter and summer were important.

6.10 The authors noted that based upon the anticipated three-year lag, the greatest impact of the 1997/98 El Niño event will be unlikely to reach South Georgia until 2000/01 (WG-Area48-98/10). The Working Group noted that some models of the physical environment are reaching sufficient maturity to provide testable predictions as to their effects on the Antarctic ecosystem. It encouraged participants to test the predictive capacity of these models by generating predictions, determining the types of data that would indicate the effects on the ecosystem and undertaking the necessary field monitoring to acquire these data. To that end, the Working Group suggested that efforts be made to formulate and test predictions arising from the anticipated influence of the 1997/98 El Niño.

ECOSYSTEM ANALYSIS

Analytical Procedures

Combination of Indices

7.1 For a number of years, the CEMP indices have been presented as standardised normal variates. At the 1997 meeting of the Subgroup on Statistics a method for the combination of these standardised indices into a Composite Standardised Index (CSI) was proposed by de la Mare (WG-EMM-STATS-97/7). At the Workshop on Area 48 a computer program provided by Drs I. Boyd and A. Murray (UK) was used to calculate CSIs. In their paper describing the operation of the program (WS-Area48-98/6) the authors commented that they had not been able to reproduce de la Mare's results exactly, because the original paper had not been explicit in describing the calculation of the covariance matrix. WG-EMM-98/45 provided a worked example of the de la Mare method which clarified this operation. It was recognised that the difference between the methods described in WG-EMM-98/45 and WS-Area48-98/6 was that the former (de la Mare method) calculated covariances by pairwise correlation over the time

series where all indices in the CSI were represented (i.e. a complete dataset, where there were no missing values, and where the covariance matrix is identical to the correlation matrix). The latter calculated covariances between indices of all available cases in each pairing.

7.2 The Working Group requested Drs Constable and Boyd to correspond in order to establish the most appropriate statistical approach to the calculation of covariance matrices for CSIs.

7.3 WG-EMM-98/45 examined the sensitivity of the CSI method to missing values in the indices making up the CSI. The most robust CSIs were those where parameters included in the index were positively correlated with all other parameters, preferably with correlations greater than 0.3. Indices including parameters that were negatively correlated with other parameters were particularly sensitive to missing values.

7.4 It was agreed that the choice of parameters to include in a CSI should be made with care, including consideration of the correlation between indices, the time and space scales integrated by them, and the weighting factors that might be applicable.

Multivariate Approaches

7.5 Examples of several possible multivariate approaches to interpreting indices were available to the Working Group. These included multiple regression (WS-Area48-98/16; Appendix D, Table 14), PCA (WS-Area48-98/10; Appendix D, Attachment E) and spectral analysis (WS-Area48-98/11). PCA and spectral analysis are primarily descriptive, rather than predictive approaches, which are of assistance in identifying components of the system which might be of most use when developing predictive models. Multiple regression and associated models have predictive capability. The various merits of these approaches are discussed in detail in Appendix D.

7.6 It was recognised that there are two primary objectives for ecosystem analysis, both of which can be approached using multivariate techniques:

- (i) understanding the autecological properties of species, and the interactions between ecosystem components; and
- (ii) identifying predictive/operational models from which management advice can be derived.

7.7 It was also recognised that the interpretation of the results of multivariate analyses is contingent on the correct formulation of the CSIs. There is unlikely to be only one CSI that is most appropriate for describing any parameter set, since the parameters and weighting factors included in a CSI are likely to be influenced by the purpose to which the CSI will be put. CSIs of use in understanding the relationships between ecosystem components might contain different parameter sets from those of use in making management decisions.

7.8 Further development of multivariate approaches, including especially exploration of the sensitivity of such analyses to the CSIs used, is encouraged. The significance of the contribution made to the multivariate model of each parameter or index should be clearly identified in the results of such studies, as should the covariance matrix of the CSI. Consideration can then be given to whether inclusion of an index, or a parameter within a CSI, is appropriate.

General Yield Model

7.9 Drs Ramm and Constable reported on progress with validation of the General Yield Model (GYM), which has been accepted by the Working Group as a replacement for the existing krill yield model (SC-CAMLR-XVI, Annex 4, paragraph 7.3). Validation will be initiated in 1998, and should be completed in 1999, before the proposed Area 48 synoptic survey.

7.10 The Working Group requested that details of the validation methods, and the worksheets and programs used in the validation procedure, be available to members of the CCAMLR scientific community as soon as possible, to encourage a peer-review process similar to that used to validate the original krill yield model. This is particularly important given the potentially high use that may be made of this model in deriving management advice for a number of harvested species. However, given the complexity of the model, it was suggested that scientists wishing to examine the validation procedures do so in close consultation with Dr Constable and the Secretariat.

7.11 The existing krill yield model will be kept at the Secretariat in its current form for cross-checking purposes. The Secretariat was requested to develop a comprehensive set of documentation for this model prior to it being archived, so that it might easily be used in the future if necessary.

Krill-centred Interactions

Krill–Environment Interactions

7.12 Considerable information was available on the interaction of krill and their environment in the report of the Workshop on Area 48 and a number of papers. The results of the workshop relevant to this agenda item are given in (Appendix D, paragraphs 8.11 to 8.43).

7.13 Introducing the relevant section of the report, Dr Hewitt identified the following main conclusions with regard to interactions:

- (i) environmental indices for SST, sea-ice and DPOI in Area 48 showed strong coherence, all being in phase with the same periods, and are an expression of the ACW (Murphy et al., 1995; White and Petersen, 1996). The phase period between the east and the west Scotia Sea is four to eight months (Appendix D, paragraph 9.2). Although data from the Antarctic Peninsula and the South Orkneys have similar signals, they are less strong and indicate that either local effects, or influences from other areas (such as the Weddell Sea) may also be important;
- (ii) proportional krill recruitment above an index value of approximately 0.3 was correlated with sea-ice extent in the Antarctic Peninsula (Appendix D, paragraph 8.17);
- (iii) krill density at South Georgia was associated with regional sea-ice and summer SOI, in particular the low krill density, low sea-ice years of 1990/91 and 1993/94 (Appendix D, paragraphs 8.21 and 8.35). In contrast krill density at the Antarctic Peninsula was not associated with indices of physical variability (Appendix D, paragraphs 8.20 and 8.34); and
- (iv) land-based and pelagic predator indices in Subarea 48.3 were correlated with summer krill densities but were also influenced independently by physical

variables (Appendix D, paragraphs 8.21, 8.24, 8.27 and 8.34). In contrast, land-based predator indices in Subarea 48.1 were not correlated with krill or physical indices (Appendix D, paragraphs 8.20 and 8.34).

7.14 WG-EMM-98/18 examined oceanic waters, the shelf slope frontal zone and inshore waters around the South Shetland Islands and found that the topographic features associated with the shelf and islands were responsible for two distinct current patterns in the area. The larvae resulting from spawning in the slope frontal zone would be carried onshore to be entrained in the Bransfield Strait by the slower currents and eddy systems along the shelf break (paragraph 4.2). In contrast adults and larvae in the offshore region would be likely to be carried through the Drake Passage away from Subarea 48.1 by the faster, more linear current flowing offshore.

7.15 WS-Area48-98/11 noted that the magnitudes and between-year gradients of change in acoustic abundance were similar at both Elephant Island and South Georgia. This indicated that densities of krill at both locations are linked and may be impacted by the same gross physical and biological factors and are in agreement with paragraph 7.13(i) above. WS-Area48-98/8 suggested that the transport of krill to South Georgia may be different in warm and cold years, possibly mediated by sea-ice extent and the relative influences of the Weddell–Scotia Confluence (WSC) and the Antarctic Circumpolar Current (ACC) in warm (reduced sea-ice) and cold (increased sea-ice) years. WG-EMM-98/32 presented direct evidence of links between krill around the Antarctic Peninsula, South Orkneys and Scotia Sea and transport to South Georgia, by mapping both current structures and krill density over the Scotia Sea in 1983/84, 1984/85 and 1987/88.

7.16 Both WS-Area48-98/8 and WG-EMM-98/32, however, found inconsistencies in simple environmental explanations of krill occurrence at South Georgia. For instance, in 1984/85, although there was a clear current between the Antarctic Peninsula and the eastern side of South Georgia, high densities of krill around South Georgia were not apparent at the time of the Russian survey. The occurrence of krill at South Georgia is therefore not simply explained by physical transport mechanisms from the Antarctic Peninsula through Subarea 48.2, but is likely to involve interactions between various biological and physical processes. A conceptual model presented in WS-Area48-98/8 captured this through the inclusion of environmental influences on egg production and overwinter survival in addition to regional transport. It was noted that both WG-EMM-98/32 and WS-Area48-98/8 presented evidence that the pattern of currents between the Peninsula and South Georgia may be quite variable, and include the abovementioned Weddell Sea input and the possibility of transport to the west of South Georgia rather than the east of the island in some years.

7.17 WG-EMM-98/32 also presents information which runs counter to the evidence for concordance within Area 48. Although these surveys did observe a decline in krill abundance in Subareas 48.1 and 48.2 in 1987/88, this was not accompanied by declines in Subarea 48.3. The abundance over the whole area (Subareas 48.1, 48.2 and 48.3) remained relatively stable in each of the surveys (1983/84, 1984/85 and 1987/88). This suggested that the multiannual trends in krill abundance seen in Subarea 48.1 did not necessarily reflect trends in krill abundance over the entire Area 48.

7.18 WG-EMM-98/12 reported that studies in the Indian Ocean Sector (Prydz Bay) had revealed that a period of high krill density from 1977 to 1984 was followed by a period of low krill density from 1985 to 1988. The Working Group noted that this coincided with the drop in krill densities seen around the Antarctic Peninsula from 1985 onwards. Although it is unlikely that there are direct links between the two areas, it is possible that both are influenced by the ACW, which has an eight-year transit cycle of two peaks, with peaks occurring at opposite sides of the Antarctic Continent simultaneously (White and Petersen, 1996). Any one side, therefore, experiences a four-year period between peaks. However, considerations of convergence between various areas in the Antarctic should be made with caution, as this periodicity appears to be a rather recent phenomenon and the wave does not necessarily progress at the same speed in all areas.

7.19 WG-EMM-98/12 reported on analyses developed by Ukrainian scientists in which krill density was linked to atmospheric pressure measurements to produce krill 'forecasts'. The Working Group reflected that this might be a similar index to the DPOI (the difference in sea-level pressure between Rio Gallegos and Esperanza) used by the Workshop on Area 48, and encouraged presentation of further details of these analyses.

7.20 The Working Group recognised that, with the large number of connections between krill abundance and environmental variables now being suggested, it might soon be possible to suggest forecasts for likely future krill recruitment and/or abundance. For instance, in 1997 observed late spawning and high salp abundance around the Antarctic Peninsula suggested that recruitment of the 1996/97 year class would be low, as indeed has been observed in 1998 (WG-EMM-98/50). WG-EMM-98/52 pointed to a number of environmental variables that could be used to make these forecasts. Using them may not be simple: the Workshop on Area 48, for instance, demonstrated a positive relationship between sea-ice and the proportion of one-year-old krill in the population only in Subarea 48.1 and only for proportions of one-year-olds greater than 0.3 (Appendix D, Figure 39). Nevertheless, the Working Group agreed that it should work towards a predictive model of krill recruitment which would improve the ability to make such forecasts.

7.21 The Working Group noted that some of the relationships established by bivariate analyses during the Workshop are probably non-linear (Appendix D, paragraph 8.43). Therefore, the Working Group agreed that it was important to carry out further analyses with regard to predicting krill recruitment.

Krill–Plankton Interactions

7.22 Results from the First Indian Antarctic Krill Expedition were presented. Sampling was conducted in Area 58 (around 61°S 34°E) during January to February 1996. Krill were sampled using a 2.5-m IKMT, a 42-m commercial trawl net, and a 49.5-m experimental midwater trawl (WG-EMM-98/38). Krill only made up 45.6% by weight of trawl catches, 54% being salps. The expedition also recorded high abundances of copepods (WG-EMM-98/34, 98/35, 98/37). These samples were taken in an oceanic area from which there are very few data on krill biology and abundance. Further information which might suggest the origin of krill in this area would be useful (see paragraphs 4.18 and 4.24). The Working Group welcomed the results of the expedition as these contributed to the knowledge of Area 58. This area has received little attention over the past 20 years. India has submitted data on by-catch to the ad hoc working group on finfish by-catch in krill fisheries.

7.23 WG-EMM-98/13 presented distribution plots which suggested separation between salps and krill in water masses north of the South Orkneys in 1997. However, examination of the full dataset would be necessary before drawing conclusions from these observations.

7.24 In the Peninsula area, poor recruitment is indicated for the 1995/96 and 1996/97 year classes (WG-EMM-98/50). Dr Hewitt recalled that the failure of the 1996/97 year class had been predicted last year (paragraph 7.20 above). This prediction was based in part on links with high salp abundance in the latter half of the 1996/97 season. WG-EMM-98/50 reported (i) that salps had been dominant in the zooplankton in 1998 and 1993, (ii) that copepods had been dominant in 1995 and 1996, and (iii) identified 1994 and 1997 as transition years between the salp dominated and copepod dominated years. The transitions happened over a matter of weeks suggesting advective rather than population processes. The Working Group suggested a number of multivariate analyses including multidimensional scaling using software such as that developed by Plymouth Marine Laboratories (UK) that might be used to characterise the years using all the species recorded. As to the question of whether salps and krill compete for phytoplankton, it was noted that WS-Area48-98/4 had found different relationships between salps and krill depending on sampling location.

7.25 The presence of the salp *Ihlearacovitzai* had been identified for the first time in US AMLR surveys (WG-EMM-98/50), although this species has been recorded from the Antarctic Peninsula region before by other national surveys. This species is generally described as being present at higher latitudes than *Salpa thompsoni*. A further unusual feature of the 1998 survey was the occurrence of unusually small krill at some southern survey stations. Several alternative hypotheses might explain these phenomena, including significant incursions of Weddell Sea waters, delayed spawning of krill in 1997 and transport of *Ihlea* from further south on the Antarctic Peninsula.

7.26 The Working Group previously noted that the Japanese fishery generally encountered green krill in the early summer, with an increasing proportion of white krill throughout the summer and autumn. Green krill are taken to reflect high levels of feeding on phytoplankton. WG-EMM-98/29 reported the proportion of green krill sampled around the South Shetland Islands, was related to the amount of phytoplankton of $>2 \mu\text{m}$ in size rather than very small phytoplankton of $<2 \mu\text{m}$ (WG-EMM-98/29). These larger phytoplankton declined in the autumn, explaining the transition from green to white krill.

Krill–Fishery Interactions

7.27 WG-EMM-98/5 reported on the Secretariat's application of the Schroeder index of spatial resource overlap to the Agnew–Phegan model of overlap between penguin foraging demands and the krill fishery in Subarea 48.1. The new results indicate that while the Agnew–Phegan index of Foraging–Fishery Overlap has been declining over the last decade, the Schroeder index has been increasing. Concern was expressed that the Schroeder index measured only the relative overlap of two 'predators', without considering the magnitude of the overlap. Thus, even if the catch was very low, if it coincided exactly with foraging areas the index would equal 1. In the current formulation of the Schroeder index this is partly a consequence of only considering catches within the critical period (December to March) rather than the whole period over which the fishery operates.

7.28 It was recognised that indices reflecting the relative degrees of overlap (such as the Schroeder index) and indices reflecting the absolute catch of krill relative to predator foraging demands (such as the Agnew–Phegan index or the catch in the critical period–distance) are required to judge the impact that the fishery might be having on predators. Both should therefore be retained for the time being, and consideration should be given to producing various graphical outputs which would aid interpretation of the indices (for instance, maps of predator consumption density). Investigation of the performance of these two indices to changes in fishing distribution and size, and to variants of model formulation, should be undertaken by the Secretariat in the intersessional period in addition to the bullet points identified as further work in WG-EMM-98/5.

7.29 One of the objectives of an ecosystem assessment should be to identify areas which, should the krill fishery increase rapidly, may require some management measures. However, estimates of predator numbers and consumption appear to be quite variable and are often, for logistic reasons, quite separated in time between various areas. A B_0 survey for predators, similar to that for krill proposed for 2000, might therefore be needed. Any quantitative assessment of the impact of the krill fishery on predators in local areas should also require the development of a functional relationship between predators, krill and the fishery.

Krill–Predator Interactions

7.30 WS-Area48-98/17 examined the differences in predator foraging characteristics in years of high and low krill abundance. A ten-fold decrease in krill abundance between 1986 and

1994 was accompanied by reduction of krill in predator diets, an increase in prey diversity and reduced diet overlap between species. Breeding success was markedly reduced in all species except macaroni penguin, which switched from krill to amphipods. The results showed a coherent pattern of responses to the reduction in krill availability, which confirm assumptions of the links between predators and krill made by the ecosystem monitoring program.

7.31 WG-EMM-98/15 showed that the amount of food brought to Adélie penguin chicks on Ross Island increased as trip duration increased up to periods of two days, and then decreased as trip duration increased further up to four days, as a result of more of the food being used for adult maintenance. A complex relationship between the consumption of *E. crystallophias*, *P. antarcticum* and the amount of pack-ice was revealed. These observations contribute to the understanding of the significance of changes in foraging duration in Adélies.

Fish- and Squid-based Interactions

7.32 The Working Group noted the work on the correlation of *Champsoccephalus gunnari* condition index with krill density from South Georgia and Subarea 48.1 (Appendix D, paragraph 8.27). Further work on this relationship should result in an index of the condition of *C. gunnari* as a krill-dependent species.

7.33 A considerable number of datasets of the by-catch of fish in krill fishing operations has now been acquired by the Secretariat (WG-EMM-98/23). The Working Group looked forward to the detailed analysis of these data to be discussed by WG-FSA.

ECOSYSTEM ASSESSMENT

Precautionary Catch Limits

8.1 The Working Group agreed that the information available to the meeting did not warrant a reassessment of precautionary catch limits for krill (SC-CAMLR-XVI, Annex 4, paragraphs 7.4 to 7.9). However, it noted that continued progress in developing a general model of krill dynamics in Area 48 arising from the Workshop on Area 48 would, in the near future, contribute to an evaluation of a subdivision of the precautionary catch limit in this area.

Assessment of the Status of the Ecosystem

8.2 Prior to assessing the ecosystem, the Working Group recalled the definition of ecosystem assessment in its report from 1995 (SC-CAMLR-XIV, Annex 4, paragraphs 2.12 to 2.21). Also, the Working Group acknowledged the considerable progress made in synthesising indices at the Workshop on Area 48 which are in line with the recommendations of the Subgroup on Statistics last year for making assessments of the status of the ecosystem (paragraphs 7.1 to 7.8; SC-CAMLR-XVI, Annex 4, Appendix D). As these methods are not yet in a form suitable for undertaking assessments, the Working Group summarised the temporal trajectories in krill catch, environmental variables (sea-ice extent and SST) and populations of krill and dependent species (population size (Method A3) and reproductive output (Method A6)) monitored at or, in the case of krill, near to CEMP study sites up to the present. These were used to undertake the following assessment which aimed to identify ecologically important values (EIVs) and/or trends in the data (see SC-CAMLR-XVI, Annex 4, paragraph 7.11). Other sources of information were used to explain observed EIVs and/or trends where appropriate.

8.3 A method of presentation was developed that provided the summaries of these data in a format similar to that developed at last year's meeting (SC-CAMLR-XVI, Annex 4, paragraphs 7.29 and 7.30; SC-CAMLR-XVI, Annex 4, Appendix D) and, at the same time, one that will be useful in displaying the results of the multivariate indices (e.g. CSI) in future years. This revised tabular format displays each of the parameters noted above for each area or subarea. Each parameter is represented as a graph showing standardised normal deviates such that wide deviations from the long-term mean can be easily discerned. Some parameters show a running five-year average alongside the graph to indicate general trends in the dataset. Also included is the coefficient of variation (CV), which scales the deviates. Percentage change in an index from time 1 to time 2 can be calculated using the following formula:

$$\% = \frac{(x_2 - x_1).CV}{1 + x_1.CV} .100$$

where % is the percentage change, x_1 and x_2 are the standardised normal deviates from time 1 and time 2 respectively. A negative % indicates a decline, while a positive indicates an increase, expressed as a percentage of the index value at time 1.

8.4 Currently, data from fisheries are reviewed as trends in total catches from each subarea or area. Such data provide a useful guide as to what catches are likely in future years. However, this data does not reflect directly the availability of krill to the fishery because it does not account for economic constraints on the fishery. As a consequence, the current analyses do not allow a comparison of the performance of the fishery with environmental, prey or other parameters. As a result, an examination of the interaction between the fishery and other parameters could not be undertaken. The Working Group agreed that, in future, fishery-dependent indices related to krill availability, such as CPUE, should be incorporated into the assessments.

8.5 The Working Group noted that results from Marion Island for abundances of macaroni and gentoo penguins in the CEMP database are not representative of the patterns observed in the literature for the population as a whole (paragraphs 8.13 and 8.14). This drew attention to the general use of Method A3. The Working Group agreed that the current description of the method was ambiguous such that data arising from this method may not provide a good indicator of trends in the overall population of a dependent species at the scale at which comparisons can be made with other parameters such as sea-ice extent, SST, krill catch and krill population parameters. To this end, the Working Group identified a number of questions to be addressed intersessionally to help with future assessments of ecologically important events or trends in each dependent species:

- (i) What size of area within a statistical area or subarea or within an Integrated Study Region (ISR) is considered to be sufficient for comparing trends in abundance of the resident species with trends in environmental or prey parameters?
- (ii) In what manner can subsampling in space and time be undertaken to give reliable estimates of the overall abundance and trends in abundance of the resident species?
- (iii) How representative are the existing datasets of the overall abundance of the resident species and how may we judge this from available data? What errors might be involved in scaling up small-scale results to the larger-scale area?
- (iv) What terminology can be used in an unambiguous way to reflect the spatial and temporal scales of sampling desired in the standard methods?

8.6 The Working Group agreed that the Secretariat be asked to contact the researchers submitting data for input to the CEMP database to examine these questions for input to the next

meeting. Despite the need to clarify these issues, the Working Group agreed that common trends or events between dependent species provide sufficient grounds for making an assessment this year.

Subarea 48.1

8.7 Table 1 provides a summary for Subarea 48.1. Declines in dependent species were generally correlated with krill density. Such a relationship is not easily interpreted at this stage because CSIs based on predator performance showed little correlation with krill density found by the Workshop on Area 48 (Appendix D). However, the Working Group recognised the need for more work on clarifying how to use and interpret CSIs (paragraphs 7.1 to 7.8).

8.8 The Working Group noted that Adélie breeding success did not show similar trends to the decline in abundance of Adélie penguins. This implies that the reduction in population size may be due to increases in post-fledging mortality rather than decreases in reproductive success.

Subarea 48.2

8.9 Table 2 provides a summary for Subarea 48.2. Gentoo penguins gradually increased in abundance between 1990/91 and 1996/97. Chinstrap penguins underwent a 28% decrease from a relatively stable larger population (over three years) to a relatively stable smaller population (over three years) between the years 1993/94 and 1994/95. As with Subarea 48.1, breeding success in penguins was unrelated to trends in the population.

Subarea 48.3

8.10 Table 3 provides a summary for Subarea 48.3. Macaroni penguins and black-browed albatrosses show consistent declines over the last decade. The Working Group noted that the decline in albatrosses is likely to result from incidental mortality in longline fishing. However, the reasons for the decline in macaroni penguins are not clear. As with Subarea 48.1, breeding success in penguins was unrelated to trends in the population. However, breeding success was extremely poor in this species in 1983/84, which has been identified as a very poor krill year (Appendix D).

8.11 The 83% increase in gentoo penguins in 1988/89 followed by a reduction to the previous level in 1990/91 is difficult to explain. One hypothesis is that the high density of krill observed to be present in the area in 1987/88 (WG-EMM-98/32) resulted in gentoo penguins immigrating to the monitored areas followed by them emigrating two years later.

Area 58

8.12 Adélie penguins have been increasing in recent years at Béchervaise Island and Syowa Station (Table 4).

8.13 The Working Group was informed by Dr D. Miller (Chairman, Scientific Committee) of trends in penguin abundances at Marion Island, which have been published in Adams and Wilson (1987). Although populations of macaroni and gentoo penguins have shown long-term stability, the breeding population of gentoo penguins has decreased steadily over the last three

years. Macaroni penguins had poor breeding success in 1994/95. Gentoo penguins had poor breeding success in 1994/95 and especially in 1997/98; the seasons in which breeding commenced early and late respectively.

8.14 The Working Group noted that these gross population estimates for penguins at Marion Island contained in the literature differed from those contained in the CEMP database. This was attributed to the data in the CEMP database coming from a single small colony. In the case of gentoo penguins on Marion Island, the CEMP data did not reflect a steady decline in the number of breeding pairs over the past three years (compared with the population trends reported above). The Working Group also noted discrepancies in breeding success for gentoos with only one poor year (1997/98) being reflected in the CEMP database compared with two (1994/95 and 1997/98) in data available to its meeting (paragraph 8.13).

8.15 The Working Group agreed that the Secretariat should seek clarity from Dr R. Crawford (South Africa), responsible for the submission of CEMP data from the Prince Edward Islands.

Area 88

8.16 The population of Adélie penguins at Ross Island has been observed to undergo cyclical fluctuations in abundance. Dr Wilson reported to the Working Group that a recent and, as yet, unpublished study, has found that the magnitude and frequency of the cycle is most likely explained by changes in mortality of adults/sub-adults and not changes in breeding success.

Development of Assessment Methods

8.17 Considerable progress has been made in recent years on developing assessment methods. The Working Group highlighted a number of areas of research required to further this work in developing a framework for evaluation of ecosystem status (part 1 of an ecosystem assessment described by the Working Group in SC-CAMLR-XIV, Annex 4, paragraphs 2.13 and 2.21). In particular, the Working Group requested further work to be undertaken on:

- (i) methods for selecting parameters to derive indices for use in assessments, including identifying parameters that:
 - (a) integrate over the temporal and spatial scales for which comparisons need to be made;
 - (b) have a clear relationship to measured parameters of the prey or environment;
 - (c) are robust to violations of underlying assumptions;
- (ii) how indices, such as CSIs, can be interpreted in relation to the demography and abundance of the indexed species; and
- (iii) defining EIVs and the methods for identifying when trends in the data are ecologically significant.

8.18 In regard to developing management advice (part 2 of an ecosystem assessment described by the Working Group in SC-CAMLR-XIV, Annex 4, paragraph 2.13), the following work should be undertaken:

- (i) developing models to help predict what might happen in the future given current trends, e.g. the recent development of a conceptual model for predicting recruitment in Subarea 48.1 (paragraph 7.20); and
- (ii) methods to assist with providing quantitative advice on the implications to the ecosystem of alternative management actions.

8.19 The Working Group noted that work is being undertaken elsewhere to develop methods for assessing the status of ecosystems relative to historical levels, notably the mass balance methods using Ecopath and Ecosim simulation software (Christensen and Pauly, 1992). It considered that an evaluation of these methods as to their applicability to the work of WG-EMM would be desirable.

Consideration of Possible Management Measures

8.20 The Working Group noted that the long time series of data now available from the CEMP and other monitoring programs provide a unique and valuable dataset for undertaking ecosystem assessments. It also noted that the graphical presentation of the temporal sequence of indices facilitated greatly the review and assessment of the status of the ecosystem. However, the causes of the trends and events discussed in paragraphs 8.7 to 8.16 above could not be explained at this stage.

8.21 No new management measures were proposed.

METHODS AND PROGRAMS INVOLVING STUDIES ON HARVESTED AND DEPENDENT SPECIES AND THE ENVIRONMENT

Methods for Estimating Distribution, Standing Stock, Recruitment and Production of Harvested Species

9.1 WG-EMM-98/19, 98/20 and 98/21 noted the difficulties associated with scaling measurements of volume backscattering strength to densities of krill. In general practice this is accomplished by using the mean target strength (TS), or the distribution of TS, for ensonified animals. The distribution of TS may be obtained from *in situ* measurements or from a theoretical model relating TS to a suite of morphometric, physiological and behavioural parameters. For krill, SC-CAMLR-X (1991) recommended the use of a simple linear relationship between body length and TS which represented a reasonable fit to several datasets available in the literature at that time. The working papers (WG-EMM-98/19, 98/20 and 98/21) made the following points:

- (i) length-frequency distributions obtained from trawl samples and those inferred from *in situ* TS measurements differed significantly; for the comparisons reported, mean length from trawls was 20 to 25% greater than that inferred from *in situ* measurements in 11 out of 13 cases resulting in as much as a 200% difference in numerical density when scaling volume backscattering strength to numerical density;
- (ii) length-frequency distributions derived from a simple sum over a series of trawl samples compared with those derived after weighting each trawl by its catch and also those weighted by both catch and catchability were different resulting in as much as a 48% difference in numerical density; and

- (iii) scaling volume backscattering strength to biomass density, rather than numerical density, substantially reduces these discrepancies and that TS per kilogram of krill is reasonably stable over a wide range of body lengths.

9.2 The Working Group noted that the third point had been acknowledged by several investigators and was one of the reasons why the results of acoustic surveys for krill are often reported in units of biomass density rather than numerical density. Furthermore, the conclusion is a consequence of using the simple model of krill target strength adopted by SC-CAMLR-X (1991) and may be less valid if a more complex model were to be used.

9.3 WG-EMM-98/24 summarised decisions and recommendations by the Scientific Committee and its working groups with regard to krill surveys over the last several years. The Working Group appreciated the collection of such material in one place and recognised its potential utility when preparing plans for the near-synoptic survey of krill in Area 48.

9.4 WG-EMM-98/47 contained a detailed specification for the collection of acoustic data in support of the near-synoptic survey of krill in Area 48, including transceivers, transducers, data logging and viewing software, calibration procedures, instrument settings, and operational protocols. The Working Group noted that such a specification, if acceptable to all participants, would ensure that data would be collected in a comprehensive and uniform manner across all ships involved in the survey. It was agreed that adopting a specification at the level of detail proposed in the paper would greatly facilitate analysis of the data and increase the probability of a successful survey.

9.5 Information contained in WG-EMM-98/14, 98/29 and 98/35 stimulated the suggestion that remote sensing of SST and/or phytoplankton pigments may be useful for locating concentrations of krill. The Working Group noted the existence of several studies that may be relevant in pursuing this idea, but cautioned that the relationship between sea-surface signatures of water temperature and/or phytoplankton biomass and krill may be complex and therefore difficult to interpret.

9.6 In response to the comments made in paragraphs 4.25 to 4.27 regarding the index of proportional recruitment for krill (R1), Dr Hewitt proposed an index of PCR:

$$PCR_{y-1} = \frac{R1_y}{(1 - R1_y)e^{M_{y-1}}}$$

where M is the post-recruit mortality rate and y is an index of year.

9.7 Use of such a formulation to index krill reproductive success, which includes reproductive output as well as survival through the egg and larval phases, is based on two assumptions that:

- (i) a representative sample of the population is available in the form of a length density distribution and that the proportion of one-year-old animals (R1) can be unambiguously determined; and
- (ii) post-recruit mortality (M) is constant over all age classes.

9.8 This formulation can be extended over a series of years by assuming that the variability of M over those years is negligible compared to the variability of reproductive output and pre-recruit mortality.

9.9 It is not necessary to assume that the same proportion of the population is sampled each year, only that the sample is representative of the total population.

9.10 Such a formulation has the following advantages:

- (i) proportional indices, such as R1, demonstrate statistical problems associated with their being constrained between zero and one; the possible range of PCR values extends from zero to infinity.
- (ii) it has a logical definition (that is, the ratio of one-year-olds to the rest of the recruited population with one year of mortality removed); and
- (iii) it is a simple transformation of the existing R1 index.

9.11 It was suggested that the statistical properties of the PCR index and its robustness to relaxation of the assumptions and sampling requirements be investigated during the intersessional period.

9.12 The intended use for a series of PCR values is to provide a measure of krill PCR that could be compared against factors postulated to affect reproductive output and survival through pre-recruit stages (e.g. sea-ice extent, salp density, seasonal timing of spawning).

Consideration of CEMP Sites

9.13 The Working Group noted that no new CEMP sites were proposed for consideration by the Working Group. It was also noted that no Protected Area Management plans had been forwarded by SCAR for consideration by the Working Group.

9.14 At the 1997 meeting of WG-EMM, a paper entitled 'The Application of CCAMLR Ecosystem Monitoring Program (CEMP) Standard Methods in the Antarctic Site Inventory Project' (WG-EMM-97/38) was considered. It was noted that the results of the study might be of interest to CCAMLR.

9.15 The Scientific Committee had invited the author, Mr R. Naveen (USA), to provide a list of its sites and to submit a paper to CCAMLR with results of studies when about five years of consecutive data are available from most sites (SC-CAMLR-XVI, paragraph 4.13).

9.16 In response, Mr Naveen submitted three recent publications to the Secretariat. The paper containing the list of sites in the Antarctic Site Inventory Project (WG-EMM-98/9) was distributed to the Working Group. In response, the Working Group thanked Mr Naveen for this information and looked forward to seeing the results of the study in the future.

Methods for Monitoring the Performance of Dependent Species

9.17 The Working Group noted that the completed revised *CEMP Standard Methods* had been circulated in September 1997.

Existing Methods

A3 – Breeding Population Size

9.18 The Working Group recalled uncertainties (see paragraph 8.5) associated with the results from the use of Method A3, and that the instructions for the use of this method are potentially confusing (particularly subparagraph 1). The Working Group recommended that the Subgroup on Methods should address these issues and revise Method A3 intersessionally.

A5 – Duration of Foraging Trips

9.19 The concerns raised last year regarding this method have been addressed by Australian scientists who have offered to conduct analyses on their extensive data and produce a discussion paper for WG-EMM in 1999. The Working Group welcomed this offer.

9.20 Last year Dr F. Mehlum (Norway) outlined the problem Norwegian scientists experienced on Bouvet Island with data using Method A5 for macaroni penguins. The method of only using males in the study reduces the chance of acquiring data since males stay at the nest for 10 days or more before they commence foraging trips after chicks hatch. Following last year's request, Norway submitted a paper (WG-EMM-98/28) which quantifies the differences between male and female foraging trips and suggests that female not male penguins, may be better for gathering data on foraging, and questioned why the standard method recommends using data only from males.

9.21 The Working Group agreed this issue should be addressed intersessionally by the Subgroup on Methods and in particular in relation to information on macaroni penguins at South Georgia. Mr T. Ichii (Japan) also noted that the recent paper by Jansen et al. (1998) on foraging modes of chinstrap penguins, which contrast daytime and overnight foraging trips, should be considered when reviewing Method A5.

A6 – Penguin Breeding Success

9.22 WG-EMM-98/10 proposed changes to the assessment technique described in Method A6. The Working Group recommended that this paper be referred intersessionally to the Subgroup on Methods for consideration.

9.23 It was noted that Method A6 specifies use of the same colonies as Method A3, although whether the concerns about A3 (paragraph 9.18) will affect the application of results from Method A6 is unknown. The Working Group requested that the Subgroup on Methods look at Method A6 when considering the problems with A3.

B3 – Black-browed Albatross Demography

9.24 The Working Group noted that Dr J. Croxall (UK) had, in July 1998, submitted the demographic data from Bird Island, for the period 1976 to 1998 (WG-EMM-98/23).

New Methods

A3B – Breeding Population Size

9.25 Dr Wilson introduced WG-EMM-98/46, a revised version of a draft standard method, for using aerial photography as an alternative method to ground counts for nests in entire colonies. The Working Group suggested that the rationale for recommending an altitude of 2 500 feet above ground level for helicopter flights be included in the method. This altitude is the minimum to avoid disturbance to the incubating adults. Additionally, reference to the footprint of the photo size should be deleted, since all photos taken by a hand-held camera are high-angle obliques, and for the purposes of counting incubating adult penguins, it is not necessary to have a measure of scale or area covered by the photograph so long as full coverage is achieved.

9.26 With these changes, the Working Group recommended adoption of this method for Adélie penguins and noted it may be applicable to, and could be tested on, other species.

B4 – Petrel Diet

9.27 The Working Group noted that the diet data for Cape petrels at Bouvet Island and Antarctic petrels at Svarthamaren requested last year from Dr S.-H. Lorentsen (Norway) (SC-CAMLR-XVI, Annex 4, paragraph 8.58) have not yet been received (WG-EMM-98/23).

B5 – Antarctic Petrel Population Size, Breeding Success

9.28 The Working Group noted that the data requested last year from Norway (for the period 1992–1998) have now been submitted. Intersessional requests for similar data to Dutch and US scientists (e.g. Drs J. van Franeker and P. Hodum) working with Australia, has not yet resulted in receipt of the data (WG-EMM-98/23).

C3 – Antarctic Fur Seal Adult Female Survival Rate and Pregnancy Rate, C4 – Antarctic Fur Seal Diet

9.29 The Working Group noted that the revision of these two methods discussed last year (SC-CAMLR-XVI, Annex 4, paragraphs 8.65, 8.66 and 8.67) has been deferred and also noted that the new method for tagging seals (SC-CAMLR-XVI, Annex 4, paragraph 8.85) to be prepared by Dr Boyd has also been deferred in both cases until WG-EMM in 1999 (WG-EMM-98/23).

New Method for Non Krill-dependent Species

9.30 A new method for non krill-dependent species, which proposes monitoring changes in coastal fish populations by the analysis of pellets of the Antarctic shag (WG-EMM-98/11) was considered by the Working Group. It was agreed that the method be approved for a five-year trial period initially. Formatting and minor alterations need to be addressed, and the originators should liaise with Dr Sabourenkov to this end. When finalised the new method will be published and circulated to all Members.

Otolith Size and Mass as Predictors of Fish Length and Mass

9.31 WG-EMM-98/43 describes measurements of otolith chord and mass from the mackerel icefish. Both chord length and mass were good predictors of fish length but mass was slightly superior. The same measures did not predict fish total mass as well because fish condition and hence mass varies with season and other environmental variables.

9.32 The Working Group acknowledged this paper improved the accuracy of assessing size and age of fish consumed by predators.

9.33 Mr Ichii, however, was concerned that the erosion of the otoliths in the gut of Antarctic fur seals would reduce the viability of the technique. The Working Group suggested overcoming that problem would be a task for dependent species researchers.

Seabirds At-sea Methodology

9.34 WG-EMM-98/22 briefly describes the methods that have been used in seabird at-sea studies in the Southern Ocean with a view to recommending methods for future studies in the region, particularly quantifying data on seabird densities. The synoptic survey of Area 48, for example, will require standardised at-sea bird methods.

9.35 The Working Group recommended that Dr Sabourenkov contact scientists with experience in recording at-sea bird behaviour for guidance on how best to formulate a new standard method for at-sea bird studies.

Crabeater Seal Monitoring

9.36 The Working Group expressed thanks to SCAR-GSS, for the report of the 1996 APIS Survey Meeting (WG-EMM-98/26) and the report on the meeting of SCAR-GSS (WG-EMM-98/27), following WG-EMM's request for this information last year.

9.37 Specifically, CCAMLR is interested in formulating a viable technique for monitoring crabeater seal abundance within CEMP. However, as WG-EMM-98/27 points out, it is unlikely the APIS program will produce a standard method for routine monitoring of crabeater seals before the APIS program is finished in the year 2000.

9.38 The Working Group expressed its continuing interest in the development of a suitable technique to be completed as soon as possible.

CEMP Indices for Environmental Variables

9.39 As part of the CCAMLR Ecosystem Monitoring Program, the Secretariat currently produces four environmental indices (F2a–c and F5) which are considered to be relevant to the assessment of dependent species indices (A1–8, B1a–b, C1–2). The dependent species indices are mainly site related and the current environmental indices reflect that situation. The existing indices are (SC-CAMLR-XVI, Annex 4, paragraph 8.92):

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

9.40 Further standard methodologies have been drafted. These indices are also site related:

- F1 Sea-ice cover viewed from a CEMP site;
- F3 Local weather at a CEMP site; and
- F4 Snow cover at a CEMP site.

9.41 In 1997, the Working Group reviewed each of the environmental indices. It noted that some Members already collect information to describe the amount of sea-ice cover in the vicinity of predator colonies (Index F1) and some Members prepare their own indices using remotely-sensed sea-ice data (Index F2). Therefore, Dr Ramm was asked to review the methodologies used by Members prior to developing or updating draft method descriptions (SC-CAMLR-XVI, Annex 4, paragraphs 8.95 and 8.96). In addition, Dr Ramm was asked to review the availability of meteorological data from CEMP sites and from research stations so that consideration of appropriate weather indices (Index F3) may be developed (SC-CAMLR-XVI, Annex 4, paragraph 8.97).

9.42 Before an index to describe the local snow cover at a CEMP site (Index F4) could be developed, the Working Group felt it would be useful for Dr Ramm to determine if snow cover records were collected at CEMP sites and to review methodologies used by Members (SC-CAMLR-XVI, Annex 4, paragraph 8.98).

9.43 Finally, the Working Group also requested the Secretariat to document the methodology used to describe the SST adjacent to a CEMP site (Index F5) and produce a method description (SC-CAMLR-XVI, Annex 4, paragraph 8.99).

9.44 WG-EMM-98/6 presents a revised draft of Index F2. It notes that sea-ice concentration is derived from satellite data (US National Snow and Ice Data Center) and provides a consistent time series of daily sea-ice concentrations. However, there is a lead time of about six months before the digital images are available.

9.45 A revised draft of Index F5 was also presented in WG-EMM-98/6. It noted that SST data are available from the US Environmental Modeling Center which analyses *in situ* and satellite data and produces weekly and monthly SST datasets. These data are freely available with no restrictions on use. The Secretariat downloads these data and has developed software to extract monthly mean SST data for 1° x 1° grids adjacent CEMP sites and calculate Index F5.

9.46 Participants reviewed the drafts of Indices F2 and F5 (WG-EMM-98/6) and accepted the revised methods.

9.47 To determine information used to calculate Indices F1, F3 and F4, the Secretariat sent a circular to Members of the Scientific Committee and WG-EMM. In addition, information on data and shore-based protocols for recording weather was sought from the US Long Term Ecological Research (LTER) and the Australian Antarctic Division.

9.48 Responses to the circular (WG-EMM-95/6) were only received from South Africa, Russia and New Zealand. Responses were also received from the LTER and the Australian Antarctic Division. The Working Group welcomed these responses and requested others to provide similar information so that the Secretariat could provide draft methods at the next meeting.

Plans for a Synoptic Krill Survey in Area 48

9.49 At previous meetings of the Working Group and the Scientific Committee a number of documents and recommendations specifically directed at planning for a synoptic survey in Area 48 had been produced. All of these discussions and recommendations were summarised in WG-EMM-98/24.

9.50 In addition, members of the synoptic survey steering committee and task groups who were present at the Workshop on Area 48 (La Jolla, USA, June 1998) met briefly to discuss progress of plans for the survey. A report of these deliberations and tasks carried out immediately following that meeting is presented in WG-EMM-98/25.

9.51 The primary objective of the synoptic survey is to improve estimates of B_0 (pre-exploitation biomass) used in the krill yield model to estimate sustainable yield for Area 48 (SC-CAMLR-XII, paragraphs 2.39 and 2.41 to 2.47).

9.52 The Working Group considered the implications of interpreting the results from a single large-scale synoptic survey for estimating a long-term annual yield. The Working Group agreed that the krill yield model was robust with respect to interannual variability in krill biomass and will be able to use the B_0 estimate directly in its calculations.

9.53 The Working Group noted that the smaller-scale regional surveys could be used to monitor for long-term trends in krill biomass. However, the relationship between these surveys and the biomass throughout Area 48 needs to be determined. In this respect it would be advantageous to ensure that the regular regional surveys (such as the US AMLR survey (USA) and the BAS Core Program (UK)) could be linked to the large-scale synoptic survey in time and space so that the temporal variations observed in the regional surveys may be interpreted in respect of the larger area.

Survey Design

9.54 A number of documents specifically addressing the subject of survey design have been submitted to WG-Krill and WG-EMM over a number of years (summarised in WG-EMM-98/24) and a number of general survey designs had been proposed.

9.55 At the Workshop on Area 48, survey design was discussed in general terms and it was agreed that a randomised design coupled to a design-based analysis would produce the most statistically defensible result (WG-EMM-98/25, Appendix 1; see also conclusions from WG-Krill-94/20 which is presented as Appendix 10 in WG-EMM-98/24).

9.56 The Working Group considered the set of four draft survey plans (WG-EMM-98/44 and 98/53) which were drawn up at the request of the Area 48 synoptic survey planning meeting. All plans considered alternative ways of interleaving the tracklines of three ships that each had 30 days of time available to carry out the entire survey (including associated logistic costs).

- (i) Plan 1 comprised a stratified random design with four strata. Three separate strata were placed around the South Shetland Islands, South Orkney Islands and South Georgia. The fourth strata covered the remaining oceanic regions of Area 48.
- (ii) Plan 2 was an adaptive survey design utilising the same large-scale grid as plan 1 but directing additional survey effort into a series of survey cells (2° latitude x 2° longitude) that were shown to have above-average levels of biomass from the first pass through the area.
- (iii) Plan 3 comprised a random transect design where all the effort for the three ships was put into conducting a series of large-scale transects across the area.
- (iv) Plan 4 was an adaptive survey design where a series of small-scale surveys were carried out each time a ship passed through an area where there was a high biomass of krill.

9.57 The Working Group first considered the relative merits of an adaptive survey design against a pre-planned survey design (plans 2 and 4 versus plans 1 and 3). It was agreed that an adaptive survey design could offer increased understanding of the structure of the system, through a more detailed description of the distribution of krill within high density areas. However, the Working Group felt that the advantages of an adaptive approach, particularly as outlined in plan 4, in terms of improving the CV of the biomass estimate were less obvious. Indeed such techniques appeared to introduce increased complexity in terms of the design, execution and subsequent analysis of the survey.

9.58 The Working Group agreed that a model simulation of the relative merits of the adaptive and pre-planned surveys would be required to quantify the advantages of the two approaches. However, considerable concern was expressed both over the time-scale of such a simulation and the conclusiveness of the outcome.

9.59 The Working Group was also in agreement that a decision on the overall survey design had to be taken at this meeting. The Working Group agreed therefore that, given the concerns expressed above, the more conservative approach of utilising a pre-planned survey should be the preferred approach. This approach had been widely used in the past (for instance FIBEX) and was statistically robust and defensible.

9.60 The Working Group then considered the relative merits of a stratified versus unstratified design (plan 1 versus plan 3). It was pointed out that if krill were distributed in similar quantities both in the open ocean and in the shelf areas then a design which gives a uniform density of sampling across the whole area should be used (plan 3). However, if krill are concentrated in particular predictable areas, then a stratified sample design which takes account of this is likely to produce a lower overall CV. Note, however, that such a design will not change the expected estimate of mean biomass.

9.61 The Working Group was unable to agree on the relative importance of krill occurring on the shelves around the coast of the Antarctic Peninsula and the islands in Area 48. A variety of datasets and published papers (cf. WG-EMM-98/18 and 98/32) illustrate the complexity of the system.

9.62 The Working Group finally agreed that a modification of plan 3 would be adopted. Such a modification seeks to maximise the coverage provided by a series of large-scale transects carried out across the Scotia Sea by the three ships undertaking the survey. However, in order to reduce the CV of the biomass estimate, within three regions (north coast of South Georgia, north coast of the South Orkneys and offshore from the South Shetlands) there will be an additional transect between each of the large-scale transects (see Figure 2), in effect doubling the transect density in the three regions described above relative to the rest of the survey area. For analytical purposes, this allocation of survey effort would provide data from two distinct strata (one being more densely sampled than the other).

9.63 To supplement the core survey as described above the Working Group also agreed that:

- (i) if a fourth or fifth ship was able to contribute time within the period January 2000 then a series of extra transects would be interleaved within the existing large-scale transects;
- (ii) the length of the transects would be tuned to the latitudinal boundaries of the krill distribution; and
- (iii) participants would be encouraged to carry out their standard regional surveys either prior to or after the main synoptic survey. This was extremely important because it is necessary to link the temporal sequence of regional surveys with the wide spatial coverage of the synoptic survey.

Methods

Acoustics

9.64 The general philosophy for the acoustic methodology and equipment had been discussed previously. All participants were using Simrad EK500 systems and it was therefore possible to ensure a high level of standardisation. A preliminary proposal suggesting standard sampling protocols had been submitted (WG-EMM-98/47). The Working Group agreed with the general philosophy of the paper; that is whenever possible exact equipment, software and settings should be dictated. When exact matches were not possible, pertinent comparative information should be specified.

9.65 These protocols which cover (i) instrument settings, (ii) data logging, (iii) system calibration including multifrequency TS calibrations, intership calibrations and characterisation of system noise, (iv) survey operations and (v) additional recommendations should be agreed by the acousticians of the participating nations.

9.66 Multifrequency acoustics (38, 120, 200 kHz frequencies) would be available on the three ships carrying out the core transects. However, if additional ships were able to contribute to the survey effort (see paragraph 9.63) then such data would be a valuable addition to the dataset even if only 38 and 120 kHz data could be provided.

Net Sampling

9.67 The Working Group agreed that the main priority for the net sampling program was the determination of krill population structure demography. The requirements for estimates of net density and target identification were of secondary importance given that much information on krill identification would come from multifrequency acoustics.

9.68 There was considerable discussion of the sampling strategy used in the draft plans submitted in papers WG-EMM-98/44 and 98/53. In this case, a single night-time period was allocated for both net sampling and oceanographic sampling.

9.69 Given that the priority was to obtain a good coverage of samples for estimating the population structure, the Working Group agreed that a net sample should be taken around midnight and midday on each day of the survey. The timing of the midnight sample was constrained by the period of darkness. However, the timing of the midday sample was more flexible and the Working Group agreed that consideration should be given to allowing the time of this sample to shift as necessary to maintain a more regular pattern of sampling stations.

9.70 The Working Group considered that given the theoretical variation in catchability and selectivity of nets (see WG-EMM-98/20) it was highly desirable to standardise on the type of net used for krill sampling. At present the following nets were available:

Country	Net	Mesh Size (mm)	Mouth Area (m ²)
Japan	KYMT	3.4	9.0
Korea, Republic of	IKMT	0.5	4.5
Russia	IKMT	6.0	6.0
UK	RMT8	4.0	8.0
USA	IKMT	0.5	2.5

9.71 The Working Group felt that the most appropriate net in terms of catchability was the RMT8. However, they recognised also the financial implications of standardising on a single design and size of net.

9.72 Therefore the Working Group made two recommendations to achieve the best possible compromise with regard to net standardisation:

- (i) to investigate the possibility of obtaining RMT8 systems from other CCAMLR Members which were not able to contribute ship time to the survey, or from any other sources; and
- (ii) if the above was not possible then to allow the use of any of the above nets which had a mouth area of between 8 and 10 m² and a mesh size of between 3.0 and 4.0 mm.

9.73 The Working Group agreed that representative samples of krill would be measured on board ship and results would be entered onto computer prior to the end of each cruise. Detailed protocols must be established as soon as possible.

Environmental Sampling

9.74 The Working Group considered that each ship should undertake a CTD to a depth of 1 000 m at each midnight and midday station. A detailed protocol including the use of water-bottle samples for CTD calibration must be produced as soon as possible and the time implications assessed.

Other Sampling

9.75 The Working Group agreed that the acoustic transects, net sampling for population structure and CTD conducted at the midnight and midday stations would form the core of the sampling program and must be undertaken to standard protocols by all ships participating in the survey.

9.76 There were likely to be a number of other variables that participating countries would normally collect (for instance phytoplankton fluorescence, macro-zooplankton species composition, underway data such as obtained by pumped seawater supply or undulator). Such measurements were encouraged by the Working Group. It was emphasised, however, that such measurements must not compromise the collection of the core datasets.

9.77 The Working Group felt that it was appropriate that protocols and arrangements could be discussed between countries intending to collect similar data through the respective cruise leaders.

9.78 Appendix 8 of WG-EMM-98/25 presented a proposal from the IWC to send whale observers to participate on synoptic survey ships. Plans for such participation would be discussed at an IWC workshop at St Andrews, Scotland in March 1999. The Working Group felt that such a proposal was a valuable contribution to the synoptic survey. However, considerable concern was expressed about the number of observers traditionally used on such sighting surveys (six to eight persons per ship).

9.79 Although it was not possible to detail exactly how many spaces would be available on each participating ship it was thought that Japan and Russia would most likely only have room for one observer on each ship, UK was also tightly constrained but might be able to offer two berths while the USA thought it likely that they would be able to accommodate four to six observers.

9.80 The UK felt that independent estimates of whale numbers and incidental bird numbers would make a valuable comparison with the continuous bird and at-sea mammal observations that it conducts on its standard core program cruises and which are likely to be a component part of the synoptic survey.

Data Analysis and Storage

9.81 The Working Group agreed that the core datasets (i.e. acoustic data, krill length-frequency data and CTD data) should be analysed in the first instance within a CCAMLR workshop by all survey participants. Such a workshop should be timed to take place as soon after the cruise as practical and in any event prior to the 2000 meeting of WG-EMM.

9.82 Further the Working Group agreed that the initial dissemination and publication of these core data results should take place as a joint undertaking.

9.83 A copy of all core data and appropriate meta-data must be deposited with the CCAMLR data centre. The Working Group agreed that the appropriate data storage formats would need to be addressed prior to the cruise.

Coordination of Planning after Meeting of WG-EMM-98

9.84 The Working Group agreed that there was an urgent requirement to appoint a survey coordinator who would undertake the following tasks:

- (i) serve as a focal point between CCAMLR and cruise participants, and among cruise participants, for all matters relating to the survey planning, conduct and analysis;
- (ii) organise a planning workshop. This would include defining all tasks to be accomplished at the workshop, coordinating the preparation of cruise protocols and ensuring such cruise methodologies are uniformly applied;
- (iii) coordinate cruise plans and preparations amongst participants prior to the beginning of the survey. This would include coordinating the participation and interchange of key experts;
- (iv) serve as the at-sea coordinator;
- (v) ensure that data are supplied to CCAMLR and participants;
- (vi) organise data analysis workshop for survey participants; and
- (vii) coordinate report generation.

9.85 The Working Group agreed that the planning workshop should take place in mid- to late March 1999.

9.86 The Working Group also agreed that each participating country should provide a summary of any additional activities relevant to the synoptic survey that they would be undertaking during the 1999/2000 season.

9.87 Such summaries, all protocols and preliminary cruise plans must be completed and circulated to participants one month prior to this planning meeting.

9.88 The Working Group asked Dr Watkins to act as coordinator. In addition Drs Hewitt, M. Naganobu (Japan) and Watkins were appointed principal contacts for participating nations.

9.89 Any other countries wishing to participate should give a firm commitment prior to the planning meeting and supply the coordinator with a principal point of contact as soon as possible, but in any event no later than 15 March 1999.

9.90 Finally, the Working Group agreed that to facilitate planning it was important to nominate a definite start date as soon as possible. As a matter of priority all participants should confirm their ability to arrive at South Georgia in the first week of January 2000 to start the first calibration.

OTHER ACTIVITIES IN SUPPORT OF ECOSYSTEM MONITORING AND MANAGEMENT

9.91 Attention of the Working Group was drawn to a number of international meetings which were of relevance to WG-EMM.

9.92 Dr Kim advised of research activities which will be carried out by the Southern Ocean GLOBEC (SO-GLOBEC) program from 1999 onwards. The SO-GLOBEC activities will focus on winter processes in Antarctic waters, which include:

- (i) over-wintering strategy of krill;
- (ii) predator-prey interactions; and
- (iii) interactions between the biological populations and their environment, especially sea-ice.

9.93 The SO-GLOBEC Steering Committee has drafted a Science Plan for this program which is in the process of being finalised. It is anticipated that this plan will be available for consideration at the forthcoming meeting of the Scientific Committee or soon thereafter.

9.94 SO-GLOBEC will focus on two primary field sites: Antarctic Peninsula area and 70°E region. In the Peninsula area, several research vessels from Germany, UK and USA will conduct research during the 2000/01 season. The 70°E program will provide seasonal coverage starting from the 1999/2000 season.

9.95 SO-GLOBEC looks for cooperation with IWC and CCAMLR, especially because a number of CCAMLR Members have conducted regular surveys in the Peninsula area during summer and CCAMLR plans to conduct the multinational synoptic survey in Area 48 in summer 1999/2000. The cooperation could, therefore, be beneficial for both organisations.

9.96 It was noted that Dr Kim, as a liaison officer between SO-GLOBEC and the CCAMLR Scientific Committee, should liaise with the coordinator of the Area 48 survey and convey details of the CCAMLR survey plan to the current Chair of the SO-GLOBEC Steering Committee (Dr E. Hofmann (USA)) (paragraph 9.92(i)).

9.97 Another meeting of interest to the Working Group will be convened in Kochi, India from 25 to 27 November 1998. Its subject is 'Large Marine Ecosystems: Exploration and Exploitation for Sustainable Development and Conservation of Fish Stocks'. The Working Group noted that the subject matter of the symposium is of relevance to the ecosystem monitoring and management and that it would be looking forward to the publication of the proceedings of the symposium.

9.98 The Convener also informed the meeting that an international workshop on interannual variability in the Southern Ocean would be held in August 1999 at the British Antarctic Survey, Cambridge, UK. Topics to be discussed at the workshop are of relevance to CCAMLR.

9.99 The Working Group noted that the subject matter of the workshop is of interest to the Working Group. At the same time it was noted that the timing of the workshop coincides with the timing of the Symposium on Krill Biology sponsored by CCAMLR. The workshop organisers pointed out that, to some extent, it would be a follow-up to CCAMLR's Workshop on Area 48. The Chairman of the Scientific Committee advised that the Committee would consider at its forthcoming meeting the CCAMLR representation at the workshop.

9.100 A Symposium of ICES/SCOR on 'Ecosystems Effects of Fishing' will be held in Montpellier, France, from 16 to 19 March 1999. The subject matter of the symposium was considered to be highly relevant to the CCAMLR objectives on ecosystem monitoring and management. Dr Constable had been invited by the organising committee to coordinate the development of a keynote paper, in conjunction with colleagues from the Scientific Committee.

It was recommended that past and current conveners involved in the development of the ecosystem approach and still involved in CCAMLR, together with the Chairman of the Scientific Committee and the former and current Data Managers, Drs Agnew and Ramm, would assist with this task.

International Coordination Plans

9.101 Dr Kim reported that the Subgroup on International Coordination plans to conduct its third activity in the Peninsula area during summer 1999/2000. Data collection activities will include acoustic surveys, net sampling and oceanographic studies. Activities will be conducted by Japan, the Republic of Korea and USA around the South Shetland Islands from December 1999 to February 2000. Efforts will be made to use the same methodologies as used by participants in the synoptic survey. It is expected these results will complement the synoptic survey objectives and activities included under SO-GLOBEC.

THE ECOSYSTEM APPROACH AS APPLIED IN OTHER PARTS OF THE WORLD

10.1 This agenda item was included with the intention to consider information outside CCAMLR on the subject of ecosystem monitoring and management. Such considerations would concentrate on the following issues:

- (i) collection of information on new scientific approaches and practical aspects of ecosystem monitoring and management in other parts of the world which might be incorporated into CCAMLR's management plan; and
- (ii) promotion of CCAMLR as a leading international organisation in the development and implementation of an ecosystem approach to fisheries management.

10.2 Dr Miller advised the Working Group of the Southern African BENEFIT Program which focuses on the Benguela Current ecosystem. The BENEFIT Science Plan will be provided to the Secretariat in the near future.

ADVICE TO THE SCIENTIFIC COMMITTEE

Management Advice

11.1 Precautionary catch limits for krill were not re-assessed. Continued progress in developing a general model of krill dynamics in Area 48 is being made (paragraph 8.1).

11.2 No new management measures were proposed (paragraph 8.21).

11.3 No proposals for new CEMP sites and for the protection of CEMP sites had been received by WG-EMM (paragraph 9.13).

11.4 Methods for preparing advice on ecosystem assessment are being developed. No specific management advice on the status of the ecosystem was provided. Analyses of the status of the ecosystem undertaken at the meeting are set out in paragraphs 8.1 to 8.21.

General Advice with Budgetary/Organisational Implications

11.5 The attention of the Scientific Committee is drawn to the following Working Group recommendations and tasks which have budgetary implications:

- (i) the report of the Workshop on Area 48 should be appended in full to the report of WG-EMM (paragraph 3.6);
- (ii) a number of new and revised standard methods should be published in the *CEMP Standard Methods* (paragraphs 9.26, 9.30 and 9.46); and
- (iii) a workshop to analyse the core datasets resulting from the synoptic krill survey in Area 48 should be convened prior to WG-EMM in 2000 (paragraph 9.81).

Future Work for WG-EMM

11.6 The Working Group has identified a number of tasks to be undertaken intersessionally by participants and the Secretariat. These tasks are summarised in the following section of the report under 'Future Work' (paragraphs 12.1 to 12.7).

Recommendations from WG-EMM to the Scientific Committee for Coordination between Groups

11.7 The Working Group found the reports on the status of birds and seals prepared by SCAR to be useful. However, since some of the data are now quite old, the Working Group recommended that the Scientific Committee consider the potential utility of data from SCAR on bird and seal population status and trends provided to CCAMLR at five-year intervals (paragraph 5.5).

11.8 The Working Group also recommended that:

- (i) a theme coordinator should be nominated for the 1999 meeting of WG-EMM (paragraphs 13.5 and 13.6); and
- (ii) application of a standard approach should be considered for placing on the CCAMLR website summary information on Members' activities in relation to WG-EMM and WG-FSA (paragraph 5.10).

FUTURE WORK

12.1 The Working Group identified a number of tasks to be carried out by WG-EMM participants and the Secretariat during the 1998/99 intersessional period. The tasks are summarised below. References are given to paragraphs in the report which contain these tasks.

12.2 The following tasks were identified in the work on **harvested and dependent species and the environment**:

Secretariat tasks:

- (i) Request submission of data for krill fisheries conducted in waters adjacent to the Convention Area (paragraph 2.3).

- (ii) Encourage submission of haul-by-haul data where possible (paragraph 2.4).
- (iii) Request information from Panama and China in order to determine their intentions to fish for krill in the Convention Area (paragraph 2.6).
- (iv) Seek further information from Canada, Ukraine and Uruguay on their krill fishing activities in 1997/98 and 1998/99 (paragraph 2.6).
- (v) Reiterate the need for observer data and encourage Members to collect such data on board krill fishing vessels (paragraph 2.13).
- (vi) Directly pursue acquisition of historical CEMP data listed in Table 1 of SC-CAMLR-XVII/BG/2 (paragraph 5.10).
- (vii) Encourage submission of data described by Ukrainian scientists in WG-EMM-98/12 (paragraph 6.4).
- (viii) Encourage presentation of further details of analyses of DPOI index (paragraph 7.19).

Working Group activities:

- (ix) Encourage Indian scientists to publish results of its 1995 krill expedition in Area 58 (paragraph 2.12).
- (x) Develop krill population models to help reconcile current problems with relating estimates of M and absolute recruitment to observed densities of krill (paragraph 4.38).

12.3 The following tasks were identified in the work on **ecosystem analysis and assessments**:

Secretariat tasks:

- (i) Develop the mechanisms for automating the production of ecosystem assessment summaries and for producing CSIs based on the existing database structures (paragraphs 7.1 to 7.4 and 8.6).
- (ii) Arrange for details of the validation methods and procedures used for the validation of the General Yield Model (GYM) to be available to CCAMLR scientists for peer review (paragraph 7.10).
- (iii) Develop and archive a comprehensive set of documentation for the existing krill yield model (paragraph 7.11).
- (iv) Request further details of analyses linking krill density to atmospheric pressure measurements to produce krill 'forecasts' – an approach outlined by Ukrainian scientists (paragraph 7.19).
- (v) In collaboration with certain Working Group participants, investigate the performance of the Agnew–Phegan and Schroeder indices of krill fishery–foraging overlap in relation to fishing distribution and size (paragraph 7.28).
- (vi) Incorporate fishery-dependent indices into the ecosystem assessment (paragraph 8.4).

- (vii) Clarify discrepancies in population estimates for penguins at Marion Island contained in the CEMP database and estimates contained in the published literature (paragraphs 8.14 and 8.15).

Working Group activities:

- (viii) Work on the identification of subsets of data which are required to investigate the effect of El Niño in the waters of South Georgia (paragraph 6.10).
- (ix) Establish the most appropriate statistical approach to the calculation of covariance matrices for the CSI (paragraph 7.2).
- (x) Encourage collection of information which might suggest the origin of krill in Area 58 (paragraph 7.22).
- (xi) Encourage development of a functional relationship between predators, krill and the fishery (paragraph 7.29).
- (xii) Further work on the correlation of *C. gunnari* condition index with krill density in Subareas 48.1 and 48.3 (paragraph 7.32).
- (xiii) Address questions on future assessments of ecologically important events or trends in dependent species (paragraphs 8.5 and 8.6).
- (xiv) Consider reasons for the decline of macaroni and gentoo penguins, and black-browed albatrosses in Subarea 48.3 (paragraphs 8.10 and 8.11).
- (xv) Investigate intersessionally properties of the index of PCR of krill (paragraph 9.11).

12.4 The following tasks were identified in the work on existing and new **standard methods**:

Secretariat tasks:

- (i) Consult experts in seabird studies for guidance on the formulation of a new standard method for at-sea bird studies (paragraph 9.35); and
- (ii) Request information used to calculate Indices F1, F3 and F4 and prepare draft standard methods for these indices (paragraph 9.48).

Working Group activities:

- (iii) Review foraging trip duration in male and female macaroni penguins at Bouvet Island in relation to information from South Georgia (paragraph 5.6).
- (iv) The Subgroup on Methods has been asked to address intersessionally the following tasks:
 - (a) review Methods A3 and A6 (paragraph 9.23);
 - (b) investigate the applicability of monitoring foraging trips of female macaroni penguins in accordance with Method A5 (paragraph 9.21); and
 - (c) consider changes proposed to the assessment technique described in Method A6 (paragraph 9.22).

12.5 The planning work for the synoptic survey of krill in Area 48 will be undertaken by the coordinating committee. The tasks for this committee are detailed in paragraphs 9.84 to 9.88.

12.6 The Working Group encouraged the Secretariat to continue its work on the CCAMLR website (paragraphs 13.10 to 13.17).

12.7 In addition to intersessional tasks the Working Group also identified the following general requirements for its current and future work:

- (i) standardise methods used to investigate polynya dynamics (paragraph 6.8).
- (ii) develop and test predictive models and investigate the effect of environmental parameters on recruitment (paragraph 7.20).

OTHER BUSINESS

13.1 The following subitems were proposed for consideration under this item:

- (i) organisation of future Working Group meetings based on a thematic approach, i.e. focusing each meeting on a specific topic;
- (ii) review of membership of the WG-EMM intersessional subgroups; and
- (iii) CCAMLR website.

Themes for Future Meetings

13.2 A thematic approach to the organisation of future meetings was discussed. It was felt that it would be appropriate if, in addition to standard and key agenda items, such as ecosystem assessments, each meeting of the Working Group could be focused on a specific topic.

13.3 It was decided that each Working Group meeting would identify a specific topic and detail the information required and the organisation of discussions. This advance notification of the topic would allow Members to nominate participants who have appropriate expertise. A theme coordinator would normally be nominated at the Working Group meeting. It would allow the nominee to be involved in the intersessional work on the preparation of the topic for discussion. The number of topics for each meeting would be limited to one and a maximum of two days at each meeting might be set aside for discussion.

13.4 It was also decided that agendas of Working Group meetings should be kept under constant review with a view to streamlining some routine parts, concentrating on key points, and giving an adequate description of the thematic topic for each meeting.

13.5 Arising from the issues identified in paragraphs 8.5 and 8.17, the Working Group agreed that a 'Sampling Approaches' theme should be included in its agenda for 1999. The theme would attempt to explore the principles underlying the sampling of prey, predators and environment in the provision of data necessary for ecosystem analysis and assessment.

13.6 To facilitate preparation, the Working Group agreed that the theme coordinator should be appointed as soon as possible to liaise with the Convener on the development of the theme topic for the 1999 meeting. In addressing this task the following general considerations would apply:

- (i) Due consideration should be given to sampling type and intensity (both spatial and temporal) in the provision of data for ecosystem analysis. Parameters to be sampled should be referenced to specific working hypotheses on ecosystem function/interactions and to consideration of, *inter alia*, the relationship between sample and population estimates of key variables, the variability over time and space of the variables and possible errors/biases likely to arise from sampling as opposed to biological variability.
- (ii) In addressing (i), focus should be given to the following guiding questions:
 - (a) What variable is being sampled?
 - (b) Why is this specific variable being sampled?
 - (c) What sampling regime is most practical?
 - (d) What statistical assumptions underline the chosen sample regime?
 - (e) What statistical procedures and general analyses should be applied to the sample data?
 - (f) What and how are sample results to be used in ecosystem analysis, assessment and the provision of management advice?

13.7 It was recognised that the points outlined in paragraph 13.6 require adequate appreciation of both ecological (including seasonal timings and geographical limitation) and logistic constraints (e.g. practical feasibility and frequency of sampling) on the chosen sampling regime.

Membership of Intersessional Subgroups

13.8 The Working Group considered membership of the following two subgroups which had been established for intersessional work by the former WG-CEMP:

- (i) subgroup on the designation and protection of CEMP sites; and
- (ii) subgroup on the practical aspects of standard monitoring methods.

13.9 It was agreed that these subgroups undertake very important work during intersessional periods which facilitate discussion at Working Group meetings. It was decided to confirm the present membership of the subgroup on the designation and protection of CEMP sites (Drs Penhale, K. Kerry (Australia) and D. Torres (Chile)) and also to add one additional member (Dr Wilson). New membership of the subgroup on practical aspects of standard monitoring methods would include Drs Boyd and W. Trivelpiece (USA) (dependent species), Dr V. Siegel (Germany) (prey species), Dr E. Murphy (UK) (environment) and Dr Constable (statistics).

CCAMLR Website

13.10 Dr Ramm reported on the development of the CCAMLR website (WG-EMM-98/23). As agreed by the Scientific Committee, the primary objective of the website is to provide a framework for organising, presenting and delivering CCAMLR information, in the four languages of the Commission, to Members of the Commission, Scientific Committee and working groups, technical coordinators, scientific observers, scientists, related organisations and the general public.

13.11 Web pages containing general information and publications would be made available to the public. However, the access to pages containing information on meeting and related papers and data would be restricted to participants at those meetings. For example, participants at meetings of WG-EMM would be issued with a single and unique user name and password. Passwords could be changed from time to time, or when the membership of each group was reviewed. The Working Group referred the membership of groups, and the way in which passwords are issued, to the Scientific Committee.

13.12 The English version of the WG-EMM web pages was released to Working Group participants on 31 July 1998 for a one-month trial. With the exception of the introductory web page, the pages were protected by password and contained information for the 1998 meeting. Selected papers were made available, with the permission of authors, for a trial electronic distribution. Information and reports from previous meetings were also available. A demonstration of the web pages was given during the meeting.

13.13 A number of the participants who had accessed the website prior to the meeting had found that the WG-EMM pages had been well structured and presented, and had provided valuable information prior to the meeting. The Working Group agreed that the website had the potential to grow into a very useful tool which would facilitate the exchange of information and expedite decision-making.

13.14 The Working Group agreed that the development of the website should continue, and include the addition of:

- (i) scanned versions of all meeting papers in advance of meetings;
- (ii) the CCAMLR bibliography;
- (iii) maps of CEMP sites showing the location of colonies; and
- (iv) STATLANT data published in the *Statistical Bulletin*.

13.15 As a further development, meeting papers could be copied from the website to CD-ROM and made available to participants during the meetings. This format may eventually provide a suitable alternative to hard copies of meeting papers.

13.16 The Working Group requested that the Secretariat specify the formats used on the website so that Members who may wish to contribute information, such as maps, may submit this in a website-ready format.

13.17 The Working Group thanked Dr Ramm and all the Secretariat staff involved in the development of the website. The Working Group agreed that this was an important activity which reflected its work in the broadest context of CCAMLR's overall activities. Dr Ramm and associated Secretariat staff were therefore encouraged to continue development of the website.

ADOPTION OF THE REPORT

14.1 During the adoption of the report, the Working Group met with Mr P.K. Brahma, Joint Secretary and Financial Adviser, Department of Ocean Development, and Dr P.C. Pandey, Director, Antarctic Study Centre, Goa, India. Both Mr Brahma and Dr Pandey welcomed the Working Group's approach to ecosystem management, and reiterated the global importance of the Antarctic and the Southern Ocean.

14.2 The report of the fourth meeting of WG-EMM was adopted.

CLOSE OF MEETING

15.1 In closing the meeting, the Convener, Dr Everson, thanked Sh. Ravindranathan and all those involved in the local organising committee for the very effective way in which the meeting was organised, and for their enthusiasm and very kind hospitality. He also thanked the staff of the Casino Hotel who had also played a large role in the successful running of the meeting. Dr Everson expressed appreciation for the hard work of the Secretariat in support of the meeting. He thanked the rapporteurs for carefully summarising papers, thus providing a sound basis for discussion, and all participants for developing the agenda in a spirit of excellent cooperation.

15.2 Dr Miller, on behalf of the Working Group, thanked Dr Everson for the large amount of work in convening the meeting, and for steering the meeting to a successful outcome. He also thanked the Government of India, the local organising committee and the staff of the Casino Hotel for organising a very successful and memorable meeting.

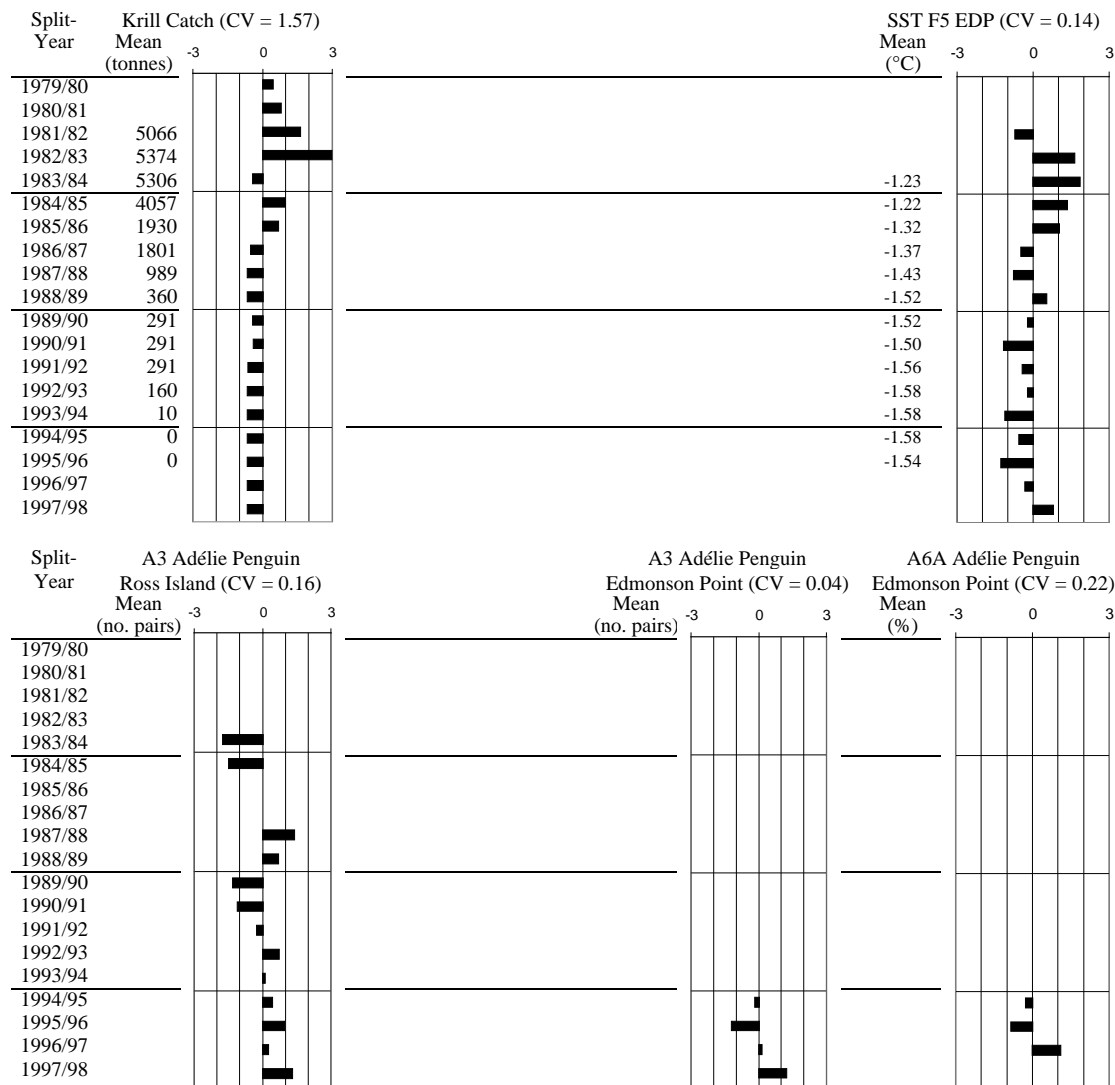
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Table 5: Ecosystem assessment for Area 88.

Five-year running means and plots of standardised normal deviates for krill catch, sea-surface temperature (SST, adjacent to Edmonson Point) and population parameters for CEMP species. CEMP data are from Edmonson Point (EDP) and Ross Island. A3 – number of pairs, A6A – % breeding success A (potential chicks).



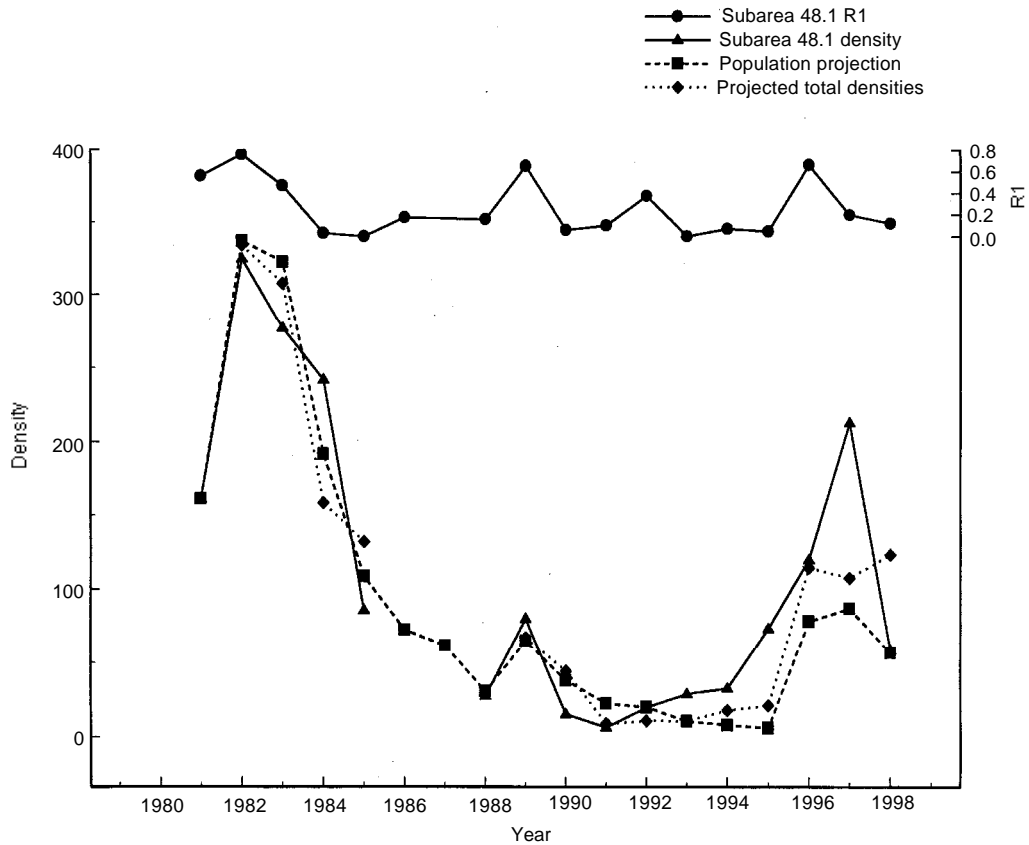


Figure 1: Comparative plot showing the **krill density** and proportional recruitment at age 1 (**R1**) estimated for Subarea 48.1 from 1980/81 to 1997/98 combined with the results of a **population projection** based on estimates of absolute recruitment and $M = 0.548$ and **projected total densities** where the density in a year was the projected density of adults from the previous year plus the density of recruits estimated for that year from R1 and the total recorded density.

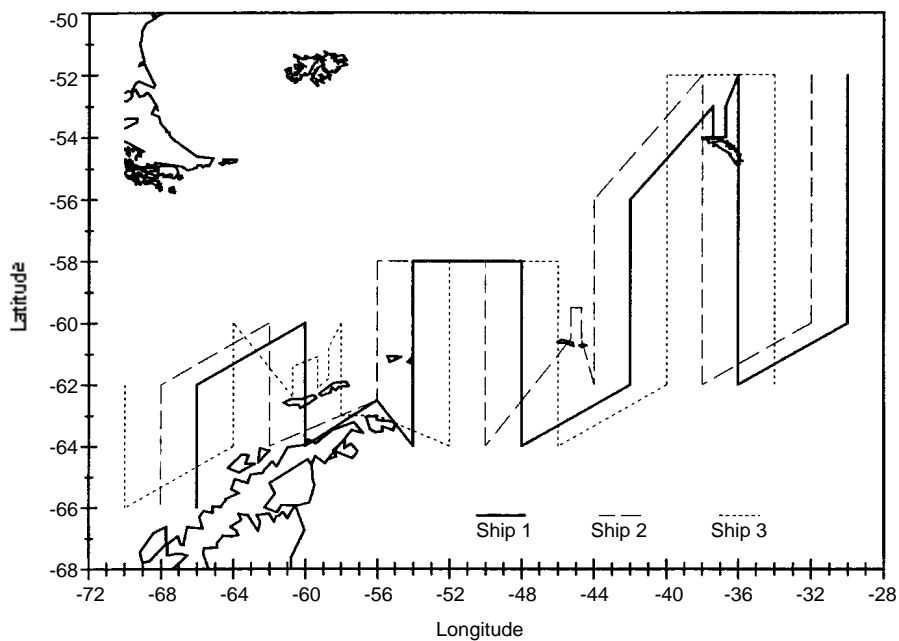


Figure 2: Proposed transects for three ships undertaking the synoptic survey in Area 48.

AGENDA**Working Group on Ecosystem Monitoring and Management
(Kochi, India, 10 to 20 August 1998)**

1. Introduction
 - 1.1 Opening of the Meeting
 - 1.2 Organisation of the Meeting and Adoption of the Agenda
2. Fisheries Information
 - 2.1 Catches Status and Trends
 - 2.2 Harvesting Strategies
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 - 2.4 Other Information
3. Meetings During the Intersessional Period
 - 3.1 Report of the Workshop on Area 48
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4. Harvested Species
 - 4.1 Distribution and Standing Stock
 - 4.2 Population Structure, Recruitment, Growth and Production
 - 4.3 Indices of Abundance, Distribution and Recruitment
 - 4.4 Future Work
5. Dependent Species
 - 5.1 CEMP Indices
 - 5.2 Studies on Distribution and Population Dynamics
 - 5.3 Future Work
6. Environment
 - 6.1 Consideration of Studies on Key Environmental Variables
 - 6.2 Indices of Key Environmental Variables
 - 6.3 Future Work
7. Ecosystem Analysis
 - 7.1 Analytical Procedures and Combination of Indices
 - (i) Multivariate Analysis of CEMP Indices
 - (ii) Use of GYM for Krill Stock Assessments
 - (iii) Other Approaches
 - 7.2 Krill-centred Interactions
 - 7.3 Fish and Squid-centred Interactions

8. Ecosystem Assessment
 - 8.1 Estimates of Potential Yield
 - 8.2 Assessment of the Status of the Ecosystem
 - (i) Current Trends by Areas and Species
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 - 8.3 Consideration of Possible Management Measures
9. Methods and Programs Involving Studies on Harvested and Dependent Species and the Environment
 - 9.1 Methods for Estimating Distribution, Standing Stock, Recruitment and Production of Harvested Species
 - 9.2 Consideration of CEMP Sites
 - 9.3 Methods for Monitoring the Performance of Dependent Species
 - (i) Consideration of Comments on Existing Methods
 - (ii) Consideration of New Draft Methods
 - 9.4 Methods for Monitoring Environmental Variables of Direct Importance in Ecosystem Assessment
 - 9.5 Plans for a Synoptic Krill Survey in Area 48
 - 9.6 Other Activities in Support of Ecosystem Monitoring and Management
10. The Ecosystem Approach as Applied in Other Parts of the World
11. Advice to the Scientific Committee
12. Future Work
13. Other Business
14. Adoption of the Report
15. Close of the Meeting.

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(Kochi, India, 10 to 20 August 1998)

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LIST OF DOCUMENTS

Working Group on Ecosystem Monitoring and Management
(Kochi, India, 10 to 20 August 1998)

WG-EMM-98/1	Provisional and Annotated Provisional Agenda for the 1998 Meeting of the Working Group on Ecosystem Monitoring and Management (WG-EMM)
WG-EMM-98/2	List of participants
WG-EMM-98/3	List of documents
WG-EMM-98/4 Rev. 2	CEMP indices 1998: summary of anomalies and trends Secretariat
WG-EMM-98/5	Revision of the fishery–foraging overlap model Secretariat
WG-EMM-98/6	Development of standard methods for environmental data Secretariat
WG-EMM-98/7 Rev. 1	Report on fine-scale krill data for the 1996/97 season Secretariat
WG-EMM-98/8	Status and trends of Antarctic seals Report of SCAR
WG-EMM-98/9	Human activity and disturbance: building an Antarctic site inventory R. Naveen, Oceanites (USA)
WG-EMM-98/10	Comments of the Antarctic site inventory project on the application of the Standard Method A6 ‘penguins breeding success’ Secretariat
WG-EMM-98/11	Monitoring changes in coastal fish populations by the analysis of pellets of the Antarctic shag <i>Phalacrocorax bransfieldensis</i> : a new proposed standard method R. Casaux and E. Barrera-Oro (Argentina)
WG-EMM-98/12	The principal results of YugNIRO complex studies in the Indian sector of the Antarctic V.I. Bondarenko, V.A. Bibik, V.V. Gerasimchok, E.P. Goubanov, A.V. Romanov and B.G. Trotsenko (Ukraine)
WG-EMM-98/13	Preliminary results of biological studies in the 1st Ukrainian Antarctic expedition in Subarea 48.2 in March 1997 V.A. Bibik (Ukraine)

- WG-EMM-98/14 VNIRO program on remote monitoring of oceanographic conditions in fishing areas of the World Ocean (the southwestern Atlantic and the southeastern Pacific)
G.P. Vanyushin, T.B. Barkanova and A.A. Troshkov (Russia)
- WG-EMM-98/15 Diet and foraging effort of Adélie penguins in relation to pack-ice conditions in the southern Ross Sea
D.G. Ainley (USA), P.R. Wilson, K.J. Barton (New Zealand), G. Ballard, N. Nur (USA) and B. Karl (New Zealand)
- WG-EMM-98/16 Report of the Workshop on Area 48
(La Jolla, USA, 15 to 26 June 1998)
- WG-EMM-98/17 Decline of Antarctic fur seal (*Arctocephalus gazella*) population at SSSI No. 32, South Shetlands, Antarctica, during 1997/98: a discussion of possible causes
R. Hucke-Gaete, D. Torres, A. Aguayo and V. Vallejos (Chile)
- WG-EMM-98/18 Occurrence of Antarctic krill (*Euphausia superba*) concentrations in the vicinity of the South Shetland Islands: relationship to environmental parameters
T. Ichii, K. Kayatama, N. Obitsu, H. Ishii and M. Naganobu (Japan)
- WG-EMM-98/19 On the possibility of practical utilisation of krill target strength TS in situ obtained on the basis of EK-500 measurements
S.M. Kasatkina (Russia)
- WG-EMM-98/20 Catchability of midwater trawls in relation to krill fishery
S.M. Kasatkina (Russia)
- WG-EMM-98/21 Some comments on the procedure of krill target strength assessment in echosurveys
S.M. Kasatkina (Russia)
- WG-EMM-98/22 SCAR Bird Biology Subcommittee Ad Hoc Working Group on Seabirds at Sea Methodology
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- WG-EMM-98/23 Secretariat work in support of WG-EMM
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- WG-EMM-98/24 Hydroacoustic and net krill sampling methods Area 48 survey (decisions and recommendations of the Scientific Committee and its working groups)
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- WG-EMM-98/25 Report from the Steering Committee for the synoptic survey of Area 48
Steering Committee
- WG-EMM-98/26 Report of the 1996 APIS Survey Design and Implementation Workshop
- WG-EMM-98/27 Report of the Meeting of the SCAR Group of Specialists on Seals Submitted by SCAR

- WG-EMM-98/28 Foraging trip duration in male and female macaroni penguins at Bouvetøya
F. Mehlum, K. Isaksen and V. Bakken (Norway)
- WG-EMM-98/29 Green krill, the indicator of micro- and nano-size phytoplankton availability to krill
S. Kawaguchi, T. Ichii and M. Naganobu (Japan)
- WG-EMM-98/30 Status of the Polish FIBEX acoustic data from the west Atlantic
P.N. Trathan (UK), J. Kalinowski (Italy) and I. Everson (UK)
- WG-EMM-98/31 Pursuit and polynyas in the Ross Sea, Antarctica
M. Naganobu, T. Tanaka, Y. Okada, N. Kimura and S. Matsumura (Japan)
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V.A. Sushin and K.E. Shulgovsky (Russia)
- WG-EMM-98/33 Proportional recruitment indices of Antarctic krill from Japanese fisheries data in Subareas 48.1, 48.2 and 48.3 during 1980 through 1997
S. Kawaguchi, T. Ichii and M. Naganobu (Japan)
- WG-EMM-98/34 Phytoplankton standing stocks in relation to krill in Antarctic waters
X.N. Verlecar, R. Vijayakumar, F. Saldhana and L. Martins (India)
- WG-EMM-98/35 Studies on zooplankton with special reference to krill from the Indian Ocean sector of the Southern Ocean
K.L. Bhat, R. Vijayakumar and V. Jaya Sree (India)
- WG-EMM-98/36 Hydroacoustic assessment of krill in Area 58 of the Indian Ocean sector of the Antarctic region
Z. Klusek and A. Anrose (India)
- WG-EMM-98/37 Biology, distribution and abundance of Antarctic krill (*Euphausia superba*) and by-catch
A. Anrose, Z. Klusek, M.K.R. Nair and M. R. Bhoopendranath (India)
- WG-EMM-98/38 Investigations on midwater trawling for krill (*Euphausiasuperba*) in the Southern Ocean
M.R. Bhoopendranath, M.K.R. Nair, A. Anrose and V.C. George (India)
- WG-EMM-98/39 Studies on Antarctic krill (*Euphausia superba*) biochemical and processing aspects
C.N. Ravishankar and K. Ashok Kumar (India)
- WG-EMM-98/40 Product development from Antarctic krill and test marketing
M.K.R. Nair, S. Giriya, K.K. Muhammad Basheer and M.K. Venu (India)

- WG-EMM-98/41 Products for human consumption from krill (*Euphausia superba*)
J. Joseph, V. Muraleedharan, R. Thankamma and C.N. Ravishankar (India)
- WG-EMM-98/42 Biochemical investigations on Antarctic krill (*Euphausia superba*)
M.R. Raghunath, T.V. Shankar, A.G. Radhakrishnan, S. Mathew, K. Ammu, C.N. Ravishankar, K. Jayan and L. Jose (India)
- WG-EMM-98/43 Otolith size in the mackerel icefish
I. Everson and B. Bendall (UK)
- WG-EMM-98/44 The Area 48 synoptic survey: an adaptive survey design
J. Watkins, A. Murray and I. Everson (UK)
- WG-EMM-98/45 Evaluation of de la Mare's composite standardised index for generating a simple time-series summary of many long-term datasets on Antarctic predators: consequences of missing values and criteria for inclusion of predator parameters
A. Constable (Australia)
- WG-EMM-98/46 CCAMLR Standard Method A3b
P. Wilson (New Zealand)
- WG-EMM-98/47 Some suggestions for acoustic protocols for the synoptic survey of FAO Area 48
D.A. Demer (USA)
- WG-EMM-98/48 A model at the level of the foraging trip for the indirect effects of krill (*Euphausia superba*) fisheries on krill predators (*Ecological Modelling* (1998), 105: 235–256)
M. Mangel and P.V. Switzer (USA)
- WG-EMM-98/49 AMLR 1997/98 Field Season Report: Objectives, accomplishments and tentative conclusions
US Delegation
- WG-EMM-98/50 Interannual variability of krill, salp and other zooplankton populations in the South Shetland Island area during Austral summer 1993–1998
V. Loeb, W. Armstrong, R. Hewitt (USA) and V. Siegel (Germany)
- WG-EMM-98/51 Acoustic estimates of krill density at South Georgia during 11 austral summers between 1981 and 1998
A.S. Brierley, J.L. Watkins, C. Goss, M.T. Wilkinson and I. Everson (UK)
- WG-EMM-98/52 Natural fluctuations in the abundance of krill with due regard to global climate changes in the southern hemisphere: forecasting possibilities
K. Shust (Russia)
- WG-EMM-98/53 The Area 48 synoptic survey: three possible approaches
J. Watkins, A. Murray and I. Everson (UK)

Other Documents

- WS-Area48-98/4 Rev. 1 Do krill and salp compete? Contrary evidence from the krill fisheries
(*CCAMLR Science*, in press)
S. Kawaguchi (Japan), W.K. de la Mare (Australia), T. Ichii and M. Naganobu (Japan)
- WS-Area48-98/6 A method for providing a statistical summary of CEMP indices
I.L. Boyd and A.W.A. Murray (UK)
- WS-Area48-98/8 Interannual variability of the South Georgia marine ecosystem: biological and physical sources of variation in the abundance of krill
E.J. Murphy, J.L. Watkins, K. Reid, P.N. Trathan, I. Everson, J.P. Croxall, J. Priddle, M.A. Brandon, A.S. Brierley (UK) and E. Hofman (USA)
- WS-Area48-98/10 Sea-surface temperature anomalies near South Georgia: relationships with the South Atlantic and the Pacific El Niño regions
P. Trathan and E.J. Murphy (UK)
- WS-Area48-98/11 Concordance of interannual fluctuations in densities of krill around South Georgia and Elephant Islands: biological evidence of same-year teleconnections across the Scotia Sea
A.S. Brierley (UK), D.A. Demer, R.P. Hewitt (USA) and J.L. Watkins (UK)
- WS-Area48-98/15 Krill population dynamics at South Georgia 1991–1997, based on data from predators and nets
K. Reid, J. Watkins, J. Croxall and E. Murphy (UK)
- WS-Area48-98/16 Environmental variability and the behavioural dynamics of Antarctic fur seals in the South Atlantic
I.L. Boyd (UK)
- WS-Area48-98/17 Diet, provisioning and productivity responses of predators to differences in availability of Antarctic krill
J.P. Croxall, K. Reid and P.A. Prince (UK)
- WS-Area48-98/18 Rev. 1 Antarctic fur seal (*Arctocephalus gazella*) pup growth rates at Cape Shirreff, Livingston Island, South Shetlands: 1994/95 to 1997/98
R. Huccke-Gaete, V. Vallejos and D. Torres (Chile)
- WS-Area48-98/21 Rev. 1 IWC whale data indices for CCAMLR Area 48 Workshop
S. Reilly, C. Allison, H. Kata and D. Borchers
- SC-CAMLR-XVII/BG/2 Draft CEMP Tables 1 to 3
Secretariat
- SC-CAMLR-XVII/BG/3 Towards a closer cooperation between CCAMLR and the IWC
CCAMLR Observer (K.-H. Kock, Germany)
- SC-CAMLR-XV/BG/29 The status and trends of Antarctic and sub-Antarctic seabirds
Submitted by the SCAR Subcommittee on Bird Biology

REPORT OF THE WORKSHOP ON AREA 48
(La Jolla, USA, 15 to 26 June 1998)

REPORT OF THE WORKSHOP ON AREA 48 (La Jolla, USA, 15 to 26 June 1998)

INTRODUCTION

1.1 The Workshop on Area 48 was held from 15 to 26 June 1998. The meeting was convened by Dr R. Hewitt (USA) and held at the Southwest Fisheries Science Center in La Jolla, USA.

1.2 The workshop was opened by Dr P. Smith, Acting Director, Southwest Fisheries Science Center.

1.3 A provisional agenda had been circulated and was discussed. It was agreed that two additional items be added to the agenda:

- 1a. Presentation of background material with a particular emphasis on Area 48; and
- 2a. Presentation and discussion of methods for combining and integrating indices, and solutions for handling missing values in datasets.

The agenda (Attachment A) was adopted without further modification.

1.4 The list of participants is included as Attachment B, and the list of documents submitted to the meeting is included as Attachment C.

1.5 The report was prepared as a collaborative effort among participants.

BACKGROUND, AIMS AND OBJECTIVES

2.1 Ecosystem variability in Area 48 (South Atlantic sector of the Southern Ocean, see Figure 1) has been documented using retrospective analyses of time series data collected at several sites and areas and presented to WG-EMM. For example, annual variability of proportional recruitment of krill (*Euphausia superba*) has been described from surveys conducted in the Antarctic Peninsula area (Subarea 48.1), variability in the reproductive success of land-breeding krill predators has been described from monitoring studies conducted near South Georgia (Subarea 48.3), and variability in sea-ice has been described from records collected in the South Orkney Islands (Subarea 48.2).

2.2 On several occasions during the meetings of WG-EMM, participants have commented on the apparent coherence between occasional observations from different sites and more complete time series collected elsewhere within Area 48. Participants have noted the need for a more formal comparison of datasets, both biological and physical, over a range of spatial scales. The objective of such an exercise would be to describe the nature, extent and scale of coherence among processes occurring in Area 48.

2.3 At its 1996 meeting, the Scientific Committee agreed to the request of WG-EMM to hold a workshop to explore the coherence among processes occurring throughout Area 48 (SC-CAMLR-XV, paragraph 5.25), and reiterated in 1997 the need for the workshop (SC-CAMLR-XVI, paragraph 6.50).

2.4 The terms of reference for the workshop were:

- (i) identify the extent of between-season and within-season variation in key indices of environment, harvested species and dependent species over past decades;
- (ii) identify coherence in the indices between sites and clarify understanding of the linkages between Subareas 48.1 (Antarctic Peninsula), 48.2 (South Orkney Islands) and 48.3 (South Georgia);
- (iii) develop working hypotheses; and
- (iv) provide a summary report for consideration of the 1998 meeting of WG-EMM.

2.5 The particular hypotheses (SC-CAMLR-XVI, paragraph 6.51) being addressed were that:

- (i) H_0 : Subareas 48.1, 48.2 and 48.3 are discrete ecosystems and events observed in any one subarea do not reflect what is happening in other subareas; or, conversely,
- (ii) H_1 : that Area 48 is a homogeneous ecosystem and events observed in any one subarea reflect the entire area.

2.6 It was recognised that neither of these hypotheses was likely to be correct. However, they represent the end points of the spectrum of possibilities and were believed to assist in focusing the objectives of the workshop.

2.7 To provide a structured basis for the workshop, it was agreed that:

- (i) indices derived from datasets (not necessarily using standard methods) should be submitted prior to the meeting;
- (ii) these indices would be loaded on a central server that could be accessed by a network of computers available to workshop participants;
- (iii) working papers could be submitted that elucidated the details of sampling and data processing leading to the formulation of an index; and
- (iv) additional working papers could be submitted which drew attention to apparent relationships between indices.

2.8 To prepare for the workshop, participants were requested to submit indices. They were also encouraged to undertake analyses of their own data (e.g. investigating properties of indices, multivariate analysis, etc.) in advance of the workshop and to report their results to it.

2.9 To assist in data coordination and submission, relevant ecosystem processes were divided into four categories and coordinators were assigned. Processes to be indexed and their coordinators were:

- (i) Physical Environment – Mr A. Amos (USA), Dr P. Trathan (UK) and Dr M. Naganobu (Japan):
 - (a) sea-ice;
 - (b) circulation;
 - (c) hydrography;
 - (d) meteorology; and
 - (e) sea-surface temperature (SST).

- (ii) Biotic Environment – Dr V. Loeb (USA):
 - (a) phytoplankton; and
 - (b) zooplankton.
- (iii) Dependent Species – Dr J. Croxall (UK) and Dr W. Trivelpiece (USA):
 - (a) CEMP indices;
 - (b) other indices; and
 - (c) cetacean catches and sightings.
- (iv) Krill – Dr J. Watkins (UK) and Dr V. Siegel (Germany):
 - (a) demographics;
 - (b) recruitment;
 - (c) abundance and distribution of post-larval forms (as determined from net samples and acoustic surveys);
 - (d) abundance and distribution of larvae; and
 - (e) fishery-dependent data.

2.10 All coordinators circulated requests for data widely amongst the community of Antarctic scientists working in relevant research fields.

2.11 In all circulars it was stressed that data contributed and workshop results would only be used by the Scientific Committee and its scientific subsidiary bodies. The basic rights of data originators/providers are regulated by CCAMLR under 'Access to and use of data within CCAMLR' (as set out in SC-CAMLR-XIII, Annex 10). Therefore, the data and results, both during and after the workshop, will not enter the public domain without the express permission of the data originators.

2.12 In order to disseminate information regarding terms of reference, background material and logistic arrangements for the workshop, Dr Hewitt created a website with open access to all potential participants. Indices were also posted on the website and cross-referenced by type (physical environment, biotic environment, krill and krill predators) and by geographic area (Subarea 48.1 – Antarctic Peninsula, Subarea 48.2 – South Orkney Islands and Subarea 48.3 – South Georgia).

2.13 The datasets available to the workshop on this website are listed in Attachment D.

2.14 To carry out a range of initial tasks involving evaluation and analysis of data and indices, five subgroups were formed:

- (i) physical environment (coordinator Dr Trathan), see Section 3;
- (ii) biotic environment (coordinator Dr Loeb), see Section 5;
- (iii) krill (coordinator Dr Watkins), see Section 4;
- (iv) land-based krill predators (coordinator Dr I. Boyd (UK)), see Section 7; and
- (v) marine predators of krill (icefish and whales) (coordinator Dr I. Everson (UK)), see Section 6.

2.15 Discussions on interactions between the environment, prey and predators were coordinated by Dr E. Murphy (UK); see Section 8.

2.16 The workshop considered data from summer and winter periods. The winter period, generally from May to October, spans the changeover date for CCAMLR split-years which run from 1 July to 30 June. The following convention was adopted throughout the text of the report:

- (i) winter as the calendar year of the observations; e.g. data from May or August 1991 would be designated 1991; and
- (ii) summer as the split-year; viz 1990/91 for the CCAMLR year 1991.

2.17 The formatting software for the figures did not allow the full implementation of these conventions and consequently seasons are specified by the calendar year in which the season ended. In this form winter seasons are the same as in the text and summer seasons as the conventional CCAMLR split-year.

PHYSICAL ENVIRONMENT

Introduction

3.1 The environmental data available to the subgroup were relatively limited and it was not possible to fully investigate all of the questions important to the aims of the workshop. The subgroup noted that there is a considerable body of literature on the physical environment in the Southern Ocean, including the Scotia Sea, and that the Southern Ocean and its linkages within the southern hemisphere is currently the focus of extensive research. The following comments are presented in this context.

3.2 In considering the physical environment as part of ecosystem interactions, the subgroup emphasised that caution should be used in interpreting relationships between physics and biology in Area 48. It was acknowledged that simplistic views of the physical environment are unlikely to be realistic.

3.3 The attention of the subgroup was drawn to a number of papers which highlight the complexity of the physical environment and its effects upon the ecosystem.

Environmental Data Available to the Subgroup

3.4 The environmental data available to the subgroup included:

- (i) sea-ice extent from 1987 to 1997 – from passive microwave sensor data for the Antarctic Peninsula, South Orkneys, South Georgia and for the Scotia Sea;
- (ii) SSTs from 1981 to 1998 – from the National Center for Atmospheric Research (NCAR);
- (iii) temperature profiles from 1990 to 1998 – from the US AMLR CTD grid near Elephant Island;
- (iv) Palmer Station air temperatures from 1947 to 1996;
- (v) Drake Passage Oscillation Index (DPOI) from 1982 to 1994 – the difference in sea-level pressure between Rio Gallegos and Esperanza;
- (vi) Southern Oscillation Index (SOI) from 1951 to 1998 – the difference in sea-level pressure between Darwin and Tahiti; and
- (vii) El Niño (EN) SST indices from 1950 to 1998 – with EN1+2 from the Eastern Pacific, EN3 from the Central Pacific and EN4 from the Western Pacific.

3.5 Dr Hewitt described monthly estimates of sea-ice extent based on subsets of ice concentration images generated from passive microwave sensor data with a nominal pixel resolution of 25 x 25 km. Subsets were defined for the South Shetland Islands, the South Orkney Islands, South Georgia and the entire Scotia Sea.

3.6 Dr Trathan described the NCAR SST data around South Georgia (WS-Area48-98/10). The data were extracted from the NCAR global database which has a spatial resolution of 1° latitude by 1° longitude with a temporal resolution of one month. The data are based on an optimal interpolation of Advanced Very High Resolution Radiometry (AVHRR) data with *in situ* data from buoys and ships (see Reynolds and Smith 1994). NCAR data at a weekly resolution were also available.

3.7 Mr Amos outlined the CTD data from the US AMLR Program. Since 1990 the Program has measured the physical oceanographic properties of the water column annually in the Elephant Island region of Subarea 48.1. Each year, two 30-day cruises have been undertaken with a standardised grid of CTD profiles to depths of 750 m (or to the bottom where depths were less than 750 m). Each year the first cruise takes place in January/February, and the second in February/March. The CTD stations' positions from the AMLR CTD grid that were used during the workshop are shown in Figure 2.

3.8 Dr Naganobu presented data on sea-level pressure (SLP) differences across the Drake Passage, reporting that these data provided an alias for fluctuations in westerly winds which may be regarded as geostrophic winds. The data were calculated as the pressure difference at sea level between Rio Gallegos (51°32'S, 69°17'W) and Esperanza (63°24'S, 56°59'W). Data were extracted from the World Surface Meteorological database supplied by the Japanese Meteorological Agency. Dr Naganobu reported that high SLP differences were associated with strong westerly winds and that low SLP differences were associated with weak westerly winds; the strength of the westerly winds governed the magnitude of Ekman transport (Defant, 1961).

Selected Subjects of Interest to the Subgroup

3.9 During the 1991 meeting of WG-Krill (SC-CAMLR-X, Annex 5), the topic of krill transport through Area 48 by the general oceanic circulation was discussed. Three hypotheses were proposed to account for the krill populations in Subareas 48.1, 48.2, and 48.3: (i) that each subarea has a self-contained stock; (ii) that all of Area 48 has a single stock; or (iii) that the Antarctic Peninsula is the major source of krill that is transported through each subarea by the circulation. A schematic diagram was developed showing the general circulation and a simple conceptual model proposed. Favouring hypothesis (iii), WG-Krill recommended that the Scientific Committee pay attention to fluxes in Area 48 and the interaction of physical and biological processes.

3.10 At the 1994 meeting of WG-Krill, the Working Group considered the topic of krill biomass and fluxes (SC-CAMLR-XIII, Annex 5, Appendix D). In evaluating krill flux factors, WG-Krill considered the report from the Workshop on Evaluating Krill Flux Factors which ran the Fine Resolution Antarctic Model (FRAM) and compared results with the geostrophic flow calculated from some of the existing hydrographic data from Area 48 (the AMLR data were not used in this exercise). FRAM predicted velocities much higher than those calculated from direct observation, did not show the counter flow of the Antarctic Coastal Current, and did not resolve seasonal variability in the flow. WG-Krill noted the distinction between theoretical and applied considerations, the utility of smaller-scale repeat surveys, and the necessity for synoptic surveys to resolve the flux problem. The idea that krill is a passive 'tracer', transported from subarea to subarea, remained as a viable hypothesis in the opinion of WG-Krill in 1994.

3.11 Based on the historical CCAMLR perspective, the subgroup considered all the data available to the workshop and formulated a series of questions that it considered to be important to the aims of the workshop. In determining these questions, notice was also taken of recent papers indicating the importance of large-scale processes in the physical environment. The main questions addressed during the workshop were:

- (i) Is the NCAR SST dataset a reasonable proxy for ocean temperatures?
- (ii) Are global atmospheric (e.g. SOI) signals present in Area 48?
- (iii) Are these atmospheric signals evident in the surface layers of the ocean?
- (iv) Is there evidence of multi-year signals in the environment?
- (v) Is there coherence among the subareas in Area 48?

3.12 In considering these questions a series of lagged cross-correlation analyses were undertaken using GENSTAT 5.3 (Payne et al., 1993). These were based on the methodology described in WS-Area48-98/10. Other comparisons were undertaken by plotting and graphing.

Comparison of NCAR SST and CTD SST

3.13 A comparison of NCAR SST data with data from the AMLR CTD grid was carried out to determine whether the NCAR data provided a good proxy for temperature data measured in the field. In order to accomplish this, 4-m CTD data were extracted from those CTD casts that occurred within each of three NCAR SST grid cells. The cells were located north of Elephant Island – Drake Passage (EI1) (60°30'S, 56°30'W), southwest of Elephant Island – Frontal (EI2) (61°30'S, 56°30'W) and southeast of Elephant Island – Bransfield (EI3) (61°30'S, 54°30'W). The CTD data are accurate to better than 0.01°C.

3.14 A plot of weekly NCAR SST data, monthly NCAR SST data and AMLR 4-m CTD data are shown in Figure 3. This indicated that the NCAR data were a reasonable proxy for data collected in the field, with the best approximation being in Elephant Island EI3.

Conclusions

3.15 It was concluded that no statistical analysis was possible with the present data, however it was recognised that a formal analysis was appropriate and should be pursued intersessionally. As the graphical comparison between the NCAR SST and the AMLR 4-m CTD temperatures suggested broad similarities, it was concluded that for the purposes of the workshop, the large-scale NCAR dataset should be used for comparisons within Area 48.

Global Atmospheric Signals in Area 48

3.16 Lagged cross-correlation analysis of SOI anomalies and DPOI anomalies (1982 to 1992) indicated that positive correlations existed between the two indices with the SOI leading the DPOI by three to four months and by 69 months. Negative correlations were also evident, with maximum correlation at a temporal lag of 43 to 44 months. Based on the significance of levels identified by $\pm 2/\sqrt{n}$ (where n is the number of values in the data series), the correlations were determined as significant, though only just so.

3.17 Lagged cross-correlation analysis of SOI anomalies and Palmer Station air temperature anomalies (1951 to 1996) indicated that strong correlations existed with the SOI leading the Palmer air temperatures. The most significant positive correlation occurred at a lag of 0 month, and the most significant negative correlation at approximately a lag of 20 months.

Conclusions

3.18 The analysis of SOI, DPOI and Palmer Station air temperature suggests that global atmospheric signals were evident in Area 48. The available data for the DPOI covered a relatively short time period (10 years), suggesting that care should be exercised in interpreting this correlation. The subgroup suggested that the analysis of DPOI should be continued with the addition of recent data. The time series for the Palmer Station air temperatures was considerably longer (45 years), suggesting that this atmospheric correlation was more robust.

Evidence of Atmospheric Signals in the Ocean

3.19 Lagged cross-correlation analysis between the SOI anomalies and EN4 anomalies indicated very strong correlations, with the strongest relationship being evident as a negative relationship at a lag of zero months.

3.20 Lagged cross-correlation analysis of SOI anomalies and sea-ice extent at the Antarctic Peninsula (1987 to 1997) indicated that correlations existed with the SOI leading the sea-ice.

3.21 A lagged cross-correlation analysis between SOI anomalies and South Georgia (54°30'S, 34°30'W) anomalies showed strong negative correlations at a lag of 34 months and strong positive correlations at four months. In contrast, lagged cross-correlation analyses between EN4 anomalies and South Georgia NCAR SST anomalies showed strong positive correlations at a lag of 34 months and strong negative correlations at 11 months. These inverse results are consistent with the anticipated negative relationship between SOI and EN4. However, for all lag periods, the correlations between EN4 and South Georgia were stronger than the correlations between SOI and South Georgia. A similar analysis for the Southeast Pacific (61°30'S, 75°30'W) showed a similar result with the strongest correlations between the Southeast Pacific and EN4 at a lag of 28 months.

Conclusions

3.22 As anticipated, the comparison between SOI and EN4 indicated that SST is negatively correlated with SOI. The analyses also confirm conclusions made by earlier investigators that large-scale signals are evident in the sea-ice extent data (for example, Carlton and Carpenter, 1989; Murphy et al., 1995; White and Peterson, 1996) and SST data (White and Peterson, 1996). The comparison between SOI and South Georgia, and EN4 and South Georgia suggested that the most obvious correlations were evident from EN indices rather than from the SOI index. The strong correlation between surface seawater temperatures at South Georgia and those recorded in the Western Pacific is highlighted (WS-Area48-98/10), and is consistent with the general circulation pattern of the Pacific.

Evidence of Multi-year Signals in the Environment

3.23 Lagged auto-correlation analyses for the separate EN anomaly indices indicated that very strong serial correlations exist in the Pacific, with the strongest relationship evident at a lag of 50 months (WS-Area48-98/10).

3.24 Lagged auto-correlation analysis for SST anomalies at a reference point in the Southeast Pacific (61°30'S, 75°30'W) indicated that very strong serial correlations exist, with the

strongest relationship evident at a lag of 50 months. Similarly, an auto-correlation analysis for SST anomalies at South Georgia (54°30'S, 34°30'W) indicated strong correlations at a lag period of 49 months (WS-Area48-98/10).

3.25 Spatial and temporal coherence was evident in the sea-ice, including evidence of a four-year cycle, confirming earlier results from other investigators (e.g. Murphy et al., 1995; White and Peterson, 1996).

3.26 The NCAR SST series for the Elephant Island area and the South Orkneys showed a multi-year warming over the latter part of the series. Figure 4 shows SST anomalies from South Georgia, South Orkneys and Elephant Island EI1 and EI2. From 1992 the temperatures at the South Orkneys, Elephant Island EI1 and EI2 show a multi-year trend.

Conclusions

3.27 Strong periodicity was evident in some of the global signals (EN) as well as in variables that described the local physical environment in Area 48 (sea-ice and NCAR SST). The period of these signals was approximately four years, equivalent to the periodicity described by White and Peterson (1996).

3.28 Other multi-year signals are also present in the NCAR SST data, with (short-term) warming trends apparent in some areas.

Coherence Among Subareas within Area 48

3.29 Lagged cross-correlation analysis between EN4 anomalies and SST anomalies for the reference point in the Southeast Pacific indicated that very strong correlations existed between the two indices, with the strongest relationships evident as positive correlations at a lag of 26 months. Similarly, an analysis between EN4 and South Georgia (54°30'S, 34°30'W) indicated strong cross-correlations at a lag of 34 months.

3.30 The difference in temporal lag for the maximum correlations between EN4 and the Southeast Pacific and the maximum correlation between EN4 and South Georgia is consistent with the circumpolar anomaly precession as reported by Murphy et al. (1995) and White and Peterson (1996). Thus the time lag between the Southeast Pacific and South Georgia was approximately eight months. White and Peterson (1996) reported that a single phase of the Antarctic Circumpolar Wave (ACW) takes approximately eight to nine years (see also Murphy et al., 1995) to propagate around the globe and that two phases are generally present. This would suggest that for the ACW to travel from the Southeast Pacific to South Georgia (41° of longitude) should take just over six months, a value comparable with the estimate derived here.

3.31 Lagged cross-correlation analysis between EN4 and Elephant Island EI1 indicated correlations exist between the two indices. However, the correlations were not as strong as those determined for the Southeast Pacific or South Georgia. Furthermore, the correlations did not follow the same simple pattern consistent with the ACW. For example, positive correlations existed at a slightly later date than those for the Southeast Pacific, however the maximum correlation peak was noisy. A similar analysis for EN4 and the South Orkneys (60°30'S, 47°30'W) showed a similar picture with noise around the maximum correlation peak.

3.32 The ACW reported by White and Peterson (1996) was described for the Antarctic Circumpolar Current (ACC); thus it may be anticipated that correlations may be weaker for

areas adjacent to the Antarctic Peninsula. In these areas other factors are likely to be important, for example, continental waters or outflow from the Weddell Sea may influence local oceanographic signals.

3.33 The calculated estimate for the precession of SST anomalies is consistent with the analysis of simulation data that indicate that water transport across the Scotia Sea from the Antarctic Peninsula region occurs with a mean of about six to eight months (WS-Area48-98/8).

3.34 However, drifter data indicate that realised rates of transport may be much greater. Values of three to four months are typical for the large-scale transport from the Antarctic Peninsula to South Georgia. Transport in about two months has also been recorded.

3.35 The subgroup noted that transport across the Scotia Sea depends on the precise nature of the flow field. The ACC comprises a series of broad slow-moving zones, separated by fast-moving frontal regions. The frontal systems are important in the transport of material across the Scotia Sea. The positions of these are known to vary but there are no recent time series which allow this to be clarified for the present exercise. Furthermore, the NCAR SST data are not of sufficient resolution to show changes in the position of fronts.

Conclusions

3.36 NCAR SST data for the Drake Passage and South Georgia are consistent with the multi-year cycle described by White and Peterson (1996). Although data from positions close to the Antarctic Peninsula and the South Orkneys have similar signals, they are less strong and indicate that either local effects, or influences from other areas (such as the Weddell Sea), may also be important.

3.37 Estimates of coherence across the Scotia Sea are compatible with the mean flow field. However, the subgroup emphasised that transport may also occur at much shorter time scales.

Indices for Analyses

3.38 In order to combine variables describing the physical environment with those describing krill and krill-dependent predator populations, a series of physical indices was calculated. To maintain compatibility with the krill and predator indices, environmental indices were based on summer and winter values. Summer was defined as the months from November to March (inclusive) and winter as the months from June to October (inclusive). Summer and winter indices were determined for NCAR SST, EN1+2, EN3, EN4, SOI, DPOI, Palmer Station air temperature and sea-ice extent (Figures 5 to 8). For the NCAR SST dataset, indices were determined by averaging summer and winter months for all included SST data.

3.39 The NCAR dataset provides global coverage of SST, with areas covered by sea-ice represented by a single fixed value (-1.79°C). As the areas selected for the NCAR SST indices may occasionally include sea-ice, especially in winter, the NCAR indices should be considered as a type of ice-ocean index.

3.40 For the South Georgia region, NCAR SST data were selected to cover the summer foraging range of predators from Bird Island. The selected areas also include a proportion of the winter foraging range of many krill-dependent species. The NCAR data were selected to avoid high levels of correlation expected from adjacent positions in the global grid.

3.41 For the Antarctic Peninsula region, NCAR SST data were selected to cover the summer and winter foraging ranges of predators foraging from Anvers Island, Admiralty Bay and Signy Island.

3.42 For the Scotia Sea region, NCAR SST data were selected to include the areas already selected for South Georgia and the Antarctic Peninsula, together with additional areas of the Scotia Sea.

3.43 For the Elephant Island area, indices were also calculated from the CTD grid of the AMLR Program. The indices were based on CTD casts within each of three NCAR SST grid cells. The cells were located north of Elephant Island (EI1), southwest of Elephant Island (EI2) and southeast of Elephant Island (EI3). CTD data within each NCAR cell were averaged for each year to produce a single temperature index for each year at the surface (in reality 4 m depth), 100 m and 500 m.

3.44 The deeper levels have oceanographic significance in Area 48. The temperature at the 100-m level approximates the winter water temperature minimum in the Antarctic Surface Water. This layer, detectable in summer, is the residual from the previous winter's upper mixed layer temperature and may be thought of as a 'fossilised' temperature, perhaps giving insight into the temperatures during the previous season's winter. At 500 m, Circumpolar Deep Water (CDW) occurs north of the South Shetlands. This warm, deep layer may encroach onto the shelf and mix with waters originating from the Weddell Sea and Bransfield Strait.

3.45 The areas of the NCAR cells (Elephant Island EI1, EI2 and EI3) within the AMLR region approximately define oceanographic domains of similar temperature and salinity characteristics. However, to further refine the classification, stations were grouped into one of five temperature and salinity zones (Amos and Lavender, 1992) with values for each of the three months (January to March) covering the AMLR surveys. The indices are the mean temperatures at 4 m, 100 m, and 500 m. In Figure 9 the mean temperatures for Drake Passage and Bransfield Strait waters are contrasted. By inspection, temperatures at 100 m are out of phase with the surface waters in the same year.

3.46 Figure 10 compares the temperature index at 100 m in the winter water minimum with the Antarctic Peninsula winter SST. Contrary to expectations, the indices appear in phase.

KRILL

4.1 Krill data on abundance, recruitment and population structure for Subareas 48.1 and 48.3 available for analysis at the workshop are summarised in Table 1.

Krill Abundance

4.2 Estimates of krill abundance derived from acoustic surveys were available from both subareas. The methods used to collect the data in the two subareas were broadly comparable, however, there were differences in technique that are likely to have introduced biases into the absolute values obtained. WS-Area48-98/9 presents the best estimates of krill biomass obtained from surveys undertaken around South Georgia (Subarea 48.3) between 1980/81 and 1997/98. The techniques used to identify krill acoustically have evolved during the data series; the earliest cruises classified all acoustic targets as krill, later cruises used either echo-chart classification or dB difference to partition acoustic biomass estimates into krill, zooplankton and nekton. Results from US AMLR surveys in Subarea 48.1 were summarised from published reports and had been loaded onto the workshop website.

4.3 WS-Area48-98/9 indicated that acoustic densities at the eastern end of South Georgia were generally higher than those estimated for the western end of the island. This difference was particularly apparent in 1997/98. In addition, the subgroup recognised that there is considerable intra-annual variability in krill acoustic density estimates (Hewitt and Demer, 1994). To overcome this problem, acoustic surveys discussed here have been restricted to the period around January each year, the one exception being the 1981/82 survey in Subarea 48.3 which took place in November and December 1981.

4.4 WS-Area48-98/11 compared the acoustic estimates for Subarea 48.3 with those produced for the Elephant Island region of Subarea 48.1. Although there were differences in sampling techniques, in particular for krill identification and diel sampling period, the subgroup agreed that these were unlikely to alter the general patterns observed between years in the two subareas.

4.5 The analysis presented in WS-Area48-98/11 indicated that krill densities at both South Georgia and Elephant Island fluctuated markedly between years. Moreover, in all but one of the years where data were available from both regions, changes in density occurred in the same direction at both sites (Figure 11). The exception was the 1997/98 season where krill biomass at South Georgia increased to one of the highest values seen in the entire data sequence (see also paragraph 4.17).

4.6 For years where acoustic data exist for both subareas, very low krill biomasses were observed concurrently in both Subareas 48.1 and 48.3 in 1993/94. While in Subarea 48.3 a similarly low biomass was observed in 1990/91, the biomass in Subarea 48.1 in 1990/91 was no lower than biomasses observed in 1983/84 and 1984/85.

4.7 For Subarea 48.1 both net and acoustic density data were available. A comparison of the two datasets (Figure 12) revealed that changes in density from year to year occurred in the same direction for both acoustic and net densities. Note, however, that the absolute relationship between the two density estimates was not constant, major changes were observed around 1985/86 and 1992/93. The subgroup was unable to establish the cause of such changes with the information available at the meeting.

Krill Population Structure

4.8 Changes in the population structure of krill in Subareas 48.1 and 48.3 were analysed in two separate ways. Firstly, recruitment indices were used as a way of considering what proportion of the population was present in particular year classes. Secondly, the shape of length-frequency histograms from scientific haul-by-haul data was used to investigate the overall population structure in each area.

4.9 Proportional krill recruitment indices for Subarea 48.3 are presented in WS-Area48-98/20. In this paper the length-frequency distributions have been weighted by the acoustically determined density of krill for the eastern and western ends of South Georgia. Such a technique was developed because relatively few standard station hauls were carried out and so it was necessary to include acoustically targeted net hauls.

4.10 At South Georgia the proportional krill recruitment of the 1+ year class (R1) was low in spawning years 1988/89, 1989/90, 1991/92 and 1993/94 (Figure 13). In contrast, a year of very high recruitment was observed for the 1+ year class spawned in 1994/95, this decreased for krill spawned in the following year and had reached zero recruitment for the krill spawned in 1996/97. Note, however, that for this last year many of the krill were found to be intermediate in size between that normally observed for 1+ and 2+ aged krill. The analysis presented in WS-Area48-98/20 allocated these small krill to the 1+ year class. Inspection of krill from

Subarea 48.1 revealed not only the presence of 2+ aged krill that were smaller than usual but also some 1+ aged krill that were smaller than usual. As a result, the subgroup re-allocated these krill found in Subarea 48.3 to the 2+ year class.

4.11 R1 in the Elephant Island region has been presented at previous meetings of WG-EMM. Comparison of these data with those from South Georgia showed considerable concordance (Figure 13). Thus, in both areas krill spawned in years 1988/89, 1989/90, 1991/92 and 1992/93 all showed very low R1 (<0.1), in addition krill spawned in 1994/95 showed very high recruitment followed by reduced recruitment in both areas. Unfortunately it was not possible to check the concordance between other years of high recruitment (spawning years prior to 1982/83, 1987/88 and 1990/91) because of the lack of data for these years around South Georgia.

4.12 The subgroup also considered the results from the proportional krill recruitment index of the 2+ year class (R2). We might expect that for any spawning year a good R1 would be reflected in a good R2. Thus R2 potentially provides data for spawning success for years not covered by R1. However, a comparison of R1 and R2 from South Georgia shows that, where R1 and R2 were available for the same year, there was little agreement on what constituted good and bad spawning years (Figure 14). Although the relationship between R1 and R2 in Subarea 48.1 showed more concordance than in Subarea 48.3, there were still a number of mismatches.

4.13 The comparison of R2 for Elephant Island and South Georgia showed much less concordance than that observed between R1 values (Figure 15). Such a result was not unexpected given the results detailed in paragraph 4.12. The subgroup recognised that this lack of concordance may be due to methodological problems inherent in the calculation of R2, in particular the difficulty in uniquely separating this year class from larger krill, the longer time period over which environmental influences may operate and the areas sampled in relation to the overall distribution of the krill population.

4.14 Abundance data (from acoustic surveys in Subarea 48.3 and net data in Subarea 48.1) and recruitment data were combined to estimate absolute recruitment of the 1+ year class (Figure 16). The overall trend for Subarea 48.1 was that absolute recruitment was highest from spawning in 1979/80 to 1981/82. Recruitment peaks from spawning in 1987/88 and 1994/95 were relatively low. It was not possible to compare the strength of recruitment peaks in Subarea 48.3 as only one peak was observed in the data. However, it is evident that low absolute recruitment occurred in spawning years 1988/89, 1989/90, 1991/92 and 1992/93 because, irrespective of the total amount of krill, the proportion of 1+ aged krill was extremely low.

4.15 Scientific survey haul-by-haul length-frequency data were available from both Subareas 48.1 and 48.3 over the period 1980/81 to 1997/98 as well as 1983/84 and 1987/88 where data were available from Subarea 48.2. Such data have considerable potential to help understand linkages within the system but it is necessary to reduce these length-frequency distributions to a more easily assimilated index. The subgroup used a cluster analysis technique that was developed for length-frequency distributions around South Georgia (WG-EMM-97/47).

4.16 A cluster analysis based on length-frequency haul-by-haul data, grouped into size classes <30 mm, 30–40 mm, 40–50 mm, and >50 mm, was performed using the furthest neighbour (complete link) hierarchical clustering algorithm in Genstat 5.4.1 (Payne et al., 1993). Grouped data were treated as Euclidean distances and standardised over a range of 0 to 100. The dendrogram of the resulting cluster analysis revealed the presence of four main clusters between 55 and 75 % similarity. The distribution of these clusters was plotted against haul position for each cruise. Following the cluster analysis, the percentage of each cluster type in each subarea in each year was calculated. This gives a measure of the relative proportions of the broad categories of length-frequency distribution in each subarea. These data were then

used to calculate a similarity matrix, again assuming that they represent Euclidean distances with a range of 0 to 100. Similarities between Subareas 48.1 and 48.3 for each year where both were sampled were extracted from the matrix. Subarea 48.2, which contained samples from only two years, was considered too poorly represented for inclusion in the similarity index.

4.17 The krill length-frequency similarity index (Figure 17) shows that krill in Subareas 48.1 and 48.3 were very similar in three years (1989/90, 1992/93 and 1996/97). In contrast, some years were very different, for a varying number of reasons. The largest difference between the two subareas was found in 1993/94. In this year large krill were found around the Antarctic Peninsula and around South Georgia. However, at South Georgia some medium to small krill were also found. In 1997/98 medium-sized krill were well represented in both subareas. However, in Subarea 48.3 large krill were found while these were not present in Subarea 48.1. Similarly, in Subarea 48.1 small krill were found which were not present in Subarea 48.3. Although a low similarity value was observed in 1987/88, this result was most likely due to the low number of hauls taken in Subarea 48.3 in this year.

4.18 WS-Area48-98/15 presents length-frequencies of krill taken from predators at South Georgia for the period from 1990/91 to 1996/97. These data indicate considerable variation in the size of krill taken in each season (Figure 18). However, in 1990/91 and 1993/94 large krill (modal size ~58 mm) were taken in December but were completely replaced by small krill (modal size ~40 mm) by February. WS-Area48-98/15 predicted that a similar pattern would be observed in 1997/98 and data presented at the meeting indicated that such a decrease in the size of krill taken by predators had indeed occurred.

4.19 Additional krill length-frequency data from penguin diet samples at Admiralty Bay (Subarea 48.1, see Attachment D) were not critically examined given the short time available at the workshop.

Krill Fishery Data

4.20 Krill fishery data for Subareas 48.1, 48.2 and 48.3 were analysed to provide a combined index for each subarea for each year. The subgroup considered that such data might be useful because the fishery at South Georgia takes place in the winter and so these data could provide information on temporal lags of a different period to those obtained from scientific survey data (which were usually restricted to the summer season).

4.21 Total catch and fishing effort data were extracted from the CCAMLR database (fine-scale catch and effort). For the Japanese krill fishery the effort index was the number of vessel days, where days are the number of days in a reporting period (e.g. ten days). For all other fleets the measure of fishing effort was the number of hours fished. Data were grouped for each fleet and for each fine-scale reporting rectangle.

4.22 Fishing areas were defined as follows:

- (i) Elephant Island: the area between 60°–61°30'S and 50°–58°W in Subarea 48.1;
- (ii) Livingston Island: the area between 61°30'–63°S and 58°–70°W in Subarea 48.1;
- (iii) South Orkneys: all of Subarea 48.2;
- (iv) Bird Island: the area between 53°–55°S and 37°–40°W in Subarea 48.3; and
- (v) East South Georgia: the area from 53°–55°S and 34°–37°W in Subarea 48.3.

Fishing periods were defined as winter and summer. The winter period was defined as the months of May to October inclusive and summer the months of November to April inclusive.

4.23 Indices of CPUE were calculated and then averaged by fishing season and area.

4.24 The indices were analysed using the Combined Standardised Index (CSI) (see paragraph 7.9) and the results presented in Figure 19 (summer and winter CPUE).

4.25 In Subarea 48.1 the pattern of CPUE from 1982/83 to 1992/93 followed the same pattern in the Elephant Island and Livingston Island areas. Outside that period this pattern was not present.

4.26 In Subarea 48.2 there is some evidence for an increasing trend over the 1980s but otherwise no clear pattern was present.

4.27 At South Georgia (Subarea 48.3 – a winter fishery), the CPUE reached a minimum around Bird Island in 1991 and 1994 and at the eastern end there were minimums in 1991 and 1993. These may reflect krill density, either in advance of, or following, the low density observed from scientific surveys in the 1990/91 and 1993/94 summer seasons.

4.28 The subgroup noted that CPUE indices on these time and space scales were not necessarily the best indicators of local density but that haul-by-haul data would be better. Such data were not used at the workshop and in any case it would have taken a great deal of time to complete any analysis.

4.29 The subgroup considered that length-frequency data from the commercial fishery were likely to be of interest but that considerable work would be required to overcome the net selectivity problems inherent in these datasets.

BIOTIC ENVIRONMENT

Primary Production

5.1 Dr C. Hewes (USA) reported that phytoplankton biomass, measured in terms of chlorophyll concentration, had large inter-, intra-annual and spatial variability. Integrated (0–100 m) chlorophyll concentrations were averaged over the entire US AMLR survey area for each year (surveys made from January to March, Figure 20). Years 1991/92, 1992/93 and 1997/98 were below, and 1989/90 and 1994/95 were above, the average phytoplankton biomass. Comparisons with Subareas 48.2 and 48.3 were not possible since chlorophyll data were not available for these other regions. Years of low chlorophyll concentrations corresponded with those of EN (low summer SOI) (Figure 20).

Zooplankton Assemblages

5.2 Dr Loeb reported that over the past six years net collections made in the Elephant Island area during US AMLR summer surveys have demonstrated a shift from strong numerical dominance by salp (*Salpa thompsoni*) (1993) to copepods (1995 and 1996) and back to salp (1998). These shifts have been associated with abundance changes of one order of magnitude for copepods (primarily *Metridiagerlachei*) and two orders of magnitude for salp. The intervening ‘transition’ periods (1994 and 1997) were marked by distinct changes in copepod and salp abundance over summer months. These abundance changes occurred over relatively brief time spans (four to six weeks) and could be due to a change in advective regimes (i.e. from poleward to equatorward advection).

5.3 Dr Loeb indicated that summers marked by salp dominance and relatively low copepod abundance (‘salp years’) have become a recurring phenomenon in this area over the past two decades. Major salp blooms have been noted every four to five years since summer 1983/84.

Dr Loeb also noted that this periodicity conforms to the eastward precession of anomalies described by Murphy et al. (1995) and the ACW wave described by White and Peterson (1996).

5.4 Dr Naganobu reported on WS-Area48-98/4 which dealt with variability of the proportion of salp and green krill (coloured by active phytoplankton feeding) density, using data from Japanese krill trawlers operating near the Antarctic Peninsula. Interannual and seasonal variability of the timing, duration and strength of salp blooms and green krill were analysed. No relationship between salp density and proportion of green krill in the catches was evident, when both salps and krill were found together. In the Livingston Island area, the proportion of green krill was high only when salp density was extremely low. However, no clear relationship was observed in the Elephant Island area.

5.5 The workshop considered these results and concluded they warranted further analysis. However, because they are related to limited areas of Subarea 48.1, and comparable results were not available from other localities, further consideration was referred to WG-EMM.

MARINE PREDATORS OF KRILL

Mackerel Icefish

6.1 The mackerel icefish (*Champsocephalus gunnari*) is found on the shelf of South Georgia, Shag Rocks, the South Orkney and South Shetland Islands in water down to 500 m depth. The species is known to feed preferentially on krill and during 'good krill years' its condition index is high (WS-Area48-98/19).

6.2 Studies have been undertaken on diet, feeding status and condition indices. The only dataset which provided a reasonable time series and for which information was available from more than one site was the condition index.

6.3 The condition index is calculated for individual fish from two variables: total mass and estimated total mass. Condition index is the ratio of total mass to estimated total mass. Data from 6 000 fish caught in seven seasons were used to determine an 'average' length-to-mass relationship. This relationship was then used to calculate an estimated mass for each of the 24 000 fish over 27 years used in the study.

6.4 Results were initially presented as mean values by month for South Georgia, Shag Rocks, Elephant Islands and South Shetlands (WS-Area48-98/19). To conform with the summer and winter periods recognised for land-based predators of krill, the data were combined into two seasonal indices, summer (November–April) and winter (May–October).

6.5 Periods when the condition index was low were:

- (i) South Georgia during the summers of 1977/78, 1982/83, 1990/91 and 1993/94 and winters of 1972, 1985, 1990 and 1997;
- (ii) Shag Rocks during the summers of 1972/73, 1986/87 and winter 1997;
- (iii) South Shetlands during summer 1984/85; and
- (iv) Elephant Island during the summers of 1978/79, 1983/84, 1984/85 and 1987/88.

Whales

6.6 The IWC has four types of whale data that potentially could be of use in addressing the questions posed for this workshop. These include sightings survey results from the International Decade of Cetacean Research (IDCR), from Japanese scouting vessels, commercial catch statistics and biological data taken from a sample of the catch. When divided into Subareas 48.1, 48.2 and 48.3, data of all four types were too sparse to allow meaningful comparisons among areas.

6.7 One source, the Japanese scouting vessels' sightings data, did allow estimation of abundance indices for seven years in Subarea 48.1, and four years in Subarea 48.2 (Figures 21 and 22). Indices were computed for blue, fin, humpback, sei, right and minke whales. Only for minke whales were there sufficient sightings to justify further scrutiny.

6.8 In Subarea 48.1, minke whale abundance was relatively stable during 1973/74, 1974/75, 1975/76, 1979/80 and 1981/82. In 1985/86 the relative abundance increased substantially, approximately sixfold from the previous level. In 1986/87 the index dropped, but only about halfway to the previous level. Assuming these data provide a reasonable index of minke whale abundance, they suggest that the 1985/86 season was notably different. Krill availability to minke whales may have been better that year in Subarea 48.1.

6.9 In Subarea 48.2, as in Subarea 48.1, only data from minke whales were sufficient to justify further scrutiny. Among the four years in which that area was searched, 1980/81 appears to stand out as having about twice the density of minke whales as during 1973/74, 1981/82 and 1985/86. Keeping in mind that these indices are presented without dispersion statistics, and the other relevant caveats, the increase in 1980/81 to just over double the other years' indices may well indicate improved krill availability to minke whales that year.

LAND-BASED MARINE PREDATORS

Data Availability

7.1 In the original subgroup circular, five sites (Bird Island, Signy Island, Seal Island, Admiralty Bay and Anvers Island) were identified for which at least five years of continuous data on dependent species exist.

7.2 For Signy Island, Seal Island and Anvers Island there were no data, additional to those in the CEMP database, available at the workshop. For Bird Island and Admiralty Bay several additional datasets and indices were provided before and/or at the start of the workshop.

7.3 Several shorter (<5 years) time series of data were also available at the workshop, either in the CEMP database (e.g. A1, A2, A3, A6a, A7 for Esperanza 1993/94–1996/97) or in tabled papers (e.g. Antarctic fur seal growth rates at Cape Shirreff 1994/95–1997/98, WS-Area48-98/18).

7.4 It was agreed to concentrate initially on analysis of the larger and longer datasets. If time permitted, the other datasets would be examined to see the extent to which they supported, or contradicted, the conclusions or inferences derived here.

7.5 The datasets available for analysis are summarised in Tables 2 to 4. Additional information on the sources and nature of the data from Bird Island and Signy Island is provided in WS-Area48-98/12 and 98/13.

7.6 Table 3 indicates the relatively restricted nature of the data available for comparisons of species across sites and at scales other than multi-year (population size) and summer.

Data Arrangement and Combination

7.7 In Table 5 the predator indices are set out in logical groupings reflecting relatively discrete biological processes. These have potential for combination into a single index. Other combined indices could also be formed to reflect the temporal scales shown in Table 5.

7.8 It is also possible to create new indices by combining some of the existing ones using simple formulae. Such indices were termed composite indices and examples of predator performance are given in Table 6.

Data Analysis

7.9 Based on the approach developed in WG-EMM-Stats-97/7, WS-Area48-98/6 provides a computer program to calculate a combined index, which we term the Combined Standardised Index (CSI). CSIs were derived from different sections of the database to provide summaries of time series within sites, species and seasons, even though the statistical properties of the index were not completely understood.

7.10 There was insufficient time at the workshop to investigate the combined indices in Table 5, other than those for summer and winter (the latter including population size). There was no time to investigate the use of composite indices.

7.11 Therefore important future tasks to help refine and improve the present analyses would be:

- (i) to compare the results of using indices combining all original variables with those combining single indices each representing a group of biologically related variables. (For several species and sites, the combined indices are currently weighted heavily in favour of diet variables.);
- (ii) to investigate the use of composite indices to replace the indices included in their calculation. (Note that the use of yield per offspring should eliminate the problems of small numbers of surviving offspring in bad years having weaning/fledging mass greater than the population mean in good years. In addition, provisioning indices would take account of potential trade-offs between meal mass and meal delivery rate.);
- (iii) to compare critically the results of using winter indices with and without population size;
- (iv) to provide a method of estimating confidence limits around the CSI; and
- (v) to examine patterns/scales of variability within the predator indices including investigation of the effects of varying the composition of the indices contributing to each CSI.

7.12 The combined summer and winter indices for each species at each site are illustrated in Figures 23 to 27.

7.13 It should be noted that all analyses, except as otherwise indicated, were performed with the original untransformed values. After Figure 23 was produced, imputed values were substituted for black-browed albatross population size in 1987/88 and population size and hatching (but not rearing) success in 1994/95.

7.14 The initial inspection of the summer indices in Figures 23 to 27 attempted to identify years of notably poor reproductive performance (see Table 7).

7.15 The next stage was to combine species within sites. To ensure that this did not involve combining species with very different patterns of reproductive performance across years, a correlation matrix was created for the combined summer variables separately (Table 8). This table highlights variables with statistically significant correlations. However, correlations between numerous variables must be interpreted cautiously as chance alone may result in a number of significant correlations. Therefore these values were used only as a guide to the level of correlation appropriate for combining or separating species within sites.

7.16 As a consequence, in respect of summer variables, species were separated across sites as follows:

- (i) Bird Island, South Georgia (see Figure 28) –
The three diving species (two penguins and Antarctic fur seal) were separated from black-browed albatross. (The lower similarity between black-browed albatross and the other species is principally due to its performance in 1987/88 and 1994/95. These were the two years of greatest abnormality in physical environmental conditions around the time of egg laying, causing numerous changes in reproductive phenology and performance, not all of which will have been addressed through the use of imputed values.)
- (ii) Signy Island, South Orkney Islands (see Figure 29a) –
The correlation coefficients suggest that Adélie penguins should be separated from the other two species; this was not, however, implemented at the time that this analysis was undertaken, whereby all three species were combined. In addition to the strong positive relationship between gentoo and chinstrap penguins, Figure 7a indicates possible time-specific differences in responses, particularly for Adélie penguins, whereby performance indices for the 1990s are generally higher than those for the 1980s.
- (iii) Admiralty Bay (see Figure 29b) –
There were low correlations for all interspecies comparisons but no indication that any separation was warranted. However, the relationship between Adélie and gentoo penguins indicates strong association across all years in the 1990s but no such relationship for the 1980s. Such a pattern is not evident in the other interspecies comparisons at this site. At neither Signy Island nor Admiralty Bay is there evidence of year-specific similarities in performance of Adélie and chinstrap penguins.
- (iv) Seal Island –
There was high correlation between the two species (chinstrap penguin and Antarctic fur seal) which were combined.

7.17 The resulting summer indices are shown in Figure 30 (note that the data for black-browed albatross now include the imputed values for 1987/88 and 1994/95). The resulting identification of years of poor reproductive performance is summarised in Table 9.

7.18 This suggests that there is evidence of coherence in respect of summer indices:

- (i) in 1983/84 between Subareas 48.3 and 48.2. Note no data for Subarea 48.1;
- (ii) in 1989/90 between Subareas 48.2 and 48.1 (but not chinstrap penguin at Seal Island);

- (iii) in 1990/91 across the whole of Area 48, except for Signy Island; and
- (iv) in 1993/94 between Subareas 48.3 and 48.2, but not Subarea 48.1 (except Seal Island).

7.19 We also investigated potential inter-relationships between species and sites by constructing a correlation matrix for breeding success – a variable which should reflect overall summer reproductive performance and which is recorded for most long time series at most sites. (The eight year datasets from Seal Island and Anvers Island were excluded from this analysis). To complete the matrix across all sites for the years 1981/82 to 1997/98 (to 1996/97 for Signy Island) values were imputed (by linear interpolation) for Antarctic fur seals at Bird Island in 1982/83 and for all three penguin species at Admiralty Bay in 1983/84.

7.20 The results, shown in Table 10 (to which the same caveats apply as in paragraph 7.15) indicate that there are trivial differences between the datasets with or without the imputed values.

7.21 Taking values >0.4 to represent correlations of biological interest, the three strongest correlations are all within-site (Admiralty Bay gentoo and Adélie penguins, Signy Island gentoo and chinstrap penguins, Bird Island gentoo penguins and Antarctic fur seals). It may be relevant that all these include gentoo penguins, a resident species of restricted foraging range which is typically very sensitive to fluctuations in prey availability. A group of somewhat weaker correlations exist for several comparisons between Bird Island and Signy Island. These involve gentoo penguin and fur seal at Bird Island with some combination of the three penguin species at Signy Island. However, gentoo penguins at Bird Island and Signy Island show no significant correlation – possibly reflecting their highly restricted, site-specific distribution at all times of year.

7.22 Another approach to examining the relationships across indices within and between species is to use Principal Component Analysis (PCA). The advantages and limitations of this technique are indicated in Attachment E. There was insufficient time to apply this technique to the appropriate predator datasets (i.e. especially to species within and between sites). An example, showing the application of the technique to gentoo penguins at Bird Island and Admiralty Bay, is provided in Attachment E.

7.23 Comparison of subareas using site-specific combined summer variables is illustrated in Figure 31. (In interpreting this figure attention has been focused on the bottom-left and upper-right quadrants, which approximate to coherence in bad and good years respectively.)

7.24 For Subarea 48.3 (Bird Island (BIG)), coherences are apparent for:

Subarea ¹	Bad	Good	None
48.2 (SIO)	83/84, 93/94	84/85, 85/86, 87/88, 88/89, 94/95 ² , 95/96, 96/97	78/79–82/83, 86/87, 89/90, 90/91
48.1 (SES)	90/91, 93/94	87/88, 88/89, 94/95 ² , 95/96 ² , 96/97	89/90, 91/92, 92/93
48.1 (ADB)	77/78 ² , 90/91	84/85, 88/89, 91/92, 94/95–96/97	81/82, 82/83, 85/86–87/88, 89/90, 92/93, 93/94

¹ For explanation of codes, see Table 2.

² Weak effect

7.25 For Subarea 48.2 (Signy Island (SIO)) the main coherences appear to be:

Subarea ¹	Bad	Good	None
48.1 (SES)	89/90 ² , 93/94	87/88, 88/89, 94/95 ² , 95/96 ² , 96/97	90/91, 91/92, 92/93
48.1 (ADB)	81/82 ² , 82/83, 89/90	84/85, 88/89, 91/92, 94/95–96/97	85/86–87/88, 90/91, 92/93, 93/94

¹ For explanation of codes, see Table 2.

² Weak effect

7.26 For within Subarea 48.1 the main coherences between Admiralty Bay (ADB) and Seal Island (SES) are:

Subarea ¹	Bad	Good	None
48.1 (SES)	89/90, 90/91, 92/93	84/85, 88/89, 91/92, 94/95–96/97	87/88, 91/92 ² , 93/94

¹ For explanation of codes, see Table 2.

² Weak effect

7.27 Overall this suggests that there is:

- (i) moderate coherence (years fairly equally divided between coherence (good or bad) and incoherence) between Subarea 48.3 and Subareas 48.2 and 48.1, with more coherence in the latter with Seal Island than Admiralty Bay;
- (ii) greater coherence between Subareas 48.2 and 48.1, again with stronger relationships with Seal Island than Admiralty Bay;
- (iii) good coherence (strong in terms of the aggregate of years but more of these fall close to the main axes) between the two sites in Subarea 48.1; and
- (iv) little change in the assessment of responses to notably bad years (i.e. 1990/91 and 1993/94) from that set out in paragraph 7.18.

7.28 To summarise the nature of coherences in bad years from the summer indices (see paragraph 7.18):

- (i) 1983/84 – coherence between Subareas 48.3 and 48.2; no data for Subarea 48.1;
- (ii) 1989/90 – coherence between Subarea 48.2 and Admiralty Bay in Subarea 48.1. Seal Island is complex with penguins showing longest ever foraging trips and third lowest fledging mass, balanced by largest meal mass. Antarctic fur seals show average foraging trip but low growth rates;
- (iii) 1990/91 – coherence throughout Area 48, except Signy Island, where penguin breeding success was normal. However, breeding population sizes in 1991 were 20 to 30% lower than in the previous year, the biggest reductions on record. (This contrasts with 1984 where breeding populations were not reduced but breeding success was very low); and
- (iv) 1993/94 – coherence between Subareas 48.3 and 48.2, but in contrast clear evidence of a good year in Subarea 48.1 at Anvers Island and Admiralty Bay. Seal Island apparently transitional (second lowest fledging mass, average foraging trip duration, large meal mass).

7.29 Substantial association across subareas in good years is evident for:

1984/85 – Subareas 48.3, 48.2 and 48.1 (Admiralty Bay but not Seal Island);
1987/88 – Subareas 48.3, 48.2 and 48.1 (Seal Island but not Admiralty Bay);
1988/89 – whole area;
1994/95 – whole area;
1995/96 – whole area; and
1996/97 – whole area.

7.30 Based on the analysis in paragraph 7.24 of the results presented in Figure 31, a scoring system was developed to examine the overall pattern of coherence across years. This involved scoring a year with a -1 if the comparison fell into the ‘bad’ (bottom left in Figure 31) category; +1 if it fell into the ‘good’ (upper right in Figure 31) category and 0 if it fell into neither of these. The totalled score for each year was divided by the sample size for each year to give an index between -1 and 1. In cases where the index was -1 this indicated absolute coherence of bad conditions across sites whereas when the index was +1 it showed absolute coherence of good conditions across sites. When the index was 0 then there was no overall coherence across sites.

7.31 Between 1977/78 and 1980/81 only one coherence measure was available but for later years the sample size was three to six except for 1983/84 when only one coherence measure was available. Coherence was either low or suggested that conditions for predators were generally poor during the early 1980s but generally conditions were good during the late 1980s (Figure 32). The index showed low coherence and conditions were generally bad during the early 1990s and in the late part of the time series the index showed a return to high coherence with good conditions.

7.32 This index provides an overall view of the temporal variability in linkages between sites used to monitor predators in Area 48. It suggests that there may be a multi-year pattern of variability with shifts from generally bad conditions for predators with relatively low coherence across monitoring sites to relatively good conditions and high coherence. Each of these phases appears to last approximately five to six years.

7.33 Investigation of the winter indices for species at sites (Figures 23b, 24b, 25b and 27b) is complicated by the fact that population size is usually the main (and often the only) variable. For most species there are strong trends in population size across all or part of the dataset, which make identifying comparable years of poor performance across the whole dataset more difficult.

7.34 Figure 33 indicates that population trends across all or part of the time series exist for:

- (i) Bird Island – black-browed albatross (decline throughout); macaroni penguin (decline since 1984); gentoo penguin (small decline overall, more noticeably since 1989);
- (ii) Signy Island – Adélie penguin (increase 1979–1989; decline thereafter, especially to 1995); gentoo penguin (increase overall); chinstrap penguin (slight decline overall);
- (iii) Admiralty Bay – Adélie penguin (decline, especially since 1989); chinstrap penguin (decline since 1979); gentoo penguin (decline since 1980); and
- (iv) Anvers Island – Adélie penguin (decline throughout).

Thus amongst all species and sites, only Antarctic fur seal at Bird Island shows an essentially stable (albeit with substantial fluctuations) population across the complete time series.

7.35 In preparation for combining species within sites, a correlation matrix (Table 11) was prepared. This is more complex to interpret than the similar matrix for summer variables. The following separations/combinations were adopted:

- (i) Bird Island, South Georgia (see Figure 34a) –
No consistent pattern, except that black-browed albatross and macaroni penguin are strongly correlated; however, no change was made to the distinction, adopted for the summer variables, between black-browed albatross and the three diving species.
- (ii) Signy Island (see Figure 34b) –
Gentoo and Adélie penguins weakly correlated; no other obvious pattern.
- (iii) Admiralty Bay (see Figure 34c) –
Gentoo and chinstrap penguins weakly correlated; no other obvious pattern.

For both the last two sites Adélie and chinstrap penguins were separated for analysis of winter variables.

7.36 The resulting combined winter indices for species at sites are shown in Figure 35. The identification of years of poor reproductive performance is shown in Table 12.

7.37 Coherence in bad years across subareas may include:

- (i) 1980 (penguins (excluding Adélie) at all sites/subareas, but weakest at Bird Island);
- (ii) 1984 (penguins at Bird Island and Signy, but weak at latter);
- (iii) 1990 (penguins at all sites/subareas – less evident for Adélie at Admiralty Bay, but population size declined by 25%, the second largest decline in the 20-year database);
- (iv) 1994 (penguins at all sites/subareas); and
- (v) 1997 (all species at Bird Island; gentoo and Adélie penguins at Admiralty Bay).

7.38 In relation to the main bad years inferred from the summer variables (see paragraph 7.28), the above suggests that the 1990 winter (preceding the 1990/91 summer) was also bad. In contrast, the bad winters of 1984 and 1994 followed the bad summers of 1983/84 and 1993/94.

7.39 To further investigate patterns of population change, a correlation matrix of the difference between populations in successive years was created (Table 13). Missing values for chinstrap and gentoo penguins at Admiralty Bay in 1984 dictated that a time series without imputed values could only commence in 1985 (first difference in 1986). Imputing (by linear interpolation) these 1984 values and also those for Antarctic fur seal and gentoo penguin at Bird Island in 1979 and 1983, and 1981 respectively, allowed the time series to commence in 1979 (first difference 1980).

7.40 In the longer time series the correlations of potential biological significance (>0.4) were chiefly between Bird Island and Signy Island penguins (seven of nine correlations) and between chinstrap penguins at Admiralty Bay and chinstrap and gentoo penguins at Signy. Only three potentially relevant within-site correlations exist: Adélie and chinstrap penguins at Signy, Antarctic fur seal and macaroni penguin at Bird Island, gentoo and chinstrap penguins at Admiralty Bay.

7.41 In the shorter time series there are more, and stronger, correlations. All but one (gentoo and chinstrap penguins at Admiralty Bay) of those from the longer time series are still present. Additional correlations are between chinstrap penguins at Admiralty Bay and all penguins at Bird Island and Signy, Adélie penguins at Admiralty Bay and Signy, Antarctic fur seal and macaroni penguin at Bird Island, gentoo and Adélie penguins at Signy. The differences between the two datasets suggest that greater coherence between sites was a stronger feature of the period after 1986.

7.42 Comparison of subareas using site-specific combined winter variables is illustrated in Figure 36.

7.43 This suggests that there is evidence of coherence between subareas in respect of winter indices as set out below:

For Subarea 48.3 (Bird Island) with:

Subarea/Species ¹	Start	Bad	Good	None
48.2 SIO (PYP, PYN)	77	78, 80, 84, 90, 94	77, 85, 88, 89, 92	79, 81–83, 86, 87, 91, 93, 95–97
48.2 SIO (PYD)	77	78, 80, 84, 90, 94, 95	77, 85, 87–89	79, 81–83, 86, 91–93, 96, 97
48.1 ADB (PYP, PYN)	77	90, 94, 97	77, 79, 81, 87, 88, 92	78, 80, 82–86, 89, 91, 93, 95, 96
48.1 ADB (PYD)	77	90, 93, 94	77, 81, 87, 88, 89	78–80, 82–86, 91, 92, 95–97

¹ For explanation of codes, see Table 2.

For Subarea 48.2 (Signy Island) with:

Subarea/Species ¹	Start	Bad	Good	None
48.1 ADB (PYP, PYN)	77	83, 90, 94	77, 88, 92, 95	78–82, 84–87, 89, 91, 93, 96, 97
48.1 ADB (PYD)	77	79, 90, 94	77, 86–89, 97	78, 80–85, 91–93, 95, 96

¹ For explanation of codes, see Table 2.

7.44 Overall this suggests:

- (i) moderate coherence (years fairly equally divided between coherence (good and bad) and incoherence) across subareas; and
- (ii) most coherence operates across the whole of Area 48. This is in contrast to the results from the summer variables, presumably reflecting the greater spatial and temporal scales over which the winter variables integrate.

7.45 More specifically, in respect of bad years, there is evidence of coherence for:

- (i) 1978, 1980 and 1984 – Bird Island and Signy only;
- (ii) 1990 – all sites/subareas; and
- (iii) 1994 – all sites/subareas.

7.46 These circumstances probably reflect responses of predators at the population level. However, whereas those in 1990 precede the bad summer of 1990/91, those in 1984 and 1994 follow the bad summers of 1983/84 and 1993/94. In the first case the low populations at the beginning of 1990/91 may reflect predators in poor condition over winter electing not to breed in that summer. In the second case the low populations in the year after bad summer conditions may reflect continuing poor conditions over winter and/or reduced survival and recruitment.

7.47 In respect of good years, coherences are indicated for:

- (i) 1977 and 1988 – all sites/subareas; and
- (ii) 1989 – Bird Island, Signy Island (all penguin species) and Adélie penguins at Admiralty Bay.

7.48 The results of a similarity analysis, like that for summer variables (see paragraph 7.30), are shown in Figure 32. (Six coherence measures were available for winter variables for each year.) Figure 32 suggests that the pattern of fluctuation of winter indices of population performance generally resembles that of the summer indices. This is particularly true for the strong positive sequence of years from 1985 to 1989. Adjacent periods match somewhat less well, the winter values showing a more complex mixture of positive and negative values. This is likely to reflect some combination of the larger spatial and temporal scales over which winter population processes integrate and the fact that the winter index combines variables with short and long temporal scales.

ENVIRONMENT–PREY–PREDATOR INTERACTIONS

Background

8.1 A synthesis of some aspects of interannual variability of the Southern Ocean ecosystem was presented in WS-Area48-98/8. This highlighted the extensive evidence that there are years when there is a very low abundance of krill in the South Georgia area, and that the variation affects much of the ecosystem with the most obvious impacts on survival and breeding success of some of the major krill predators. The open nature of the South Georgia ecosystem means this variability has large-scale relevance.

8.2 Fluctuations in year class success in parts, or all, of the population across the Scotia Sea, can generate large changes in the available biomass. The ocean transport pathways, maintain the large-scale ecosystem structure by moving krill over large distances to areas where they are available to predator colonies. This large-scale physical system shows strong spatial and temporal coherence in the patterns of the interannual and sub-decadal variability. The physical variability affects both the population dynamics of krill and the transport pathways, emphasising that both the causes and consequences of events at South Georgia are part of much larger-scale processes.

8.3 Model analyses of krill demography and large-scale transport were presented which highlighted how both aspects are important in generating the observed variability. The krill population dynamic processes introduce lags which mean that analyses with environmental variables must be carried out with caution. A conceptual model was presented illustrating how the physical variability can affect krill demography, distribution and abundance.

8.4 Predators are likely to respond to the integrated signal from several environmental variables simultaneously in a way that cannot readily be reflected by bivariate plots amongst environment, prey and predator variables. This theme was developed in WS-Area48-98/16 in which a single predator performance index (16-year time series of fur seal foraging trip duration at Bird Island) was related to several environmental indices, including El Niño Southern Oscillation (ENSO), sea-ice and krill recruitment.

8.5 The results suggested that there was significant cross-correlation between ENSO and fur seal foraging at lags of -9 and +11 months. The negative lag might suggest that fur seals anticipate ENSO. However, this effect is probably the result of harmonics from cyclical processes that are best represented by the positive lag at approximately one year. Overall, these results suggest that Antarctic fur seals at South Georgia are influenced (albeit indirectly) by large-scale physical processes.

8.6 Furthermore, in a multiple regression analysis the combination of sea-ice indices lagged by one year and ENSO also lagged by one year explained a large proportion of the variation in fur seal foraging trip duration. This also suggested that ENSO influenced fur seal foraging trip duration at South Georgia up to one year after the main effect in the Pacific but that variance in foraging trip duration due to physical variables in multiple regression models was greater when ENSO was present in combination with the sea-ice index. Therefore, by combining physical variables in a single analysis it was possible to explain more of the variation in behaviour, suggesting that Antarctic fur seals are responding to environmental factors that depend on both sea-ice and ENSO variability.

8.7 Relationships between population change in Adélie and chinstrap penguins in Subareas 48.1 and 48.2 and ice duration and extent (both in the vicinity of breeding colonies and in areas co-extensive with the penguins winter foraging range) have been investigated by Fraser et al. (1992) and Trathan et al. (1996). Both papers concluded that there was evidence of ice-mediated effects on penguin populations, chiefly in winter, and that these were different for the two species.

8.8 In WG-EMM-95/63 changes in Adélie penguin population size and demography at Admiralty Bay (Subarea 48.1) were linked to reported declines in winter sea-ice extent (Stammerjohn and Smith, 1996) and krill biomass (Siegel and Loeb, 1995) in this same region. Adélie cohort survival dropped from a mean of 22% for the 1982 to 1987 cohorts to 10% for the 1988 to 1995 cohorts. Adélie population size also declined precipitously in 1990 and 1991, two years after the change in cohort survival (consistent with the age of first recruitment at two years in Adélie penguins). These findings suggest that Adélie penguins are responding to observed changes in their physical and biotic environments. However, interpreting the mechanisms and interactions underlining these responses is complicated by multi-year effects known to influence changes in population size and demography.

8.9 WS-Area48-98/17 investigates interspecies differences in the reproductive performance of predators at South Georgia in years of high and low prey availability. The order-of-magnitude difference in krill biomass between 1986 (good year) and 1994 (bad year) was accompanied by: (i) 90% reduction in the mass of krill in predator diets (and some increase in the fish component); (ii) greater prey diversity for most species; (iii) reduced diet overlap between species; and (iv) switching from krill to amphipods in macaroni penguin but no major dietary change in other species. Rates of provisioning offspring decreased by 90% in gentoo penguin and 40 to 50% in the other three species; this was due to reduced meal size in penguins (by 90% in gentoo and 50% in macaroni) and to doubling of foraging trip duration in albatrosses. Breeding success was reduced by 50% in grey-headed albatross (the species least dependent on krill), by 90% in black-browed albatross and gentoo penguin (only 3 to 4% of eggs producing fledged chicks) but only by 10% in macaroni penguin, presumably reflecting its ability to switch to small prey unprofitable for the other species. All species (except black-browed albatross) and particularly macaroni penguin produced fledglings significantly lighter than usual, probably affecting their subsequent survival. These results indicate a coherent, though complex, pattern of within- and between-species similarities and differences, mainly reflecting degree of dependence on krill, the feasibility of taking alternative prey and constraints on trip duration and/or meal size imposed by foraging adaptations (especially relating to travel speeds and diving abilities). Therefore even in a year of very low prey availability there may be important interspecies differences in indices of predator performance – albeit within an overall pattern of poor performance.

8.10 Dr Naganobu reported on the relationship between krill recruitment and DPOI (WS-Area48-98/5). The DPOI showed good correlation with the variability of krill recruitment. The years with high DPOI, meaning strong westerlies, coincided with the high recruitment of krill (1981/82, 1987/88 and 1990/91). The large values of mean R1 occurred in the years of high DPOI (1981/82, 1987/88 and 1990/91). Conversely, the years of extremely small DPOI, meaning weak westerlies, coincided with the extreme poor recruitment of krill (1982/83, 1983/84, 1988/89, 1991/92 and 1992/93). The low values of mean R1 occurred in the years of low DPOI for 1982/83, 1983/84, 1988/89, 1991/92 and 1992/93 respectively. Other years of the low mean R1, e.g. in 1984/85 and 1989/90, approximately coincided with weak values of the DPOI. These coincidences between the DPOI and R1 suggest that the strength of the westerly winds affects krill recruitment through variability of oceanographic conditions mainly caused by Ekman transport. The years of the low DPOI also coincided with EN years in 1983, 1988 and 1992. The result suggests that the DPOI is linked with the SOI.

Workshop Analysis of Interactions

8.11 A combined set of environment, prey and predator indices was generated based on the indices derived by the subgroups. The physical variables consisted of atmospheric indices relating to EN, regional and large-scale SST, and regional and large-scale descriptions of sea-ice. The prey data included indices of recruitment and density of krill. The predator data included information on fish and on land-based predators. The land-based predator data included composite indices based on a number of species and variables and indices based on only one or two species.

8.12 A description of the combined dataset is given in Table 14. This highlights that even with this derived set of data there are many variables for which the data series are incomplete and a number for which there are only a few data points. This restricts the potential of the multivariate analyses to give a complete view of the interactions.

8.13 The analyses were undertaken using three basic approaches with considerable interaction between the different individuals involved in carrying out the analyses. This allowed ideas and information to be exchanged as the analyses progressed. The three approaches were: (i) to develop bivariate plots of some of the relationships; (ii) to undertake a preliminary multivariate analysis; and (iii) to carry out a multiple regression exercise based on the ideas presented in Adams and Wilson (unpublished).

Bivariate Relationships

8.14 There were a number of pre-existing hypotheses relating indices of aspects of krill biology and ecology to environmental variation and others relating predator biology to prey and environmental variability. These were examined using bivariate plots of key variables. As the multivariate analyses developed, these helped in the process of focusing on some of the key relationships. This process was not completed and is best regarded as a first preliminary assessment of the data. It should also be remembered that the data are not independent samples but are time series.

8.15 Attention was given first to relationships between the krill variables from the two subareas. This illustrates (Figure 37) that although there is a general coherence between the acoustic density recorded in Subareas 48.1 and 48.3 this is mainly based on the simultaneous occurrence of years of low krill density in 1991 and 1994. Attention was drawn to the fact that these surveys were based on very different methodologies and may not be fully comparable.

For the relationship between krill recruitment in the two areas there is little resolution in the data as there are so few data points. There is some indication of coherence in 1995 and 1996 when recruitment was high in both subareas.

8.16 An initial examination of the krill density and recruitment values from the two areas in relation to the regional summer SST based on the derived indices does not suggest any simple relationships, although particular years are highlighted (Figure 38).

8.17 The hypothesised relationship of krill recruitment to sea-ice based on data from Subarea 48.1 was examined by plotting the proportional recruitment in Subarea 48.1 against the South Shetland sea-ice index (Figure 39). This suggests that for values of the recruitment index above about 0.3 there is an increase in the proportional recruitment as the ice index increases. Below an index value of 0.3 the data are highly variable and suggest that such values cannot be adequately resolved.

8.18 A plot of log-transformed absolute recruitment against the sea-ice index indicates that higher recruitment occurs at higher values of the index (Figure 40). This is, however, more variable than the relationship for proportional recruitment.

8.19 Plots of the recruitment against the regional sea-ice index in Subarea 48.3 do not reveal simple relationships although there are very few data available (Figures 41 and 42).

8.20 Bivariate plots of the density of krill in Subarea 48.1 and various environmental variables such as regional SST, sea-ice and the larger-scale summer SOI did not reveal any simple relationships, although particular years are identified as outliers in a number of the plots (Figures 43 to 45; see also paragraph 8.35).

8.21 In Subarea 48.3 krill density did not show a relationship with the regional SST index (Figure 46). However, there did appear to be an association between the krill density, the regional sea-ice and the large-scale summer SOI index (Figures 47 and 48; see also paragraph 8.35). These analyses emphasised the difference of the low density years of 1991 and 1994 which occurred in low ice years.

8.22 It was noted in a number of the plots that there is auto-correlation in the time series. In some this is revealed as a cyclical effect. This is illustrated in Figure 49 where the performance of the diving predators at Bird Island and the regional winter SST show a tendency to cycle together. This is not a simple direct response of the performance to the environmental variation and suggests that further examination of the underlying dynamics of some of the relationships will be valuable.

8.23 On the basis of previous hypotheses a number of plots were made of some of the predator performance indices and the krill and environmental values (Figures 50 and 51).

8.24 The performance during summer of the Bird Island diving predators (CSI) shows a relationship with the acoustic density of krill in the area with highest performance values at the highest densities (Figures 51 and 52; see also paragraph 8.32). However, this appears to be an asymptotic relationship, although again attention was drawn to the fact that the krill data were based on different surveys covering different regions.

8.25 The condition index for icefish is assumed to be primarily dependent on krill availability. Consequently, the relationship between icefish condition index and average krill density was investigated.

8.26 Data were available from Subareas 48.1 and 48.3. The mean summer icefish condition index was plotted against average acoustic krill density for the same period. Icefish data from South Shetlands and Elephant Island were used for comparison in Subarea 48.1. In

Subarea 48.3 all the krill acoustic data were from surveys on the South Georgia shelf and these were plotted against icefish data from that region. No comparable data were available for Shag Rocks or the South Orkneys.

8.27 The results are plotted in Figure 53. The correlation between icefish condition and krill density was significant ($r^2 = 0.73$, $N = 10$). The relationship appears to be linear, indicating that icefish condition index is a reasonable proxy, over a wide range of values, for average acoustic krill density.

8.28 Periods when condition index was low, and by implication krill availability low, were:

- (i) South Georgia during the summers of 1977/78, 1982/83, 1990/91 and 1993/94, and winters of 1972, 1985, 1990 and 1997;
- (ii) Shag Rocks during the summers of 1972/73, 1986/87 and winter 1997;
- (iii) South Shetlands during summer 1984/85; and
- (iv) Elephant Island during the summers of 1978/79, 1983/84, 1984/85 and 1987/88.

8.29 For South Georgia, the relationship between icefish summer and winter condition indices and the combined summer and winter performance indices (CSI) for penguins and Antarctic fur seals are shown in Figure 55 (BIG 3 PS and BIG 3 PW). Although there is good agreement in some of the bad years (e.g. summers 1990/91 and 1993/94, winters 1990 and 1997) and good years (e.g. summers 1984/85, 1988/89, 1994/95 and 1995/96 and winter 1977), the overall pattern does not show particularly high concordance.

Multivariate Relationships

8.30 The next aspect of the analyses involved the development of multiple regression models. Simple bivariate regression highlighted several potentially significant relationships between indices of the physical environment, harvested species and dependent species, some of which have been discussed above (Table 15). To investigate the relative contributions and interactions of some of the physical and biological variables in relation to both harvested and dependent species, the analysis was extended to include multiple regression models.

8.31 Some of these models explained extraordinarily high levels of variability in the dependent variables (e.g. $r^2 > 0.9$), largely because of the high level of parameterisation in relation to limited sample size. However, in some cases it was possible to show that with even a small number of variables in the model (e.g. three variables), a relatively high degree of variability in the data was explained by the model.

8.32 In particular, the CSI of the three diving predators from Bird Island in summer was influenced by krill acoustic density in Subarea 48.3 but the explained variation was increased when physical variation was included in the model (Table 15, models 1–5). When the Scotia Sea SST was present in the model together with the summer SOI, SOI was found to make the greater contribution to variation in predator performance. When sea-ice was considered in the model containing SOI and krill acoustic density (Table 15, models 38–41), sea-ice tended to reduce the importance of the relative contribution made to the explained variation by SOI.

8.33 Bird Island predator performance was weakly related to krill acoustic density in Subarea 48.1 (Table 15, model 18). Overall, Bird Island winter indices were not as closely related to krill acoustic density in the summer or to summer physical variables as the Bird Island

predator indices from the summer season (Table 15, models 1–5, cf. 6–10). However, additional analyses are required to examine the predator winter indices in relation to krill acoustic density in the previous summer period.

8.34 The summer predator indices for Subarea 48.1 (Admiralty Bay) showed little or no relationship with krill acoustic density in Subarea 48.1 (Table 15, models 11 and 16). Addition of physical variables, including local sea-ice indices, did not provide extra significant explanatory power (Table 15, models 12–15 and 17).

8.35 Acoustic density of krill in Subarea 48.3 was strongly related to the South Georgia sea-ice index and to the summer SOI (Table 15, models 42–44) but, when present in combination within models, sea-ice was the dominant physical variable affecting krill acoustic density in Subarea 48.3. There was no equivalent set of relationships when krill acoustic density in Subarea 48.1 was considered.

8.36 Overall, these results suggest that land-based predator performance in Subarea 48.3 is influenced by krill density and, independently, by physical variables which have their greatest effect through sea-ice. In contrast, land-based predator performance in Subarea 48.1 is not closely linked with the current indices of krill density or physical variability. In addition, krill density in Subarea 48.1 appears not to be closely related to local sea-ice or other physical variables.

8.37 In a situation where there are such diverse data types including environmental and biological data, a multivariate statistical approach is often adopted. A simple correlation matrix and PCA was performed on the combined table of indices. The aim was to identify any strong coherence between variables and to help clarify the key factors generating variability in the dataset. In particular, the analysis was used to examine questions of coherence between regions and relationships between krill indices and predator performance.

8.38 PCA was applied to data for sea-ice, physical variables, krill acoustic density, an icefish condition index and predator summer and winter indices in Subarea 48.3 to examine association among variables and ordering of years. This analysis has been carried out mainly for illustration. The scope of the analysis was limited due to incomplete data, since PCA can only be used when data are present for all variables (Attachment E).

8.39 The results are shown graphically in Figure 55. The first principal component, which accounted for 50% of variance in the data, is dominated by physical variables, mainly sea-ice and SST. Interestingly, SOI in summer was different because it was more closely aligned with the second axis.

8.40 The additional proportion of variation explained in the data by the second axis was 25%. Thus, the total variation due to the first two axes was 75%. The second axis was representative of the summer biological indices, SOI and krill acoustic density. However, winter biological variables were aligned more closely with the first axis and therefore were associated with the sea-ice.

8.41 Despite the limited number of years that could be included in this particular analysis the relationships among years were consistent with previous analyses that identified anomalous years in the data time series.

8.42 Additional analyses were undertaken using, for example, krill-related variables individually in order to include a larger sample of years. These and other similar analyses provided results that were broadly consistent with those shown in Figure 54.

8.43 A Canonical Correspondence Analysis (or other multivariate analytical techniques) approach is likely to be useful with such data where many of the relationships involved are not linear. Careful consideration of the development of a detailed multivariate model is required and

would take more time than was available to the subgroup. The subgroup felt that there were clear indications from the analyses carried out that such an approach might be useful. The subgroup considered that it was important to develop such an analysis in the future.

Long-term Trends

8.44 From the analyses the subgroup noted that there were some indications of longer-term change in the data. There is evidence of sub-decadal/decadal variability in the SST data from Elephant Island. There were also some indications that such variability was present at the South Orkneys but not at South Georgia. From krill density, estimated from net sampling, in Subarea 48.1 there are indications of sub-decadal/decadal variability with higher values prior to 1985 (Siegel et al., 1998). For land-based marine predators there are indications that reproductive performance in the 1980s was consistently different from the 1990s based on data for penguins (particularly Adélie) at Signy and Adélie and gentoo penguins at Admiralty Bay (paragraph 7.16; see also paragraph 7.41). There was not time at the workshop to examine this further. The subgroup considered that further investigation might be useful.

SUMMARY CONCLUSIONS

9.1 In respect of the workshop's terms of reference (paragraph 2.4) and hypotheses being addressed (paragraph 2.5), the following results were emphasised.

9.2 Environment:

- (i) Global ocean/atmosphere signals (SOI, Western Pacific SST) were evident in Area 48 (DPOI, Palmer Station air temperature, sea-ice, SST) (paragraphs 3.18 and 3.22).
- (ii) Approximately four-year periodicity was evident (SST, sea-ice, Eastern Pacific SST) which was consistent with previous studies (paragraph 3.27).
- (iii) Precession of SST anomalies across Scotia Sea was consistent with the FRAM advective transport model, suggesting transport times of four to eight months between Antarctic Peninsula and South Georgia (paragraph 3.33).
- (iv) Global ocean/atmosphere signals (SST) showed strongest coherence with South Georgia and weaker coherence with the Antarctic Peninsula and the South Orkneys, implying different local influences (such as Weddell Sea) (paragraph 3.36).
- (v) Warming trend over last seven years was apparent in the NCAR SST data only at the Antarctic Peninsula and the South Orkneys (paragraph 3.26).

9.3 Krill:

- (i) Patterns of year-to-year variation in krill density (as measured by acoustic surveys) and population demographics (as defined by R1) were similar in Antarctic Peninsula and South Georgia (paragraphs 4.5 to 4.11):

	Antarctic Peninsula	South Georgia
Low densities	1990/91	1990/91
	1993/94	1993/94
High R1	1982/83	No Data
	1987/88	No Data
	1994/95	1994/95
Low R1	1988/89	1988/89
	1989/90	1989/90
	1991/92	1991/92
	1992/93	1992/93

- (ii) Length frequency of krill in the diet of predators at South Georgia for 1991 to 1997 showed a pronounced change between two modal sizes during the course of 1991 and 1994 but not in other years (paragraph 4.18).

9.4 Dependent species:

- (i) Although the whale data were extensive in spatial and temporal coverage, the temporal overlap with other available datasets in Area 48 was restricted. Of note, minke whale abundance was highest during 1980/81 in Subarea 48.2 and 1985/86 in Subarea 48.1 (paragraphs 6.7 and 6.8).
- (ii) Most land-based predator indices showed greater coherence between species within sites than across sites (paragraph 7.16).
- (iii) Land-based predator indices in summer were coherent across subareas in ‘good’ years (1984/85, 1987/88, 1988/89, 1994/95 to 1996/97), and in ‘bad’ years (1990/91 and 1993/94), particularly 1990/91 (paragraphs 7.23 to 7.29).
- (iv) Coherence in land-based predator indices for summer across subareas was generally more evident in good than in bad years (paragraphs 7.28 and 7.29).
- (v) Winter land-based predator indices show less coherence across subareas than summer indices. When there was coherence (1990 and 1994 as ‘bad’ years, 1977, 1988 and 1989 as ‘good’ years), it was more consistently area-wide than in summer (paragraphs 7.44 to 7.47).
- (vi) There was no consistent sequence in land-based predator indices between bad winters and bad summers; that is, either can precede the other (paragraph 7.45).

9.5 Interactions:

- (i) Proportional krill recruitment above an index value of approximately 0.3 was correlated with sea-ice extent in the Antarctic Peninsula (paragraph 8.17).
- (ii) Krill density at South Georgia (Subarea 48.3) was associated with regional sea-ice and summer SOI. This particularly emphasised the low krill density and low sea-ice in 1990/91 and 1993/94 (paragraphs 8.21 and 8.35). In contrast, krill density at the Antarctic Peninsula (Subarea 48.1) was not associated with indices of physical variability (paragraphs 8.20 and 8.34).

- (iii) Land-based and pelagic predator indices in Subarea 48.3 were correlated with summer krill densities but were also influenced independently by physical variables (paragraphs 8.21, 8.24, 8.27 and 8.34). In contrast, land-based predator indices in Subarea 48.1 were not correlated with krill or physical indices (paragraphs 8.20 and 8.34).

9.6 It was agreed that the summary statements presented above offer a useful basis for the development of working hypotheses on the ecosystem dynamics of Area 48.

CLOSE OF WORKSHOP

10.1 The report of the workshop was adopted. In closing the meeting, Dr Hewitt thanked all workshop participants for their contributions.

10.2 On behalf of the participants and WG-EMM, Dr Everson thanked Dr Hewitt for his tremendous work in organising the workshop, keeping participants informed during the period leading up to the workshop, and for chairing the workshop.

10.3 Dr Miller also thanked Dr Hewitt for his efforts, and the Southwest Fisheries Science Center for hosting the workshop and providing excellent technical and logistic support. He thanked Mrs J. Leland (UK) and Dr D. Ramm (Secretariat) for their valuable support at the workshop. Dr A. Murray (UK) expressed his appreciation to the Center's computing staff.

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Table 1: Krill data available at the workshop.
 L: length-frequency data; R: recruitment indices; D: density estimates from net sampling;
 A: density estimates from acoustic surveys.

Year	Subarea		
	48.1	48.2	48.3
1977/78	L D R	L	L
1978/79			
1979/80			
1980/81	L D R A		L A
1981/82	L D R		L A
1982/83	L D R		
1983/84	L D R A	L	L
1984/85	L D R A		
1985/86	R		L
1986/87	R A		L
1987/88	L D R A	L	L
1888/89	L D R A		
1989/90	L D R A		L R A
1990/91	L D R A		L R A
1991/92	L D R A		A
1992/93	L D R		L R A
1993/94	L D R A		L R A
1994/95	L D R A		
1995/96	L D R A		L R A
1996/97	L D R A		L R A
1997/98	L D R A		L R A

Table 2: Predator index reference matrix for Antarctic fur seal (SEA), gentoo penguin (PYP), Adélie penguin (PYD), chinstrap penguin (PYN), macaroni penguin (EUC) and black-browed albatross (DIM). Each series represents presence (1) or absence (0) of data for Bird Island South Georgia (BIG), Signy Island (SIO), Admiralty Bay (ADB), Seal Island (SES) and Anvers Island (AIP), respectively. The time span over which indices integrate is divided into multi-year (MYEAR), year (YEAR), winter (WIN) and summer (SUM).

Index	Units	Code	SEA	PYP	PYD	PYN	EUC	DIM	MYEAR	YEAR	WIN	SUM
Juvenile survival	proportion	1	00000	00100	00100	00000	00000	00000	00100	00000	00000	00000
Breeding population size	absolute number	2	10000	11100	01101	01100	10000	10000	11111	00000	11111	00000
Adult survival	rate	3	00000	00100	00100	00100	00000	10000	00000	10100	00000	00000
Arrival/lay date	d before 31 Dec	4	10000	10000	00000	00000	00000	10000	00000	00000	10000	00000
Arrival mass male	g	5	00000	00000	00100	00100	10000	00000	00000	00000	10000	00000
Arrival mass female	g	6	00000	00000	00100	00100	10000	00000	00000	00000	10100	00000
Birth mass female	g	7	10000	00000	00000	00000	00000	00000	00000	00000	10100	00000
Birth mass difference (m-f)	g	8	10000	00000	00000	00000	00000	00000	00000	00000	10000	00000
'B' egg size	ml	9	00000	00100	00100	00100	00000	00000	00000	00000	00100	00000
Incubation shift duration (m+f)	d	10	00000	00000	00100	00100	00000	00000	00000	00000	00000	00100
Meal mass	g	11	00000	10100	00100	00110	10000	00000	00000	00000	00000	10110
% fish by mass	1-proportion	12	00000	10100	00101	00110	10000	00000	00000	00000	00000	10011
Frequency of occurrence fish	1-proportion	13	10000	10100	00101	00110	10000	00000	00000	00000	00000	10111
% krill by mass	proportion	14	00000	10100	00101	00110	10000	00000	00000	00000	00000	10111
Frequency of occurrence krill	proportion	15	10000	10100	00101	00110	10000	00000	00000	00000	00000	10111
Foraging trip duration	h.-1	16	10110	00000	00001	00010	00000	00000	00000	00000	00000	10011
Offspring growth female	kg.month	17	10010	00000	00000	00000	00000	00000	00000	00000	00000	10010
Offspring growth difference (m-f)	kg.month	18	10010	00000	00000	00000	00000	00000	00000	00000	00000	10010
Offspring combined growth	kg.month	19	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000
Fledge/weaning mass female	g	20	10000	00000	00000	00000	00000	00000	00000	00000	00000	10000
Fledge/weaning mass difference	g	21	10000	00000	00000	00000	00000	00000	00000	00000	00000	10000
Fledge/weaning mass combined	g	22	00000	10000	00101	00110	10000	10000	00000	00000	00000	10011
Hatching success	proportion	23	00000	00100	00100	00000	00000	10000	00000	00000	00000	10100
Fledging success	proportion	24	00000	00100	00100	00000	00000	10000	00000	00000	00000	10100
Breeding success	proportion	25	00000	11100	01101	01110	10010	10000	00000	00000	10100	11111

Table 3: Summarised predator index reference matrix, emphasising number of variables available for analysis by species, site and time scale (M: multiyear; Y: year; W: winter; S: summer). Shaded areas indicate absence of species at specific sites. Species and site abbreviations as in Table 2.

	SEA				PYP				PYD				PYN				EUC				DIM			
	M	Y	W	S	M	Y	W	S	M	Y	W	S	M	Y	W	S	M	Y	W	S	M	Y	W	S
BIG	1		2	8	1		1	7									1		2	9	1	1	1	4
SIO					1			1	1			1	1			1								
ADB					1	1	2	8	2	1	2	9	1	1	2	7								
SES				3												8				1				
AIP									1			7												

Table 4: Summary of predator indices, indicating years for which data are available (x). Species and site abbreviations and variables (var) as in Table 2. Years are designated by that in which the summer ends; i.e. 76 refers to the 1975/76 summer.

Site	Species	Var	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98
ADB	PYN	10								x		x	x	x	x										
ADB	PYN	11			x				x	x					x	x		x						x	x
ADB	PYN	13			x				x	x					x	x		x						x	x
ADB	PYN	14			x				x	x					x	x		x						x	x
ADB	PYN	22													x									x	x
ADB	PYN	25																	x	x	x	x	x	x	x
ADB	PYP	11			x				x	x						x	x	x						x	x
ADB	PYP	12			x				x	x						x	x	x						x	x
ADB	PYP	13			x				x	x						x	x	x						x	x
ADB	PYP	14			x				x	x						x	x	x						x	x
ADB	PYP	15			x				x	x						x	x	x						x	x
ADB	PYP	22																							x
ADB	PYP	23			x				x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
ADB	PYP	24			x				x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
ADB	PYP	25			x				x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
ADB	PYD	10							x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x
ADB	PYD	11			x				x	x					x	x	x	x						x	x

Table 5: Summary of predator indices (code number in parentheses; see Table 2 for definitions), showing potential groupings at the process level and in relationship to temporal scale.

Index	Index Group	Temporal Scale Group
Juvenile survival (1) Population size (2) Adult survival (3) Arrival/laying date (4) Arrival/laying mass (5–6) Birth/egg mass (7–9) Incubation shift (10) Meal mass (11) % Fish (12, 13) % Krill (14, 15) Growth rates (17–19) Wean/fledge mass (20–22) Hatch success (23) Fledge success (24) Breeding success (25)	Arrival (4–9) Diet (11–15) Foraging (11–16) Foraging trip (16) Growth (17–22) Productivity (23–25)	Multi-year Multi-year (also winter) Year Winter (4–9) Summer (10–25)

Table 6: Potential composite indices of predator performance.

- I_2 breeding population size;
- I_{11} meal mass;
- I_{14} % krill by mass;
- I_{16} foraging trip duration;
- I_{20} weaning mass, female;
- I_{21} weaning mass, difference (m-f);
- I_{22} fledging mass;
- I_{24} fledging success (chicks reared per egg hatched); and
- I_{25} breeding success (pup survival).

Composite Index	Formula
Yield per offspring	$B_1 \text{ Birds} = I_{24} \cdot I_{22}$
Total yield	$B_1 \text{ Seals} = I_{25} \cdot$ where $= (2 \cdot I_{20} + I_{21})/2$
	$B_2 \text{ Birds} = B_1 \text{ Birds} \cdot I_2$
	$B_2 \text{ Seals} = B_1 \text{ Seals} \cdot I_2$
Krill availability	$A_k = I_{11} \cdot I_{14}$
Provisioning index	$P\text{Birds} = (-1) \cdot (I_{11}/I_{16})$
	$P\text{Seals} = (-1) \cdot (/I_{16}) = (-1) \cdot (B_1 \text{ Seals}/I_{25})/I_{16}$

Table 7: Years of poor reproductive performance, based on combined summer index, for land-based marine predators in Area 48 (see Figures 23 to 27 for data). Site and species abbreviations as in Table 2. Years are designated by that in which the summer ends; i.e. 76 refers to the 1975/76 summer.

	Start													
Bird Island (BIG)														
DIM	76	78*		80		84*		87	88		91		94 95	98
EUC	77	78	79			84		87*	88*		91*		94	
PYP	77	78			82	84*		87*		90*	91		94	98
SEA	79		79			84					91		94	98
Signy Island (SIO)														
PYD	80							strong positive trend across series						
PYN	79			81		84				90			94	
PYP	80		79*	80	81	84*		87*		90			94	
Admiralty Bay (ADB)														
PYD	78									90	91	93*	positive trend after '93	
PYN	78				82	83*	85	86*		90*			97*	
PYP	78				82	83		87			91		positive trend after '91	
Seal Island (SES)														
PYN	88										91		94	
Anvers Island (AIP)														
PYD	90									90	91			96*

* Weak effect

Table 8: Matrices of correlation coefficients and associated probabilities for summer combined index for land-based marine predators for all species at each site for 1975/76 to 1997/98. Site and species abbreviations as in Table 2. Values significant at $P < 0.05$ are highlighted and in white; values significant at $0.05 > P > 0.10$ are also highlighted.

Correlation coefficients													
	ADBPYD	ADBPYN	ADBPYP	AIPPYD	BIGDIM	BIGEUC	BIGPYP	BIGSEA	SESPYN	SESSEA	SIOPYD	SIOPYN	SIOPYP
ADBPYD	1.000												
ADBPYN	-0.118	1.000											
ADBPYP	0.267	0.218	1.000										
AIPPYD	0.44	0.609	0.621	1.000									
BIGDIM	0.229	-0.594	0.044	0.063	1.000								
BIGEUC	-0.029	-0.428	0.136	0.167	0.406	1.000							
BIGPYP	0.02	-0.092	0.132	0.372	0.33	0.576	1.000						
BIGSEA	0.099	-0.309	-0.048	0.432	0.383	0.788	0.768	1.000					
SESPYN	0.416	-0.47	0.069	0.277	0.299	0.419	0.897	0.788	1.000				
SEASEA	0.517	-0.143	-0.282	0.689	-0.066	-0.213	0.45	0.299	0.689	1.000			
SIOPYD	-0.127	0.259	0.637	0.042	-0.065	0	0.215	0.213	0.451	0.263	1.000		
SIOPYN	0.276	-0.022	-0.037	0.433	0.357	0.091	0.321	0.365	0.494	0.625	0.267	1.000	
SIOPYP	-0.146	-0.247	-0.209	0.104	0.242	0.264	0.144	0.36	0.14	0.216	0.13	0.788	1.000

Correlation probabilities													
	ADBPYD	ADBPYN	ADBPYP	AIPPYD	BIGDIM	BIGEUC	BIGPYP	BIGSEA	SESPYN	SESSEA	SIOPYD	SIOPYN	SIOPYP
ADBPYN	0.652												
ADBPYP	0.301	0.401											
AIPPYD	0.275	0.109	0.1										
BIGDIM	0.378	0.012	0.866	0.883									
BIGEUC	0.913	0.086	0.603	0.693	0.061								
BIGPYP	0.938	0.725	0.614	0.364	0.144	0.006							
BIGSEA	0.726	0.262	0.865	0.286	0.117	0	0						
SESPYN	0.232	0.171	0.851	0.506	0.401	0.228	0	0.007					
SEASEA	0.189	0.735	0.499	0.13	0.877	0.612	0.263	0.473	0.059				
SIOPYD	0.651	0.352	0.011	0.921	0.797	1	0.408	0.429	0.191	0.53			
SIOPYN	0.32	0.938	0.895	0.283	0.133	0.711	0.194	0.15	0.147	0.098	0.283		
SIOPYP	0.604	0.374	0.454	0.806	0.333	0.291	0.58	0.171	0.7	0.607	0.608	0	

Table 9: Years of poor reproductive performance, based on combined summer index across species within sites, for land-based marine predators in Area 48 (see Figure 30 for data). Site and species abbreviations as in Table 2. Years are designated by that in which the summer ends; i.e. 78 refers to the 1977/78 summer.

	Start															
Bird Island (BIG)																
DIM	78		80		83*	84		87	88		91	92*	94*	95		98*
Penguins (PYP, EUC)/Seal	78	79				84					91	92*	94			98
Signy Island (SIO)																
Penguins (PYP, PYD, PYN)			80	81		84				90			94			
Seal Island (SES)																
Penguin (PYN)/Seal											91		94			
Admiralty Bay (ADB)																
Penguins (PYP, PYD, PYN)					82	83				90	91	(positive trend after '91)				
Anvers Island (AIP)																
Penguin (PYD)†										90	91					96*

* Weak effect

† See Figure 27 for data

Table 10: Correlation matrices of breeding success for land-based marine predators, from 1981/82 to 1997/98, without and with imputation of missing values.

Correlation matrix % breeding success for 1981/82, 1985/86–1997/98 (Signy to 1996/97) – no imputation										
	ADBPYDb	ADBPYNb	ADBPYPb	BIGDIMb	BIGEUCb	BIGPYPb	BIGSEAb	SIOPYDb	SIOPYNb	SIOPYPb
ADBPYDb	1.00									
ADBPYNb	0.08	1.00								
ADBPYPb	0.54	-0.04	1.00							
BIGDIMb	0.11	-0.35	0.17	1.00						
BIGEUCb	-0.44	-0.11	-0.15	0.13	1.00					
BIGPYPb	-0.08	0.25	0.22	0.33	-0.21	1.00				
BIGSEAb	-0.16	-0.02	0.16	0.37	-0.19	0.71	1.00			
SIOPYDb	-0.12	0.05	0.47	-0.05	-0.03	0.45	0.31	1.00		
SIOPYNb	0.03	-0.19	-0.05	0.09	-0.24	0.40	0.37	-0.08	1.00	
SIOPYPb	-0.38	-0.25	-0.21	0.11	0.20	0.07	0.40	-0.15	0.67	1.00

Correlation matrix % breeding success for 1981/82–1997/98 (Signy to 1996/97) – imputation by long term means										
	ADBPYDb	ADBPYNb	ADBPYPb	BIGDIMb	BIGEUCb	BIGPYPb	BIGSEAb	SIOPYDb	SIOPYNb	SIOPYPb
ADBPYDb	1.00									
ADBPYNb	0.18	1.00								
ADBPYPb	0.55	0.04	1.00							
BIGDIMb	0.04	-0.41	0.12	1.00						
BIGEUCb	-0.28	-0.06	-0.09	0.25	1.00					
BIGPYPb	-0.11	0.16	0.20	0.36	-0.05	1.00				
BIGSEAb	-0.14	0.00	0.16	0.39	0.14	0.70	1.00			
SIOPYDb	-0.03	0.26	0.45	-0.08	0.18	0.39	0.37	1.00		
SIOPYNb	0.04	-0.07	-0.04	0.15	0.24	0.41	0.48	0.11	1.00	
SIOPYPb	-0.35	-0.15	-0.20	0.14	0.31	0.10	0.45	-0.03	0.69	1.00

Table 11: Matrices of correlation coefficients and associated probabilities for winter combined index for land-based marine predators for all species at each site from 1976 to 1998. Site and species abbreviations as in Table 2. Values significant at $P < 0.05$ are highlighted and in white; values significant at $0.05 > P < 0.10$ are also highlighted.

Correlation coefficients											
	ADBPYD	ADBPYN	ADBPYP	AIPPYD	BIGDIM	BIGEUC	BIGPYP	BIGSEA	SIOPYD	SIOPYN	SIOPYP
ADBPYD	1.000										
ADBPYN	0.268	1.000									
ADBPYP	0.217	0.625	1.000								
AIPPYD	-0.085	0.129	0.749	1.000							
BIGDIM	0.359	0.283	0.154	-0.891	1.000						
BIGEUC	0.315	0.554	0.116	0.885	0.634	1.000					
BIGPYP	0.116	0.286	-0.35	0.028	0.326	0.3	1.000				
BIGSEA	0.278	0.595	0.219	-0.135	0.396	0.423	0.419	1.000			
SIOPYD	0.319	-0.188	-0.05	-0.11	0.078	0.051	0.54	0.69	1.000		
SIOPYN	0.235	0.274	0.127	0.808	0.246	0.687	0.489	0.486	0.263	1.000	
SIOPYP	-0.217	-0.652	-0.227	-0.952	-0.372	-0.629	0.18	0.256	0.406	-0.359	1.000

Correlation probabilities										
	ADPYD	ADBPYN	ADBPYP	AIPPYD	BIGDIM	BIGEUC	BIGPYP	BIGSEA	SIOPYD	SIOPYN
ADBPYN	0.426									
ADBPYP	0.359	0.04								
AIPPYD	0.873	0.808	0.087							
BIGDIM	0.11	0.4	0.517	0.017						
BIGEUC	0.164	0.077	0.628	0.019	0.002					
BIGPYP	0.627	0.424	0.142	0.958	0.149	0.187				
BIGSEA	0.265	0.07	0.399	0.798	0.104	0.081	0.095			
SIOPYD	0.184	0.603	0.843	0.836	0.75	0.836	0.021	0.002		
SIOPYN	0.332	0.444	0.617	0.052	0.31	0.001	0.039	0.048	0.276	
SIOPYP	0.373	0.041	0.366	0.003	0.117	0.004	0.474	0.321	0.084	0.131

Table 12: Years of poor predator performance, based on combined winter index across species within sites, for land-based marine predators in Area 48 (see Figure 34 for data). Site and species abbreviations as in Table 2.

	Start								
South Georgia (BIG)									
DIM	75		80			91			97
Penguins (PYP, EUC)/Seal	76	78	80*	84		90		94	97
Signy Island (SIO)									
Penguins (PYP, PYN)	77		80	84*		90		94	
Penguin (PYD)	77	78				90		94	
Admiralty Bay (ADB)									
Penguins (PYP, PYN)	77		80		85	90		94	97
Penguin (PYD)	77		79	82			91	94	96

* Weak effect

Table 13: Correlation matrices for population change between successive years for land-based marine predators from 1986 to 1998 (without imputed values) and 1980 to 1998 (with imputed values) (see paragraph 7.39). Site and species abbreviations as in Table 2.

Correlation matrix delta population as % of 1986–1998 (Signy to 1997) no imputation										
	ADBPYDdp	ADBPYNdp	ADBPYPdp	BIGDIMdp	BIGEUCdp	BIGPYPdp	BIGSEAdp	SIOPYDdp	SIOPYNdp	SIOPYPdp
ADBPYDdp	1.00									
ADBPYNdp	0.36	1.00								
ADBPYPdp	-0.10	0.25	1.00							
BIGDIMdp	0.34	0.00	0.36	1.00						
BIGEUCdp	0.37	0.61	0.06	-0.10	1.00					
BIGPYPdp	0.41	0.67	-0.08	-0.13	0.86	1.00				
BIGSEAdp	0.34	0.46	0.08	0.06	0.42	0.53	1.00			
SIOPYDdp	0.52	0.41	0.16	0.00	0.68	0.69	0.70	1.00		
SIOPYNdp	0.29	0.43	0.24	0.04	0.83	0.81	0.71	0.75	1.00	
SIOPYPdp	0.29	0.57	0.13	0.11	0.19	0.41	0.60	0.42	0.35	1.00

Correlation matrix delta population as % for 1980–1998 (Signy and Bird Island seals to 1997) – imputation of population sizes by linear interpolation										
	ADBPYDdp	ADBPYNdp	ADBPYPdp	BIGDIMdp	BIGEUCdp	BIGPYPdp	BIGSEAdp	SIOPYDdp	SIOPYNdp	SIOPYPdp
ADBPYDdp	1.00									
ADBPYNdp	0.39	1.00								
ADBPYPdp	-0.06	0.49	1.00							
BIGDIMdp	0.30	0.02	0.00	1.00						
BIGEUCdp	0.36	0.37	0.09	0.23	1.00					
BIGPYPdp	0.01	-0.08	0.06	-0.29	0.34	1.00				
BIGSEAdp	0.24	0.35	0.04	0.14	0.43	0.24	1.00			
SIOPYDdp	0.35	0.30	0.19	-0.02	0.51	0.61	0.62	1.00		
SIOPYNdp	0.25	0.44	0.28	0.19	0.68	0.53	0.64	0.72	1.00	
SIOPYPdp	0.36	0.54	-0.02	0.08	0.14	-0.08	0.45	0.22	0.14	1.00

Table 14: The set of regression analyses carried out on summary data for Area 48. The abbreviations are referred to in Table 15.

REGRESSION MODEL				r ²	P
Dependent Variable	Independent Variable				
I. Effects of acoustic density of krill, Scotia Sea SST and SOI					
Predators, Subarea 48.3 (summer)					
1.	BIG3ps	acd483		0.324	0.086
2.	BIG3ps	acd483	ssssts	0.630	0.083
3.	BIG3ps	acd483	ssssts sois soiw	0.970	0.060
4.	BIG3ps	acd483	ssssts sois	0.950	0.004
5.	BIG3ps	acd483	sssstw	0.644	0.075
Predators, Subarea 48.3 (winter)					
6.	BIG3pw	acd483		0.002	0.971
7.	BIG3pw	acd483	ssssts	0.575	0.117
8.	BIG3pw	acd483	ssssts sois soiw	0.822	0.325
9.	BIG3pw	acd483	ssssts sois	0.707	0.103
10.	BIG3pw	acd483	sssstw	0.481	0.194
Predators, Subarea 48.1 (summer)					
11.	ADB3ps	acd483		0.161	0.284
12.	ADB3ps	acd483	ssssts	0.025	0.938
13.	ADB3ps	acd483	ssssts sois soiw	0.216	0.953
14.	ADB3ps	acd483	ssssts sois	0.096	0.930
15.	ADB3ps	acd483	sssstw	0.024	0.940
Predators, Subarea 48.1 (winter)					
16.	ADB3pw	acd483		0.115	0.338
17.	ADB3pw	acd483	ssssts	0.025	0.938
Predators, Subarea 48.3 (summer)					
18.	BIG3ps	acd481		0.278	0.05
19.	BIG3ps	acd481	ssssts	0.362	0.132
20.	BIG3ps	acd481	ssssts sois soiw	0.540	0.306
21.	BIG3ps	acd481	ssssts sois	0.383	0.253
22.	BIG3ps	acd481	sssstw	0.364	0.130
Predators, Subarea 48.3 (winter)					
23.	BIG3pw	acd481		0.002	0.871
24.	BIG3pw	acd481	ssssts	0.082	0.679
25.	BIG3pw	acd481	ssssts sois soiw	0.246	0.744
26.	BIG3pw	acd481	ssssts sois	0.086	0.875
27.	BIG3pw	acd481	sssstw	0.411	0.093
Predators, Subarea 48.3 (summer)					
28.	ADB3ps	acd481	ssssts	0.118	0.613
29.	ADB3ps	acd481	ssssts sois soiw	0.176	0.887
30.	ADB3ps	acd481	ssssts sois	0.174	0.698
31.	ADB3ps	acd481	sssstw	0.255	0.030
Predators, Subarea 48.1 (winter)					
32.	ADB3pw	acd481		0.002	0.890
33.	ADB3pw	acd481	ssssts	0.023	0.897
II. Effects of sea-ice and SOI					
Predators					
34.	ADB3ps	sshetic		0.001	0.896
35.	ADB3pw	sshetic		0.078	0.247
36.	ADB3ps	icexadb		0.123	0.182

Table 14 (continued)

REGRESSION MODEL			r^2	P	
Dependent Variable	Independent Variable				
37.	ADB3ps	ice481	0.060	0.359	
38.	BIG3ps	sgice	0.319	0.089	
39.	BIG3ps	sgice soiw	0.885	0.004	
40.	BIG3ps	acd483 sgice soiw	0.976	0.035	Small sample
41.	BIG3ps	sgice lagged-soiw	0.816	0.034	
Krill, Subarea 48.3					
42.	acd483	sgice	0.675	0.012	
43.	acd483	sgice soiw	0.718	0.150	
44.	acd483	sois	0.589	0.016	
100 m temperature, Subarea 48.1					
45.	t100m	sssstw	0.093	0.424	
46.	t100m	eisstw sssstw soiw	0.681	0.169	Small sample

Table 15: Variables used in analyses of interactions (Table 14 and Figures 37–55).

Category	Code	Description	Number of Years	Earliest Year	Last Year
predator	BIG3ps	summer CSI (SEA, EUC, PYP)	22	77/78	97/98
predator	BIG3pw	winter CSI (SEA, EUC, PYP)	22	77	97
predator	BIGEUCb	breeding success	22	76/77	97/98
predator	BIGEUCdp	% population change from previous year	21	77/78	97/98
predator	BIGPYPb	breeding success	21	76/77	97/98
predator	BIGPYPdp	% population change from previous year	21	77/78	97/98
predator	BIGSEAb	breeding success	18	78/79	97/98
predator	BIGSEAdp	% population change from previous year	19	79/80	97/98
predator	ADB2pw	winter CSI (PYN, PYP)	21	77	97
predator	ADBPYDdw	winter CSI	21	77	97
predator	ADB3ps	summer CSI (PYD, PYN, PYP)	17	77/78	97/98
predator	ADBPYDdp	% population change from previous year	20	78/79	97/98
predator	ADBPYNdp	% population change from previous year	20	78/79	97/98
predator	ADBPYPdp	% population change from previous year	20	78/79	97/98
predator	ADBPYDb	breeding success	17	77/78	97/98
predator	ADBPYNb	breeding success	17	77/78	97/98
predator	ADBPYPb	breeding success	17	77/78	97/98
predator	SIO2pw	winter CSI (PYN, PYP)	21	77	97
predator	SIOPYDw	winter CSI	21	77	97
predator	SIOalls	summer CSI (PYD, PYN, PYP)	19	78/79	96/97
predator	SIOPYNb	breeding success	19	78/79	96/97
predator	SIOPYNdp	% population change from previous year	18	79/80	96/97
predator	SIOPYDb	breeding success	18	79/80	96/97
predator	SIOPYDdp	% population change from previous year	18	79/80	96/97
predator	SIOPYPb	breeding success	18	79/80	96/97
predator	SIOPYPdp	% population change from previous year	18	79/80	96/97
icefish	SGifS	South Georgia icefish condition index for summer	14	75/76	96/97
icefish	SGifW	South Georgia icefish condition index for winter	8	77	97
krill	pr481	proportional recruitment (R1) Subarea 48.1	17	79/80	96/97
krill	ar481	absolute recruitment (R1) Subarea 48.1	16	79/80	96/97

Table 15 (continued)

Category	Code	Description	Number of Years	Earliest Year	Last Year
krill	netdn481	krill density from nets Subarea 48.1	16	80/81	97/98
krill	acden481	krill density from acoustics Subarea 48.1	14	80/81	97/98
krill	acden483	krill density from acoustics Subarea 48.3	10	80/81	97/98
krill	ar483	absolute recruitment (R1) Subarea 48.3	7	88/89	96/97
krill	pr483	proportional recruitment (R1) Subarea 48.3	7	88/89	96/97
physical	sois	Southern Oscillation Index – summer	22	75/76	96/97
physical	soiw	Southern Oscillation Index – winter	21	75	96
physical	ssssts	Scotia Sea NCAR SST – summer	16	81/82	96/97
physical	sssstw	Scotia Sea NCAR SST – winter	16	81	96
physical	IcexADB	Stranger Point proportion of year ice free (CEMP F2b)	19	79	97
physical	IcexAIP	Anvers Island proportion of year ice free (CEMP F2b)	19	79	97
physical	IcexSES	Seal Island proportion of year ice free (CEMP F2b)	19	79	97
physical	IcexSIO	Signy Island proportion of year ice free (CEMP F2b)	18	79	96
physical	IcewADB	Stranger Point weeks with sea-ice within 100km (CEMP F2c)	19	79	97
physical	IcewAIP	Anvers Island weeks with sea-ice within 100km (CEMP F2c)	19	79	97
physical	IcewSES	Seal Island weeks with sea-ice within 100km (CEMP F2c)	19	79	97
physical	IcewSIO	Signy Island weeks with sea-ice within 100km (CEMP F2c)	19	79	97
physical	Ice481	Subarea 48.1 September sea-ice cover (%) (CEMP F2a)	19	79	97
physical	Ice482	Subarea 48.2 September sea-ice cover (%) (CEMP F2a)	19	79	97
physical	Ice483	Subarea 48.3 September sea-ice cover (%) (CEMP F2a)	19	79	97
physical	SShetice	normalised South Shetlands sea-ice extent – annual	19	79	97
physical	ScSeaice	normalised Scotia Sea sea-ice extent – annual	10	88	97
physical	SGice	normalised South Georgia sea-ice extent – annual	10	88	97
physical	SOrkice	normalised South Orkney Island sea-ice extent – annual	10	88	97

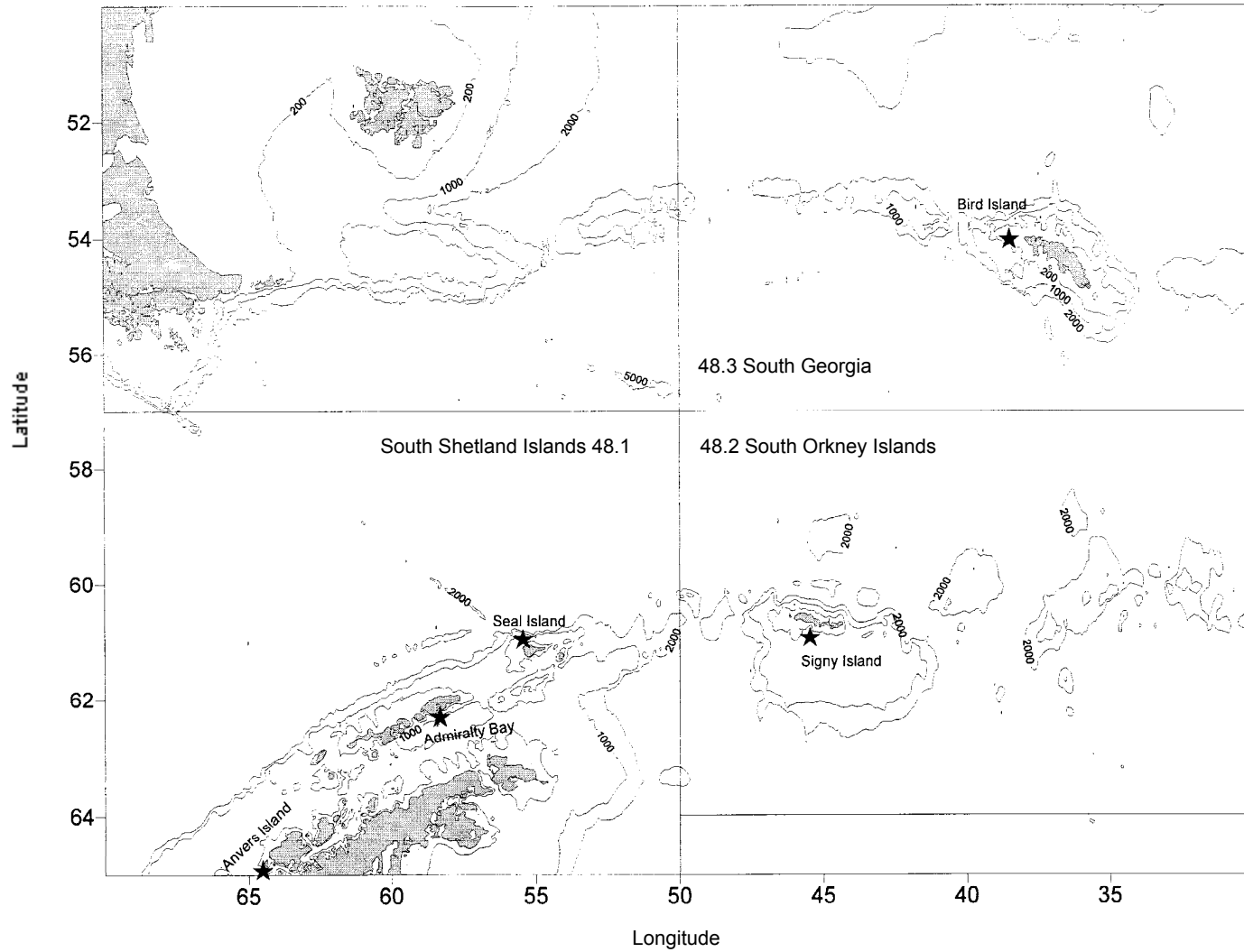


Figure 1: Map of the three statistical areas (Subareas 48.1, 48.2 and 48.3) examined during the workshop. Surveys were generally conducted in waters adjacent to South Georgia and the South Shetland Islands, and most of the data on predators were collected at Admiralty Bay, Anvers Island, Bird Island, Seal Island and Signy Island.

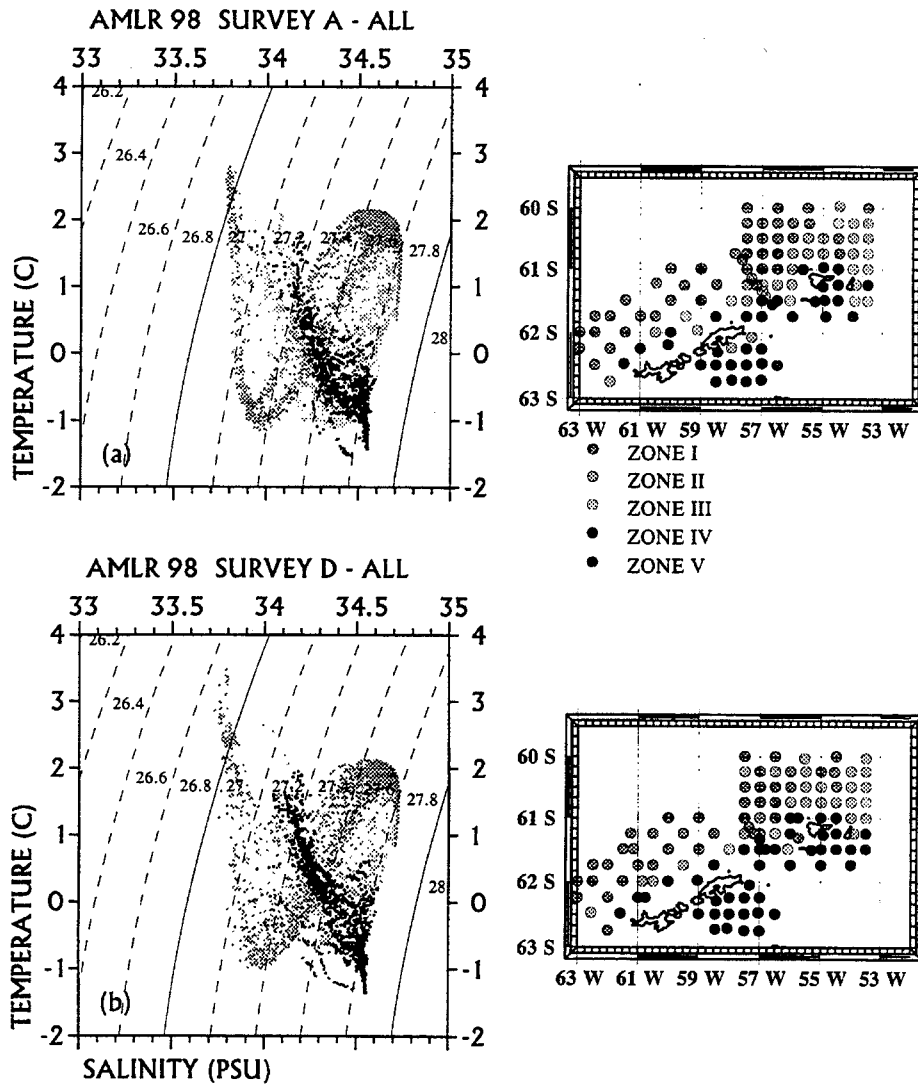


Figure 2: Typical AMLR CTD temperature and salinity diagram and station grid for all stations from the area: (a) Leg I (January/February); (b) Leg II (February/March). Symbols on inset maps show station locations shaded by zones of similar temperature and salinity characteristics.

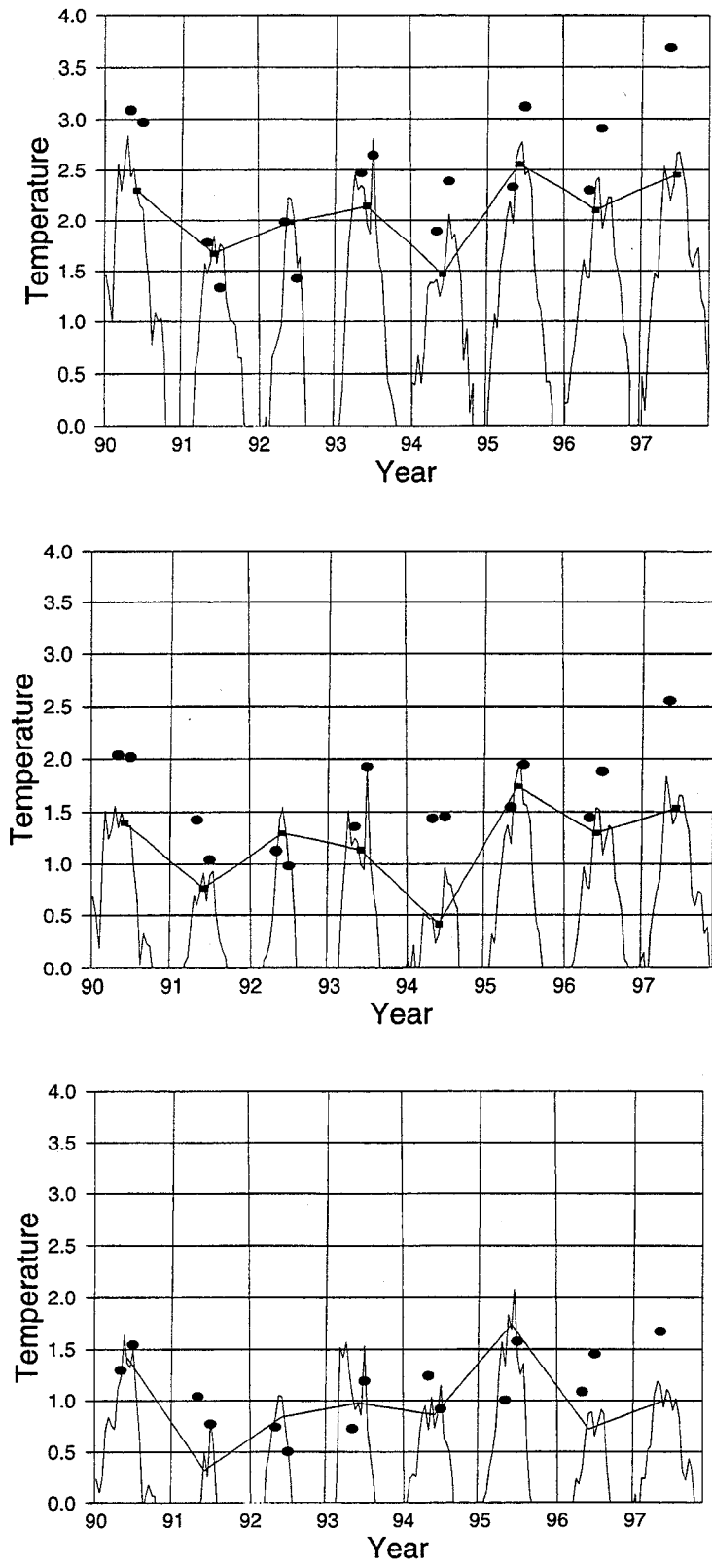


Figure 3: Comparison of AMLR CTD surface (4 m) temperatures with NCAR SST. Weekly NCAR SST data for December through to April and monthly NCAR SST data for February are shown. Average values for both the AMLR cruises carried out each year are shown (one cruise only in 1998). Years are identified by the CCAMR split-year designation. (a) Elephant Island EI1 ($60^{\circ}30'$, $56^{\circ}30'W$); (b) Elephant Island EI2 ($61^{\circ}30'S$, $56^{\circ}30'W$); (c) Elephant Island EI3 ($61^{\circ}30'S$, $54^{\circ}30'W$).

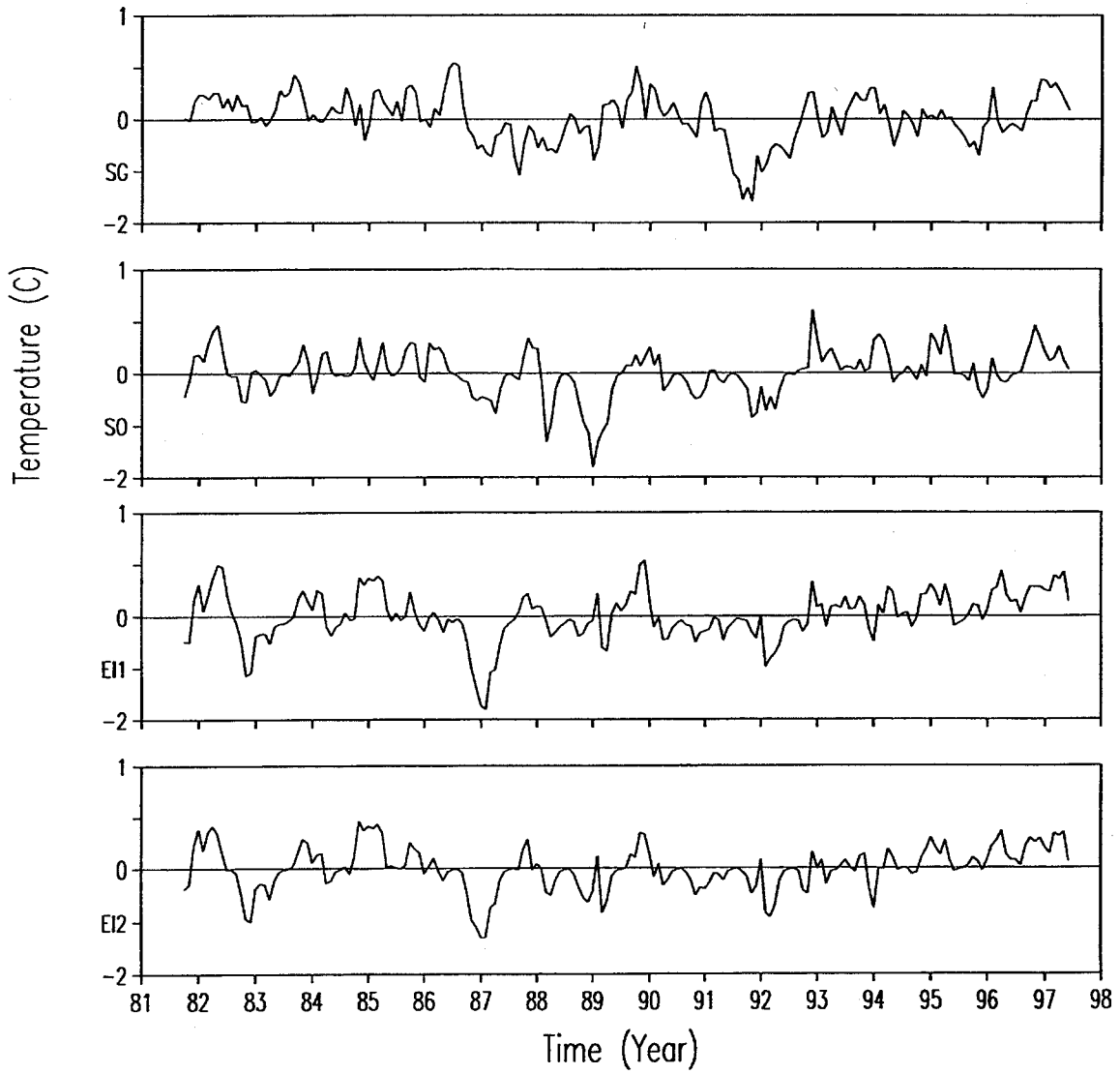


Figure 4: Time series plots for selected NCAR SST monthly time series: (a) South Georgia ($54^{\circ}30'S$, $34^{\circ}30'W$); (b) South Orkneys ($60^{\circ}30'S$, $47^{\circ}30'W$); (c) Elephant Island EI1 ($60^{\circ}30'S$, $56^{\circ}30'W$); (d) Elephant Island EI2 ($61^{\circ}30'S$, $56^{\circ}30'W$).

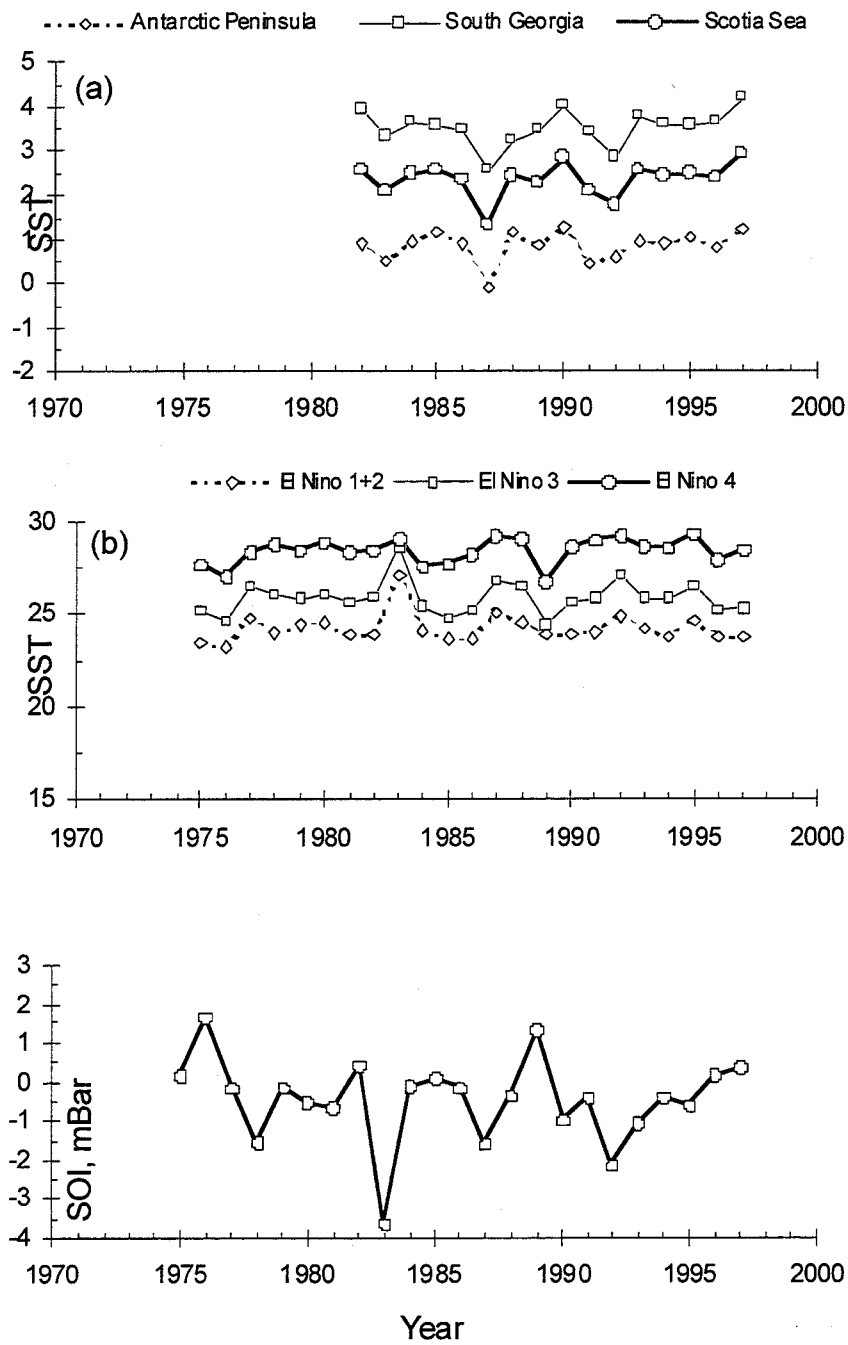


Figure 5: Annual summer index plots: (a) NCAR SST at the Antarctic Peninsula, South Georgia and the Scotia Sea; (b) sea-surface temperature for El Niño 1+2, El Niño 3 and El Niño 4; (c) SOI.

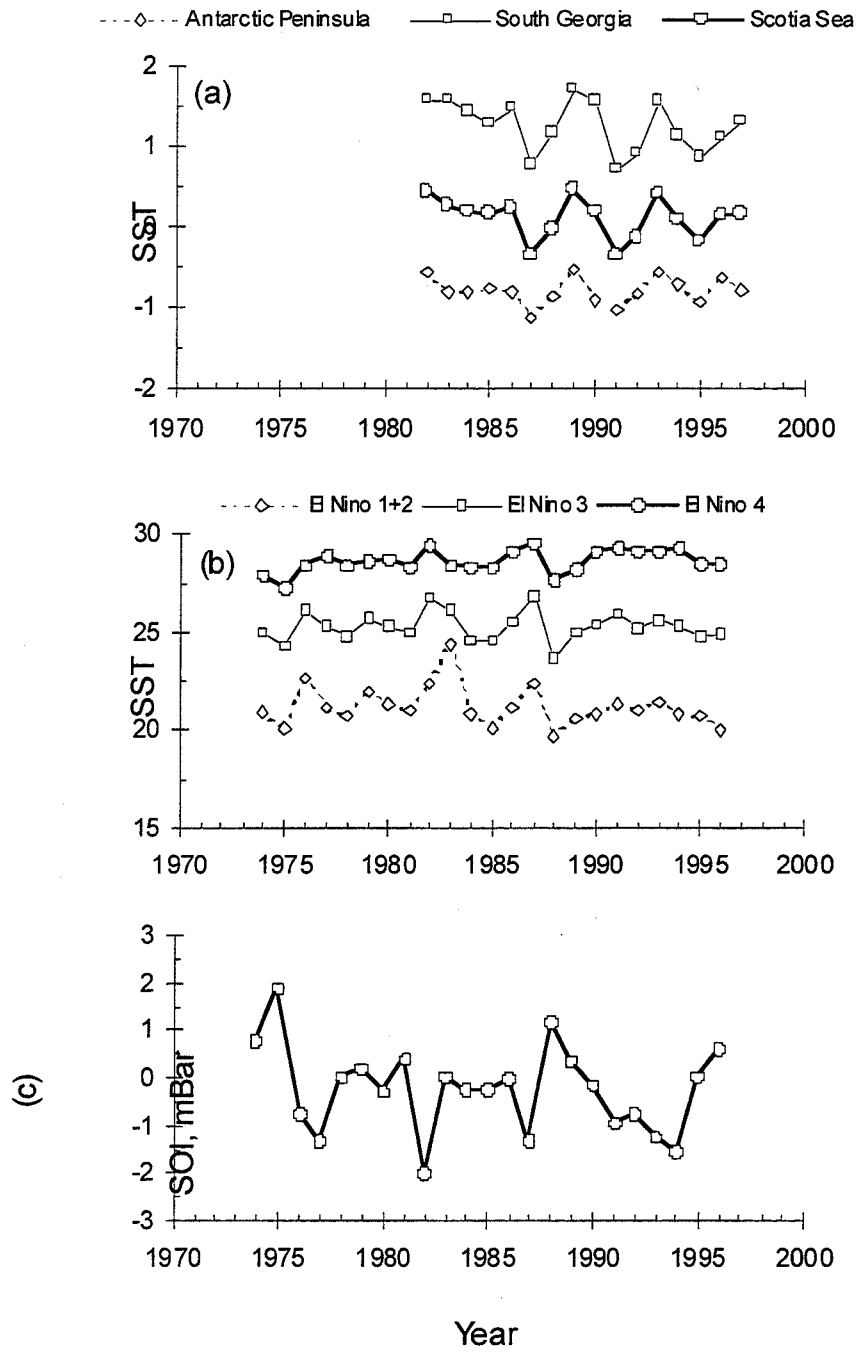


Figure 6: Annual winter index plots: (a) NCAR SST at the Antarctic Peninsula, South Georgia and the Scotia Sea; (b) sea-surface temperature for El Niño 1+2, El Niño 3 and El Niño 4; (c) SOI.

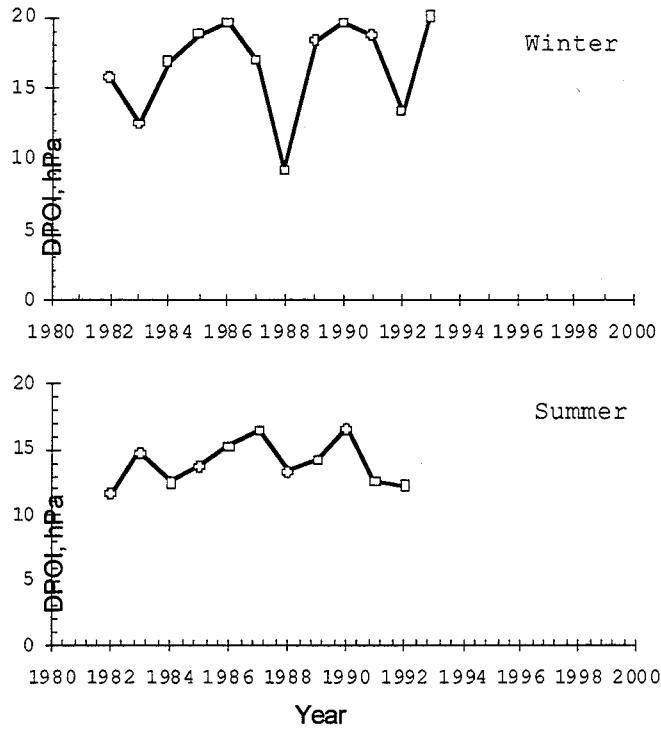


Figure 7: Annual index plots for DPOI: (a) winter; (b) summer.

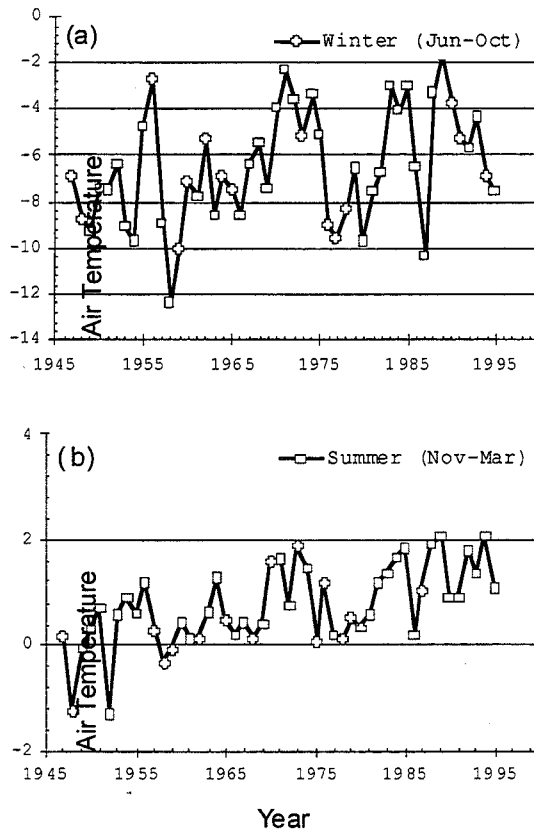


Figure 8: Annual index plots for Palmer Station air temperatures: (a) winter; (b) summer.

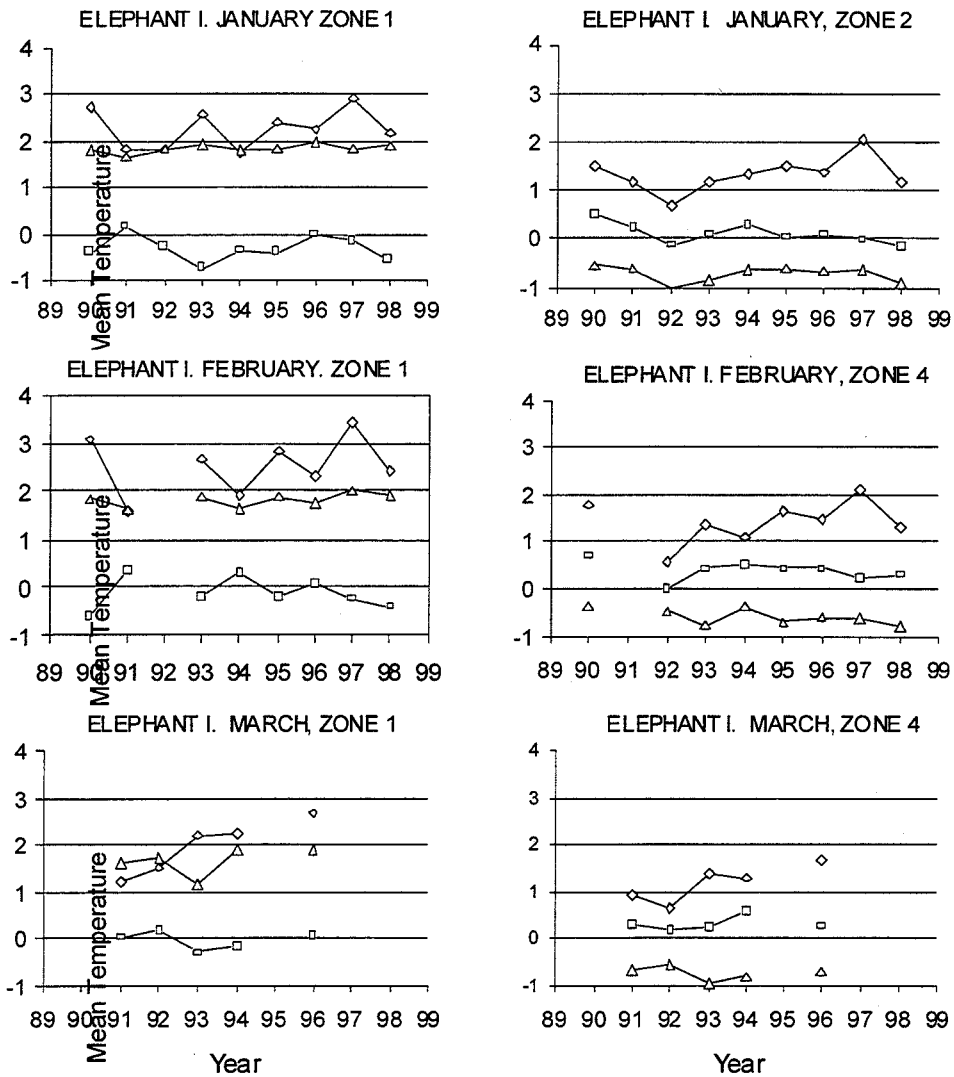


Figure 9: Sea temperature at 4 m (\diamond), 100 m (\square) and 500 m (Δ) in the Elephant Island area from 1990 to 1998. Zones of similar temperature and salinity characteristics (see Figure 2) are compared for January, February and March. Data from AMLR CTD stations in Zone 1 (Drake Passage) and Zone 4 (Bransfield Strait).

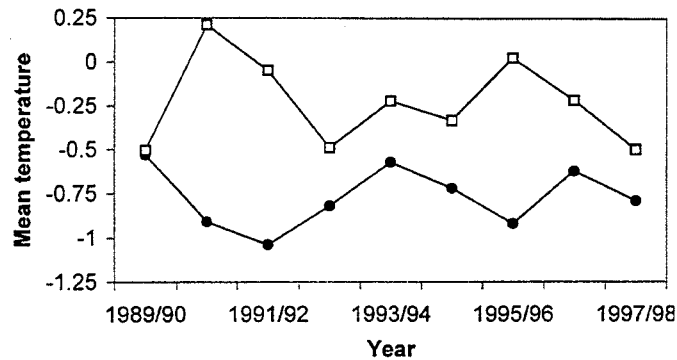


Figure 10: Temperature at 100 m (\square) in the Drake Passage winter water from AMLR CTD data compared to NCAR winter SST (\bullet) in the Antarctic Peninsula Area.

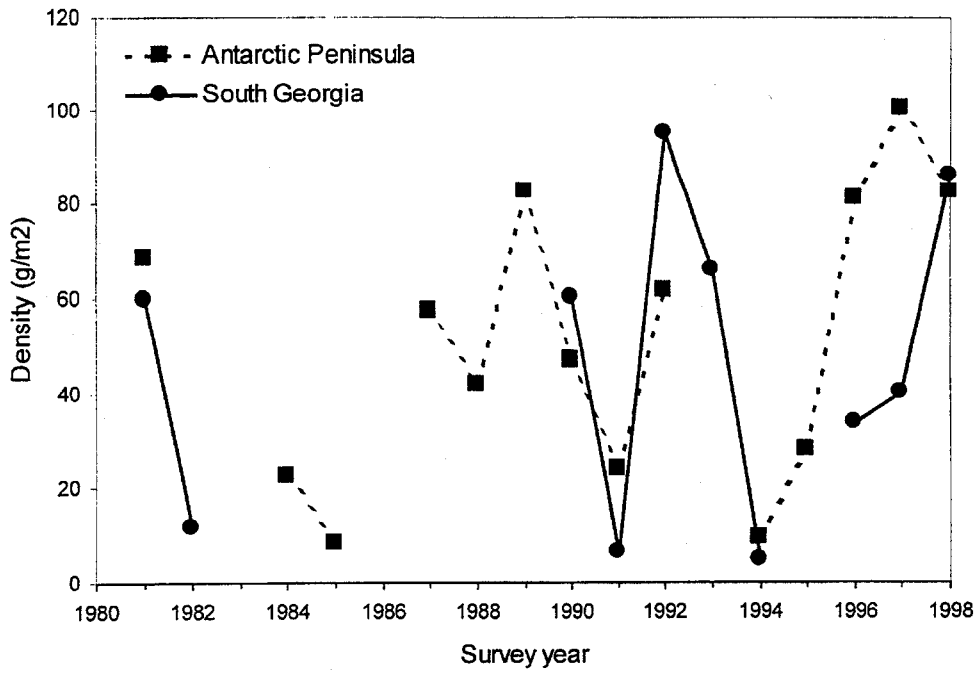


Figure 11: Interannual changes in acoustic krill density estimates for Subareas 48.1 and 48.3.

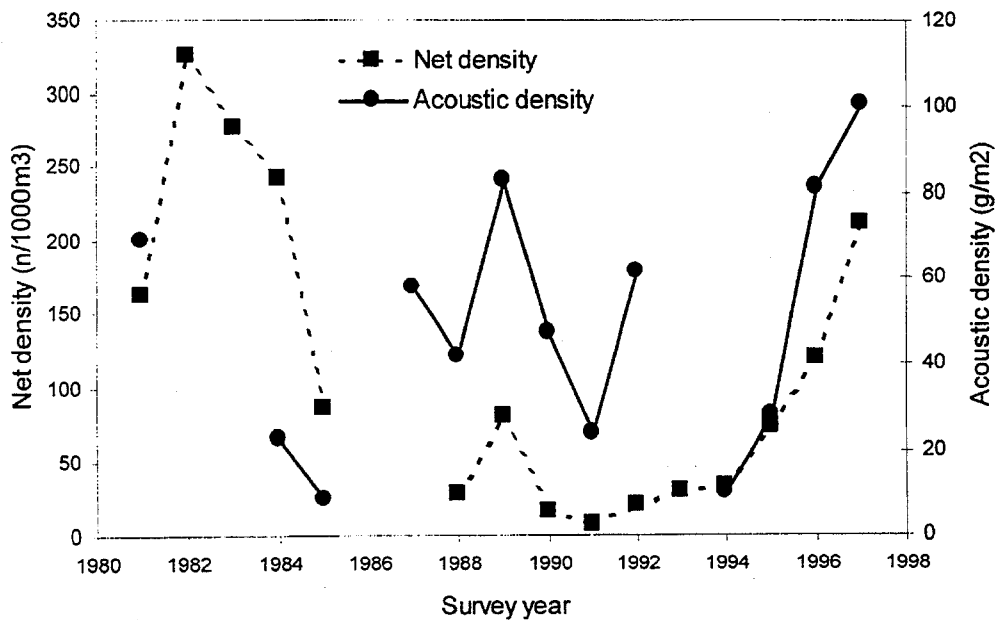


Figure 12: Interannual changes in net and acoustic estimates of krill density in Subarea 48.1.

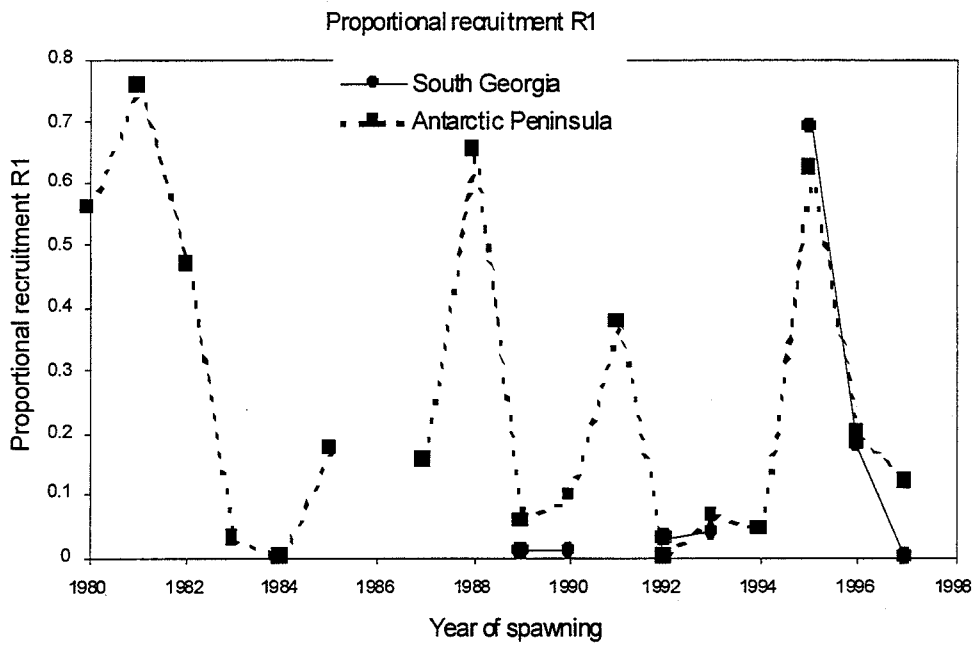


Figure 13: Interannual changes in proportional krill recruitment index (R1) in Subareas 48.1 and 48.3.

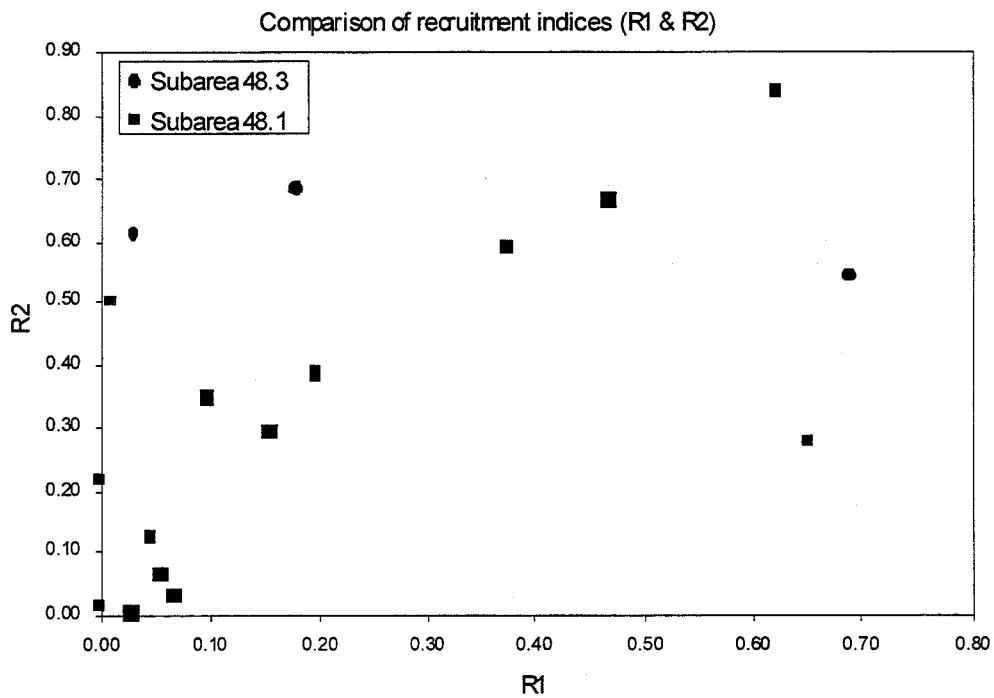


Figure 14: Comparison of R1 and R2 proportional krill recruitment indices.

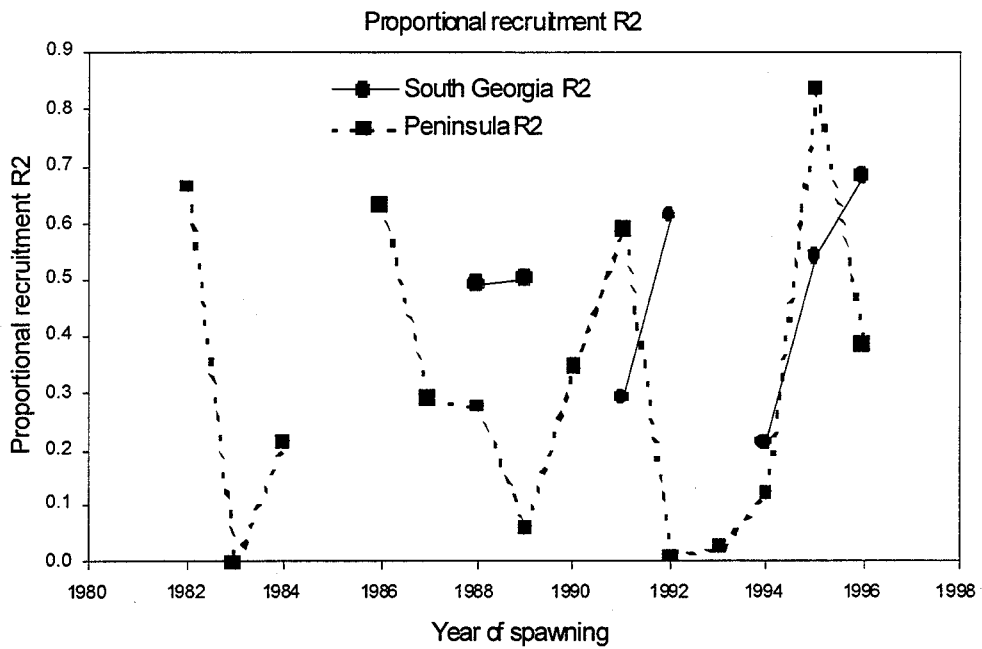


Figure 15: Interannual changes in proportional krill recruitment index (R2) in Subareas 48.1 and 48.3.

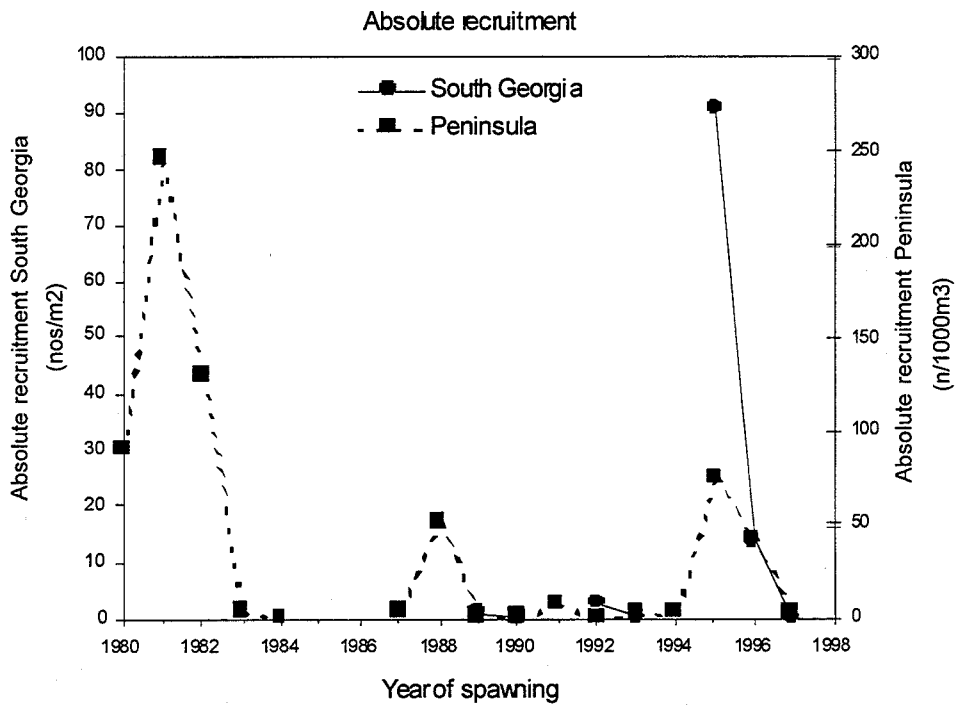


Figure 16: Interannual changes in absolute recruitment of 1+ krill in Subareas 48.1 and 48.3.

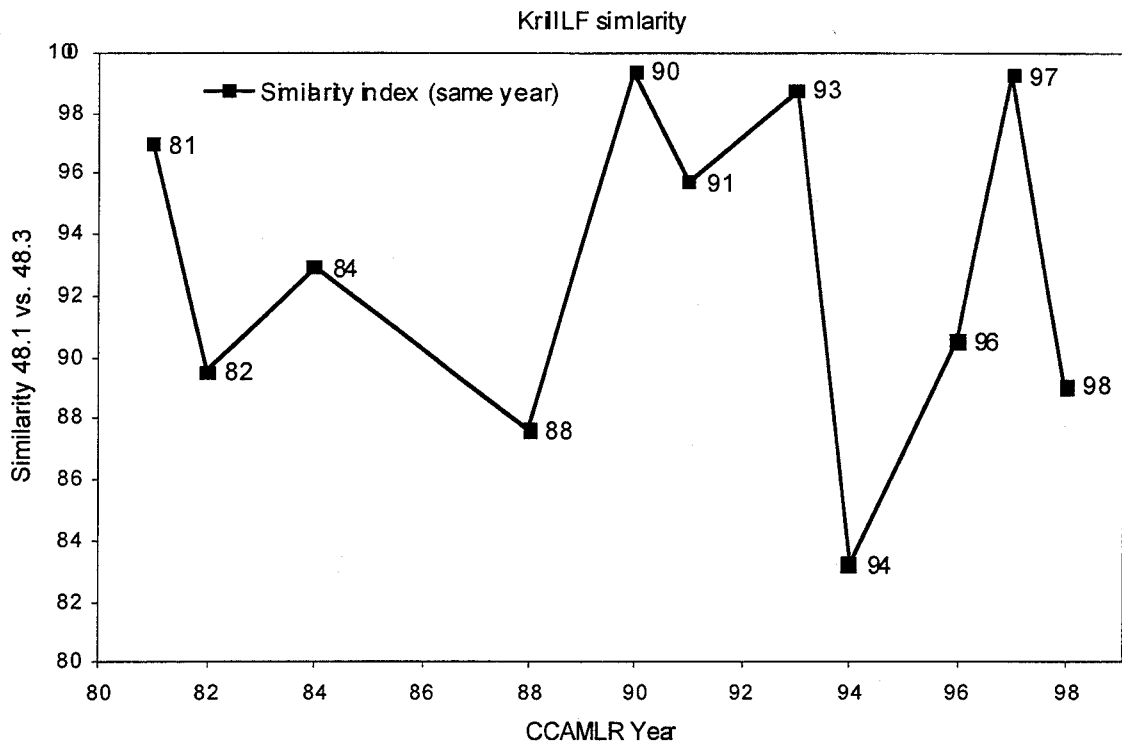


Figure 17: Interannual changes in krill length-frequency similarity index derived from cluster analysis of haul-by-haul length-frequency data in Area 48.

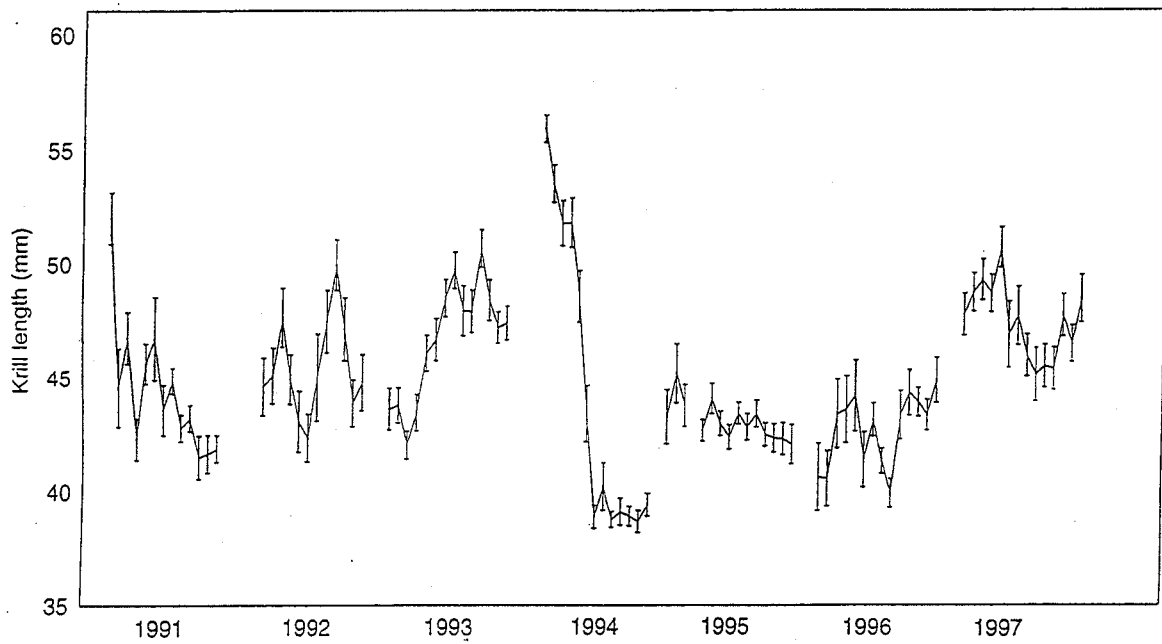


Figure 18: Weekly variation in mean krill length in the diet of Antarctic fur seals during the breeding seasons of 1991 to 1997 (error bars are shown at ± 1 standard error). Figure taken from WS-Area48-98/15.

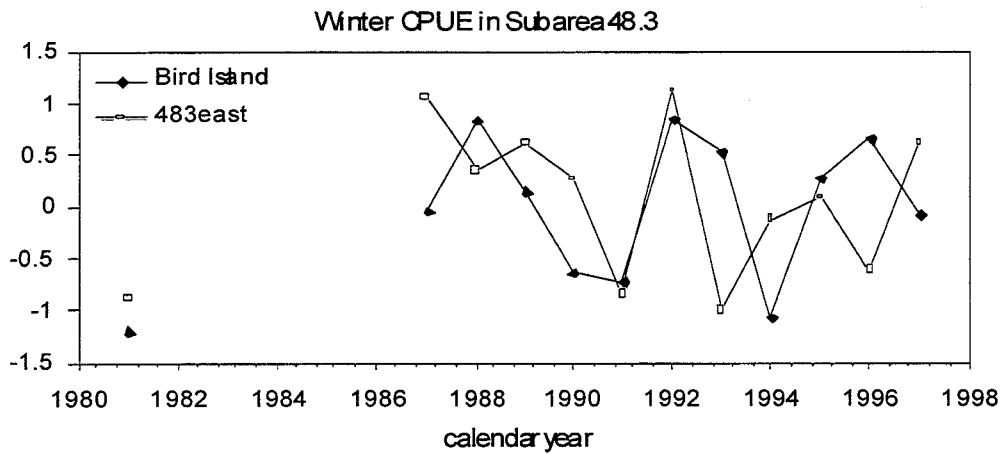
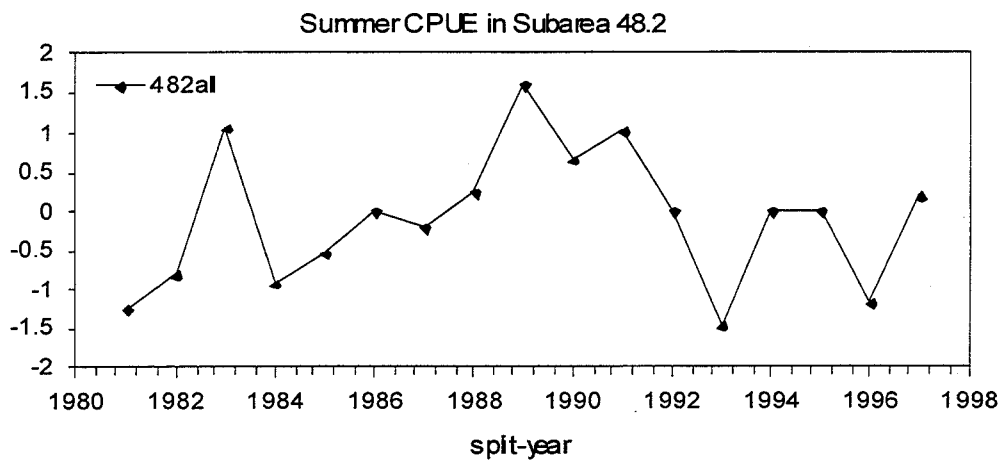
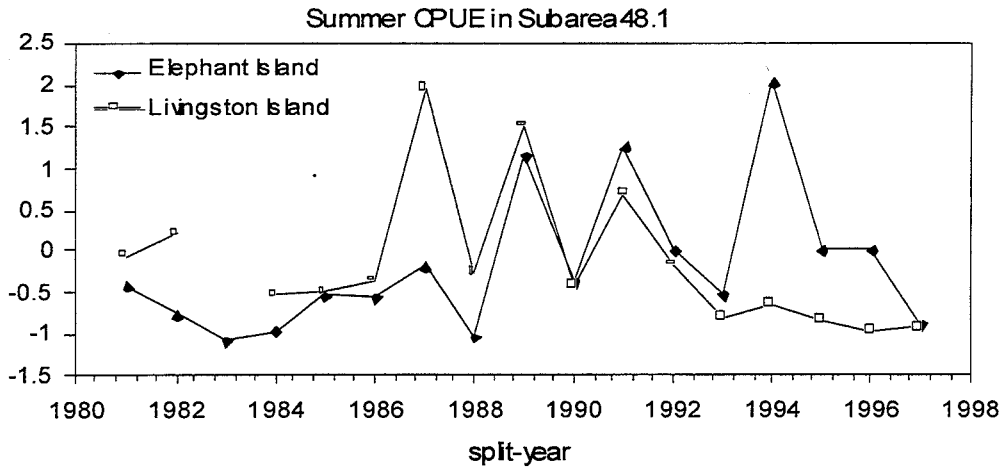


Figure 19: Indices of summer CPUE for krill fishery in Subareas 48.1 and 48.2 and winter CPUE for krill fishery in Subarea 48.3.

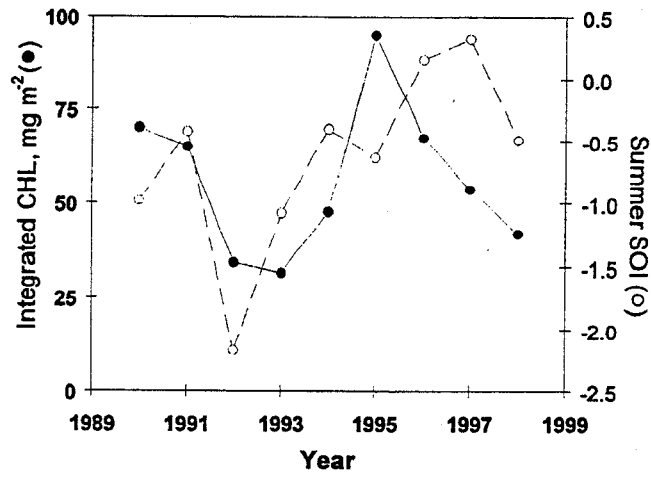


Figure 20: Integrated chlorophyll concentrations (mg-m⁻²) averaged over US AMLR survey grid (●) and the summer SOI (○) from 1990 onwards.

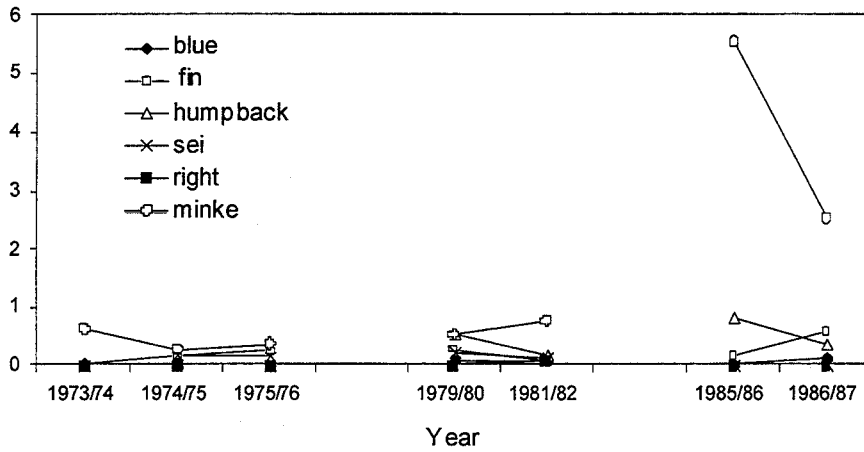


Figure 21: Japanese scouting vessel indices of whale abundance in Subarea 48.1.

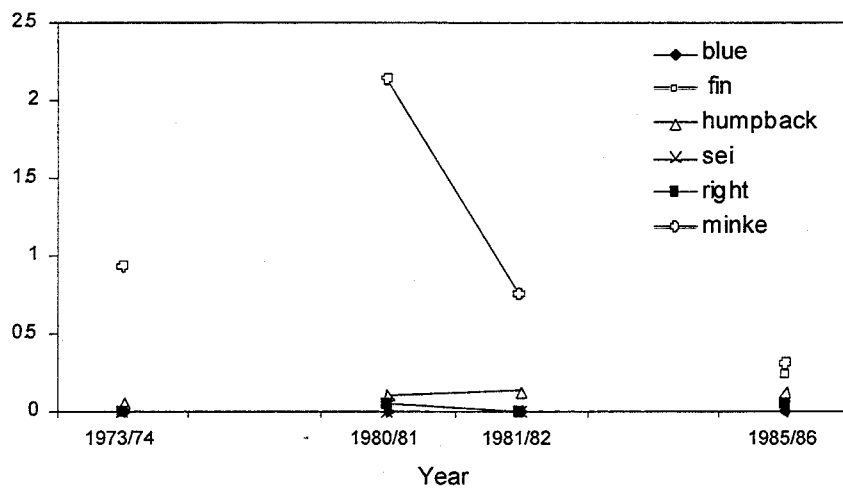


Figure 22: Japanese scouting vessel indices of whale abundance in Subarea 48.2.

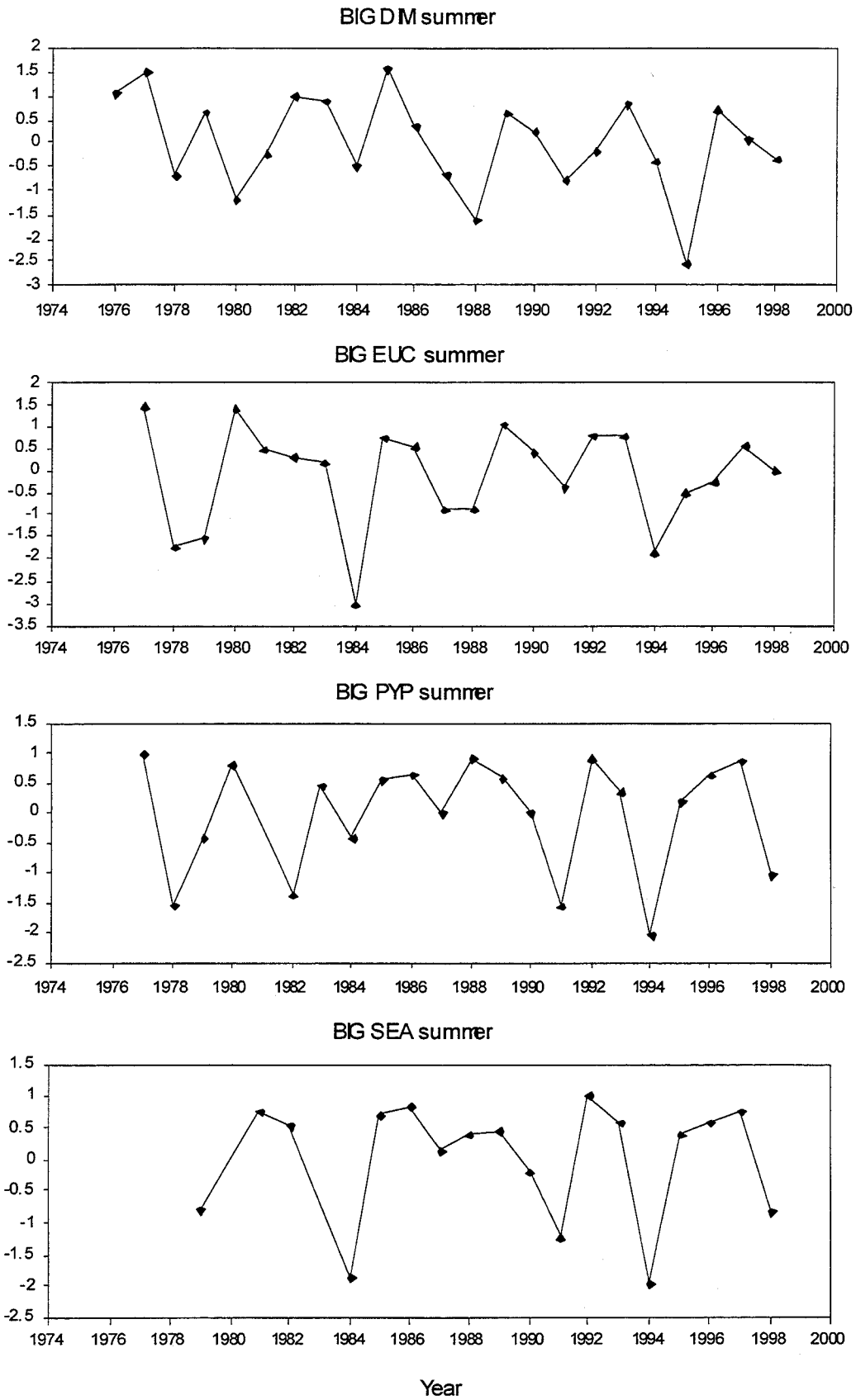


Figure 23a: Bird Island, South Georgia (BIG) CSIs for black-browed albatross (DIM), macaroni penguin (EUC), gentoo penguin (PYP) and Antarctic fur seal (SEA) in summer.

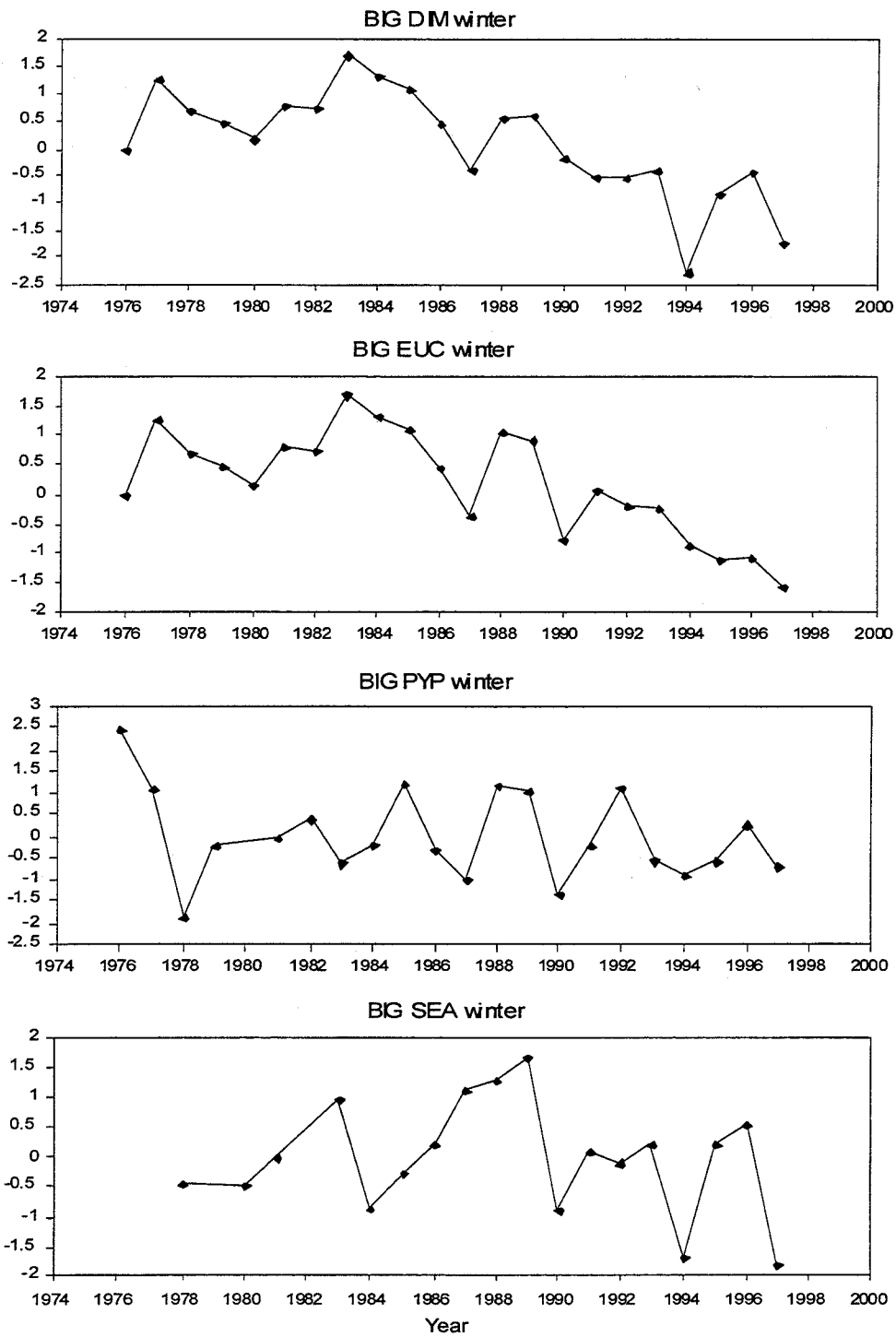


Figure 23b: Bird Island, South Georgia (BIG) CSIs for black-browed albatross (DIM), macaroni penguin (EUC), gentoo penguin (PYP) and Antarctic fur seal (SEA) in winter.

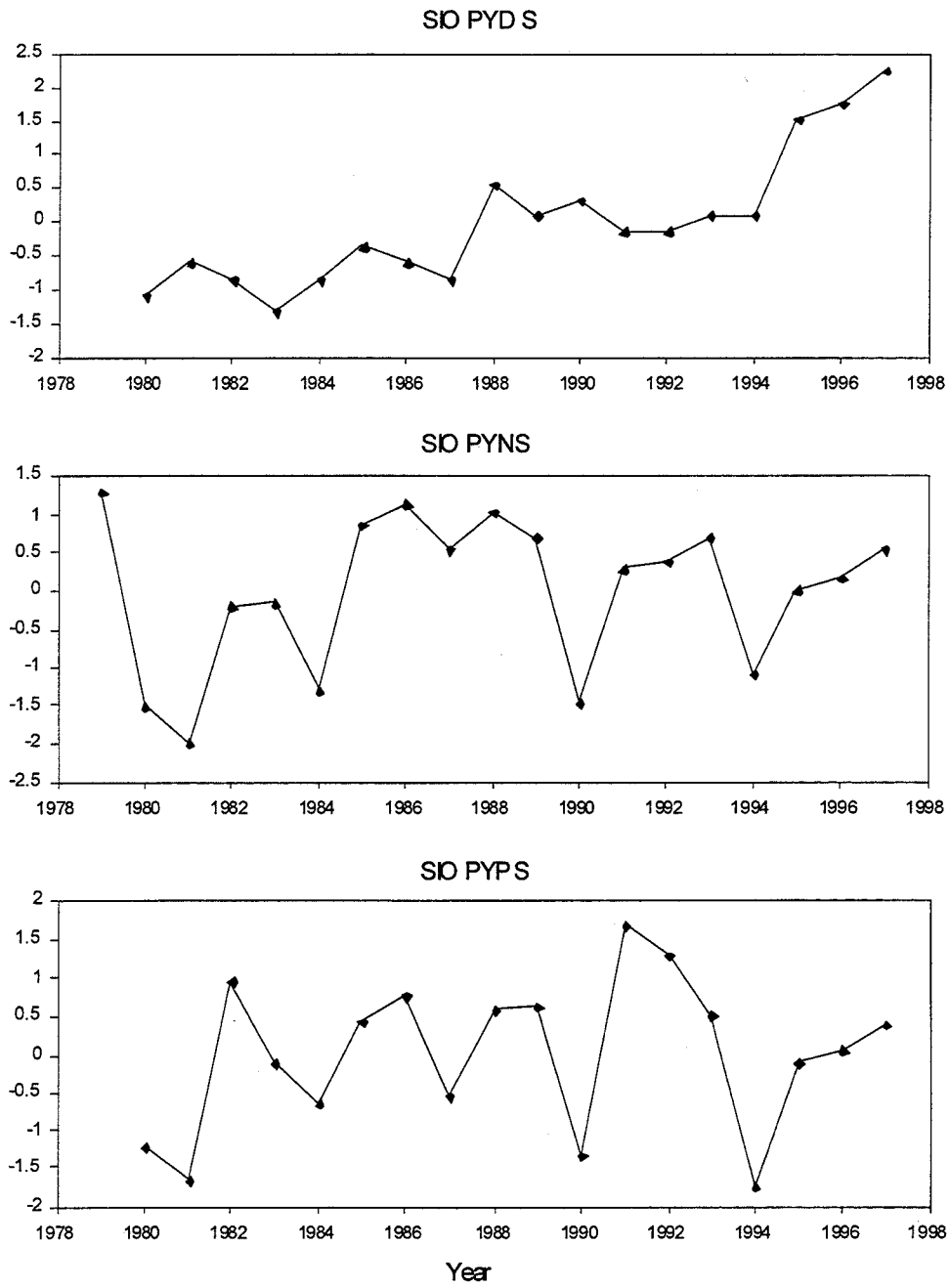


Figure 24a: Signy Island, South Orkney Islands (SIO) CSIs for Adélie (PYD), chinstrap (PYN) and gentoo (PYP) penguins in summer.

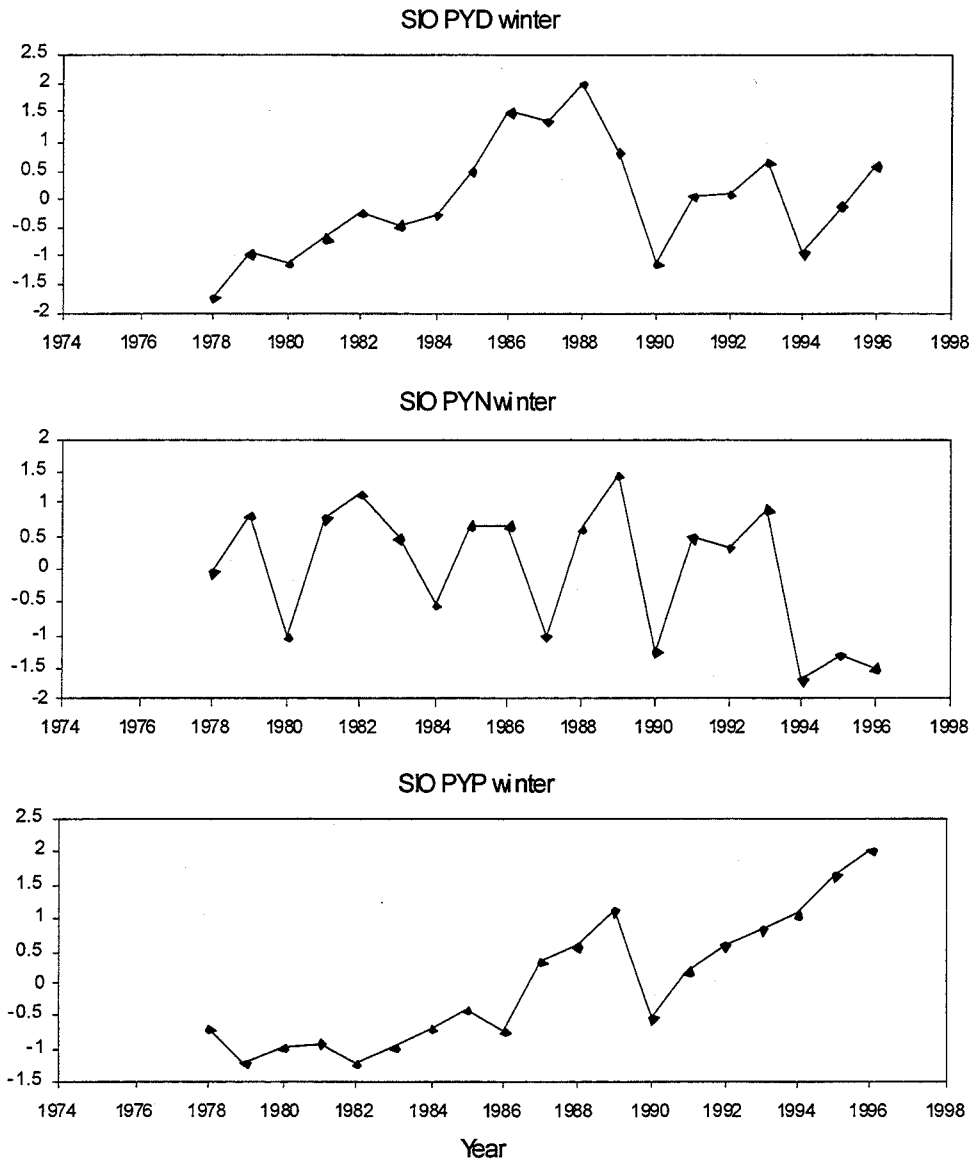


Figure 24b: Signy Island, South Orkney Islands (SIO) CSIs for Adélie (PYD), chinstrap (PYN) and gentoo (PYP) penguins in winter.

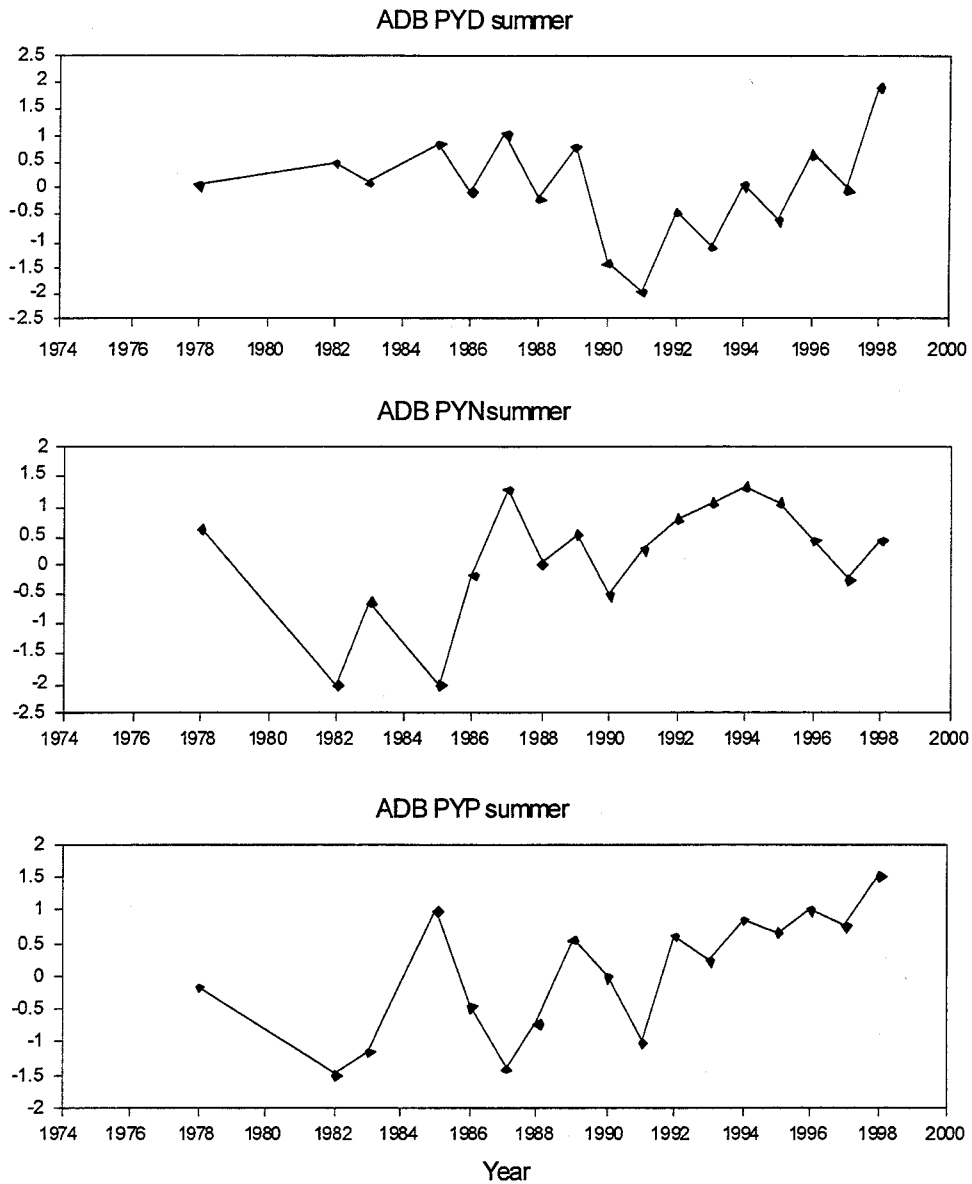


Figure 25a: Admiralty Bay, King George Island, South Shetland Islands (ADB) CSIs for Adélie (PYD), chinstrap (PYN) and gentoo (PYP) penguins in summer.

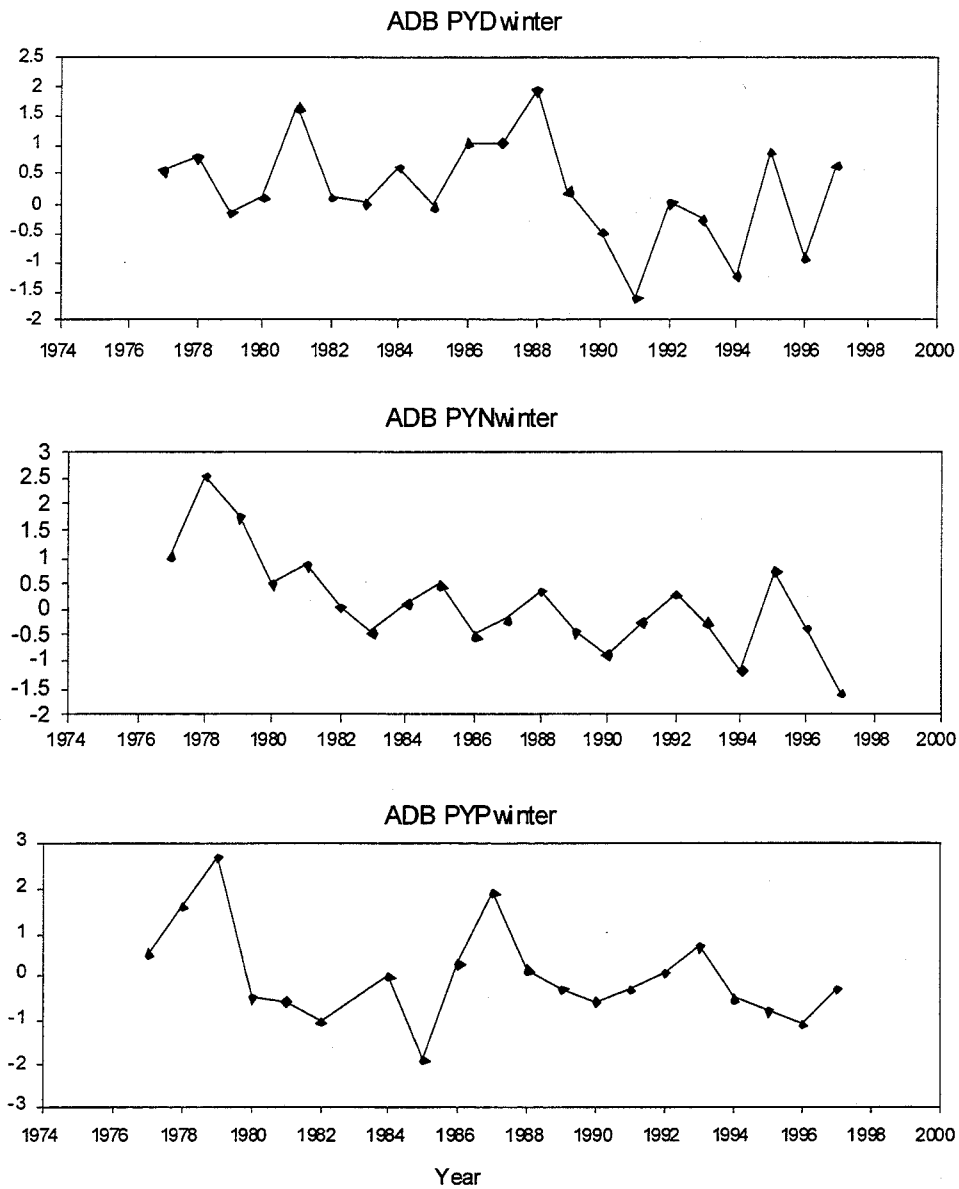


Figure 25b: Admiralty Bay, King George Island, South Shetland Islands (ADB) CSIs for Adélie (PYD), chinstrap (PYN) and gentoo (PYP) penguins in winter.

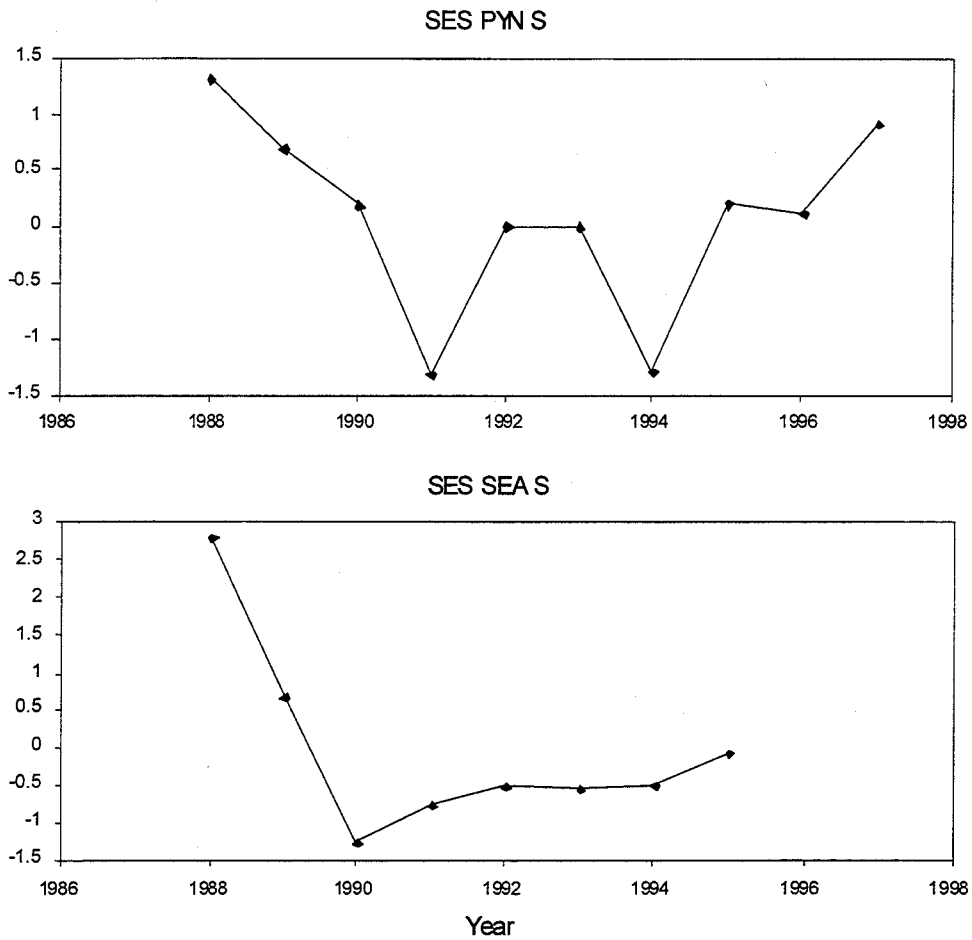


Figure 26: Seal Island, South Shetland Islands group (SES) CSIs for chinstrap penguin (PYN) and Antarctic fur seal (SEA) in summer (S).

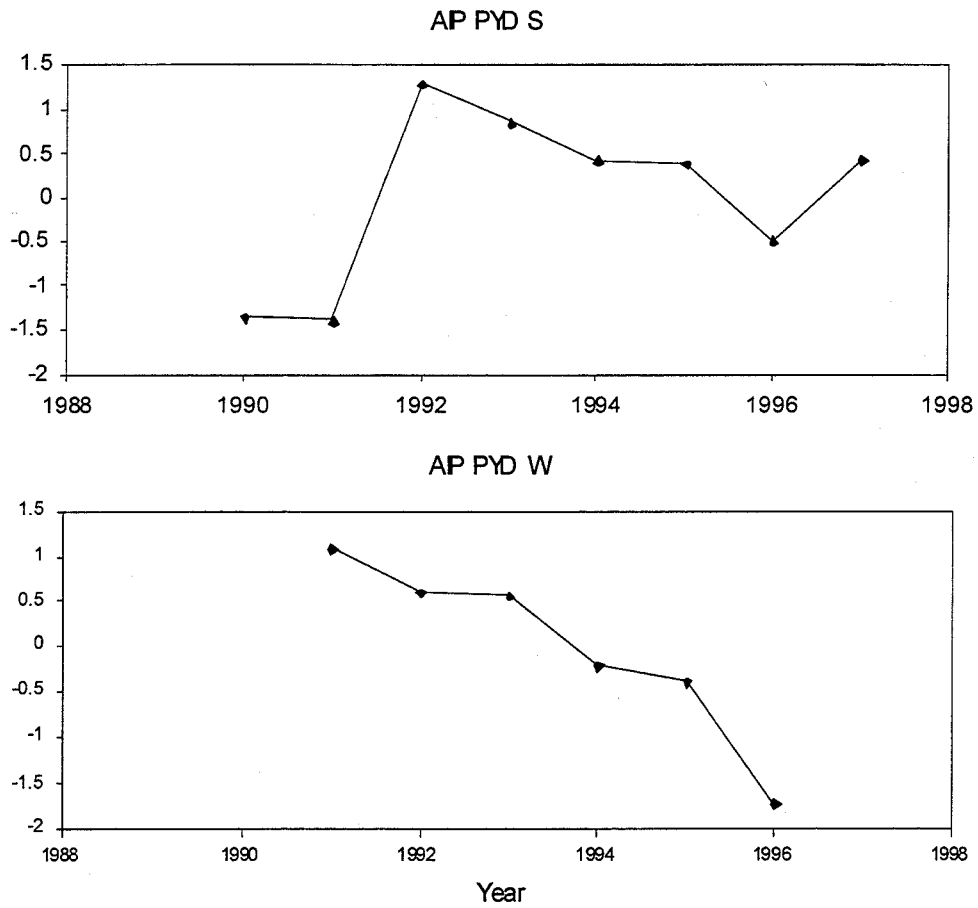


Figure 27: Anvers Island, Antarctic Peninsula (AIP) CSIs for Adélie penguins (PYD) in summer (S) and winter (W).

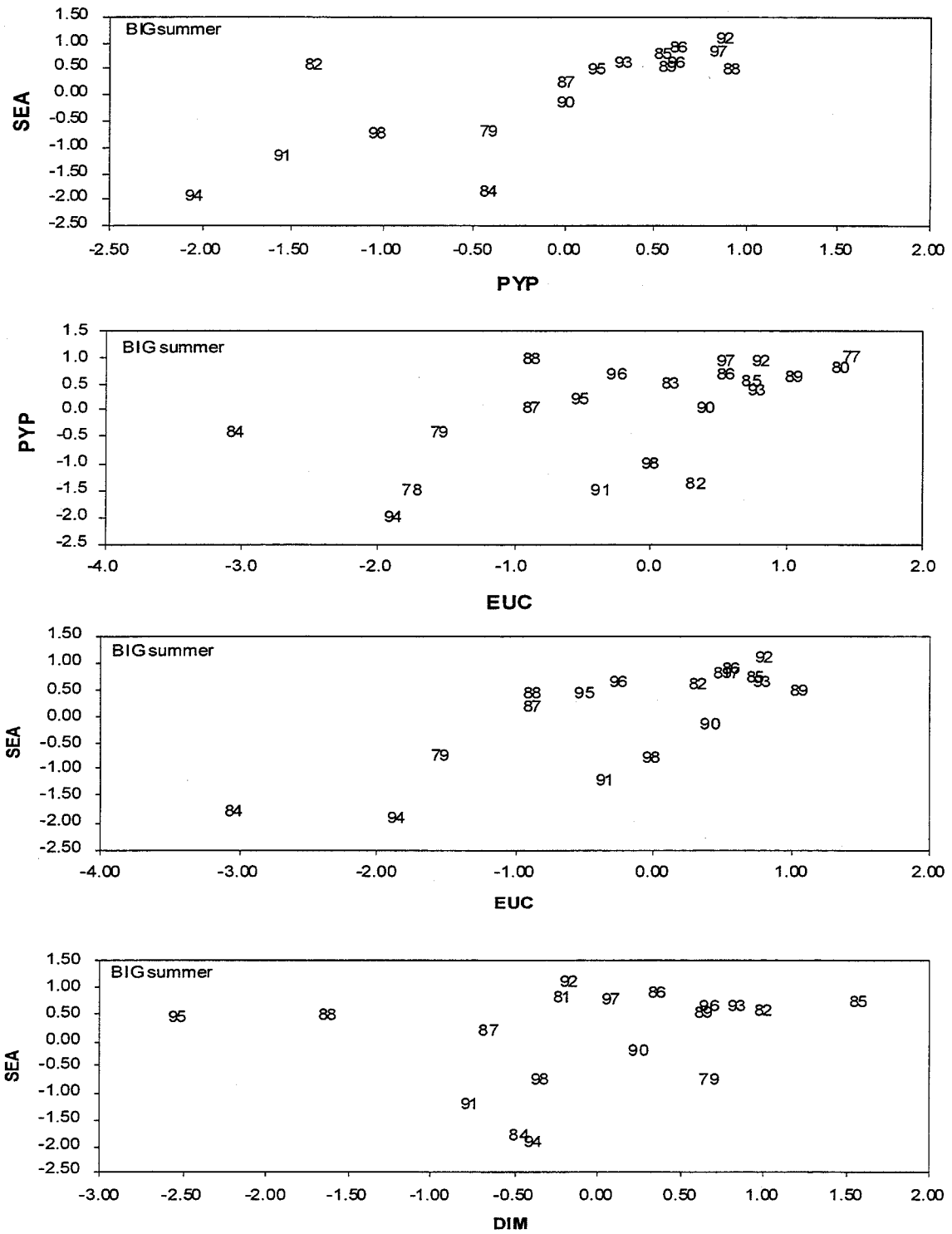


Figure 28: Relationships between summer CSIs at Bird Island (BIG) for different pairwise combinations of predators. Abbreviations as in Table 2 and Figure 23.

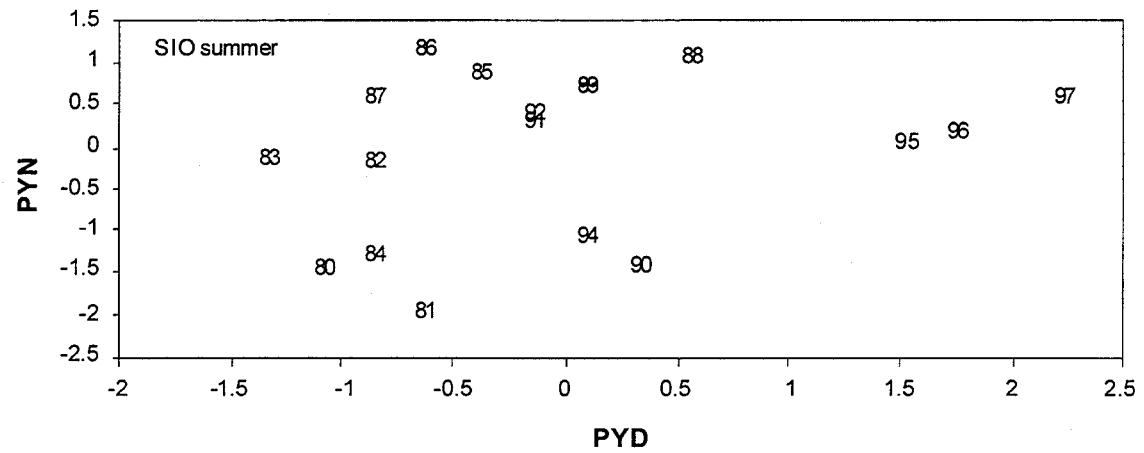
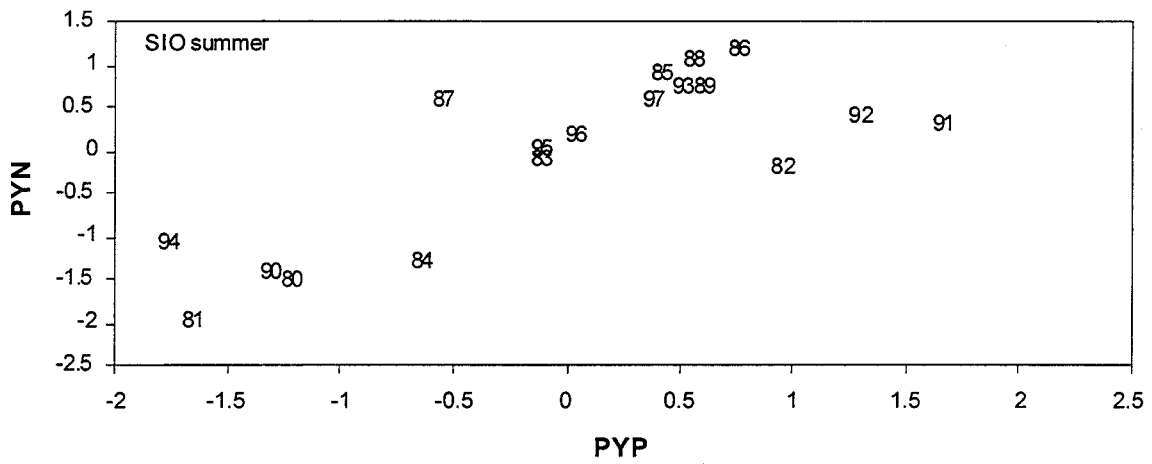
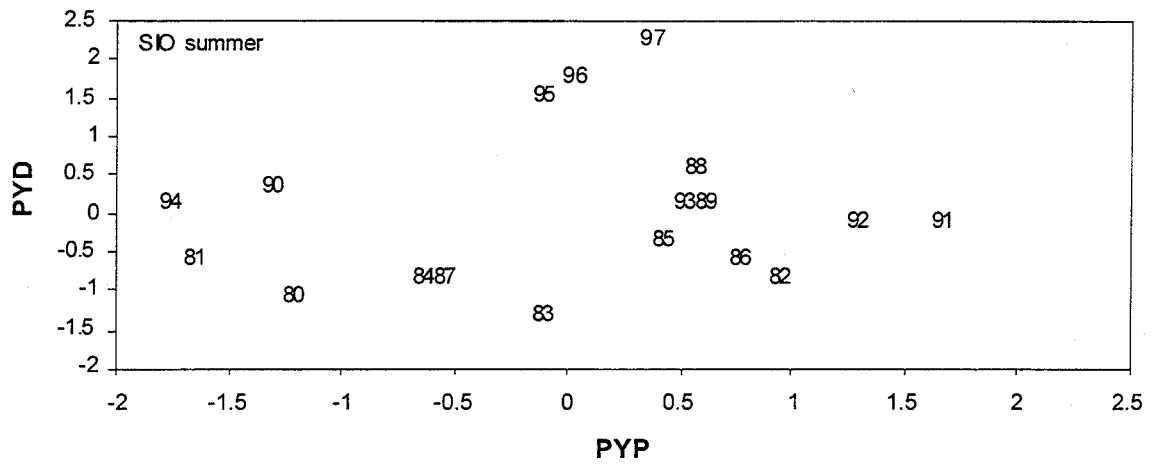


Figure 29a: Relationships between summer CSIs for different pairwise combinations of penguin species at Signy Island (SIO) for Adélie (PYD), chinstrap (PYN) and gentoo (PYP) penguins.

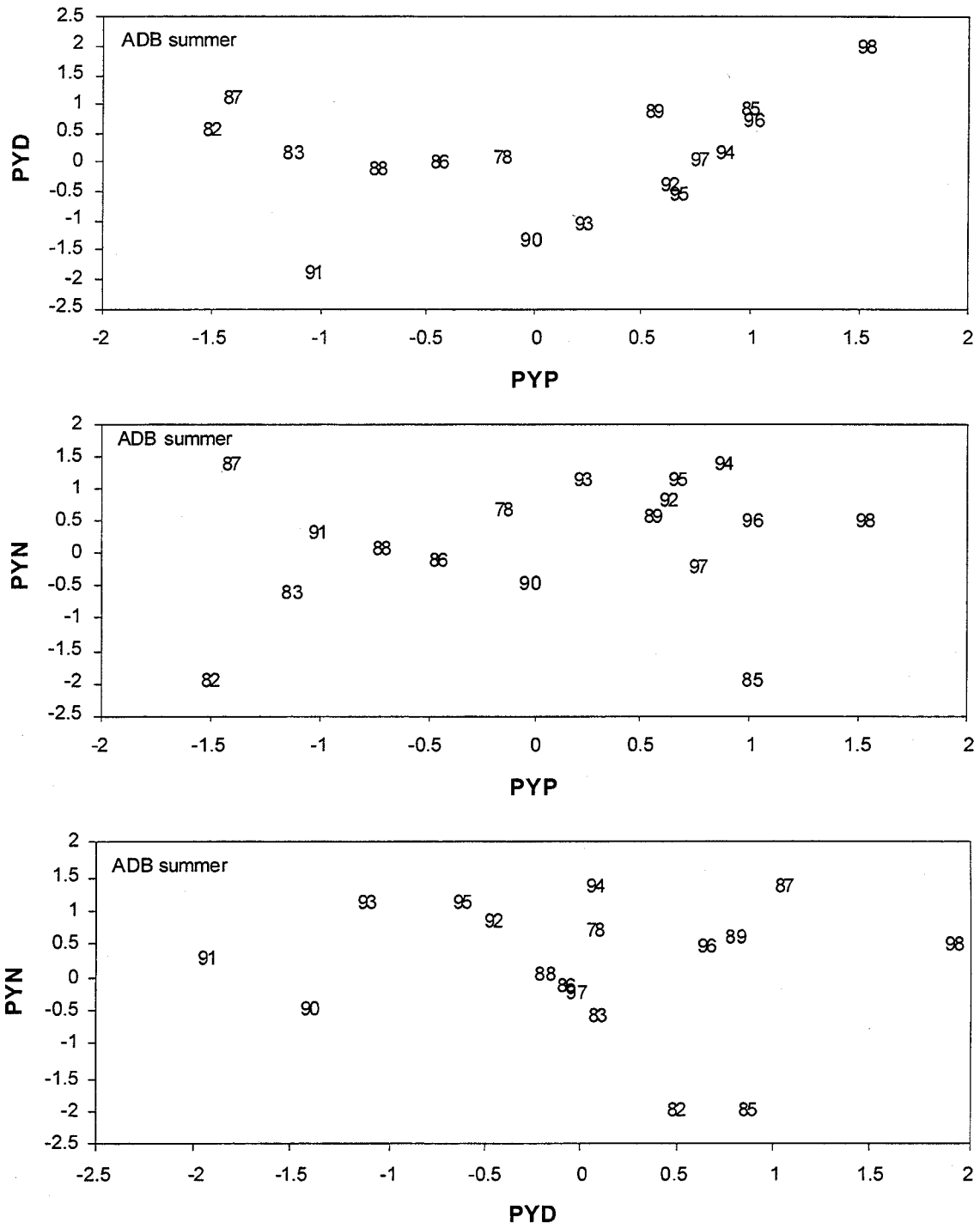


Figure 29b: Relationships between summer CSIs for different pairwise combinations of penguin species at Admiralty Bay (ADB) for Adélie (PYD), chinstrap (PYN) and gentoo (PYP) penguins.

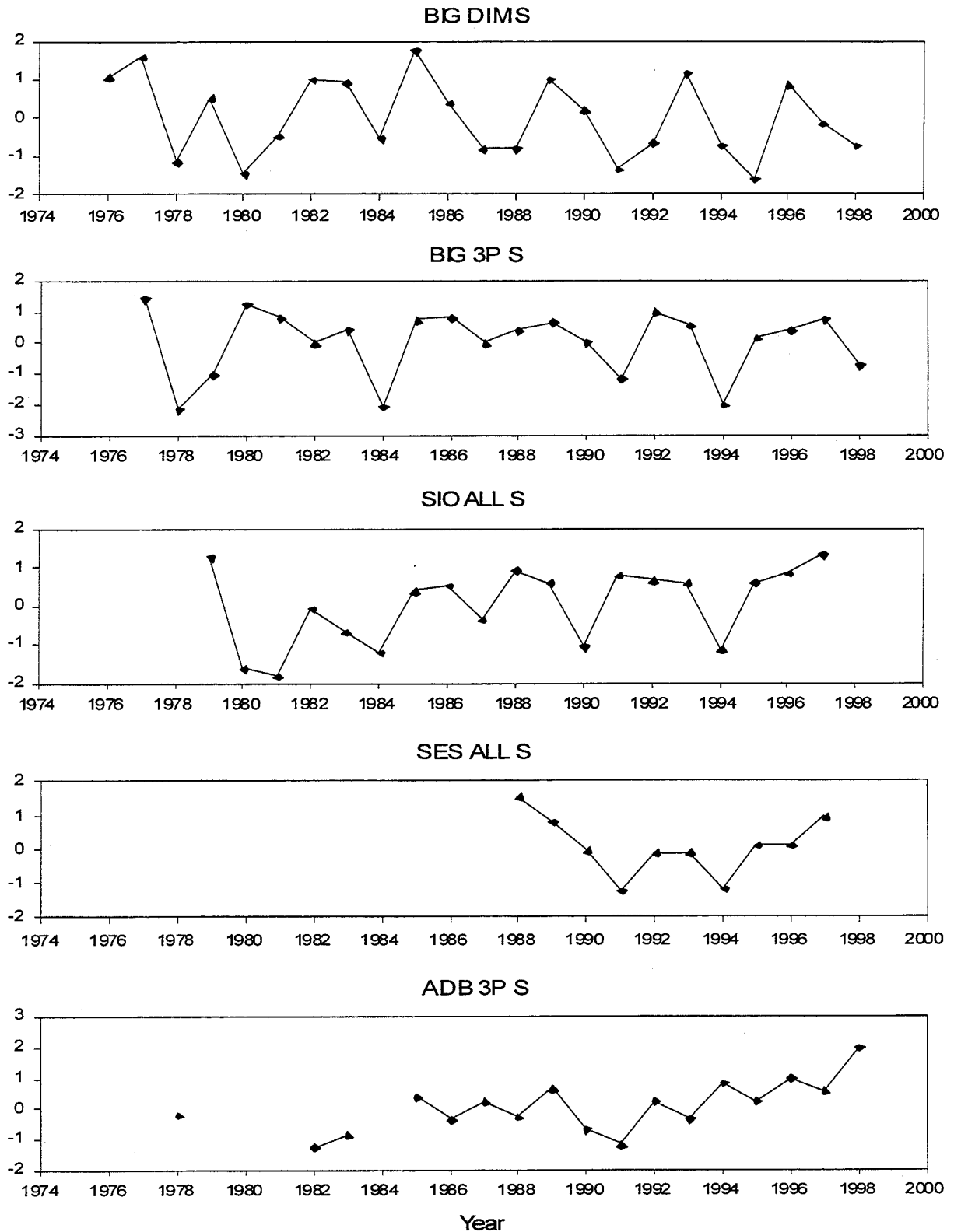


Figure 30: Summer CSIs grouped across species within sites (see paragraph 7.16). BIG 3 PS involves the combination of gentoo penguin, macaroni penguin and Antarctic fur seal at Bird Island; ADB 3 PS and SIO ALL S involve the combination of Adélie, chinstrap and gentoo penguins at Admiralty Bay and Signy Island respectively; SES ALL S involves the combination of chinstrap penguin and Antarctic fur seal at Seal Island.

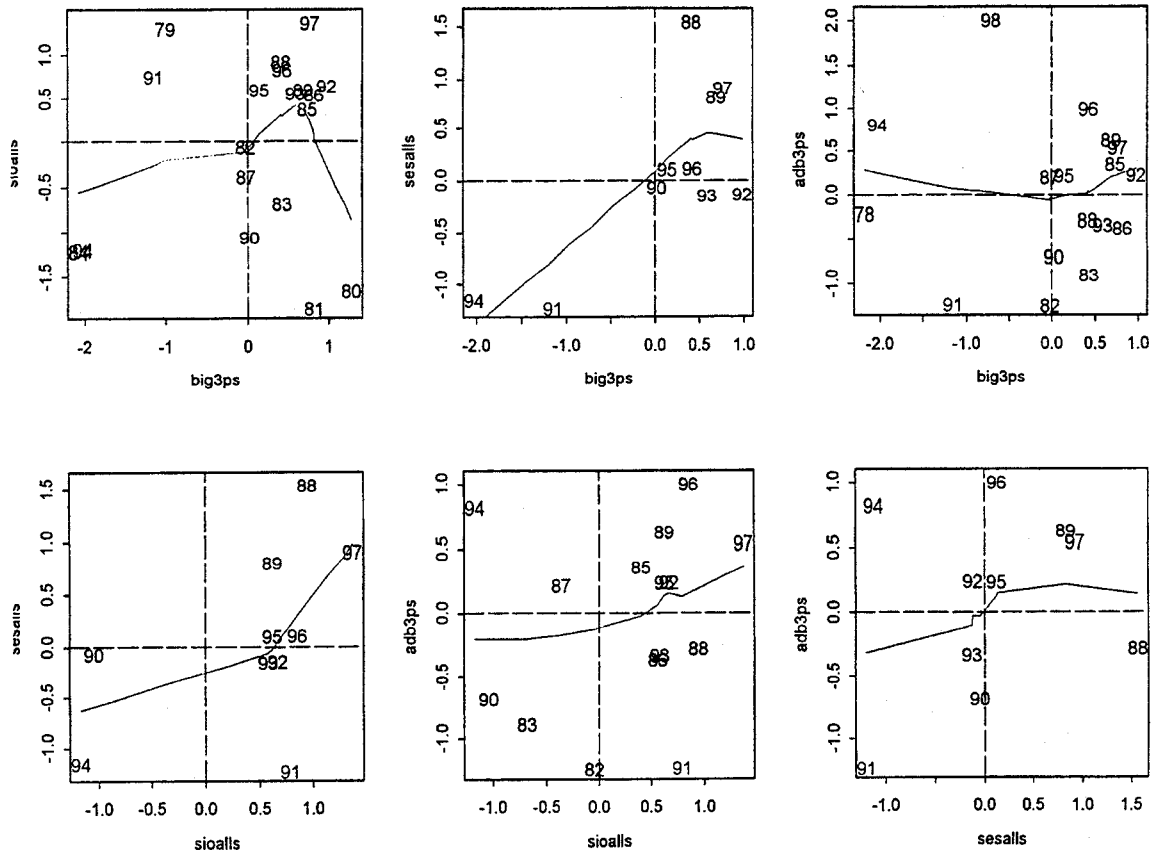


Figure 31: Comparison of predator performance between sites/areas based on summer CSIs for species group within sites. Four quadrants are shown that indicate concordance between variables in each year. Points in the top-right and bottom-left quadrants indicate relatively high concordance whereas those falling in the other two quadrants indicate relatively low concordance. Points are denoted by the number of the calendar year. The solid lines are non-parametric smoothers. BIG 3 PS involves the combination of gentoo penguin, macaroni penguin and Antarctic fur seal at Bird Island; ADB 3 PS and SIO ALL S involve the combination of Adélie, chinstrap and gentoo penguins at Admiralty Bay and Signy Island respectively; SES ALL S involves the combination of chinstrap penguin and Antarctic fur seal at Seal Island.

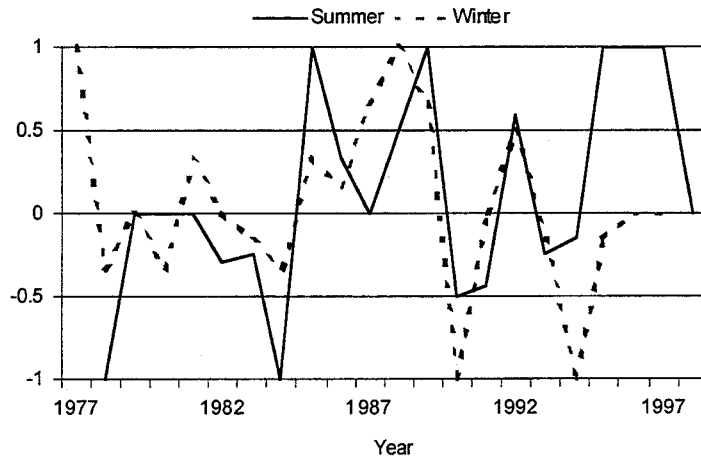


Figure 32: Similarity plot of indices of coherence derived from summer data in Figure 31 and winter data in Figure 35 (see paragraph 7.30 for explanation).

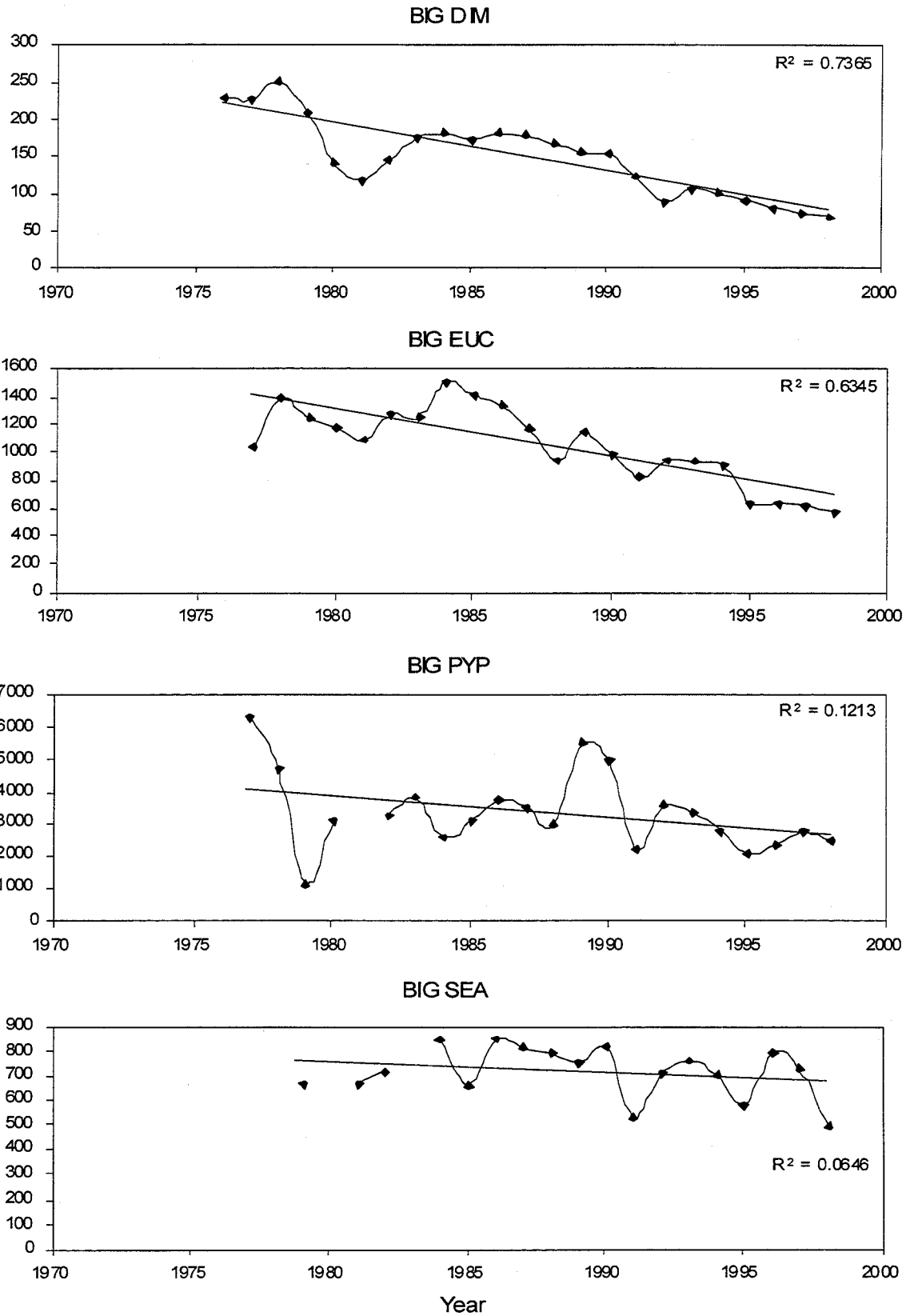


Figure 33: Changes in breeding population size in land-based marine predators at: (a) Bird Island (BIG), (b) Signy Island (SIO), (c) Admiralty Bay (ADB), (d) Anvers Island (AIP). Species abbreviations as in Table 2. Solid lines are least squares linear regression, with R^2 as indicated.

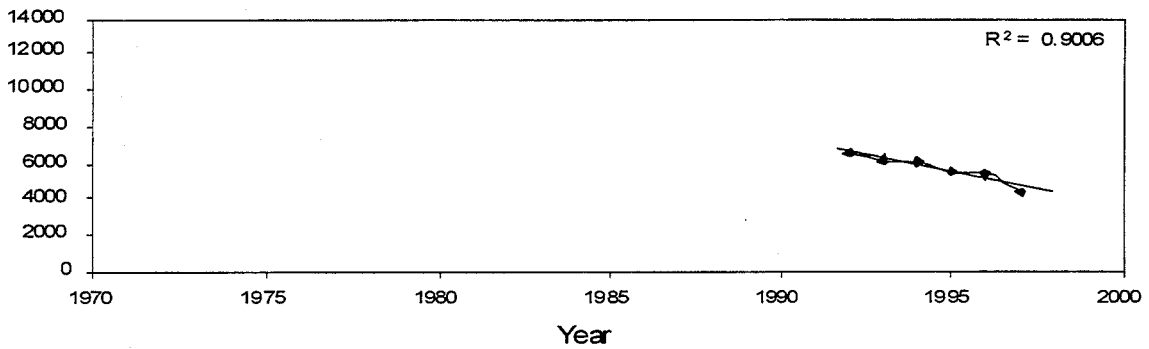
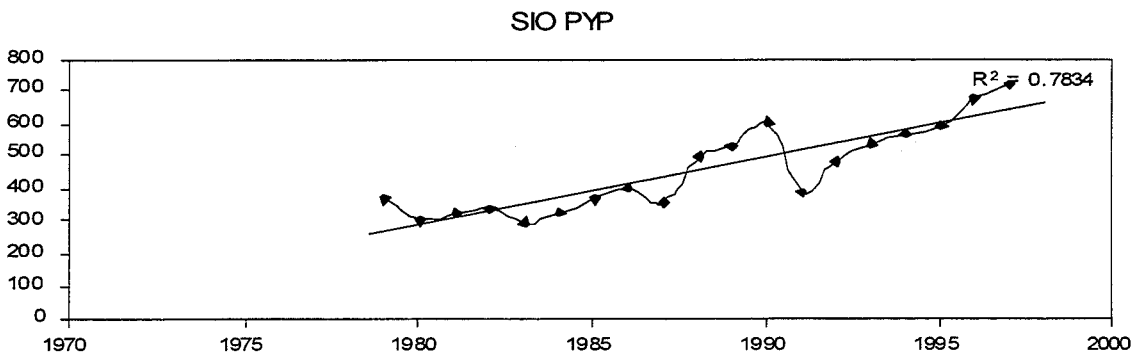
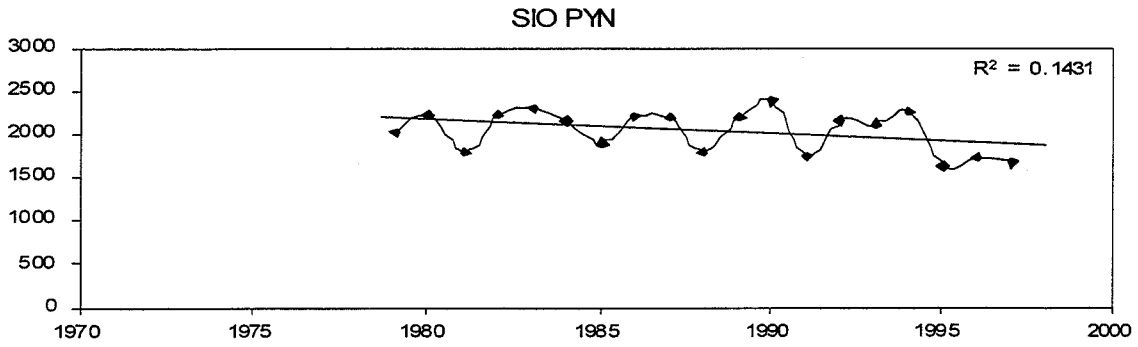
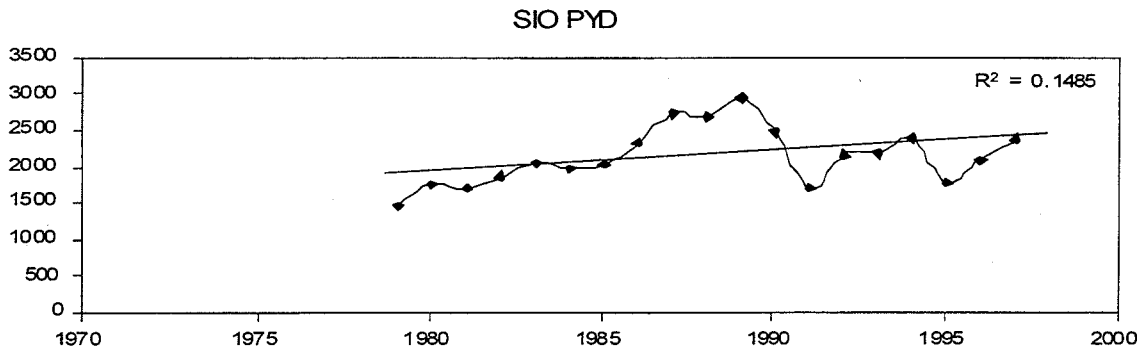


Figure 33 (continued)

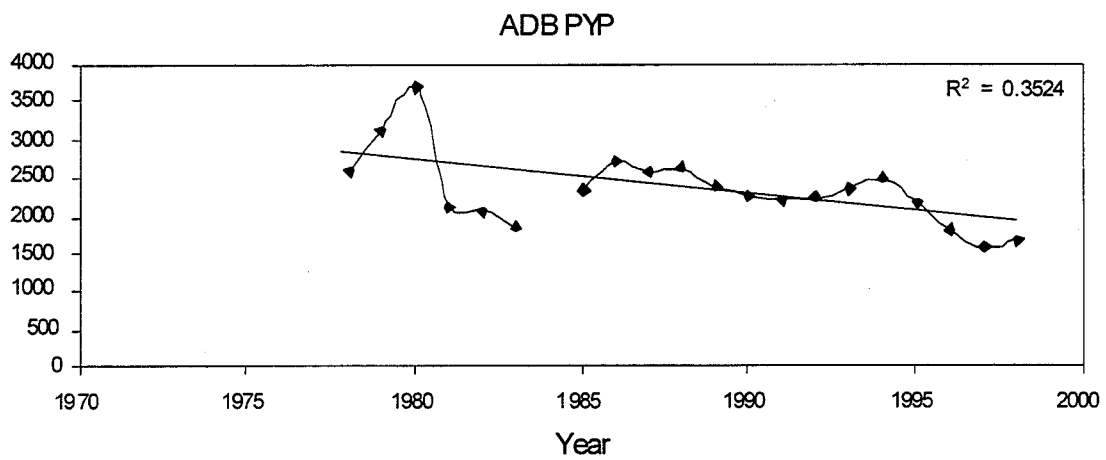
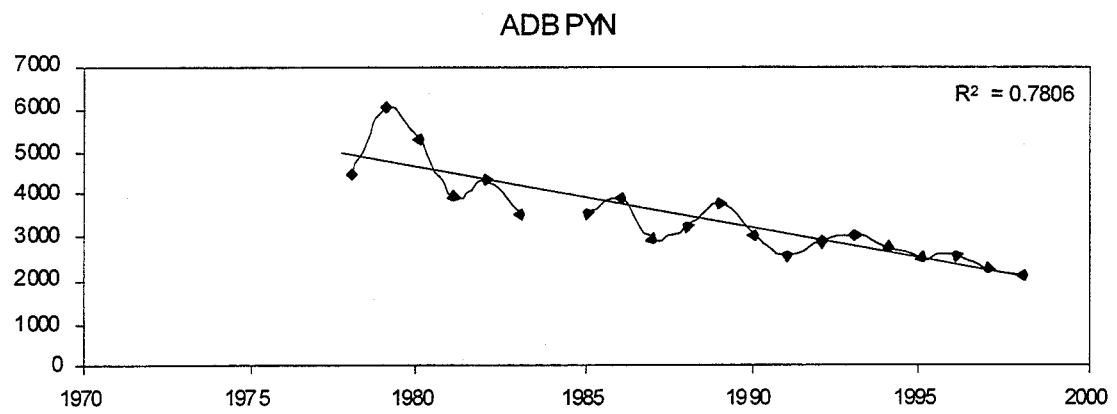
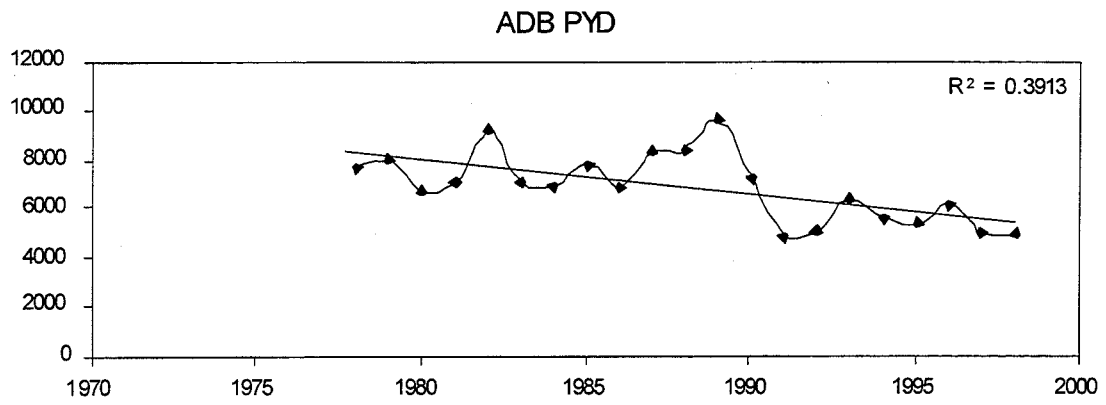


Figure 33 (continued)

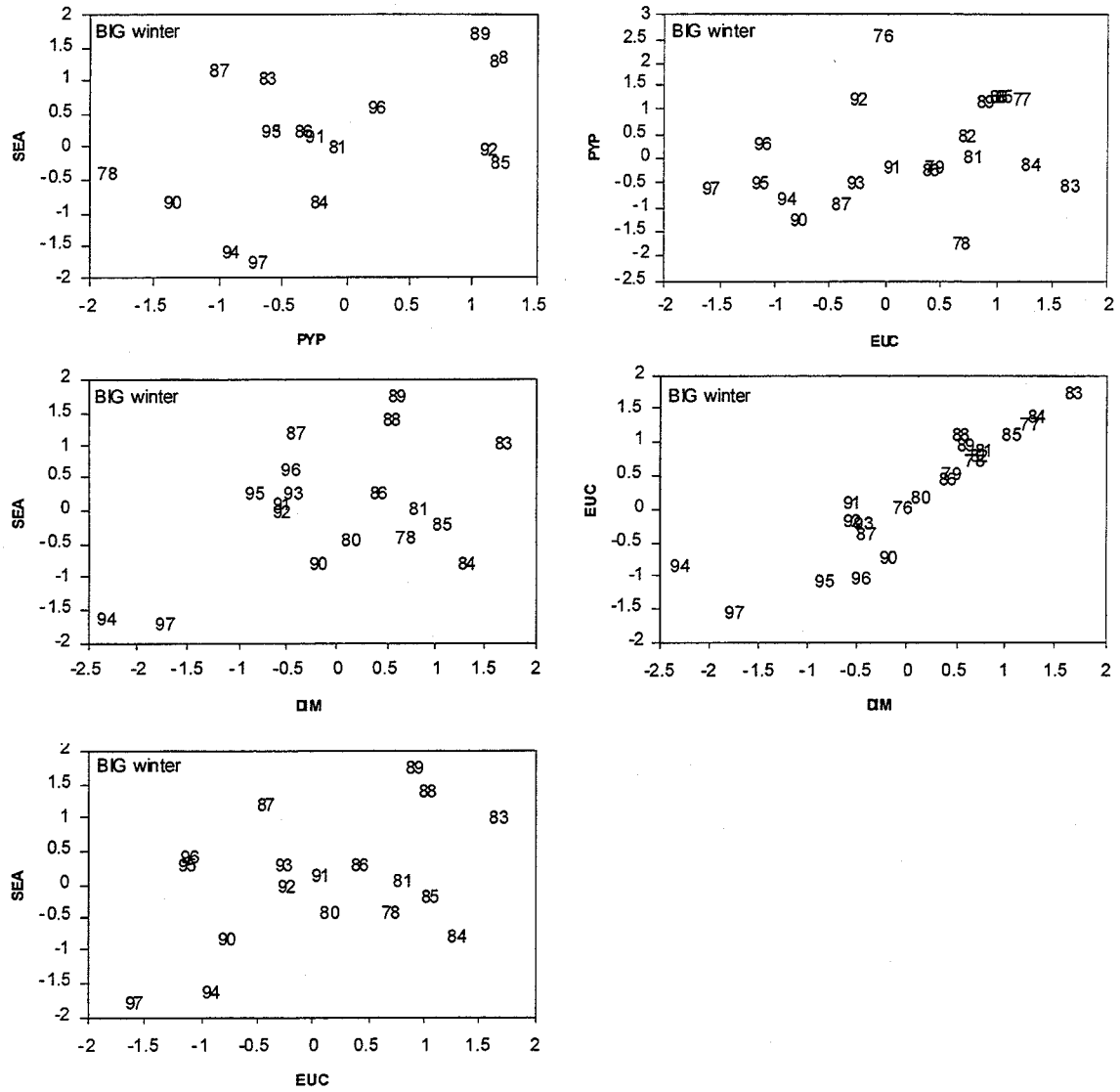


Figure 34a: Relationships between winter CSIs for various pairwise comparisons of predator species at Bird Island (BIG). Species abbreviations as in Table 2.

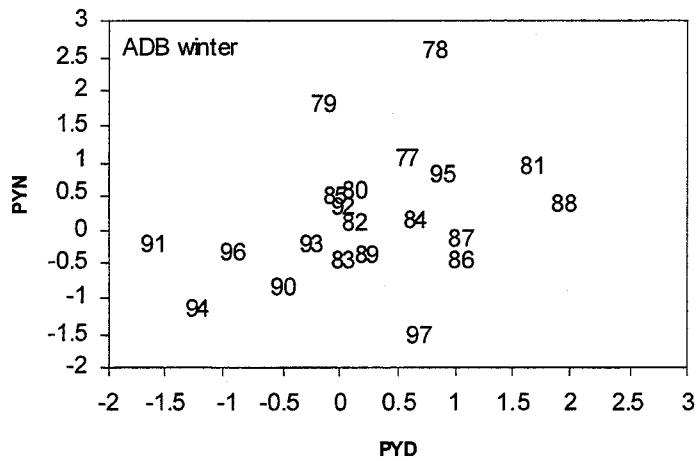
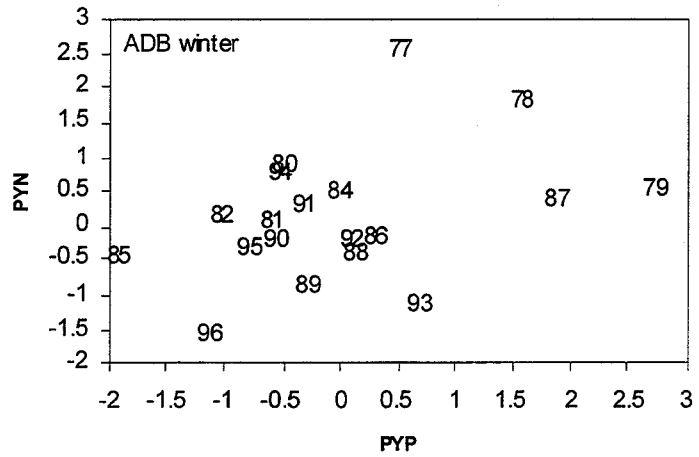
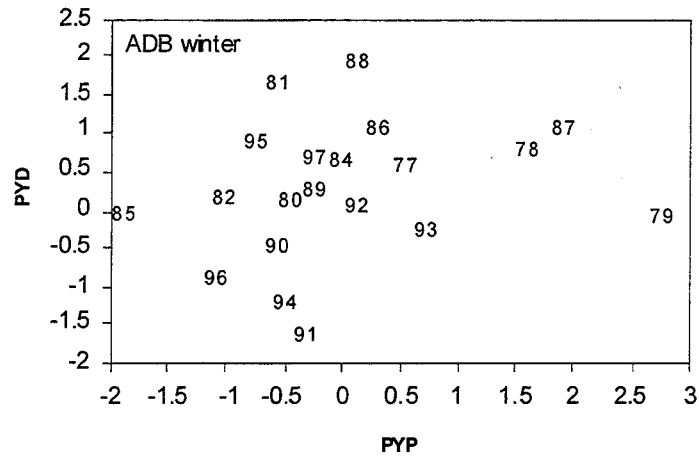


Figure 34b: Relationships between winter CSIs for various pairwise comparisons of predator species at Signy Island (SIO). Species abbreviations as in Table 2.

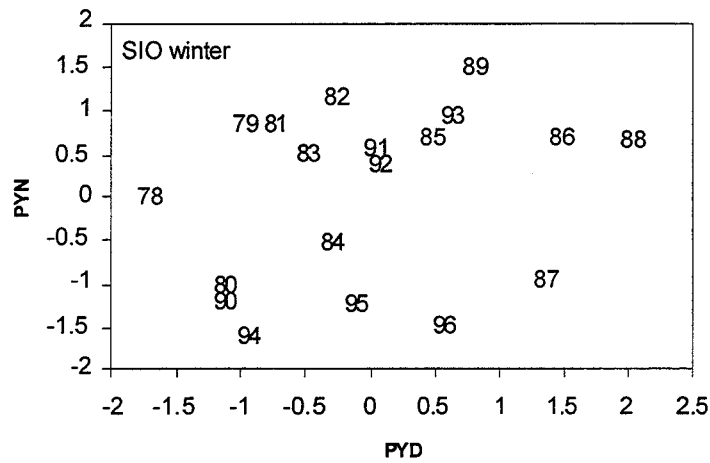
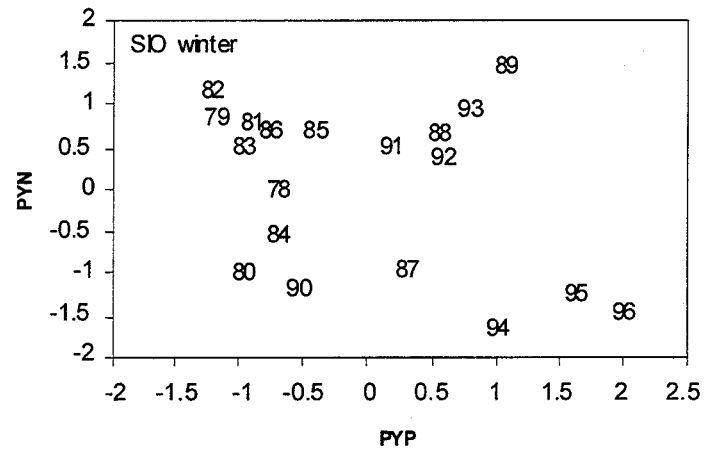
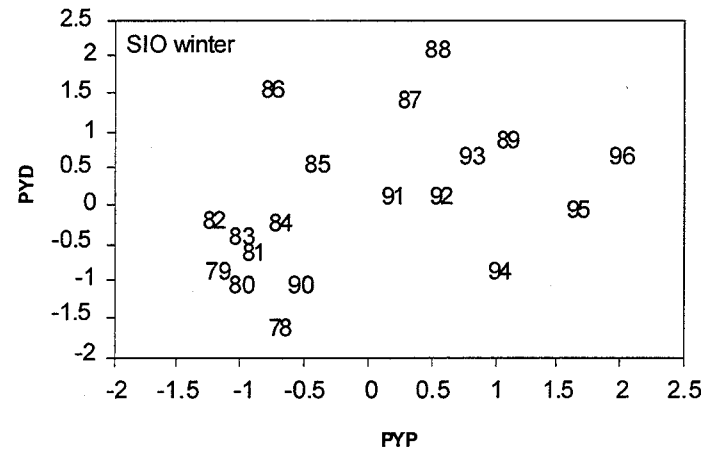


Figure 34c: Relationships between winter CSIs for various pairwise comparisons of predator species at Admiralty Bay (ADB). Species abbreviations as in Table 2.

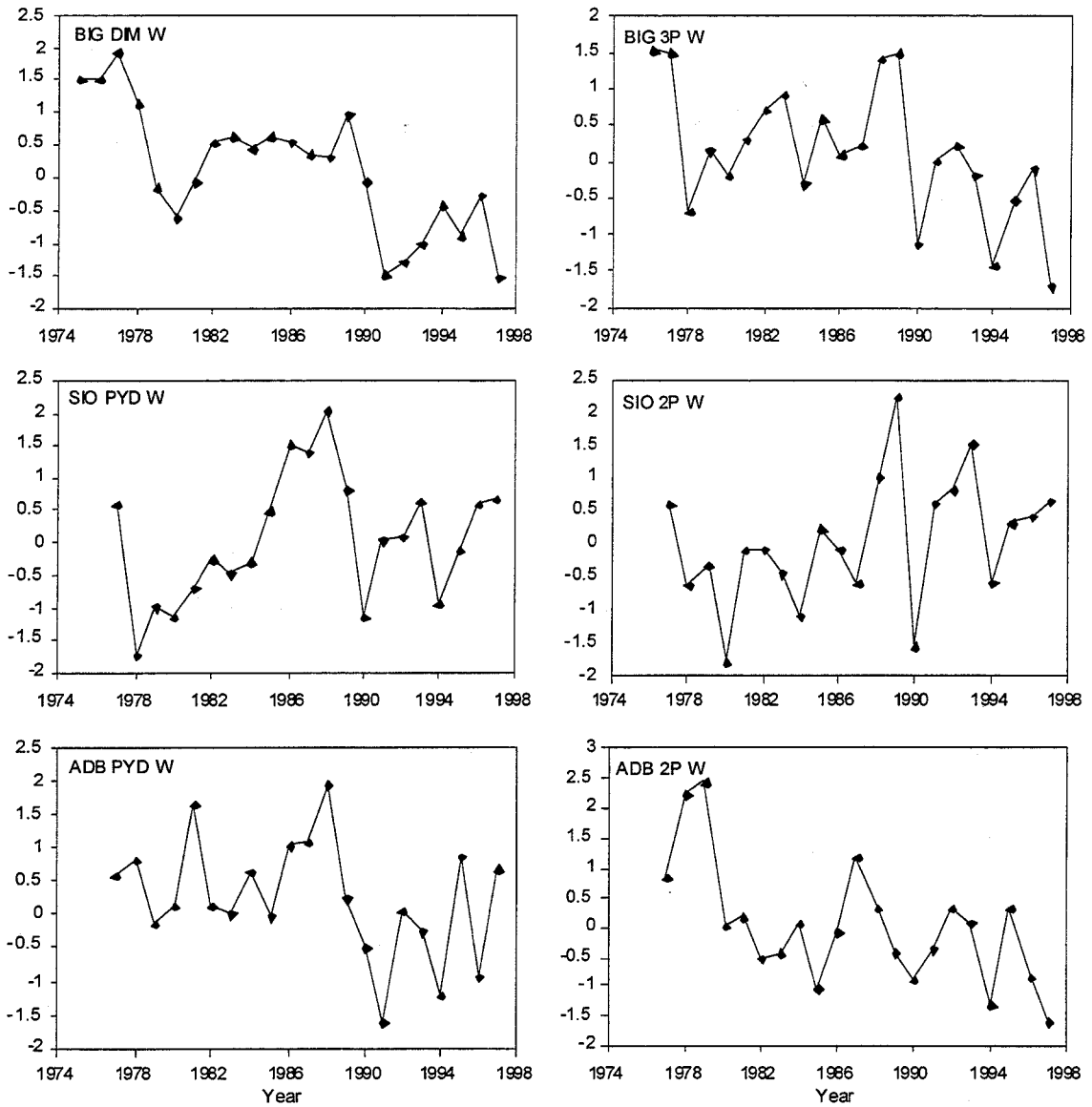


Figure 35: Winter CSIs grouped across species within sites (see paragraph 7.35). BIG 3 PS involves the combination of gentoo penguin, macaroni penguin and Antarctic fur seal at Bird Island; SIO 2 PW and ADB 2 PW involve the combination of chinstrap and gentoo penguins.

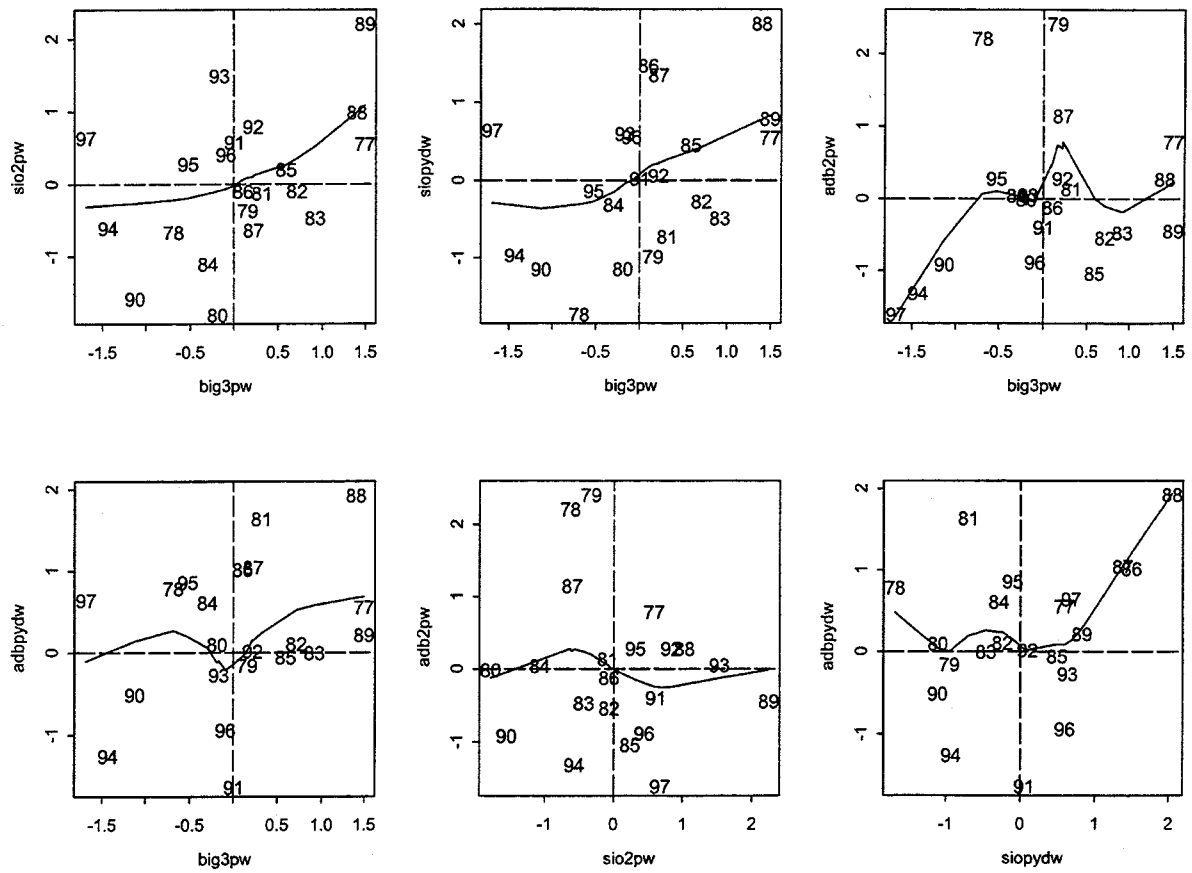


Figure 36: Comparison of predator performance between sites/areas based on winter CSIs for species group within sites. Four quadrants are shown that indicate concordance between variables in each year. Points in the top-right and bottom-left quadrants indicate relatively high concordance whereas those falling in the other two quadrants indicate relatively low concordance. Points are denoted by the number of the calendar year. The solid lines are non-parametric smoothers. BIG 3 PW involves the combination of gentoo penguin, macaroni penguin and Antarctic fur seal at Bird Island; SIO 2 PW and ADB 2 PW involve the combination of chinstrap and gentoo penguins. SIO PYD W and ADB PYD W are Adélie penguins at Signy Island and Admiralty Bay respectively.

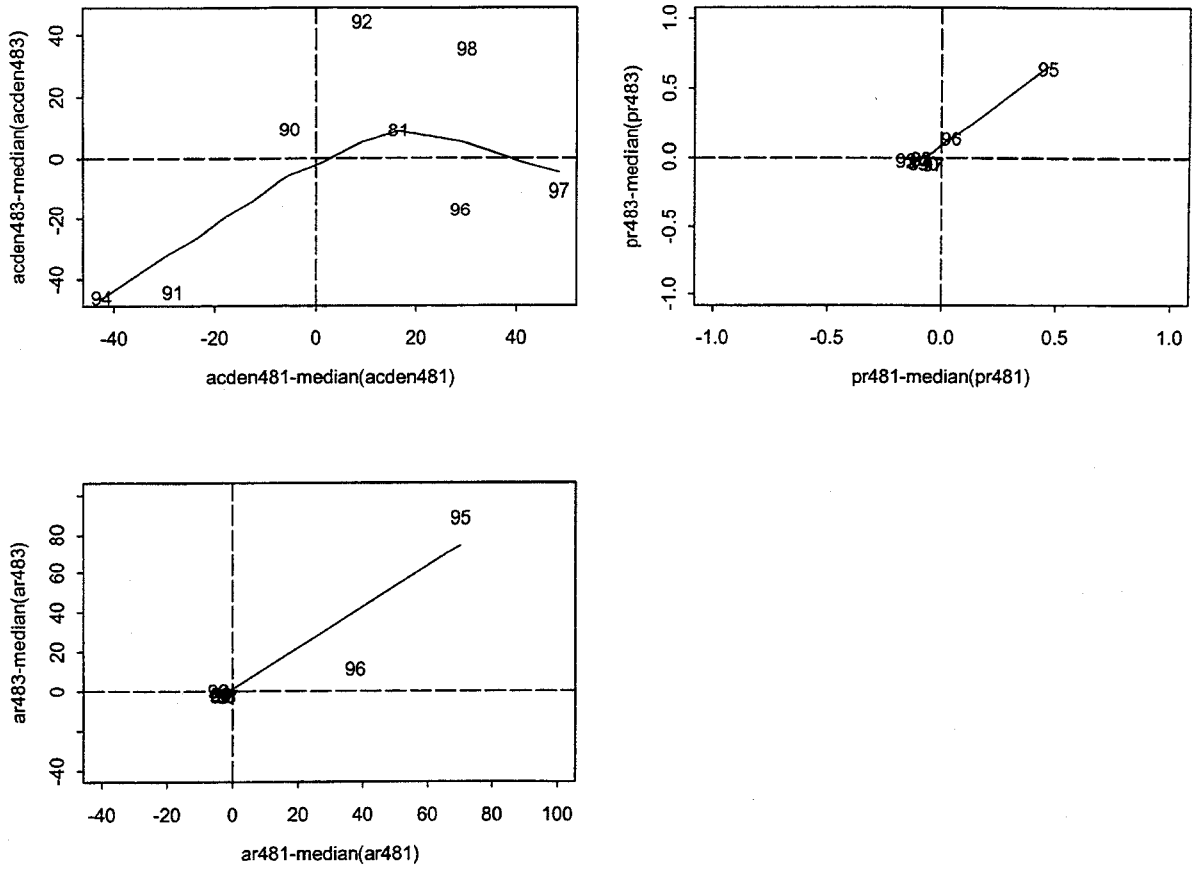


Figure 37: Comparisons of krill indices between areas. Each index is expressed relative to its median value. Four quadrants are shown that indicate concordance between variables in each year. Points in the top-right and bottom-left quadrants indicate relatively high concordance whereas those falling in the other two quadrants indicate relatively low concordance. Points are denoted by the number of the calendar year.

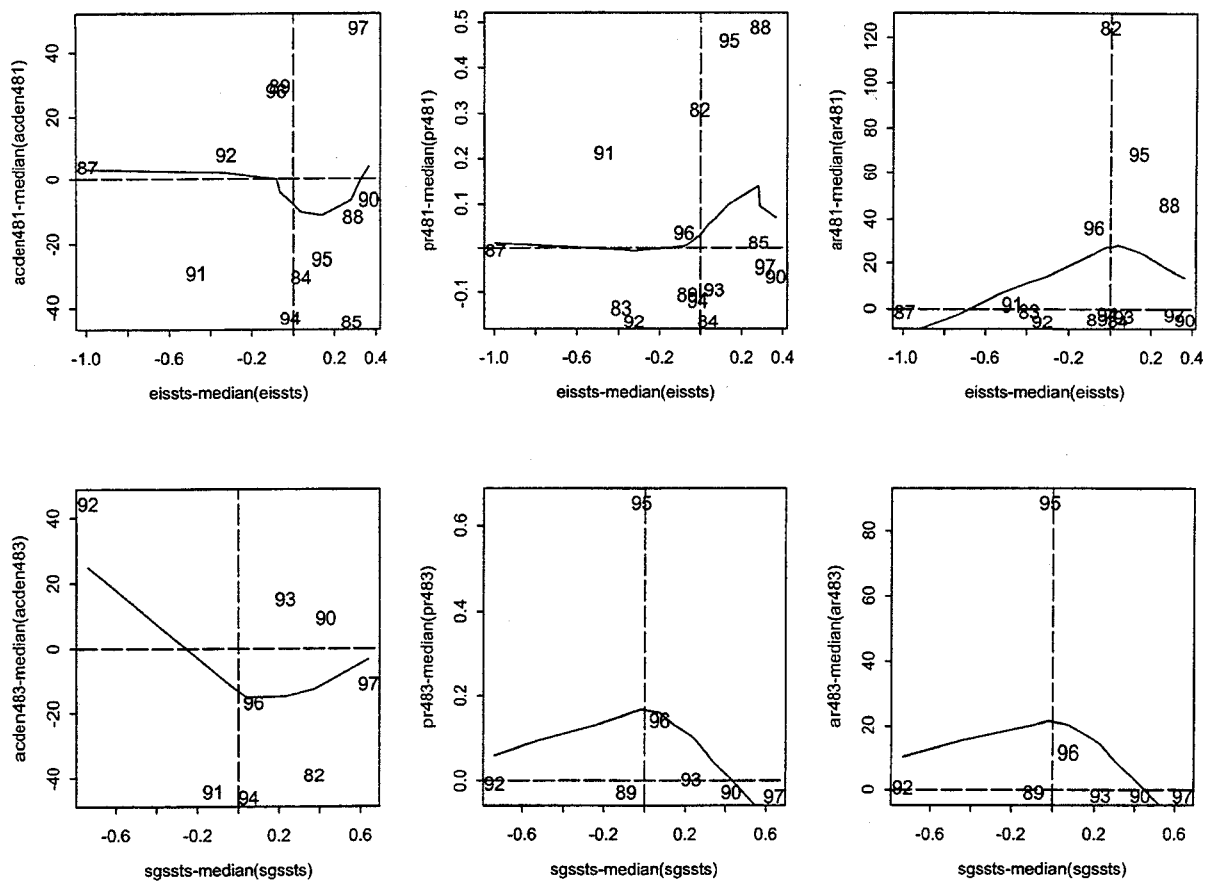


Figure 38: Krill indices in relation to SST within areas. Each index is expressed relative to its median value. Four quadrants are shown that indicate concordance between variables in each year. Points in the top-right and bottom-left quadrants indicate relatively high concordance whereas those falling in the other two quadrants indicate relatively low concordance. Points are denoted by the number of the calendar year.

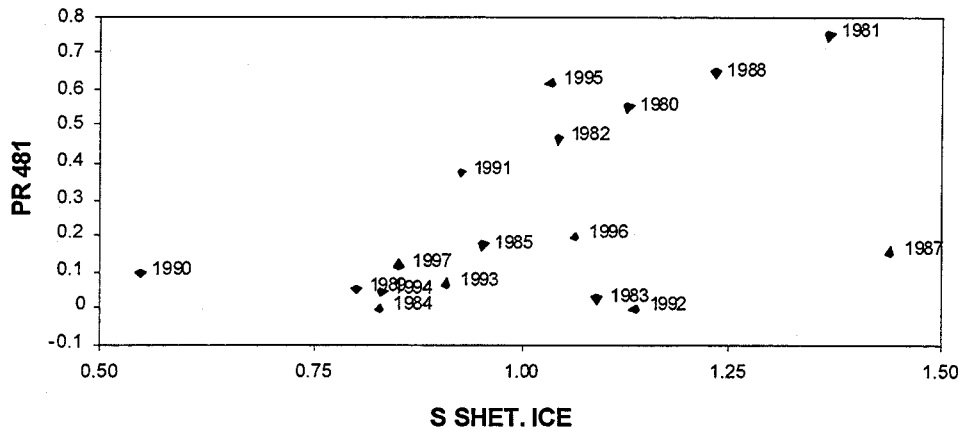


Figure 39: The relationship between proportional krill recruitment in Subarea 48.1 and sea-ice in the South Shetlands. Each point is labelled with the year in which data were collected.

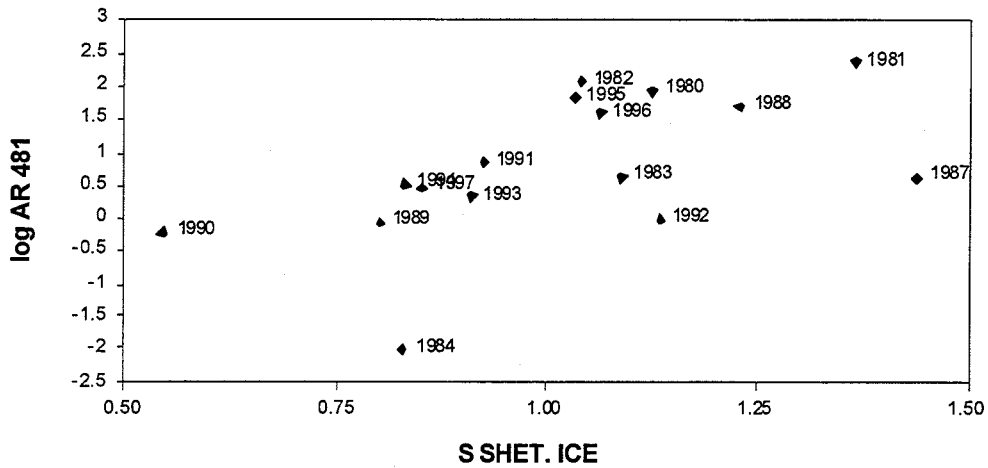


Figure 40: The relationship between the log of proportional krill recruitment in Subarea 48.1 and sea-ice in the South Shetlands. Each point is labelled with the year in which data were collected.

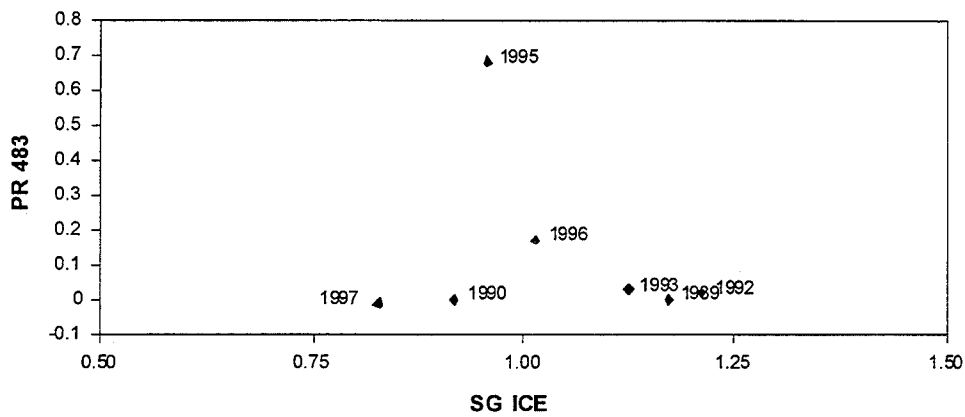


Figure 41: The relationship between proportional recruitment in Subarea 48.3 and the South Georgia sea-ice index. Each point is labelled with the year in which data were collected.

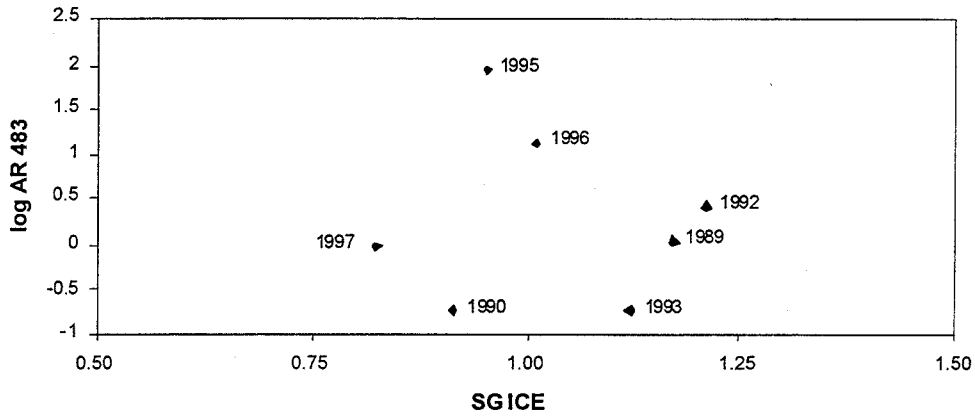


Figure 42: The relationship between the log of proportional recruitment in Subarea 48.3 and the South Georgia sea-ice index. Each point is labelled with the year in which data were collected.

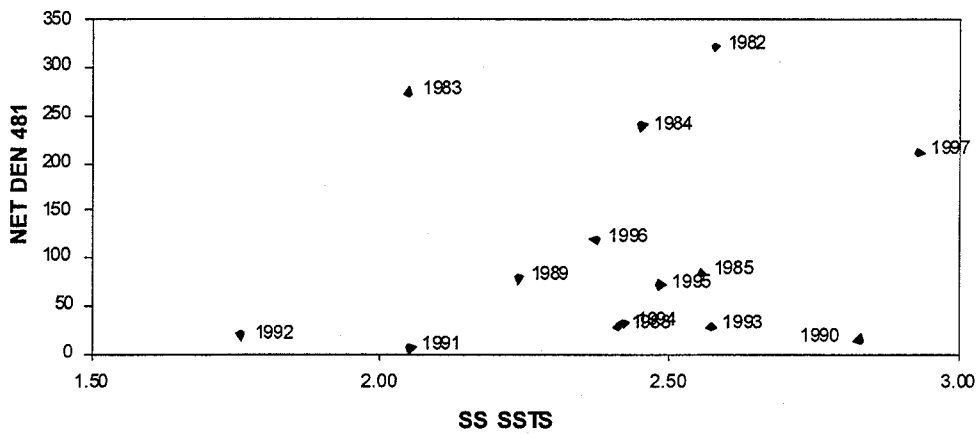


Figure 43: The relationship between krill density determined using net sampling in Subarea 48.1 and the Scotia Sea summer SST. Each point is labelled with the year in which data were collected.

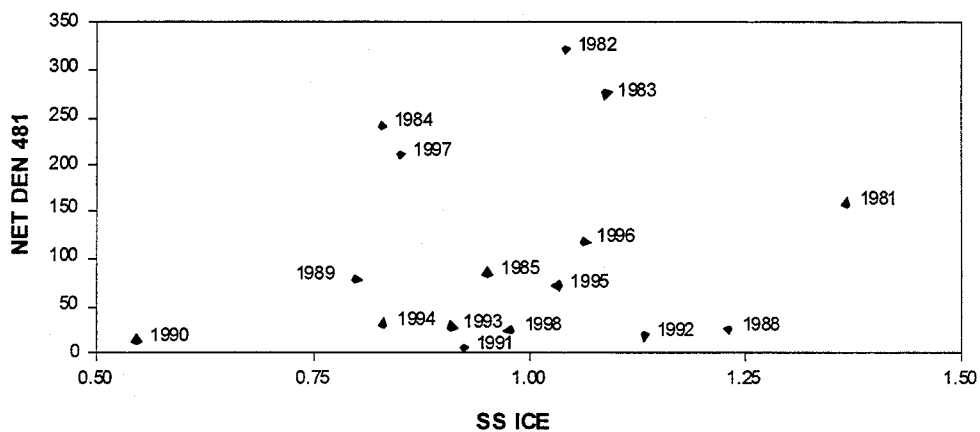


Figure 44: The relationship between krill density determined using net sampling in Subarea 48.1 and the Scotia Sea sea-ice index. Each point is labelled with the year in which data were collected.

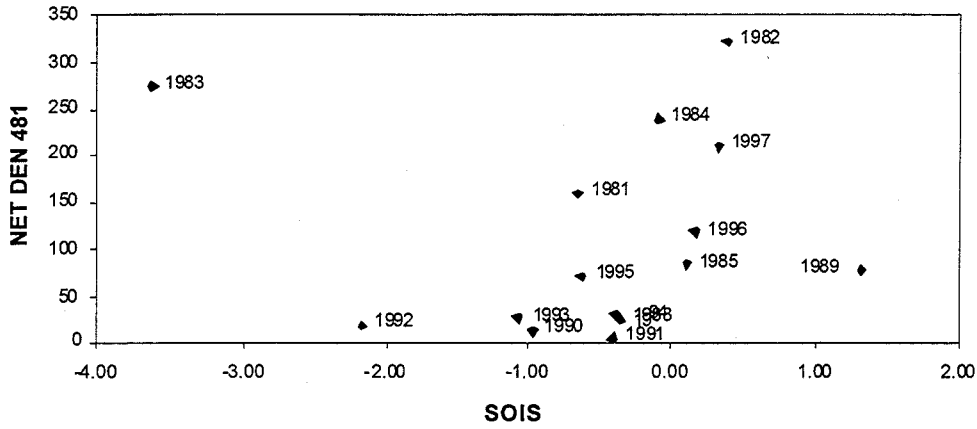


Figure 45: The relationship between krill density determined using net sampling in Subarea 48.1 and the summer SOI. Each point is labelled with the year in which data were collected.

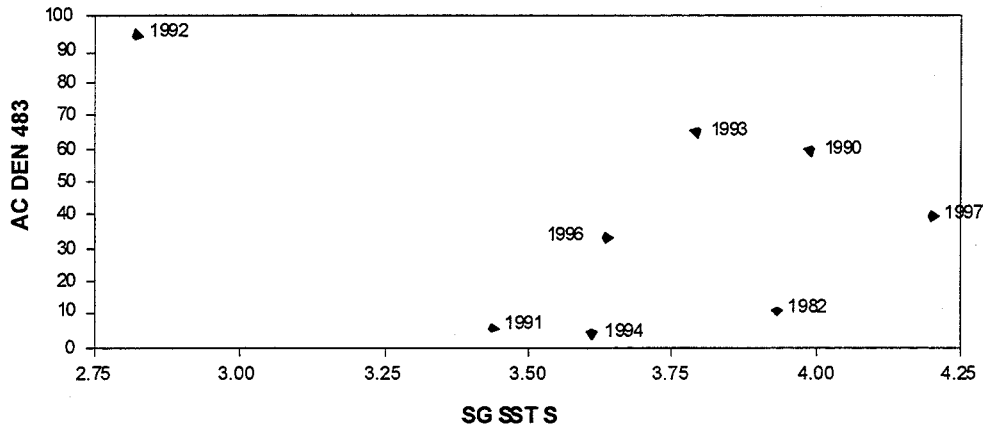


Figure 46: The relationship between krill density determined using acoustic sampling in Subarea 48.3 and the South Georgia summer SST. Each point is labelled with the year in which data were collected.

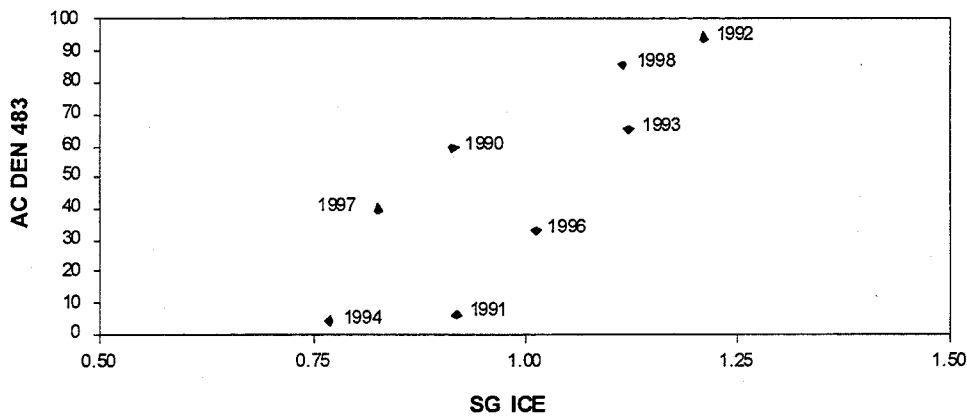


Figure 47: The relationship between krill density determined using acoustic sampling in Subarea 48.3 and the South Georgia sea-ice index. Each point is labelled with the year in which data were collected.

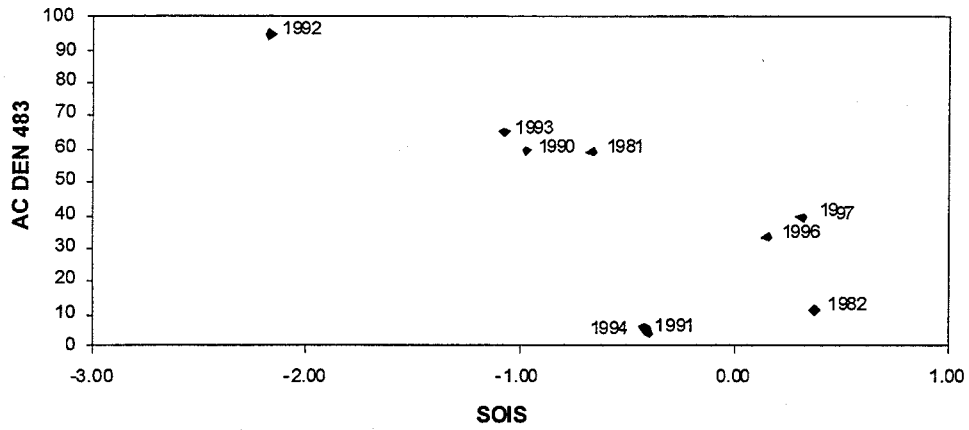


Figure 48: The relationship between krill density determined using acoustic sampling in Subarea 48.3 and the summer SOI. Each point is labelled with the year in which data were collected.

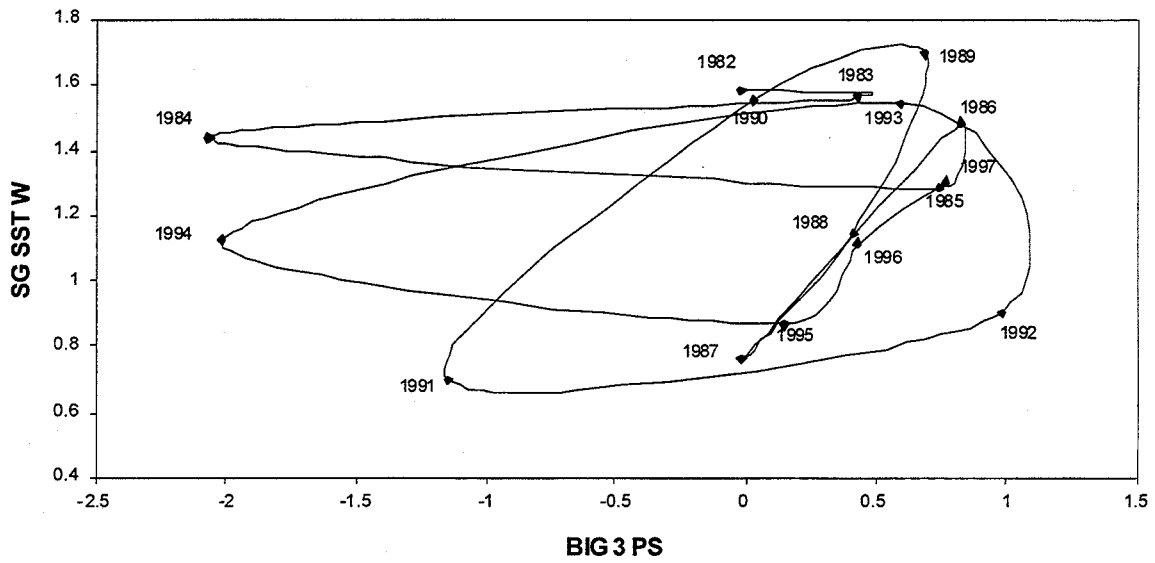


Figure 49: The relationship between the South Georgia winter SST index and the combined index of diving predators at Bird Island in summer. Each point is labelled with the year in which data were collected and they are connected in date order.

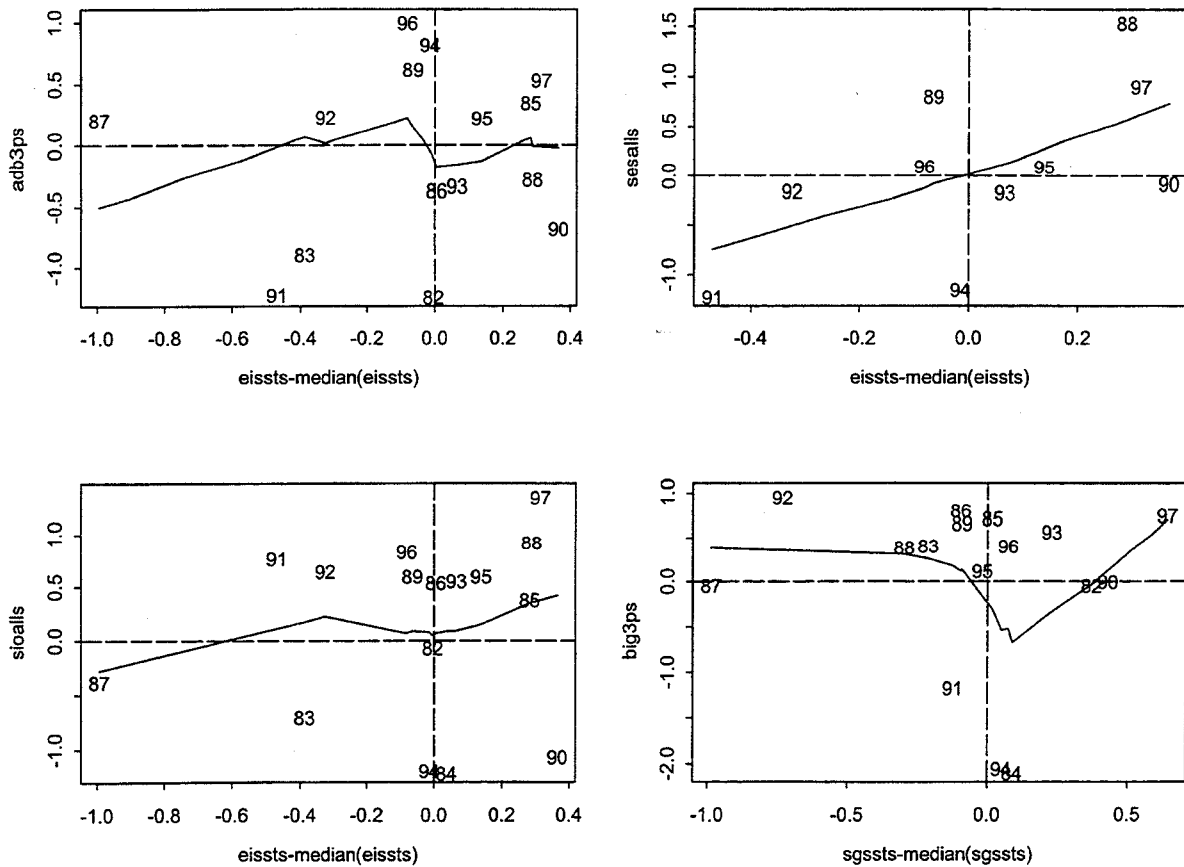


Figure 50: Predator performance indices in relation to SST within areas. Each index is expressed relative to its median value. Four quadrants are shown that indicate concordance between variables in each year. Points in the top-right and bottom-left quadrants indicate relatively high concordance whereas those falling in the other two quadrants indicate relatively low concordance. Points are denoted by the number of the calendar year.

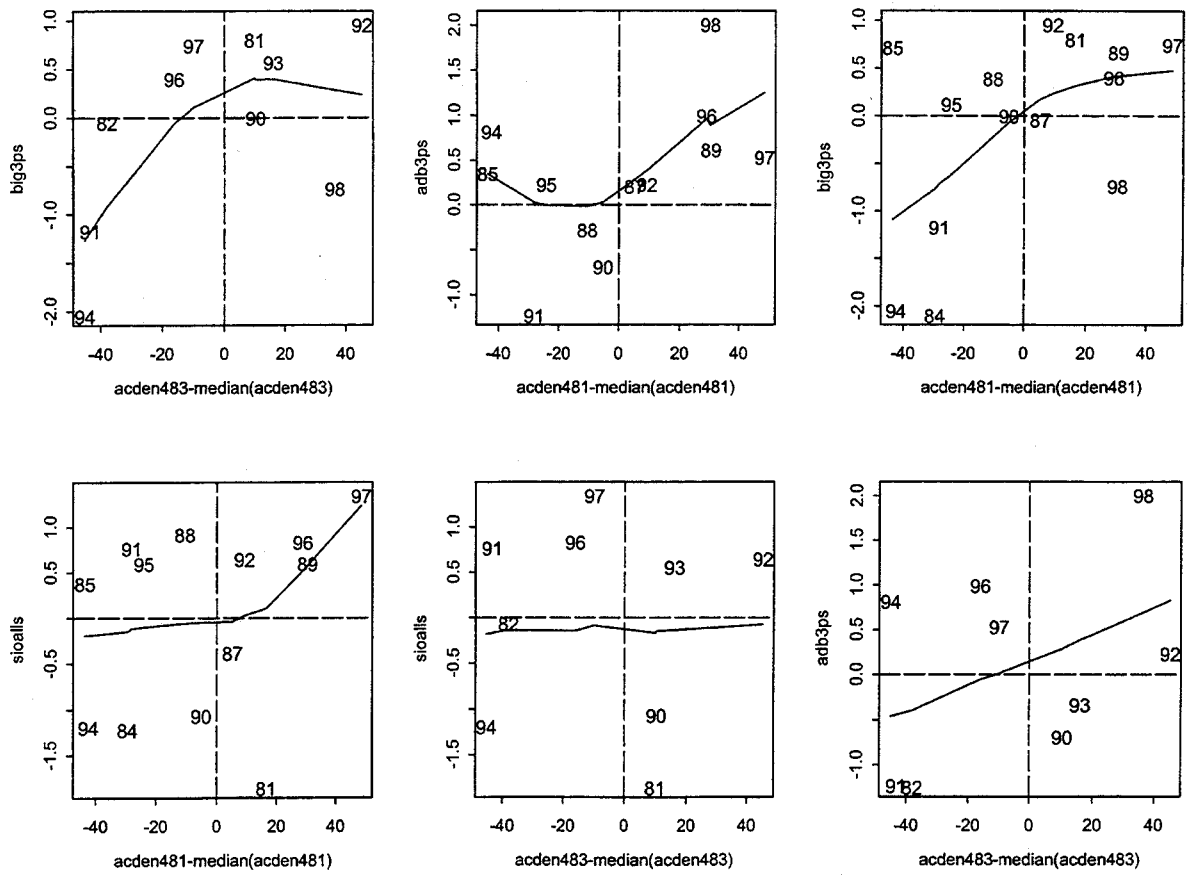


Figure 51: Predator performance indices in relation to acoustic krill density within areas. Each index is expressed relative to its median value. Four quadrants are shown that indicate concordance between variables in each year. Points in the top-right and bottom-left quadrants indicate relatively high concordance whereas those falling in the other two quadrants indicate relatively low concordance. Points are denoted by the number of the calendar year.

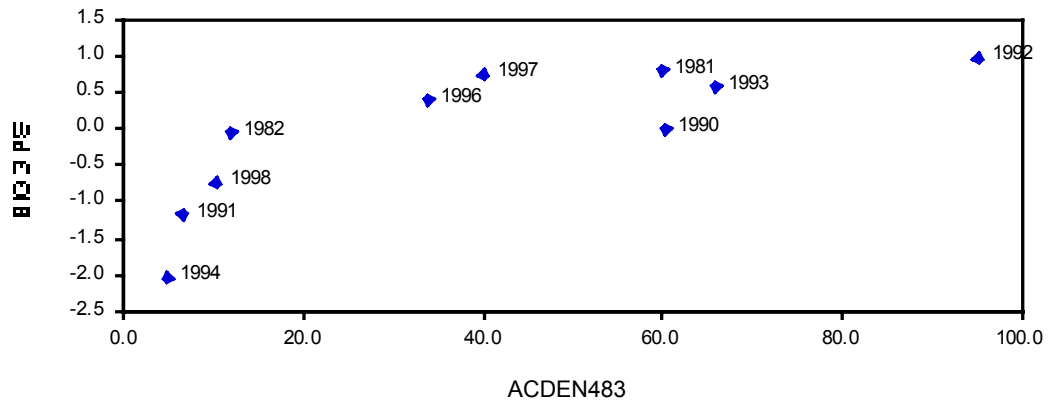


Figure 52: Composite index of the summer performance of diving predators at Bird Island in relation to the acoustic density of krill recorded in the South Georgia area (Subarea 48.3).

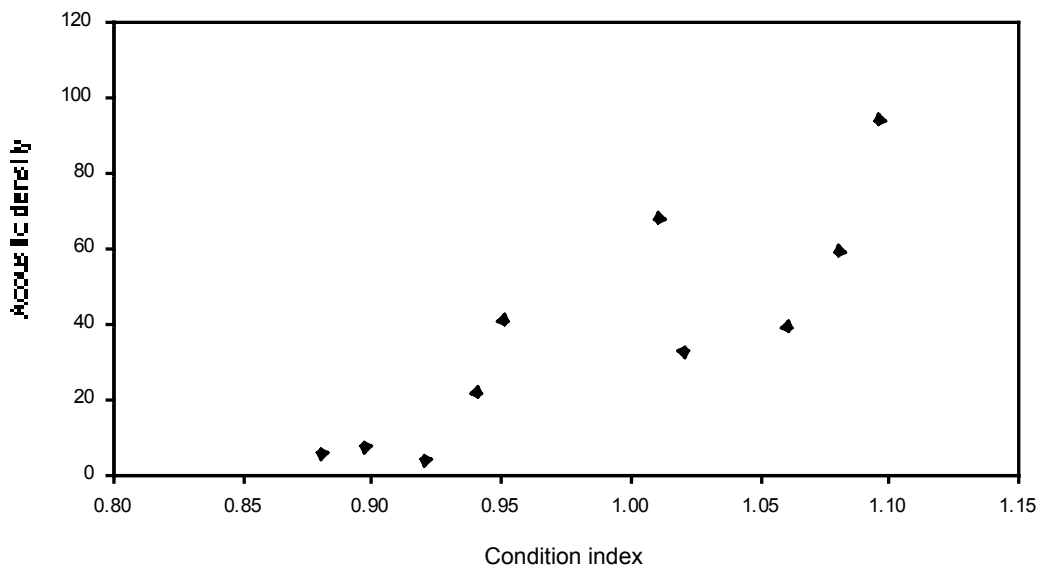


Figure 53: Icefish condition index in relation to acoustic density of krill based on combined data from Subareas 48.1 and 48.3.

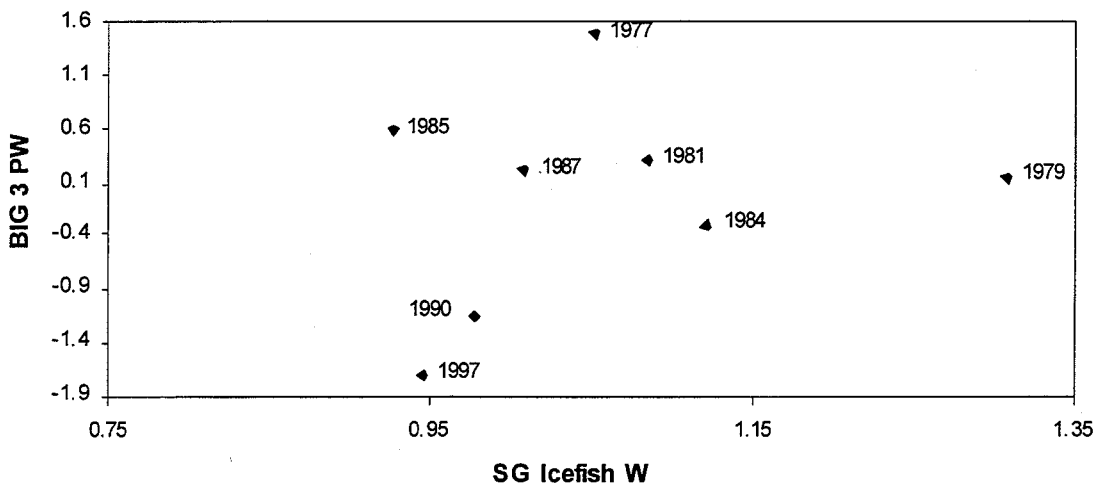
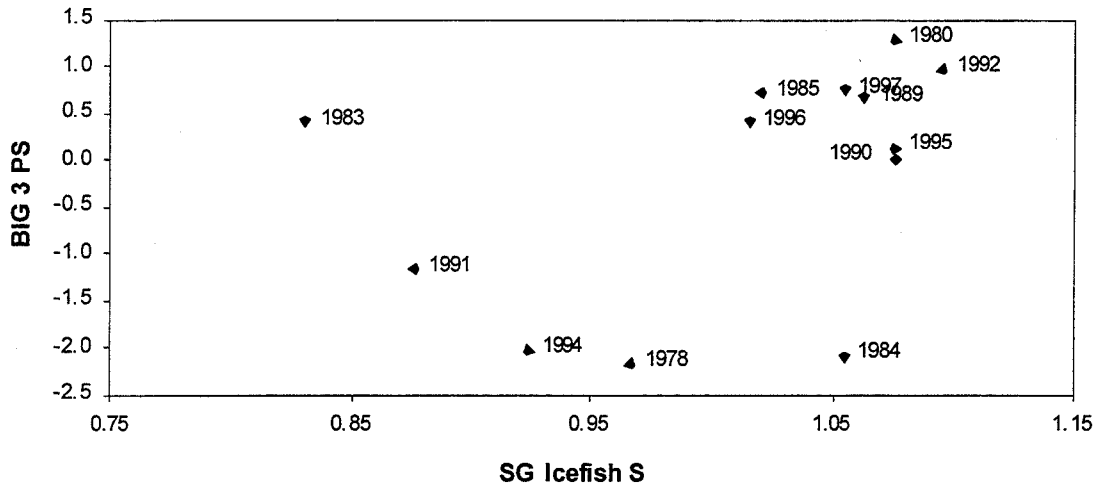


Figure 54: Relationship between the CSI for icefish at South Georgia (SG) in summer (S) and winter (W) and the CSI for gentoo and macaroni penguins and Antarctic fur seal in summer (BIG 3 PS) and winter (BIG 3 PW).

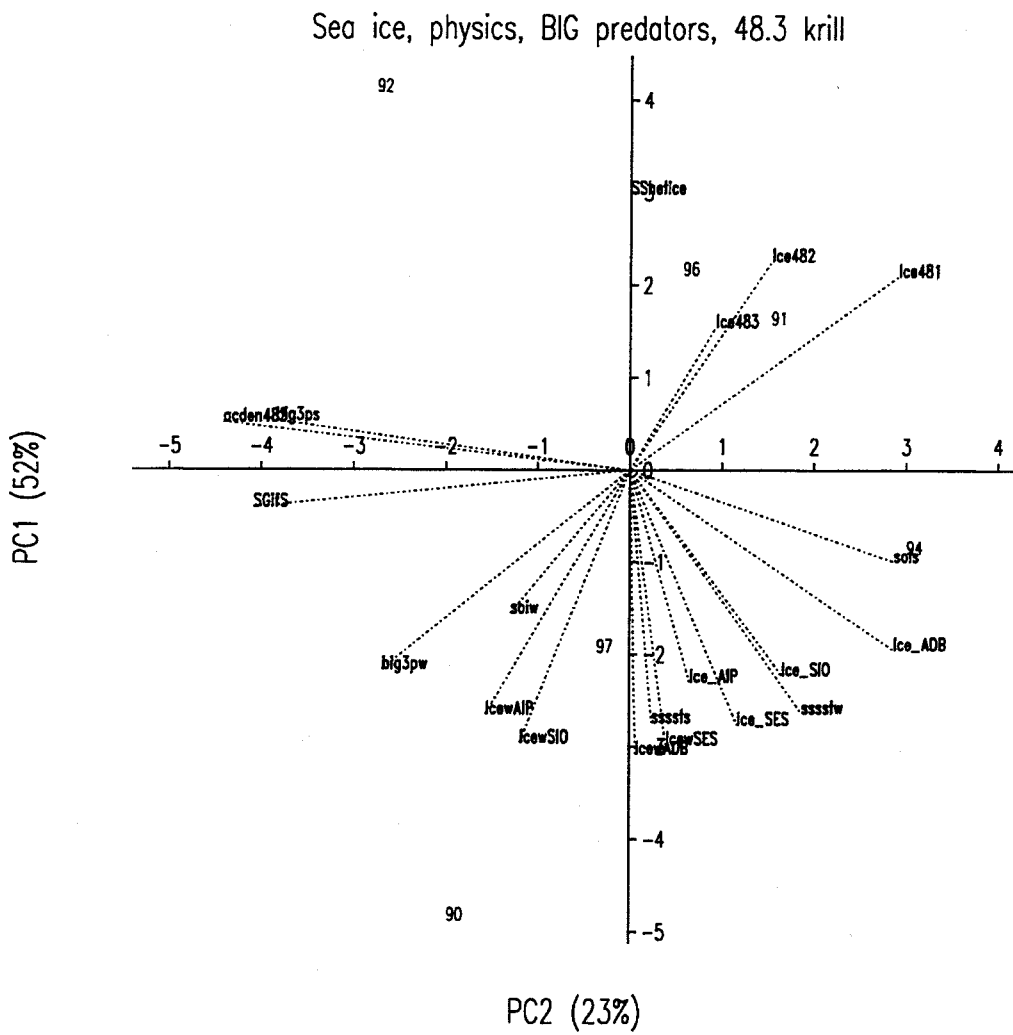


Figure 55: The first two components from a PCA of selected variables. Variables are represented by vectors and points to represent years (indicated by the year in which the season ended) from 1989/90 to 1996/97 but omitting 1992/93 and 1994/95 when no acoustic survey data are available.

AGENDA

Workshop on Area 48
(La Jolla, USA, 15 to 26 June 1998)

1. Introduction:
 - 1.1 Discussion of, and agreement to, the policy regarding data ownership, sharing, collaboration and authorship.
 - 1.2 Description of local facilities and infrastructure for accessing datasets and using analytical tools.
 - 1.3 Discussion of, and agreement to, work timetable and output of workshop.
 - 1.4 Appointment of subgroup coordinators and rapporteurs.
- 1a. Presentation of background material with a particular emphasis on Area 48.
2. Presentation and discussion of indices.
- 2a. Presentation and discussion of methods for combining indices and integrating indices, and solutions for handling missing values in datasets.
3. General discussion including elaboration of hypotheses from the work of subgroups:
 - 3.1 Evaluation and comparison of indices and, in some cases, the underlying datasets.
 - 3.2 Identification of solutions for handling missing values in datasets.
4. Presentation and discussion of the results from the subgroups, including graphic displays, summaries of analyses and conclusions.
5. Outline report:
 - 5.1 Outline the format and contents of the report.
 - 5.2 Delegate work for writing sections and generating graphs.
6. Write report.
7. Adopt report.

LIST OF PARTICIPANTS

Workshop on Area 48
(La Jolla, USA, 15 to 26 June 1998)

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LIST OF DOCUMENTS

Workshop on Area 48
(La Jolla, USA, 15 to 26 June 1998)

- WS-Area48-98/1 Provisional Agenda for the 1998 Workshop on Area 48
- WS-Area48-98/2 List of Participants
- WS-Area48-98/3 List of Documents
- WS-Area48-98/4 Do krill and salp compete? Contrary evidence from the krill fisheries (*CCAMLR Science*, in press)
S. Kawaguchi (Japan), W.K. de la Mare (Australia), T. Ichii and M. Naganobu (Japan)
- WS-Area48-98/5 Relationships of Antarctic krill (*Euphausia superba* Dana) variability with westerlies fluctuations and ozone depletion in the Antarctic Peninsula area
(*Journal of Geophysical Research*, submitted)
M. Naganobu, K. Kutsuwada, Y. Sasai and S. Taguchi (Japan)
- WS-Area48-98/6 A method for providing a statistical summary of CEMP indices
I.L. Boyd and A.W.A. Murray (UK)
- WS-Area48-98/7 Ecosystem monitoring and management, past, present and future
I. Everson (UK)
- WS-Area48-98/8 Interannual variability of the South Georgia marine ecosystem: biological and physical sources of variation in the abundance of krill
E.J. Murphy, J.L. Watkins, K. Reid, P.N. Trathan, I. Everson, J.P. Croxall, J. Priddle, M.A. Brandon, A.S. Brierley (UK) and E. Hofmann (USA)
- WS-Area48-98/9 Acoustic estimates of krill abundance at South Georgia, 1981–1998
A.S. Brierley, J.L. Watkins, C. Goss, M.T. Wilkinson and I. Everson (UK)
- WS-Area48-98/10 Sea-surface temperature anomalies near South Georgia: relationships with the South Atlantic and the Pacific El Niño regions
P. Trathan and E.J. Murphy (UK)
- WS-Area48-98/11 Concordance of interannual fluctuations in densities of krill around South Georgia and Elephant Islands: biological evidence of same-year teleconnections across the Scotia Sea
A.S. Brierley (UK), D.A. Demer, R.P. Hewitt (USA) and J.L. Watkins (UK)
- WS-Area48-98/12 Indices of predator performance from Signy Island, South Orkney Islands 1979–1997
A.S. Lynnes and A.W.A. Murray (UK)
- WS-Area48-98/13 Indices of predator performance from South Georgia 1976–1998
D.R. Briggs, K. Reid, J.P. Croxall, I.L. Boyd and D.J. Brown (UK)

- WS-Area48-98/14 Combined indices of predator performance at South Georgia 1976–1998
K. Reid, D.R. Briggs, I.L. Boyd and J.P. Croxall (UK)
- WS-Area48-98/15 Krill population dynamics at South Georgia 1991–1997, based on data from predators and nets
K. Reid, J.L. Watkins, J.P. Croxall and E.J. Murphy (UK)
- WS-Area48-98/16 Environmental variability and the behavioural dynamics of Antarctic fur seals in the South Atlantic
I.L. Boyd (UK)
- WS-Area48-98/17 Diet, provisioning and productivity responses of predators to differences in availability of Antarctic krill
J.P. Croxall, K. Reid and P.A. Prince (UK)
- WS-Area48-98/18 Antarctic fur seal (*Arctocephalus gazella*) pup growth rates obtained at Cape Shirreff, Livingston Island, South Shetlands: 1994/95 to 1997/98 (CEMP index C2, procedure B)
R. Huccke-Gaete, V. Vallejos and D. Torres (Chile)
- WS-Area48-98/19 Variation in condition of the mackerel icefish (draft only for discussion at Area 48 Workshop)
I. Everson (UK) and K.-H. Kock (Germany)
- WS-Area48-98/20 Population structure and recruitment indices of *Euphausia superba* around South Georgia
J.L. Watkins (UK)
- WS-Area48-98/21 IWC whale data indices for CCAMLR Area 48 Workshop
S. Reilly, C. Allison, H. Kato and D. Borchers
- Other documents:
- WG-EMM-98/4 Rev. 1 CEMP indices 1998: summary of anomalies and trends
Secretariat
- WG-EMM-98/5 Draft revision of the fishery–foraging overlap model
Secretariat
- WG-EMM-98/6 Draft development of standard methods for environmental data
Secretariat
- WG-EMM-98/7 Draft report on fine-scale krill data for the 1996/97 season
Secretariat

DATASETS AVAILABLE TO THE WORKSHOP ON AREA 48

PHYSICAL ENVIRONMENT DATASETS

- Sea-ice extent (passive microwave imagery)
 - South Shetland Islands
 - Methods
 - Monthly estimates of ice cover (1979–1997)
 - Annual indices of ice cover spatial and temporal extent (1979–1997)
 - South Orkney Islands
 - Methods
 - Monthly estimates of ice cover (1987–1997)
 - Annual indices of ice cover spatial and temporal extent (1987–1997)
 - South Georgia
 - Methods
 - Monthly estimates of ice cover (1987–1997)
 - Annual indices of ice cover spatial and temporal extent (1987–1997)
 - Scotia Sea
 - Methods
 - Monthly estimates of ice cover (1987–1997)
 - Annual indices of ice cover spatial and temporal extent (1987–1997)
- Air temperature at Palmer Station
 - Methods
 - Monthly mean air temperature (January 1947–June 1996)
 - Annual mean air temperature (1947–1995)
- Sea-surface temperature
 - Methods
 - Annual SST values and indices at South Georgia (1982–1996)
 - Monthly Pacific El Niño indices and anomalies (January 1974–July 1997)
 - Monthly SST values at Georgia Basin (38°5'W, 51°5'S, November 1981–December 1997)
 - Monthly SST values at South Georgia East Cell (34°5'W, 54°5'S, November 1981–December 1997)
 - Monthly SST values at South Georgia West Cell (38°5'W, 53°5'S, November 1981–December 1997)
 - SST anomalies for February and September at South Georgia (1982–1997)
- Sea-surface temperature and sea-ice at CEMP sites
 - Methods
 - CEMP sea-ice and SST
- Sea-level pressure gradient across Drake Passage
 - Methods
 - Sea-level pressure gradient across Drake Passage (1982–1993)
- Sea temperatures near Elephant Island from US AMLR program
 - Average CTD temperatures at 4 100 and 500 m

BIOTIC ENVIRONMENT DATASETS

- Chl-*a* concentrations near Elephant Island
 - Integrated Chl-*a* over entire US AMLR survey area
 - Chl-*a* concentration for shelf area between Elephant and King George Islands
- Salp abundance near Elephant Island
 - Methods
 - Annual estimates of salp abundance near Elephant Island
- Major zooplankton constituents in the South Shetlands
 - *Salpa Thompsoni*, copepods, *Thysanoessa macrura*, *Themistogaudichaudii* from US AMLR surveys
- Salps and *Thysanoessa macrura* near Elephant Island
 - Methods
 - *Salpa thompsoni* and *Thysanoessa macrura* from German surveys (1976–1997)
- Salps and *Thysanoessa macrura* near South Orkney Islands
 - Methods
 - *Salpa thompsoni* and *Thysanoessa macrura* from German surveys (1976 and 1989)
- Salp abundance near South Georgia
 - Methods
 - Salp abundance from German surveys (1975/76)

KRILL DATASETS

- Krill length distributions
 - US AMLR surveys near Elephant Island
 - Methods
 - Krill length distributions for January of each year (1988–1997)
 - German surveys near Elephant Island
 - Methods
 - Krill length distributions by survey year and quarter (1978–1997)
 - German surveys near South Orkney Islands
 - Methods
 - Krill length distributions (1984, 1988, 1989)
 - German surveys near South Georgia
 - Methods
 - Krill length distributions (1984 and 1988)
- Krill maturity distributions
 - German surveys near Elephant Island
 - Methods
 - Krill maturity distributions by survey year and quarter (1978–1997)
- Krill recruitment indices
 - Elephant Island region
 - Methods
 - Annual estimates of krill density, proportional recruitment and absolute recruitment (1980–1996)
 - South Georgia region
 - Krill recruitment indices near South Georgia (1987–1997)
- Acoustic estimates of krill biomass
 - Elephant Island region
 - Methods
 - Annual estimates of krill density near Elephant Island (1998–1997)
 - US AMLR surveys (1992–1997)
 - South Georgia region
 - Annual estimates of krill density near South Georgia (1981–1998)

- Krill diet samples
 - Methods
 - Krill diet samples from Admiralty Bay penguins by 5 mm size classes
 - Krill diet samples from Admiralty Bay penguins by 1 mm size classes

PREDATOR DATASETS

- Macaroni penguins (*Eudyptes chrysolophus*)
 - Macaroni penguins at Bird Island (CEMP data base)
 - Macaroni penguins at South Georgia
 - Macaroni penguins at Stinker Point and Seal Island (CEMP data base)
- Gentoo penguins (*Pygoscelis papua*)
 - Gentoo penguins at Signy Island (CEMP data base)
 - Gentoo penguins at Bird Island (CEMP data base)
 - Gentoo penguins at South Georgia
 - Gentoo penguins at Signy Island
 - Gentoo penguins at Admiralty Bay
 - Notes on methods used to monitor penguins at Admiralty Bay
- Adélie penguins (*Pygoscelis adeliae*)
 - Adélie penguins at Signy and Laurie Islands (CEMP data base)
 - Adélie penguins at Signy Island
 - Adélie penguins at Anvers Island, Esperanza Station and Stranger Point (CEMP database)
 - Adélie penguins at Admiralty Bay
 - Notes on methods used to monitor penguins at Admiralty Bay
- Chinstrap penguins (*Pygoscelis antarctica*)
 - Chinstrap penguins at Signy Island (CEMP data base)
 - Chinstrap penguins at Signy Island
 - Chinstrap penguins at Seal Island, Stinker Point and Cape Shirreff (CEMP data base)
 - Chinstrap penguins at Admiralty Bay
 - Notes on methods used to monitor penguins at Admiralty Bay
- Black-browed albatross (*Diomedea melanophrys*)
 - Black-browed albatrosses at Bird Island (CEMP data base)
 - Black-browed albatrosses at South Georgia
- Antarctic fur seals (*Arctocephalus gazella*)
 - Antarctic fur seals at Bird Island (CEMP data base)
 - Antarctic fur seals at South Georgia
 - Antarctic fur seals at Seal Island and Cape Shirreff (CEMP data base)
- Krill diet samples
 - Methods
 - Krill diet samples from Admiralty Bay penguins by 5 mm size classes
 - Krill diet samples from Admiralty Bay penguins by 1 mm size classes
- IWC baleen whale surveys
 - Methods
 - IWC/IDCR sightings surveys (1981, 1982, 1983, 1986, 1987, 1989, 1990, 1994)
 - Japanese scouting vessel sightings Surveys (1973, 1975, 1976, 1980, 1981, 1982, 1986)
 - Map IWC/IDCR Survey Effort
 - Map of Japanese scouting vessel survey effort
 - Map of krill distribution by size based on whale stomach samples
 - Minke whale take (1957–1987)
 - Minke whale blubber and Stomach Contents (1976)
- Icefish condition indices
 - Methods
 - Icefish condition index at South Georgia and Shag Rocks
 - Icefish condition at South Shetlands and Elephant Island

SUMMARY INDICES

- Physical Environment
 - Summer sea-surface temperatures, SOI, El Niño indices, DPOI and Palmer air temperature (November–March)
 - Winter sea-surface temperatures, SOI, El Niño indices, DPOI and Palmer air temperature (June–October)
 - Normalised annual ice cover indices for South Shetlands, South Orkneys, South Georgia and Scotia Sea
 - Graph of monthly proportions of ice cover for South Shetlands, South Orkneys, South Georgia and Scotia Sea
 - 4 100 and 500 m temperatures at Elephant Island Zones 1 and 4
- Biotic Environment
 - *Salpa thompsoni*, copepods, *Thysanoessamacrura*, *Themistogaudichaudii*, integrated Chl-*a* for January in the Elephant Island area (1990–1998)
- Krill
 - Krill acoustic and net density, proportional and absolute recruitment for Subareas 48.1 and 48.3
 - Krill CPUE indices
- Predators
 - Summer predator performance at Bird Island, Signy Island, Seal Island, Admiralty Bay and Anvers Island
 - Winter predator performance at Bird Island, Signy Island and Admiralty Bay
 - Baleen whale sightings in Subareas 48.1, 48.2 and 48.3
 - Icefish condition index at South Georgia and Shag Rocks
 - Icefish condition at South Shetlands and Elephant Island

PRINCIPAL COMPONENTS ANALYSIS (PCA)

BACKGROUND

1. Advantages of this method include:
 - (i) a descriptive technique – not formal testing so no requirement for ‘normality’ of underlying distributions;
 - (ii) identification of new ‘synthetic’ variables (principal components) which are linear combinations of the original (standardised, $\mu = 0$, $\sigma = 1$) variables;
 - (iii) summary of most of the variation in a dataset in two or three such principal components (PCs), thereby reducing the ‘dimensionality’ of the data;
 - (iv) works on the correlation matrix of the variables encapsulating their inter-relationships;
 - (v) allows ordering of the observations which can then be compared with known physical or environmental gradients;
 - (vi) displays results in an intuitively easy to understand graph showing both the observations and the original variables (a ‘biplot’); and
 - (vii) methods are available for comparison between PCAs.
2. Limitations include:
 - (i) may not find well-fitting low dimensional solution;
 - (ii) method is ‘linear’ and so may not do full justice to any non-linear patterns in the data;
 - (iii) the more variables are included, the less well the low dimensional solution will fit due to random noise in the variables and consequential weakening of the observed correlations; and
 - (iv) requires a ‘complete’ dataset – any missing observations (columns) result in omission of that unit (row) from the analysis.

APPLICATION TO ANALYSIS OF GENTOO PENGUIN DATA

3. All variables for this species at the Bird Island and Admiralty Bay sites from 1986 to 1998 were used. Population size was included as the difference between population size in successive years.
4. For Bird Island (Figure E.1) the first two principal components comprise 75% and 13% of the overall variation respectively. The first component essentially separates these strong bad years of 1991, 1994 and 1998 and the weak bad years of 1997 and 1990 from the rest.

5. The second principal component indicates some separation between the summer variables (meal mass and breeding success) and the proximate winter variable (arrival date) with the winter/multi-year variable (differential population size) intermediate. This may indicate a degree of difference between the characteristics of some of the good years (e.g. 1998 and 1993).

6. For Admiralty Bay (Figure E.2) the first two principal components comprise 76% and 14% of the overall variation respectively. The first component differentiates the bad years of 1987 and 1991 from the rest. Summer variables (breeding success and its components) are orthogonal to winter variables (survival population change and egg mass). 1986 is also identified as distinctive, probably reflecting the exceptional recruitment failure (low juvenile survival) in this year.

7. Comparing the gentoo penguins at the two sites by direct comparison of their Combined Standardised Index (CSI) scores (Figure E.3) identifies strong similarity in response in the bad year of 1991, good coherence over the years 1988 to 1992 and weaker coherence in 1995 and 1996. The years 1986, 1994 and 1998 (and to a lesser extent 1993) show least coherence essentially opposite responses.

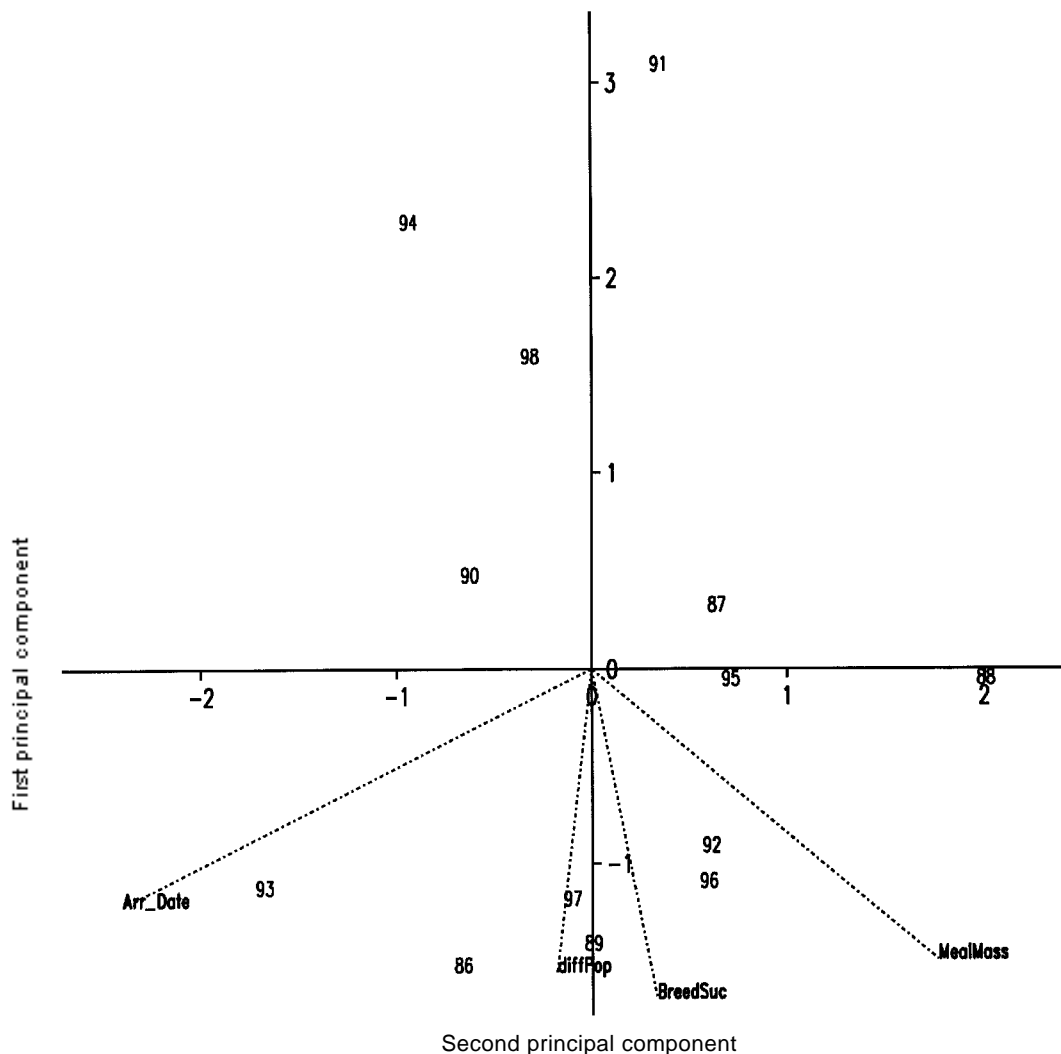


Figure E.1: PCA for Bird Island (BIG) gentoo penguin (PYP) using arrival date (days before 31 December), meal mass, breeding success, and annual change in population size. Variables are displayed as vectors and years as points labelled with the year in which the breeding season ended.

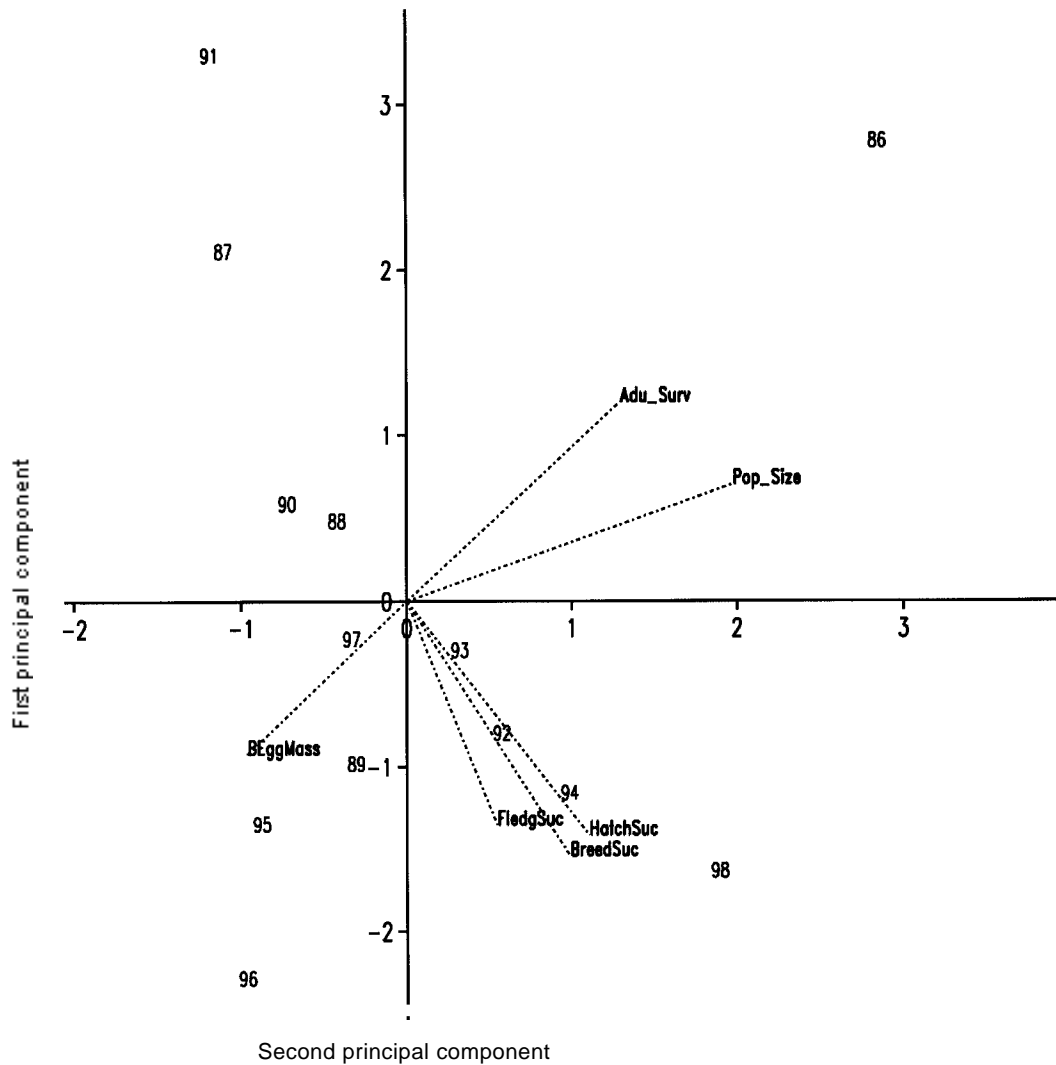


Figure E.2: PCA for Admiralty Bay (ADB) gentoo penguin (PYP) using adult survival, B egg size, hatching, fledging and breeding success, and annual change in population size. Variables are displayed as vectors and years as points labelled with the year in which the breeding season ended.

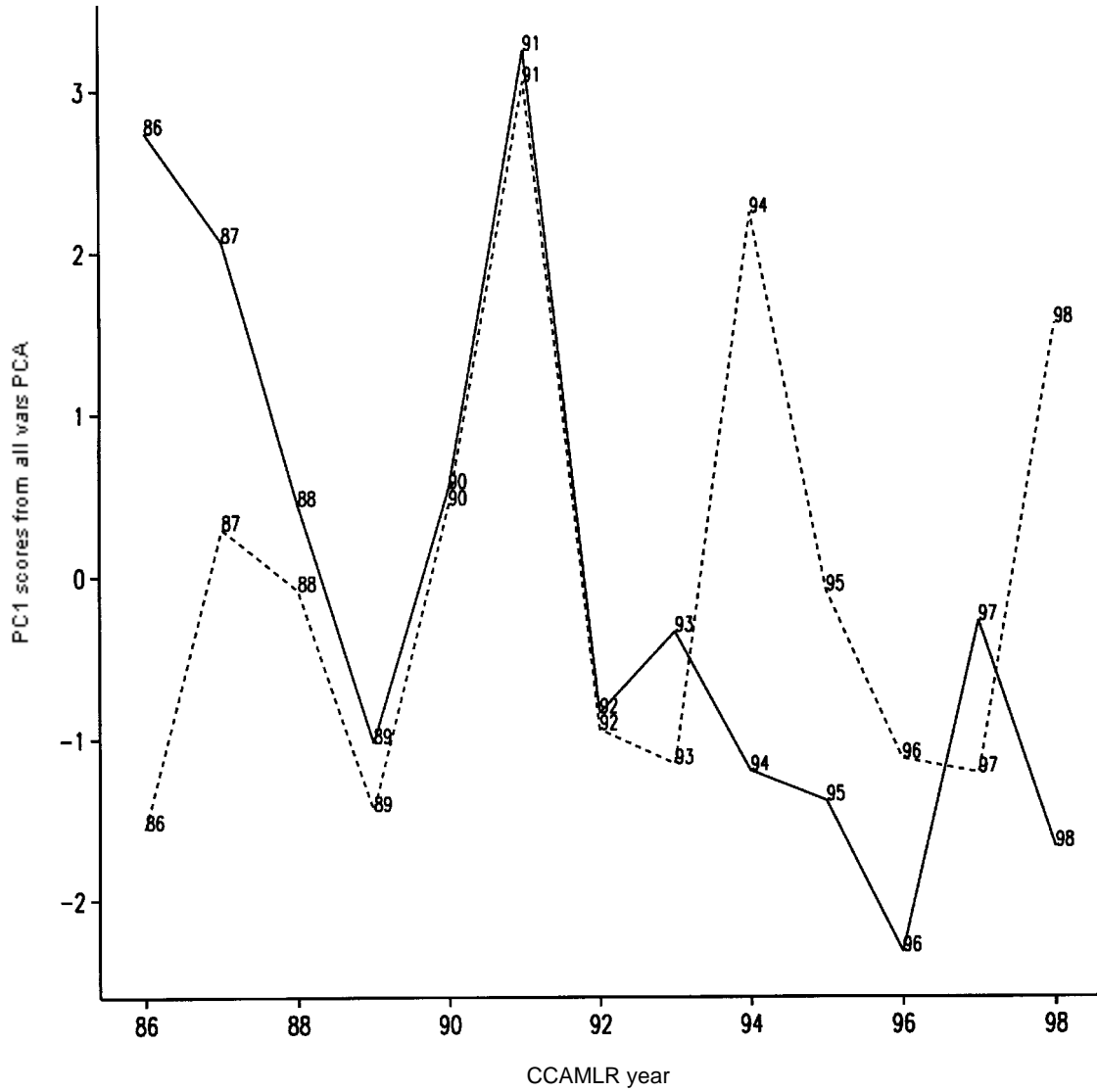


Figure E.3: Plot of the first principal component scores for the analyses shown in Figures E.1 and E.2 against time (year in which the breeding season ended). Solid line for Admiralty Bay (ADB), dotted line for Bird Island (BIG).

**REPORT OF THE WORKING GROUP
ON FISH STOCK ASSESSMENT**

(Hobart, Australia, 12 to 22 October 1998)

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**REPORT OF THE WORKING GROUP
ON FISH STOCK ASSESSMENT**
(Hobart, Australia, 12 to 22 October 1998)

INTRODUCTION

1.1 The meeting of WG-FSA was held at CCAMLR Headquarters, Hobart, Australia, from 12 to 22 October 1998.

1.2 Dr D. Miller (Chairman, Scientific Committee) explained to the Working Group that following the resignation of the Convener, Dr W. de la Mare (Australia), during the intersessional period, Dr R. Holt (USA) had agreed to convene the 1998 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. It was agreed that Subitem 3.6 be renamed 'Developments in Assessment Methods and Scheme for Validating Models' and the following subitems be added:

- 3.7 'Consideration of Management Areas and Stock Boundaries';
- 4.2.11 'Crozet Islands (Subarea 58.6) and Prince Edward and Marion Islands (Subarea 58.7)';
- 9.3 'Convenership of WG-FSA and Coordinator of ad hoc WG-IMALF'; and
- 9.4 'Workshop on *Champscephalus gunnari*'.

It was also agreed to revise the structure and content of Agenda Item 7 'Incidental Mortality Arising from Longline Fishing'. 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 Dr A. Constable and Mr B. Baker (Australia), Dr E. Balguerías (Spain), Mr N. Brothers (Australia), Mr J. Cooper (South Africa), Profs J. Croxall (UK) and G. Duhamel (France), Drs I. Everson (UK), R. Gales (Australia) and S. Hanchet (New Zealand), Mr C. Jones (USA), Drs G. Kirkwood (UK) and D. Miller (Chairman, Scientific Committee), Ms J. Molloy (New Zealand), Prof. C. Moreno (Chile), Dr G. Parkes (UK), Mr M. Purves (South Africa), Drs G. Robertson and G. Tuck (Australia) and G. Watters (IATTC), Mr R. Williams (Australia) and the Secretariat.

2.4 Dr Everson informed the Working Group that it was very sad that Dr K.-H. Kock (Germany), who has regularly attended meetings of WG-FSA and made a major contribution to its work, was unable to participate this year due to ill health. The Working Group recognised that his presence would be missed and wished him a full and speedy recovery.

REVIEW OF AVAILABLE INFORMATION

Data Requirements Endorsed by the Commission in 1997

3.1 The Secretariat's work in support of WG-FSA was summarised in WG-FSA-98/5 and related papers. The Working Group considered this work, and agreed that the list of tasks and actions should be referred to during the meeting, and that specific issues should be addressed under the relevant agenda items. Specifically, priority tasks would be evaluated, and follow-up actions identified in Section 9 of this report. For example, the broadening of the role of technical coordinators to encompass fishery and CEMP data (SC-CAMLR-XVI, Annex 5, paragraph 3.5) required follow-up action, and this matter was referred to the Scientific Committee. As another example, the format of the table summarising the revised catch limits for new and exploratory fisheries in 1998/99 (WG-FSA-98/5, Appendix 1) needed to be revised under Agenda Item 4. In addition, the growing number of tasks in support of ad hoc WG-IMALF may indicate a need to appoint a coordinator to oversee the large amount of work of that group. The Working Group thanked the Secretariat for its work during the intersessional period.

Data Inventory and Developments in the CCAMLR Database

3.2 A large number of computer-based datasets are maintained by the Secretariat to support the work of CCAMLR, and the inventory was presented in WG-FSA-98/8. A long-term aim is to move all datasets into formats supported by a database management system, and to document each dataset in the Secretariat's Dataset User Guide.

3.3 As part of this long-term integration of datasets, the Secretariat is developing an intranet (WG-FSA-98/7). This intranet can only be accessed from within the Secretariat's local area network using a password, and no access outside this network is possible. The intranet will provide a way of distributing and collecting information within the Secretariat using the same infrastructure and technology as those used on internet websites.

Database Data Entry and Validation

3.4 Dr D. Ramm (Data Manager) presented a brief report on the status of data available at the meeting. All of the available fishery, observer and survey data for the 1997/98 split-year, and earlier years, have been entered and validated. However, as in previous years, some datasets have only recently been submitted, and these were being processed in the following order of priority:

- (i) fine-scale catch and effort data to the end of the 1997/98 split-year (one dataset);
- (ii) observer data with complete records (four datasets);
- (iii) remaining fine-scale catch and effort data (one dataset);
- (iv) fine-scale biological data to the end of the 1997/98 split-year (six datasets); and
- (v) remaining data (seven datasets).

3.5 Some data for 1997/98 were either overdue or in the process of being submitted, and these were not available at the time of the meeting (see CCAMLR-XVII/BG/4 Rev. 1, Table 4).

3.6 The Working Group noted that some further problems had been identified with the survey data held in the CCAMLR database. Dr P. Gasiukov (Russia) had found a problem with the dates of samples taken in a UK survey dataset which the Secretariat had sent to him, and Dr Everson identified a further problem with some of the depth records within that dataset.

This was the third year during which problems had been found in transferring survey data from the CCAMLR database to Dr Gasiukov. The Secretariat was asked to investigate and correct these problems.

3.7 The Secretariat was also tasked with the transfer of all available survey data to the newly-designed database (see WG-FSA-98/5, Appendix 2). As part of this task, participants were encouraged to either submit or resubmit recent survey data and support documentation to the Secretariat so that these data could be used in future analyses of the Working Group. Survey data would need to be submitted in a format, and using data codes, compatible with those in use in the CCAMLR database.

Other

3.8 At last year's meeting, the Working Group used estimates of seabed area within two fishing depth ranges as the basis for estimating the amount of potentially suitable substrate available to *Dissostichus eleginoides* and *Dissostichus mawsoni* in regions where new and exploratory fisheries had been proposed. The fishing depth ranges were defined as 600 to 1 800 m for longlining, and 500 to 1 500 m for trawling. Some concern had been raised regarding the method of estimating seabed areas and the Secretariat had been tasked with further priority investigations (SC-CAMLR-XVI, Annex 5, paragraphs 3.13 and 3.14; WG-FSA-98/5).

3.9 Estimates of seabed areas by depth strata were revised, and compared with available information (WG-FSA-98/6). The estimates were derived from the Sandwell and Smith dataset which contained mean depths of 2 x 2 minute grid squares derived from data from satellite altimetry and shipboard soundings. This dataset covered waters within the Convention Area north of 72°S, and was the same dataset as used last year (SC-CAMLR-XVI/BG/17). However, the technique for sampling the Sandwell and Smith dataset had been improved, and modified to take advantage of a higher resolution (1 x 1 minute grid) version of the dataset which is due to be released in late 1998.

3.10 Two other papers presented alternative analyses of seabed areas. WG-FSA-98/14 estimated the surface areas of seabed within the 500 m isobath for waters adjacent to the South Shetland Islands in Subarea 48.1 using the Sandwell and Smith dataset, data collected during the 1998 US AMLR survey, and hydrographic charts from the US Defense Mapping Agency. WG-FSA-98/50 estimated seabed areas within fishing depth ranges for Subarea 88.1 using data from the US National Geophysical Data Center (GEODAS), the US Naval Oceanographic Office, and Sandwell and Smith. Estimates were calculated between 65° and 72°S for comparison with WG-FSA-98/5, and for the entire subarea. Seabed under permanent ice cover was excluded from the analysis of the southern region of Subarea 88.1. Comparison between depths estimated in WG-FSA-98/6 and those reported in WG-FSA-98/14 and 98/50 showed generally good agreement (see WG-FSA-98/6, Table 2).

3.11 While Sandwell and Smith data may be unreliable in shallow areas, the Working Group concluded that seabed areas within fishing depth ranges reported in WG-FSA-98/6 Rev. 1 were adequate for the purpose of estimating the amount of potentially suitable substrate available to *D. eleginoides* and *D. mawsoni* in regions where little information was available. Importantly, catch limits in new and exploratory fisheries were based on the ratio of the fishable area in known regions (e.g. Subarea 48.3) to the potentially fishable area in regions proposed for new and exploratory fisheries, and a consistent method for estimating seabed areas across all regions was essential.

3.12 The Working Group encouraged Members to continue collecting detailed bathymetry data, and to submit these to the Secretariat so as to develop a high resolution bathymetry dataset which could be used to further the knowledge of key species.

Fisheries Information

Catch, Effort, Length and Age Data

3.13 Catches reported from the Convention Area during the 1997/98 split-year (1 July 1997 to 30 June 1998) were presented in SC-CAMLR-XVII/BG/1 Rev. 1 and are summarised in Table 1. These catches included those 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.

3.14 Fisheries prosecuted under the conservation measures in force during the fishing season of 1997/98 were reported in CCAMLR-XVII/BG/4 Rev. 1. Reported catches from all fisheries are summarised in Table 2. The fisheries include:

- (i) trawl fishery for *Euphausia superba* in Area 48 (80 980 tonnes, 10 vessels);
- (ii) trawl fisheries for *Champscephalus gunnari* in Subarea 48.3 (5 tonnes, one vessel – see paragraph 3.16) and Division 58.5.2 (115 tonnes, one vessel – see Table 2);
- (iii) trawl fishery for *D. eleginoides* in Division 58.5.2 (2 699 tonnes, three vessels);
- (iv) longline fisheries for *D. eleginoides* in Subareas 48.3 (3 328 tonnes, 11 vessels); 58.6 (1 tonne, one vessel, outside EEZs) and 58.7 (<1 tonne, one vessel, outside EEZ); and
- (v) longline fishery for *Dissostichus* spp. in Subarea 88.1 (39 tonnes, one vessel).

3.15 Fishing in Division 58.5.2 was continuing at the time of the meeting. The remaining fisheries covered under the conservation measures in force were not prosecuted during the 1997/98 season. These included the new and exploratory fisheries for *Dissostichus* spp. in Subareas 48.6 and 88.2, and Divisions 58.4.3 and 58.4.4. The opening of new longline fisheries for *Dissostichus* spp. in Subareas 48.1 and 48.2 in 1997/98 was conditional on the results of a feasibility survey conducted by Chile. The mean catch rate in each subarea surveyed was below the Commission's criterion of 0.1 kg/hook (CCAMLR-XVI, paragraph 9.29), and the fisheries were not opened. There was no fishing for *Electrona carlsbergi*, *Martialia hyadesi* or crab reported during 1997/98.

3.16 Catches of *D. eleginoides* were also reported by France from the French EEZs around Kerguelen and Crozet Islands (Division 58.5.1 and Subarea 58.6 respectively), and by South Africa for the South African EEZ around the Prince Edward Islands (Subareas 58.6 and 58.7). All catches for *Dissostichus* spp. for the period between the end of the Commission meeting in 1997 and the time of the Working Group meeting are summarised in Table 2, including those for new and exploratory fisheries.

3.17 The fishery for *C. gunnari* in Subarea 48.3 was detailed in WG-FSA-98/53. One Chilean vessel targeted *C. gunnari* using a midwater trawl over 10 days in December 1997 and January 1998. The total catch of *C. gunnari* was 5 tonnes, and fish ranged from 22 to 30 cm in length. The distribution of the target species was patchy, and 67% of the total catch was taken in two tows. The total catch of non-target species was 0.2 tonne. It was not clear whether the poor catches were due to a low standing stock of *C. gunnari*, or the inexperience of the fishing master in locating fishable concentrations of the target species.

3.18 The development of a register of collections of otoliths and scales of *D. eleginoides* is detailed in WG-FSA-98/41. Collections are held by Australia, France, Germany, Spain and the UK.

3.19 The Working Group noted that the Secretariat had completed last year's request (SC-CAMLR-XVI, Annex 5, paragraph 4.304) to enter all available haul-by-haul data from the South African fishery for *D. eleginoides* in Subareas 58.6 and 58.7. The data had been used during the present analyses. The Working Group also noted that the Secretariat had sent a request to Ukraine seeking haul-by-haul data from the Ukrainian fishery in Division 58.5.1 (SC-CAMLR-XVI, Annex 5, paragraph 4.256). Data had been submitted, but problems encountered during processing and validation by the Secretariat remained unresolved (WG-FSA-98/5). The Working Group encouraged follow-up action.

Unreported Catches of *D. eleginoides*

Estimates of Catches of *D. eleginoides* and *D. mawsoni* inside and outside the CCAMLR Area

3.20 The Working Group considered information from various sources in order to be able to estimate the magnitude of catches in the authorised and in the unregulated fishery on *D. eleginoides*. Information was drawn from:

- (i) STATLANT 08A reports;
- (ii) domestic fishery statistics provided by Members;
- (iii) reports of landings in ports of southern Africa and Mauritius from June 1996 to September 1998;
- (iv) reports on fishing vessels implicated as taking part in fishing in various subareas and divisions, available from Commission circulars and national authorities;
- (v) known and estimated fishing capacities of these vessels;
- (vi) catch and effort data from fishing vessels taking part in authorised fishing in the same subareas and divisions; and
- (vii) trade statistics from Japanese and US markets for *D. eleginoides*.

3.21 The information was considered in two parts, the CCAMLR split-year 1997/98 and the period from 1 July to 30 September 1998.

3.22 Reported catches of *D. eleginoides* and *D. mawsoni* and estimates of unreported catches by Members and Acceding States inside and outside the CCAMLR Convention Area are set out in Table 3. Catches for the 1996/97 split-year are shown in brackets. Information on the total catch in EEZs outside the CCAMLR Convention Area was available for most countries with the exception of Uruguay (Table 3). Estimates of unreported catches were available for Argentina, Chile, Portugal, South Africa and Uruguay. Estimates for these countries are based on a crude estimate of the catch and effort of vessels in the Indian Ocean sector. They should therefore be treated with the necessary caution.

3.23 Information on landings by all countries (CCAMLR Members and non-Members) of *D. eleginoides* in Cape Town (South Africa), Walvis Bay (Namibia) and Mauritius was available from South African and French authorities and commercial sources for the 1997/98 season and for the period July to September 1998 (Table 4). Estimates of landings for the 1996/97 split-year were adjusted when it was realised that product weights reported in Table D.2 (SC-CAMLR-XVI, Annex 5, Appendix D) were green weights and should not have been multiplied with a conversion factor. The original product weights were also adjusted using a conversion factor of 1.7 instead of the conversion factor of 1.6 used in the original

analyses. These adjusted landing figures are also shown in Table 4. Main ports for landing in the first half of the 1996/97 season were Cape Town and Walvis Bay, while Mauritius became more and more important from April/May 1997 onwards. From July 1997 onwards the only catches landed in Cape Town were from the regulated fishery. It is estimated that from July 1997 to September 1998 more than 80% of unregulated catches were landed in Mauritius.

3.24 Based on sightings of longliners in various subareas and divisions, their known fishing capacities in some instances, reports of some of their landings and estimates of their catch and effort, the Working Group attempted to estimate the magnitude of the unreported catch in these regions. The information on which these estimates are based is set out in Table 5.

3.25 The estimated unreported catch by subarea/division derived from catch and effort data of sighted vessels is shown in Table 6. In most subareas/divisions, unreported catches accounted for more than 60 to 90% of the estimated total catch derived from catch and effort data. Estimates for the 1997/98 split-year of landings of unregulated catches in Mauritius and Walvis Bay accounted for 25 503 tonnes. This is quite similar to the estimated unreported catch of 22 415 tonnes from the CCAMLR area (Table 6).

Estimated Unreported Catches of *D. eleginoides* for the Generalised Yield Model (GYM)

3.26 Estimates of total catches were required to update the current assessment for *D. eleginoides* in Subareas 58.6 and 58.7, and for those in Divisions 58.5.1 and 58.5.2. Therefore, a more detailed analysis was undertaken to provide a range of catches for the analyses.

3.27 The estimates of total catches of *D. eleginoides* in Subareas 58.6 and 58.7 were revised for 1996 and 1997. The updated estimates of catches are set out in Table 7. Adjusted attribution of the estimated unreported catches for Subarea 58.7 were based on catch rates of the legal fishery, which were substantially lower than the mean catch rates of 7.7 tonnes per day as was used in previous analyses (SC-CAMLR-XVI, Appendix D, Table D.3). It was also noted that landing figures for *D. eleginoides* in Cape Town and Walvis Bay for the 1996/97 split-year had mistakenly been adjusted with a conversion factor despite these totals already representing a green weight figure. This led to an overestimation of unregulated catches taken during this period and attributed to Subarea 58.7. It was further assumed that catches taken in the 1995/96 season were mostly from the Prince Edward Island area. These catches were reapportioned on the basis of the approximate seabed areas in respect of Subarea 58.7 and Subarea 58.6 (mostly Africana Rise). The total catch of 19 233 tonnes of catch taken in Subarea 58.6 in 1997 was based on the observed number of vessels and an estimate of their catch effort. It is assumed that most of this catch was taken around the Crozet Islands.

3.28 Estimates of total catch of *D. eleginoides* for the different subareas or divisions were calculated for the period November 1997 to September 1998 for assessment purposes (Table 8). These figures are based on sightings of longliners in the different areas, their known fishing capacity in some instances, reports of some landings and estimates of their catch and effort.

Estimated Trade in *D. eleginoides* for 1997 and 1998

3.29 Trade statistics for *D. eleginoides* were received from Japan, USA, Chile, Australia, Ukraine and the FAO. From these trade reports it was estimated that about 90% of *D. eleginoides* was exported to Japan and the USA. Other markets include China, Thailand, Taiwan, Uruguay, Spain, Canada and other European markets. No market statistics were

available for these smaller markets. For the 1997 calendar year (Table 9) trade figures were only available for *D. eleginoides* fillets on the Japanese market and total product for the USA market. Assuming that the proportion of products traded on these markets was similar to the more accurate trade figures of 1998, it was estimated that 69 978 tonnes of *D. eleginoides* were traded in 1997 (Table 9).

3.30 From combined trade statistics for 1997 and 1998 it was estimated that at least 60 518 tonnes of *D. eleginoides* were traded in the 1997/98 split-year. The total estimated catch for this period was 50 323 tonnes, 16 698 tonnes from national fisheries (Table 3), 11 210 tonnes from CCAMLR fisheries (Table 3) and 22 415 tonnes from the unregulated fishery (Table 5).

3.31 For 1998 import statistics were available from January to August 1998 for the Japanese market and from January to June for the USA market (Table 10). For this period 33 825 tonnes of *D. eleginoides* were traded. Chile and Argentina were responsible for 58% of this trade.

3.32 The Working Group noted that trade statistics should be treated with the necessary caution as the export sources of product are not necessarily responsible for the catching of the fish. Other anomalies between catch statistics and market figures might be caused by inter-market transfers of product and stockpiling of product in anticipation of better market prices.

3.33 The Working Group noted that estimates of total catch of *D. eleginoides* for the 1996/97 split-year (SC-CAMLR-XVI, Annex 5, Appendix D, Table D.1) of 70 261 tonnes were very similar to the estimated trade in *Dissostichus* spp. of 69 978 tonnes in 1997 (Table 9). It was also noted that catch figures in 1998 were similar to trade statistics for this period.

3.34 The Working Group further noted that catches reported from national and CCAMLR fisheries constituted less than 50% of the *D. eleginoides* trade during the 1997/98 split-year and that this has serious implications for yield estimates both over the short and long term.

WG-FSA Commentary on Estimated Total Removals of *D. eleginoides* and *D. mawsoni*

3.35 In 1997, the Scientific Committee expressed great concern at the continuing high levels of unregulated fishing, especially in the Indian Ocean sector. Such levels were as much as five- to six-times greater than in the regulated fishery and would be likely to affect the sustainability of the *D. eleginoides* stocks being targeted. These unreported catches were taken into account by WG-FSA in developing its management advice on the assumption that unregulated catches for *D. eleginoides* can be brought under control (see discussion in SC-CAMLR-XVI, paragraph 2.13 and associated discussion in paragraphs 5.100, 5.108 to 5.111, 5.130 and 5.138).

3.36 The Working Group noted that the total unreported catch for *Dissostichus* spp. in the Convention Area during 1997/98 was 22 415 tonnes (Table 6). This compared with an estimate of 38 000 to 42 800 tonnes in 1996/97 (SC-CAMLR-XVI, Annex 4, Appendix D, Table D.4). The observed drop in catches between the two years could not be attributed to any particular cause, although it may be speculated that declining catch rates across the Indian Ocean may be a contributing factor. In this context, Table 6 indicated that most unreported catches in 1997/98 were attributed to Division 58.5.1 compared to Subareas 58.6 and 58.7 in 1996/97 (SC-CAMLR-XVI, Annex 4, Appendix D, Table D.4). This would suggest some movement eastward by the unregulated fishery.

3.37 Attention was drawn to the fact that the 1997/98 catches for *D. eleginoides* reported for Walvis Bay and Mauritius (Table 4) were quite similar to the total unreported catches from the

CCAMLR area (Table 3) (paragraph 3.25). This would imply that such catches were being taken from the general region in which these two ports are located and would tend to substantiate the assignment of catches set out in the previous paragraph.

3.38 Comparison of *Dissostichus* spp. trade figures with estimated catches for the 1997/98 split-year (paragraph 3.29) showed that at least 10 000 tonnes remain unaccounted for in addition to the 22 415 tonnes assigned to the unregulated catches for that year. The combined discrepancy between trade figures and total catches was some 10 000 tonnes for 1996/97 and 1997/98 combined. The Working Group agreed that such reconciliation highlighted the points already made in paragraph 3.32.

3.39 The Working Group emphasised that the situation outlined holds serious implications for its efforts to assess the long-term yield of *D. eleginoides* in particular. Provided that unregulated catches can be eliminated and total removals of *D. eleginoides* in the Indian Ocean can be kept at levels close to those calculated for the precautionary catch limits (see Table 19), then the long-term effects of the high levels of unregulated fishing may not be so severe over the 35-year projection employed in the Working Group's assessment procedure. However, such an optimistic forecast may be untenable if, as indicated last year (especially SC-CAMLR-XVI, Annex 5, paragraphs 4.297, 4.299 and 4.308) for Subareas 58.6 and 58.7, total catches have been at such a high level over the past three years as to compromise median unexploited spawning stock biomass in the longer term (see also paragraph 4.154).

3.40 Furthermore, even though trends in CPUE (paragraph 4.153) indicate some short-term effects of the high total catch levels in Subareas 58.6 and 58.7, such effects may be masked if, for assessment purposes, constant median recruitment is assumed and mostly younger fish are caught. Consequently, it was agreed that there is some urgency in the need to investigate the stock-recruitment relationship for *D. eleginoides* in areas where there has been substantial unregulated fishing and for which current yield estimates are low.

3.41 Given that it is unlikely that unregulated fishing will cease immediately, the Working Group agreed that there is a distinct possibility that the *D. eleginoides* fishery will become self-regulating because catch levels and rates will reach levels which are no longer commercially viable. Under these circumstances, several bird populations would be reduced to very low levels. In such a state, this situation may contravene Article II.3(c) of the Convention. Attention would need to be given as to how long, and under what circumstances, *D. eleginoides* stocks would take to recover.

Scientific Observer Information

3.42 The available information collected by scientific observers was summarised for trawl operations (WG-FSA-98/9) and longline operations (WG-FSA-98/10 Rev. 2). International and national scientific observers provided 100% coverage of fishing operations of vessels targeting *Dissostichus* spp. or *C. gunnari* in the Convention Area during 1997/98, and reports and logbook data were submitted from 29 cruises aboard longliners and four cruises aboard trawlers. These cruises covered longlining in Subareas 48.3, 58.6, 58.7 and 88.1, trawling in Subarea 48.3 and Division 58.5.2, and a feasibility longline survey in Subareas 48.1, 48.2 and 88.3. In addition, the observer aboard during the feasibility survey reported on catches taken with pots, and two other observers are presently aboard trawlers fishing in Division 58.5.2.

3.43 The quality of the logbooks submitted this year had improved on previous years and all data had been submitted using the CCAMLR logbook forms, although some data forms were outdated and several lacked some information (e.g. numbers of hooks observed). However, with the fishing season for many fisheries ending on 31 August and delays in the arrival of some logbooks and reports at the Secretariat, there was a high data entry workload immediately

prior to and during the meeting. Eighteen logbooks arrived at the Secretariat within two weeks of the WG-FSA meeting. Of these, eleven arrived during the week leading up to the meeting and nine were from cruises on which the last day of observation was prior to July 1998. By the start of the meeting, eight logbooks from Subarea 48.3, two logbooks from Subareas 58.6 and 58.7 and one logbook from Subarea 88.1 had been entered into the database.

3.44 Whilst the submission of logbooks and reports had improved substantially compared to previous seasons, the Working Group requested that Members be encouraged to ensure that these data and information are submitted to the Secretariat as soon as possible after the observation periods and at least within the time specified in the Scheme of International Scientific Observation. Any problems with meeting the submission deadline should be reported at the earliest opportunity to the Secretariat by the observer technical coordinators.

3.45 At last year's meeting of WG-FSA, a task group was formed to consider comments from scientific observers on the utility and feasibility of data recording forms and procedures currently in use for observations on board longline vessels (SC-CAMLR-XVI, Annex 5, paragraphs 3.33 and 3.34). The group comprised all technical coordinators of national scientific observation programs. The task group has worked intersessionally and collated comments and suggestions received from scientific observers.

3.46 The report of the task group (WG-FSA-98/46) contains summaries of observers' comments submitted to the Secretariat by technical coordinators from Australia, UK and South Africa.

3.47 WG-FSA noted that due to the timing of the submission of observer reports, the task group had not yet been given the chance to consider the comments submitted by observers.

3.48 It was agreed that following the review of observers' comments by WG-FSA and intersessionally by the task group, a number of changes needed to be made to the observers' logbook forms and instructions. These changes would be made with the aim of updating and distributing new logbook forms and instructions by February 1999.

3.49 The Working Group therefore chiefly reviewed comments extracted directly from observer reports, advice received from ad hoc WG-IMALF and other matters raised by meeting participants.

3.50 Some of the observers indicated that they had had difficulties in gaining access to the vessel logbook. They reported that on some occasions the captain or officers prevented access to the logbook.

3.51 Many observers indicated that more space is necessary, in general, to complete the forms. In particular, Form L5 needs additional space.

3.52 Form L3 'Daily Work Schedule of Observers': Most observers found that this form was unworkable and time consuming to complete (see WG-FSA-98/46). Observers commented that it was difficult to divide tasks into time periods. WG-FSA recalled that the purpose of this form was to collect information on the daily work schedule of observers in order to enable the Scientific Committee to decide on allocating priorities to observation tasks on board different types of fishing vessels. It was noted that only a few completed L3 Forms were submitted to the Secretariat in the past. It was recommended that instructions on data recording for this form should be amended to reflect that completing this form should be done at the discretion of the observer for a limited number of days during the cruise. Existing completed forms should be reviewed and summarised intersessionally so that discussion on observer work schedules could take place at the 1999 WG-FSA meeting.

3.53 Form L4 ‘Daily Setting Observations’:

- (i) Many observers felt that it was difficult to accurately record seabird and marine mammal abundance as well as seabird activity at night or when visibility was poor (see WG-FSA-98/46). WG-FSA advised that data recording instructions should be changed to reflect the fact that there is no need to complete this form in full when visibility was low or at night, but that the form should remain in use for research trips. Even at night, however, information on the presence, and, if possible relative abundance of seabirds, especially at-risk species (albatrosses, giant petrels, *Procellaria* petrels) was required.
- (ii) Some observers indicated that it is difficult to record the frequent alterations in course during the set whilst observing from the stern. They felt that space for a pictorial representation of the set pattern extrapolated from the vessels’ record on the GPS would be an improvement.

3.54 Form L5 ‘Daily Hauling Observations’: Observers commented on the wording in the marine mammal interaction section L5(iv), indicating that the current observation area of 500 x 500 m astern did not allow recording observations of marine mammals around the vessel (WG-FSA-98/46). WG-FSA advised that data recording instructions for Form L5 should be amended to cover observations within a radius of 500 m from the hauling site of the vessel.

3.55 Form L5 (vii) ‘Fish Age and Maturity Subsampling’: Some observers felt that for determination of the gonadal maturity stages in *D. eleginoides* the *Scientific Observers Manual* should include visual guidance (drawings/photographs) of the stages (i.e. similar to that of krill). The task force was encouraged to develop guidelines.

3.56 Form L5(v) ‘Seabird By-catch’: Observers proposed that there could be space for recording incidental mortalities or injuries of seabirds caused by collision with the vessel (WG-FSA-98/46). WG-FSA advised that there was a provision in the Form L5(v), (‘Cause of Injury’) to record this information but might be simplest to have details of observations such as this recorded in the observer’s cruise report.

3.57 The Working Group welcomed the offer made by Dr Robertson to review the logbook forms, based on his recent experiences observing longline operations on board a number of vessels using Spanish and autoliner systems. Comments received intersessionally from Dr Robertson would also be forwarded to the task group for consideration.

3.58 For the present, Dr Robertson noted that the description of the longline fishing gear and the illustration of its deployment were insufficiently detailed for assessing its likely performance, especially in relation to seabird by-catch issues. It would be desirable to have more detail of certain elements of the gear and better (and larger) illustration of its configuration.

3.59 The Working Group identified some additional potential tasks for observers in relation to fish work.

- (i) Better description of the type of processing, i.e. headed, gutted and/or tailed product.
- (ii) Although samples of scales of *D. eleginoides* are useful for age determination, these have rarely been collected. This task could be carried out more frequently with little effort.

3.60 Ad hoc WG-IMALF expressed concern over a number of aspects of the execution and reporting of observations on seabird by-catch:

- (i) Location (vantage point) of observation. During hauling it is vital that observers have an unhindered view of the line from the time it breaks the surface to coming on board as it is hauled in and can include in their records birds lost before they are brought on deck. Specification of vantage position and whether by-catch observations relate to all birds, or only those brought on deck, are needed.
- (ii) Recording of hauling observation time. This needs clearly defining as time spent actually observing the line being hauled (rather than the time span over which sample observations are made) (see WG-FSA-98/46 Addendum).
- (iii) Proportion of time devoted to observation of seabird by-catch. Judging from the reported percentages of observed hooks (see e.g. WG-FSA-98/10 Rev. 2, Table 6), this ranges between 1 and 100%, with a mean value across all vessels of 24% (range 1–57%) for Subarea 48.3 and 61% (range 18–100%) for Subareas 58.6 and 58.7. Some of the values and differences between subareas may reflect different reporting bases (see subparagraph (ii) above). Nevertheless, observing less than 40 to 50% of the line-hauling operation may well yield unrealistic estimates of seabird by-catch.

3.61 The Working Group recognised the physical and practical difficulties for observers of spending long periods in exposed vantage points in order to acquire accurate records of seabird by-catch. It urged vessel owners and captains to provide as much protection as possible for observers against adverse weather conditions. It also believed that some Members were experimenting with the use of video recording to provide observers with a continuous uninterrupted view and record of line hauling. The use of such techniques should be further investigated (as they might greatly improve the amount and quality of scientific observer data); Members with relevant experience were urged to report these to the next meeting of the Working Group.

3.62 WG-FSA re-emphasised the importance of developing electronic forms and formats for the submission of observer data (see SC-CAMLR-XVI, Annex 5, paragraph 10.11). It requested the Secretariat to develop appropriate programs which could be distributed to all Members.

3.63 The Working Group recognised that simple programs for data entry, particularly for use in the field (see SC-CAMLR-XVI, Annex 5, paragraph 10.11) might also be useful, particularly with some types of fish data. However, it felt that real-time field data entry might not be appropriate for the collection of seabird information, as the time taken to enter data might reduce substantially the time an observer could spend making the actual observations.

3.64 Specifically, Dr Ramm was tasked with the development of a stand-alone database which would contain the essential elements of the CCAMLR observer database, and could be used on laptop computers commonly carried by scientific observers. The database should include the observer data forms and instructions, CCAMLR codes and basic validation routines. Such systems are already in use by some national observer programs, and participants were encouraged to submit details to the Secretariat so as to facilitate the development of a standard CCAMLR system.

3.65 Amendments to the method proposed last year by Mr J. Ashford (UK) and Prof. Duhamel for sampling *D. eleginoides* in a longline fishery (WG-FSA-97/4) were provided in WG-FSA-98/60.

3.66 This longline sampling method allows for the randomised sampling of a number of sections of the longline, with the objective of providing an unbiased random sample of fish on the longline and allowing statistical analysis of inter- and intra-line differences. While the method proposed has many advantages, it was found that single observers who had a number of other tasks additional to measuring fish were restricted in their ability to apply the method

due to time constraints. An alternative was proposed in WG-FSA-98/58 whereby observers adopted a sampling protocol in which samples would be taken at random over the duration of line haul. The expected duration of line haul would be divided into hourly or half-hourly periods, two periods being chosen at random for sampling the catch and two for recording events on deck. The result would be a dataset of random samples of fish from each haul which did not have power for intra-haul statistics but did allow inter-haul comparisons. Some flexibility would be required with this system as fishing operations would not be identical on all vessels.

3.67 The Working Group noted that in WG-FSA-98/58 scientists applying the methodology of WG-FSA-97/4 found that single observers, with a number of other tasks in addition to measuring fish, were restricted in their ability to apply the method due to time constraints.

3.68 The Working Group felt that whereas the randomised sampling design proposed might be very appropriate for sampling fish, it might not be adequate to ensure reliable recording of the much rarer events of seabird by-catch. A general concern was expressed over the practicality of applying a random sampling strategy to the way observers carry out their deck observations. Due to the nature of shipboard routines and harsh working conditions of observers, it was felt that a more routine observation pattern might be more feasible for an observer to carry out.

3.69 These views indicated the difficulty of expecting observers satisfactorily to execute the current range of fish and seabird tasks proposed for scientific observers.

3.70 The Working Group re-emphasised earlier advice of WG-FSA and the Scientific Committee that, wherever possible, two scientific observers should be used, one expert in fish work, the other experienced with seabirds. When only one scientific observer could be used there would need to be some clear instruction on work priorities and/or how to subsample within and between the main fish and seabird tasks. Evaluation of existing observer work tasks needs priority attention at the next meeting of the Working Group.

3.71 The Working Group thanked all scientific observers involved in monitoring fisheries in 1997/98 for the great deal of very good work which they had done under difficult conditions. The data and reports had contributed substantially to the analyses of the Working Group. The Working Group particularly acknowledged the efforts made by Mr M. Lewis (UK), scientific observer aboard the ill-fated longliner *Sudur Havid*, which sank while fishing in Subarea 48.3 on 6 June 1998, with the loss of 17 lives. The Working Group also acknowledged the efforts of the captain and crew of the Chilean longliner *Isla Camila* and Mr P. Marshall (UK), scientific observer on board, which rescued the survivors of the sinking.

3.72 The Working Group reviewed the contents of Tables 5 to 7 in last year's report (SC-CAMLR-XVI, Annex 5), and the revised tables in WG-FSA-98/10 Rev. 2. The Secretariat had prepared these revised tables as a priority request from the Working Group (WG-FSA-98/5). These tables were found to contain important information on the types of data available, and the revised format and contents is given in Tables 11 and 12. An evaluation of the vessels' compliance with Conservation Measure 29/XVI and other measures in force, and the crews' awareness of the publication *Fish the Sea Not the Sky*, is given in Section 7.

3.73 Many of the observers' reports contain information on experiments to determine conversion factors from processed to whole weight of *D. eleginoides*. The values determined by the observers are usually different from those used when calculating the catch taken by the vessel and are frequently higher (Table 13).

3.74 This can have a significant effect on the amount of catches reported. Table 13 shows information for all vessels in Subarea 48.3 during the 1996/97 and 1997/98 seasons for which data on vessel's conversion factor, observer-determined conversion factor and reported catch

are all available. This demonstrates that for both these seasons catches calculated using observer-determined conversion factors are about 10% higher than those actually reported from the vessels.

3.75 The Working Group noted that there is no standard methodology available to CCAMLR observers for the estimation of conversion factors, nor is there any standard terminology to describe the processing method used on a vessel. This makes it difficult to assess the validity of the various estimates of conversion factor.

3.76 A subgroup headed by Prof. Duhamel formulated a draft protocol for estimation of conversion factors to be evaluated by observers during the 1998/99 season. In doing this, experience was drawn from some Members' domestic fisheries. This protocol is detailed in Appendix D.

3.77 Last year a request was made (SC-CAMLR-XVI, Annex 5, paragraph 7.9; SC-CAMLR-XVI, paragraph 4.38) to acquire information on the awareness of fishing crews of CCAMLR conservation measures and on the availability and utility of the CCAMLR booklet *Fish the Sea Not the Sky*. A number of observers had commented on these topics. WG-FSA noted that while the level of awareness was good, there was still room for improvement and that some vessels were still unaware of CCAMLR regulations and measures to prevent incidental mortality of seabirds. The Working Group noted that technical coordinators and scientific observers have a vital role to play in ensuring that captains, fishing masters and crew are fully aware of the details of CCAMLR conservation measures in force.

3.78 The presence on board longline vessels of the CCAMLR information booklet was quite low, despite the fact that many copies had been sent to all the relevant fishing Members. The Working Group decided that in addition to the distribution of the booklet to CCAMLR Members and directly to fishing companies, sufficient copies (including in languages appropriate for vessels being observed) should be provided to technical coordinators for passing them on, via scientific observers, to crews of observed vessels.

3.79 WG-FSA commended the training program by Chile for their observers and also for observers from Uruguay (SCOI-98/8), and noted the importance training has for the reliability of the data collected. The Working Group noted that other Members had training programs in place for CCAMLR observers. It was also felt that holding a CCAMLR workshop for training technical coordinators and encouraging Members to send their technical coordinators to the meeting of WG-FSA, would improve their understanding of the data collection requirements and increase the completeness and standard of the data collected.

3.80 Very few observer reports provided any information on the disposal of garbage and fishing gear at sea (Table 7). One vessel (*Lord Auckland*, Subarea 88.1) was reported as returning all non-biodegradable garbage to its home port. Two vessels had plastic bands aboard, one of which (a trawler) was reported to have dumped them at sea in contravention of Conservation Measure 63/XV. Several observers reported the loss of hooks in fish heads, estimated as high as 20% of heads by one observer. No reports of oil spillages were made.

3.81 Ms Molloy informed the Working Group that the publication of the *Identification Guide to Southern Ocean Seabirds*, especially developed for use by scientific observers, is in the final stages of preparation. All illustrations are ready and all language versions of the text have been verified by appropriate specialists. A final progress report on the publication will be submitted by the Delegation of New Zealand at the forthcoming meeting of CCAMLR.

Research Surveys

3.82 The results of the US AMLR bottom trawl survey near Elephant Island and the lower South Shetland Islands in Subarea 48.1 were reported in WG-FSA-98/15 and 98/17. The

survey followed a random stratified design, and tows were made to depths of 500 m from March to April 1998. The survey provided information on the biology of *C. gunnari*, *Chaenocephalus aceratus*, *Chionodraco rastrispinosus*, *Gobionotothen gibberifrons* and *Lepidonotothen squamifrons*, and estimates of biomass for these species and *Notothenia rossii*, *Notothenia coriiceps* and *Lepidonotothen larseni*.

3.83 A longline research survey was conducted by Spain in the southeast Atlantic, including Subarea 48.6 and Division 58.4.4 from October to December 1997 (WG-FSA-98/48). The aim of the survey was to document the relative abundance and biology of *D. eleginoides* near seamounts. Longlines were set across the bathymetry gradient so as to sample a wide range of depths. The abundance and size structure of *D. eleginoides* varied substantially between seamounts, and changes in length with depth were influenced by local topography.

3.84 Results of a feasibility survey conducted by Chile in Subareas 48.1, 48.2 and 88.3 in February and March 1998 were reported in SC-CAMLR-XVII/BG/7 and WG-FSA-98/20. The mean catch rate of *Dissostichus* spp. was low: 19.1 g/hook in Subarea 48.1, 3.0 g/hook in Subarea 48.2 and 5.7 g/hook in Subarea 88.3. Pots were fished between 290 and 1 920 m, and the dominant species caught was *Paralomis anemerae* (mean catch rate: 111 g/pot); the highest catch rate for that species was in Subarea 48.2 (549 g/pot).

3.85 Australia conducted a random stratified trawl survey on Shell Bank and the Heard Plateau in Division 58.5.2 in June 1998. The data allowed a revision of catch limits for *C. gunnari* over the coming two seasons in 1999 and 2000 (WG-FSA-98/54). The survey also indicated that the abundance of *C. gunnari* was substantially lower than that estimated from a survey conducted eight months earlier. The Working Group considered reasons for this, including the possibility that the lower abundance was due to *C. gunnari* aggregating prior to spawning. However, the survey eight months earlier had been conducted during the spawning season, and no clear trend was identified.

3.86 The Working Group found that the information obtained during the longline survey in Subarea 48.6 and Division 58.4.4, and the feasibility survey in Subareas 48.1, 48.2 and 88.3, had made a valuable contribution to the knowledge on *Dissostichus* spp. in regions where new and exploratory fisheries had been proposed. Chile and Spain were thanked for their efforts, and Members were encouraged to conduct further surveys in regions where there was little, or no, information (see also Section 4.1).

Mesh/Hook Selectivity and Related Experiments Affecting Catchability

3.87 No papers on these topics were presented at the meeting. The Working Group identified the need for information on selectivity so as to estimate the potential range of catch rates in new and exploratory fisheries from observations made during surveys.

Status of Fisheries

Resumption of Closed or Lapsed Fisheries

3.88 At its meeting last year, WG-FSA had advised that there was a need for development of a formal procedure for dealing with closed or lapsed fisheries (SC-CAMLR-XVI, Annex 5, paragraphs 4.320 to 4.323). Such a procedure might be similar to those for new and exploratory fisheries. This view was endorsed by the Scientific Committee (SC-CAMLR-XVI, paragraphs 5.150 to 5.152) and the Commission had requested that the Scientific Committee and its working groups continue to work on this (CCAMLR-XVI, paragraphs 10.1 to 10.3).

3.89 In relation to fisheries that had lapsed for reasons not related to conservation concerns, and for which a stock assessment had been conducted previously by the Scientific Committee, Dr Constable noted that one unresolved issue was the currency of the previous assessment (i.e. for how long did the assessment remain valid). This was a matter that had not previously been considered by the Scientific Committee or WG-FSA.

3.90 For ongoing established fisheries, the Scientific Committee customarily conducts a new assessment each year, including assessments of long-term annual yield, and so the issue of the currency of the assessment does not really arise. However, for some lapsed fisheries, e.g. that for myctophids in Subarea 48.3, an assessment had been carried out using the GYM, which at least nominally provides estimates of long-term annual yields. Dr Constable noted, however, that the efficacy of such long-term annual yield estimates had not yet been formally assessed using techniques of management strategy evaluation. The currency of such assessments therefore remains an open question that should be addressed by the Working Group.

3.91 The question of how often lapsed or closed fisheries should be assessed also raises important issues relating to the workload of the Working Group, which has increased substantially over the last two years with the large number of notifications for new or exploratory fisheries. Dr Parkes pointed to the annotations to Item 4 of the WG-FSA agenda, which indicated that in the absence of new data, specific direction for the Scientific Committee or the existence of a fishery or notification for a fishery for a specific stock or area, that stock should not be considered on the agenda. These issues suggest that any formal procedure for resumption of closed or lapsed fisheries should include prior notification and advice from the Scientific Committee as to the date on which a previous assessment for a stock would lapse.

3.92 WG-FSA also noted that the development of a long-term management plan for *C. gunnari* would be highly relevant to the request for developing a formal procedure for closed or lapsed fisheries. This was to have been addressed at the Workshop on *C. gunnari* this year, but that had been postponed. These points would be taken into account when considering terms of reference for a rescheduled workshop (see paragraphs 9.9 and 9.10). Dr Constable noted that the current methods being used for *C. gunnari*, in which an estimate of the long-term yield can be supplemented by calculations of short-term yields if a recent survey had been conducted, might provide a possible solution for dealing with lapsed fisheries, and that this should also be considered by a future workshop on *C. gunnari*.

General Scheme

3.93 The submission by the European Community of a discussion paper on a unified regulatory framework for CCAMLR based on stages of fishery development (CCAMLR-XVII/18) was widely welcomed by WG-FSA. This was viewed as an important initiative, and WG-FSA endorsed the need to develop a framework of this type. The Working Group also agreed with the sentiments expressed in the final paragraph of this document, which indicated that development of such a framework will take some time, and that Conservation Measures 31/X and 65/XII should remain in force until a replacement scheme is adopted.

3.94 In addition to the points raised in paragraph 3.88 above, which relate to the recommencement of closed or lapsed fisheries, discussion of this paper centred around scientific criteria for transitions between the other categories of fisheries. Of particular importance was the transition from a developing to an established fishery. From a scientific point of view, this should only occur when the Scientific Committee has been able to conduct a satisfactory stock assessment. This was the intent of Conservation Measure 65/XII in relation to exploratory fisheries, particularly in respect of the need to continue to classify a fishery as exploratory until such time as sufficient information as set out in paragraph 1(ii) of the conservation measure is available. The Working Group agreed that it is important that any new framework should retain this requirement. Dr Miller emphasised that in his opinion this would

be more consistent with the application of a precautionary approach especially since the proposed framework made it possible to transfer directly to established fishery status immediately following notification.

3.95 The prominence given in the discussion paper to the need for prior notification of intention to fish was strongly endorsed by WG-FSA.

Fish and Squid Biology/Demography/Ecology

Dissostichus spp.

Identification

3.96 Three species of toothfish are known to occur in the Southern Ocean *D. eleginoides*, *D. mawsoni* and *Gvozdarus svetovidovi*; this last species being very rare. The distributions of *D. eleginoides* and *D. mawsoni* probably overlap and consequently it is essential to clearly differentiate between them in commercial catches.

3.97 The following diagnostic features, currently incorporated into the *Scientific Observers Manual*, were discussed:

- (i) Scales on the top of the head. In *D. eleginoides* the top of the head has narrow elongate scale-free areas, whereas in *D. mawsoni* the head is fully scaled forward to the front of the eye. This feature appears to be a good one but experience indicates that it is often difficult to determine the extent of squamation in live fish.
- (ii) Middle lateral line. In *D. eleginoides* this extends forward to the forward end of the ventral fin whereas in *D. mawsoni* it is very short. This feature was considered a good diagnostic feature for live fish.

3.98 In the Ross Sea where the species co-occur, it has been noted that the second dorsal, anal and caudal fins typically have a white margin in *D. eleginoides*. The margins of these fins in *D. mawsoni* are dark. Such differences had not been noted for other regions, but participants were requested to investigate whether this was a good diagnostic characteristic in other areas.

3.99 The otoliths are also clearly distinguishable between species. Otoliths of *D. eleginoides* are elongate with a deep sulcus acusticus and prominent cristae, whereas those of *D. mawsoni* are oval to quadrate in shape and have a much less prominent sulcus acusticus and cristae.

Distribution

3.100 Exploratory fishing for *Dissostichus* spp. in Subareas 48.1, 48.2 and 88.3 reported in SC-CAMLR-XVII/BG/7, indicated that *D. mawsoni* was present around Peter 1st Island, Bellingshausen Sea and north to Elephant Island. *D. eleginoides* was taken around King George Island and in the Scotia Sea. Large numbers of by-catch species such as *Chinobathyscus dewitti*, *Cryodraco antarcticus*, *Macrourus whitsoni* and *Lepidonotothen kempfi* were also caught. These results indicate that there is a significant area of overlap between the two *Dissostichus* species.

3.101 Results from exploratory fishing in 1997/98 indicate that the distributions of *D. eleginoides* and *D. mawsoni* overlap in both the Pacific and the Atlantic Ocean sectors (WG-FSA-98/37 and SC-CAMLR-XVII/BG/7). In these overlap regions both species can be

caught on a single longline. North of the overlap area, the dominant species is *D. eleginoides*, and south of the overlap area, it is *D. mawsoni*. However, individuals of each species do occur outside their normal range.

3.102 The overlap area in Subarea 88.1 is approximately 66° to 68°S, or 120 n miles. Within this region all catches are mixed. However, in Subarea 48.1 the overlap region is further north, around 61° to 63°S.

3.103 The Working Group agreed that information on the distribution should be collated in order to facilitate assessments of new and exploratory fisheries on these species. The information is summarised in Figure 1. It was noted that the pattern of large-scale distribution was likely to vary with time due to variation in major ocean circulation patterns. This topic is discussed further in paragraphs 3.149 and 3.150.

Dissostichus eleginoides

Age Determination

3.104 During WG-FSA-97, Mr Williams had been requested to collate information on collections of toothfish otoliths and scales. This information is summarised in WG-FSA-98/41. Recognising that the list was incomplete, participants agreed to provide further information on samples that had been collected; this listing would lead to a central register to be held at the Secretariat.

3.105 WG-FSA-98/52 describes a study comparing age, estimated from annuli on otoliths, using two different discrimination criteria. The results were reasonably consistent although there were major differences between estimates on the same otolith when applying the different criteria. The CVs were also different, being much lower for C1, the criterion giving the higher readings.

3.106 Radiocarbon dating studies indicate that age determination is consistent with estimates of age from otolith sections (WG-FSA-98/40). Direct comparison between two readers indicated that the difference between readers was less than four years for most otoliths, however, this was equivalent to a 33% error. The results from both these studies indicated that *D. eleginoides* can live for over 40 years. It was noted that the radiocarbon dating method was still under development and that application to deepwater species may be seriously compromised by the time delay for the radionuclides to be carried to the location of the fish.

3.107 WG-FSA-98/23 reported a study on age determination using otoliths that had been baked and sectioned. The samples were from fish caught in Subarea 88.1 and the results fell broadly in line with those from Subarea 48.3. The results indicated that there was no clear difference between the growth rates of male and female fish.

3.108 Some participants reported that from their experience scales provided clearer annuli than otoliths and consequently provided a simpler and more accurate method for age determination. It was recalled that this had been described in WG-FSA-96/42. That paper had noted good agreement between ages estimated from scales and otoliths from the same fish. It had also been noted that annuli in otoliths were frequently indistinct. Participants were encouraged to report their findings on the use of scales and comparisons with otoliths for age determination to the next meeting of the Working Group.

3.109 It was recognised that further work was needed to validate ageing methods to determine the timescale of annulus formation. Studies were described relating microincrement counts to annulus counts, injection of strontium as an otolith marker during tagging experiments and comparisons of scales from tagged fish at the time of tagging and on recapture.

Reproduction

Fecundity

3.110 WG-FSA-98/13 describes a study on the fecundity of *D. eleginoides* on samples from Subarea 48.3. Absolute fecundity is highly size dependent varying from 56 900 to 567 500 over the size range 90 to 170 cm. The relationship to mass is well fitted by a straight line. Relative fecundity was not size dependent, mean 8.19 ± 1.73 (thousands). The study confirmed that two distinct groups of oocytes are typically present in a mature ovary. Immediately prior to spawning the gonadosomatic index was close to 10%.

Maturity

3.111 Concerns raised at WG-FSA-97 prompted two studies on size and age at maturity using data from the observer program. In WG-FSA-98/16 Rev. 1, the von Bertalanffy growth parameters from Aguayo (1992) were used to convert fish size at maturity to age at maturity. Since the growth rates of male and female fish are similar, the differences in L_{m50} are considered to be due to male fish maturing at a younger age than female fish.

3.112 In WG-FSA-98/27, data from the 1996 and 1997 seasons were compared. The data from 1996 for both sexes provide a clear maturity ogive in line with previous studies. The 1997 results for female fish, when the conventional model is fitted, provide a different L_{m50} and a poor fit to the data. An alternative model, which incorporates a component for 'non-response', provides a much better fit to the data. The proportion of fish coming into spawning condition appeared to be increasing as the season progressed. This may indicate that the spawning season was, for some reason, delayed in 1997. It was also considered possible that the result could be due to there being only one spawning period in that year rather than two, one during March/April and the other during July/August, as suggested in WG-FSA-98/58. It was concluded from the study that L_{m50} for males is correctly estimated at 75 to 80 cm and for females 98 to 100 cm.

3.113 Data from the observer program in 1996, 1997 and 1998 in Subarea 48.3 had been used to indicate the depth distribution and spawning patterns of *D. eleginoides*. It is inferred that in addition to a major spawning event in late July/August, there may be a small spawning event in April/May. Observed shifts in mean length of fish with depth were thought to indicate that spawning occurs at around 1 000 to 1 300 m after which the fish may migrate up the slope into shallower water.

Stock Structure

3.114 WG-FSA-98/39 reports on a study at Macquarie Island using DNA microsatellite markers. The loci had 7, 9, 12, 16 and 23 alleles. Two of the loci had P values <0.05 , suggesting that samples from the two sites, Aurora Trough and Grand Canyon, were not homogeneous. Combining the individual probabilities for each locus (0.025, 0.046, 0.244, 0.637 and 0.135) gave the overall low P value of 0.019, again indicating a lack of genetic homogeneity and showing that there were genetic differences between the two sites.

3.115 As part of the same study TIRIS radio-frequency identification tags were used on samples of fish with the following results:

- (i) Aurora Trough – 1 551 tagged, 336 recaptured all from tagging area; and
- (ii) Grand Canyon – 1 081 tagged, 132 recaptured all except one from tagging location.

Only one fish out of a total of 469 recaptures was recaptured outside the ground at which it was released.

3.116 Because many tag recaptures occurred more than one year after initial release and the overall recapture rate approaches 20%, it is unlikely that insufficient mixing of the tagged fish in the general population or insufficient recaptures could be distorting the results.

3.117 The evidence from the tagging studies corroborates the conclusion that, even though the sites were separated by only 40 n miles and are situated on the same topographic feature, there is very little interchange between the sites. Bearing in mind that *D. eleginoides* is an apparently active and predatory fish with pelagic eggs and larvae, the Working Group was surprised that such little interchange was revealed by either the tagging or the DNA studies. If this degree of localisation of *D. eleginoides* stocks at Macquarie Island is confirmed in further studies, and is ultimately found to be applicable to this species in other areas, the assessment of current fisheries will have to be made on a finer geographical scale.

3.118 During the meeting, a report was received that a *D. eleginoides*, tagged in the Falklands/Malvinas area, was recaptured close to Coquimbo in Chile, a distance of several thousand kilometres from its initial tagging location. The Working Group looked forward to receiving information on this and other tagging studies at its next meeting.

3.119 Detailed studies of the otolith chemistry on samples from Heard Island, Macquarie Island, Chile, Falkland/Malvinas Islands, Prince Edward Island and Kerguelen Island were reported in WG-FSA-98/40. Eight elements were consistently above the detection threshold of the laser ablation-inductively coupled plasma mass spectrometer (LA-ICPMS) and of the elements lithium, magnesium, strontium and barium showed significant variation across otoliths. Analyses are still in progress but initial results indicate that lithium concentrations are significantly lower in the cores of otoliths from areas outside, compared to those from within the CCAMLR area.

By-catch

3.120 Results from a research longline cruise reported in WG-FSA-98/48 caught a total of 2 822 *D. eleginoides* (total mass 20.502 tonnes). The by-catch of less than 5% by mass was dominated by *Macrourus carinatus*, 210 individuals with a total mass of 0.53 tonnes.

3.121 Targeted trawl fishing on *D. eleginoides* in Division 58.5.2 produced catches almost exclusively (99.4%) of the target species.

Dissostichus mawsoni

3.122 During the experimental study undertaken in February and March 1998 and reported in SC-CAMLR-XVII/BG/7 most of the fish caught had gonads in maturity stage I, immature, or II indicating that the fish were in a resting condition.

3.123 Information contained in the observer report from the exploratory longline fishery in Subarea 88.1 indicated that 25% of a sample of 849 fish had empty stomachs. The diet was mostly piscivorous with 87% of the stomachs containing fish remains. Of the fish prey, 54% could not be identified, 15% were Macrouridae, 15% Muranolepididae, 10% Channichthyidae and 6% *Pagothenia* spp. The second major item was squid, which formed 10% of the diet. Other prey items included octopus, prawn and crabs, and an unidentified penguin of c. 50 cm.

3.124 There is considerable uncertainty over the growth rate and maximum age of *D. mawsoni*. A study based on 46 fish from McMurdo Sound (Burchett et al., 1984) produced a maximum age of 24 years and a growth curve with the following von Bertalanffy growth parameters: $L_{\text{inf}} = 185.2$; $k = 0.056$; $t_0 = -4.73$. The youngest fish recorded was age 7 and the model fitted the early growth of this species poorly as indicated by the t_0 of -4.7 years. An ageing study of *D. mawsoni* based on 20 fish was carried out by Horn (WG-FSA-98/23). These results indicated a faster growth rate than that of Burchett et al. (1984), but had the same maximum age of 24. The largest specimen so far reported was 2.04 m total length and weighed 162 kg.

3.125 Recaptures from 13 tagged fish at McMurdo Sound suggested growth rates of adult fish averaged 2 to 3 cm per year (WG-FSA-98/49).

3.126 Examination of scales indicates that the scales do not begin to form until the fish are in their second year (WG-FSA-98/49).

Ecosystem Interactions

3.127 During an 18-day period in December 1996 in the Ross Sea, a single Weddell seal caught and consumed about 150 lb (~65 kg) of *D. mawsoni* per night. These fish ranged in mass from 6.5 to 28 kg (WG-FSA-98/49). *D. mawsoni* are known to be preyed on by sperm whales (WG-FSA-98/37 and 98/49).

3.128 Although the fish are neutrally buoyant they do not possess a swim bladder. Neutral buoyancy is achieved by skeletal reduction and the incorporation of a large proportion (10%) of lipid into the body, mostly close to the skin. *D. mawsoni* feed predominantly on *Pleuagramma antarcticum* and deepwater mysids.

Champscephalus gunnari

Standing Stock

3.129 The standing stock estimates of *C. gunnari* around Elephant Island and the South Shetlands from results from a bottom trawl survey in March 1998 are presented in WG-FSA-98/17. Using the seabed area estimates of Kock and Harm (1995), the estimated standing stock was 10 524 tonnes, whereas using the seabed area given in WG-FSA-98/14 the estimate is 8 166 tonnes. A large proportion of female fish were not coming into spawning condition (WG-FSA-98/15) making it difficult to estimate spawning stock biomass.

Length Frequency

3.130 The same paper gave length frequency results. For samples from Elephant Island there was a clear mode at 24 cm total length and a less clearly defined mode at around 35 cm. For samples from South Shetlands there was a clear mode at 28 cm, the second peak in the distribution was less clearly defined at around 34 cm.

Size at Maturity

3.131 Results presented in WG-FSA-98/15 indicate that sexual maturity occurs at a large size in fish from the South Shetlands and Elephant Island in comparison with the South Orkneys,

South Georgia and Kerguelen. The results from Elephant Island were biased upwards because a large proportion of fish large enough to be sexually mature did not appear to be coming into spawning condition.

By-catch

3.132 WG-FSA-98/9 and 98/53 describe catches made by a commercial trawler fishing for *C. gunnari* in Subarea 48.3. Catches of non-target species were low (4%) relative to the catch of *C. gunnari*.

3.133 Targeted trawl fishing on *C. gunnari* in Division 58.5.2 produced 80.5% of the target species. The main by-catch species were *D. eleginoides* (9.0%) and *Channichthysrhinoceratus* (4.2%) (WG-FSA-98/9).

Other Species

3.134 Results from a 15-year study on *N. rossii*, *G. gibberifrons* and *N. coriiceps* caught in trammel nets at Potter Cove (Subarea 48.1) were presented in WG-FSA-98/57. *N. rossii* and *G. gibberifrons*, two commercially fished species, had declined relative to *N. coriiceps*. The trammel net results are consistent with those from observations on the diet of *Phalacrocorax bransfieldensis*, a key predator which is also monitored (WG-EMM-98/11). The current relatively low abundance levels of *N. rossii* and *G. gibberifrons* are thought to be due to commercial fishing in the late 1970s.

3.135 It was noted that the trends observed in independent survey estimates of the standing stock of *G. gibberifrons* by Japanese surveys in 1981 and 1982 in the lower South Shetland Islands area, when the standing stock was high, and the US AMLR survey in 1998, when the standing stock was low, matched the observations in WG-FSA-98/57. It was agreed that a further examination of this relationship might provide a further index of the status of fish stocks on the shelf. Dr E. Barrera-Oro (Argentina) and Mr Jones agreed to investigate this further.

3.136 A study using pots attached to the end of experimental longlines fished in Subareas 48.1, 48.2 and 88.3 was described in WG-FSA-98/20. The main species caught was the crab *P. anemerae*, 28% by mass. Other species taken were *L. kempfi* (17%), *Lycenchelys bellingshauseni* (13%) and *Muraenolepis microps* (11%).

Decision Rules and Biological Reference Points

3.137 No new information on these topics was presented at the meeting.

Developments in Assessment Methods

Generalised Yield Model (GYM)

3.138 Dr Constable introduced a user guide to the GYM (WG-FSA-98/21). The user guide detailed the computations used to project population characteristics, the algorithm for evaluating yields and the requirements for inputting parameters into the model, and was designed for interactive use.

3.139 Recent updates to the model were outlined in WG-FSA-98/22. Minor modifications were made to the version of the GYM used last year: all parameters are now referenced to dates in a year; and the output files have been reformatted to allow easy export to other programs. Two minor errors, identified during the initial validation (WG-FSA-98/18), had been rectified (see also paragraph 3.141). The new version also included two substantive additions: the incorporation of interannual variability in natural mortality; and a user interface. This version of the model (GY301) was used for the GYM assessments conducted during the meeting.

3.140 Validation of the GYM had been identified as a high priority task for the Secretariat during the past intersessional period (WG-FSA-98/5) and the findings were reported in WG-FSA-98/18. The GYM was validated by examining and testing selected components of the source code, and logistically testing the main steps in the model (version GY301). The validation was designed to test key elements of the model. All of the tests found the model to be correct, and the model outputs to agree with expected values generated using alternative software.

3.141 In the process of testing the major components of the model, two minor errors were identified in the source code. These caused the yield-per-recruit option to be inoperable, and an error in the generation of the plus age class under the special case of no mortality ($M = 0$ and $F = 0$). Neither of these minor errors would have affected past predictions of yield using the GYM and both errors have been rectified (WG-FSA-98/22).

3.142 The Working Group noted the recent developments and validation of the GYM. The availability of the user guide and the new user interface had now facilitated the operation of the model, and Members were encouraged to conduct further evaluation. The Secretariat was tasked with establishing a register of tests conducted on the GYM (see below).

Other Methods

3.143 WG-FSA-98/35 reported on the findings of an examination of the Generalised Linear Model (GLM) used for evaluating trends in catch rates of *Dissostichus* spp. Problems with the standardisation of catch rates were found when data from summer seasons of the fishery for *D. eleginoides* in Subarea 48.3 (1992/93) were analysed with data from subsequent winter seasons. The problem was rectified by excluding data from the summer seasons. However, some information was lost because these summertime data reported catch rates from the early phase of that fishery. The GLM based on data from the winter seasons could be further refined by including depth as a factor.

3.144 The efficiency of various stratification schemes for conducting trawl surveys for *C. gunnari* in Subarea 48.3 was evaluated in WG-FSA-98/47. Estimates derived from stratified surveys were found to be less accurate than those derived using simple random sampling. Further work will be conducted to establish the optimum sampling strategy for *C. gunnari*.

Status of Assessment Methods

3.145 Dr Everson outlined a proposal for recording the status of assessment methods and associated computer programs used by CCAMLR. The Working Group had expressed concern that some of the programs which it used regularly had not been fully validated. This did not mean that the results were necessarily incorrect. However, total reliance should not be placed on the results until validation was completed. The Working Group considered three categories for programs in use by CCAMLR:

- (i) programs fully tested and internationally accepted (e.g. VPA);
- (ii) programs currently used by CCAMLR and tested and approved for use in the assessments (e.g. GYM); and
- (iii) programs considered to be suitable but still awaiting full evaluation (e.g. mixture analysis, trawlCI).

3.146 The Working Group recognised both the need to identify the status of programs used and the difficulties in conducting adequate validation. Following further discussion, the Working Group agreed that only those programs used routinely by CCAMLR should be allocated to the three categories. Members were encouraged to undertake validation of programs in category (iii), and to submit tests and datasets so as to develop a library of validation procedures.

3.147 Three main steps were identified in documenting and validating programs:

- (i) description of the intent of the program;
- (ii) verification that the program, including the source code, performed according to its intent and that it was properly documented; and
- (iii) description of the limitations of the program and the underlying assumptions.

3.148 The Secretariat was tasked with establishing a central repository of programs used by CCAMLR and the tests conducted as part of their validation. As part of this work, it was essential that the Secretariat maintains an up-to-date suite of software which would enable it to fully document and operate validation procedures provided by Members, and conduct further tests as required.

Consideration of Management Areas and Stock Boundaries

Distribution of *D. eleginoides* and *D. mawsoni*

3.149 Last year, the Working Group had used the best available information on the geographic distributions of *D. eleginoides* and *D. mawsoni* to allocate catch limits to these species in new and exploratory fisheries. The area of overlap between the two species was believed to be small, and both the northern limit of the distribution of *D. mawsoni* and the southern limit of *D. eleginoides* had been set at 65°S in Subareas 48.1, 48.6, 88.1, 88.2 and 88.3, and 60°S in Subarea 48.2 and Divisions 58.4.3 and 58.4.4.

3.150 The geographic distribution of these species was revised in the light of reviews of the biology of *D. mawsoni* (WG-FSA-98/37 and 98/49), catches reported in 1997/98 and results from the Spanish and Chilean longline surveys (WG-FSA-98/48, SC-CAMLR-XVII/BG/7). Spatial overlap between *D. eleginoides* and *D. mawsoni* was reported in Subareas 48.1 and 88.1, and only *D. eleginoides* had been found in Subarea 48.6 and Division 58.4.4, north of 55°S. Accordingly, the limits of distributions were revised. The delineation between *D. eleginoides* and *D. mawsoni* was generally set, for the purpose of assessing catch limits in new and exploratory fisheries, at 60°S in Subarea 48.6 and Divisions 58.4.1, 58.4.3 and 58.4.4, and 65°S in Subarea 88.1 (Figure 1). *D. eleginoides* was believed to occur throughout BANZARE Bank (Divisions 58.4.1 and 58.4.3) and the boundary was shifted to 62°S in that region.

Stock Boundaries

3.151 The Working Group also discussed further developments in the assessments for new and exploratory fisheries, and the need to account for the possibility that discrete stocks of *Dissostichus* spp. may occur over smaller spatial scales than the management areas currently used by CCAMLR (e.g. paragraphs 3.114 to 3.119).

3.152 Analyses of seabed areas within the fishing depth range of 500 to 1 800 m (WG-FSA-98/6) have indicated that many of the statistical areas within the Convention Area contain seamounts and rises isolated by deep (>3 000 m) water. Notably, high densities of seamounts occur in Subarea 88.1 and the northern section of Subarea 48.6, and Ob and Lena Banks in Division 58.4.4 consist of a series of discrete rises. Other areas contain rises which may straddle statistical or political boundaries (EEZ and Convention Area), such as the Delcano Rise in Subareas 58.6 and 58.7, the Kerguelen/Heard Islands Plateau in Divisions 58.5.1 and 58.5.2, and BANZARE Bank in Divisions 58.4.1 and 58.4.3.

3.153 Given the present level of uncertainty regarding the structure of *Dissostichus* spp. stocks, and the geographic distribution of *D. eleginoides* and *D. mawsoni* in areas notified for new and exploratory fisheries, the most precautionary approach is to assume that discrete stocks of *Dissostichus* spp. may occur over small spatial scales. The Working Group considered two types of spatial scale: the geographic area over which stocks were assessed (assessment unit) and the geographic area over which stocks were managed (management unit).

3.154 The Working Group agreed that the assessment of catch limits for new and exploratory fisheries should be based on the method used last year, and that for this purpose the boundaries of assessment units should match those of the subareas and divisions under consideration. However, smaller management units should be used as a first step in distributing effort within each subarea or division (Table 15 and Figure 1).

ASSESSMENTS AND MANAGEMENT ADVICE

New and Exploratory Fisheries

New Fisheries in 1997/98

4.1 Seven conservation measures relating to new fisheries were in force during 1997/98, but fishing was conducted under the terms of only three of these measures. Summary information on the seven new fisheries during 1997/98 is contained in CCAMLR-XVII/BG/4 Rev. 1.

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

4.2 Under the provisions of Conservation Measures 134/XVI, 135/XVI and 140/XVI, Chile conducted a prospecting cruise to determine the feasibility of new fisheries in these areas. The cruise was conducted during February and March 1998; results from the cruise were reported in SC-CAMLR-XVII/BG/7 Rev. 1. It was concluded that new fisheries in Subareas 48.1, 48.2, and 88.3 would not be feasible, and commercial-scale fishing operations were not conducted in these three subareas.

New Fisheries for *Dissostichus* spp. in Subareas 48.6
and 88.2 and Divisions 58.4.3 and 58.4.4

4.3 Although South Africa notified the Commission of its intent to conduct new fisheries in Subarea 48.6 and Divisions 58.4.3 and 58.4.4 during 1997/98 (CCAMLR-XVI/7), no South African vessels fished under the terms of Conservation Measures 136/XVI, 137/XVI and 138/XVI.

4.4 Although Norway notified the Commission of its intent to conduct a new fishery in Subarea 48.6 during 1997/98 (CCAMLR-XVI/10), no Norwegian vessels fished under the terms of Conservation Measure 136/XVI.

4.5 Although Ukraine notified the Commission of its intent to conduct a new fishery in Division 58.4.4 during 1997/98 (CCAMLR-XVI/6), no Ukrainian vessels fished under the terms of Conservation Measure 138/XVI. The Working Group noted that, at its last meeting, the Scientific Committee 'recommended that Ukraine be requested to submit historical trawl survey data for Division 58.4.4 as soon as possible' (SC-CAMLR-XVI, paragraph 9.89). The Secretariat had sent a letter to Ukraine, but such data were not received and were not available for use by the Working Group.

4.6 Although New Zealand notified the Commission of its intent to conduct a new fishery in Subarea 88.2 during 1997/98 (CCAMLR-XVI/17), no New Zealand vessels fished under the terms of Conservation Measure 139/XVI.

Exploratory Fisheries in 1997/98

4.7 Five conservation measures relating to exploratory fisheries were in force during 1997/98; fishing was conducted under the terms of four of these measures. Summary information on all five exploratory fisheries is contained in CCAMLR-XVII/BG/4 Rev. 1.

Exploratory Longline Fisheries for *D. eleginoides*
in Subareas 58.6 and 58.7 outside EEZs

4.8 Although Ukraine notified the Commission of its intent to conduct exploratory fisheries in Subareas 58.6 and 58.7 outside EEZs during 1997/98 (CCAMLR-XVI/6), no Ukrainian vessels fished under the terms of Conservation Measures 141/XVI and 142/XVI.

4.9 Although Russia notified the Commission of its intent to conduct exploratory fisheries in Subareas 58.6 and 58.7 during 1997/98, no Russian vessels fished under the terms of Conservation Measures 141/XVI and 142/XVI.

4.10 Under the terms of Conservation Measures 141/XVI and 142/XVI, South African vessels conducted exploratory fishing operations for *D. eleginoides* in Subareas 58.6 and 58.7 during 1997/98. Outside the EEZs, one vessel fished in each subarea.

Exploratory Longline Fisheries for
Dissostichus spp. in Subarea 88.1

4.11 In Subarea 88.1, one vessel from New Zealand conducted exploratory fishing operations under the terms of Conservation Measure 143/XVI from 21 February to 25 March 1998. All fishing was conducted south of 65°S. Fishing was carried out over

30 fine-scale rectangles. *D. eleginoides* was recorded much further south than previously reported with a 7.5 kg fish caught at 73°S. *D. mawsoni* was present throughout the region, extending as far north as 65°S. *Dissostichus* spp. were present in 97% of the fine-scale rectangles, indicating these species are present over wide areas of Subarea 88.1.

Exploratory Trawl Fishery for *Dissostichus* spp.
in Division 58.4.3

4.12 Although Australia notified the Commission of its intent to conduct an exploratory trawl fishery in Division 58.4.3 during 1997/98, no Australian vessels fished under the terms of Conservation Measure 144/XVI.

Exploratory Jig Fishery for *M. hyadesi*
in Subarea 48.3

4.13 Although the UK and the Republic of Korea notified the Commission of their intentions to conduct an exploratory squid fishery in Subarea 48.3 during 1997/98 (CCAMLR-XVI/21), no vessels fished under the terms of Conservation Measure 145/XVI.

New Fisheries Notified for 1998/99

4.14 New fisheries notifications for 1998/99 are listed in Table 16.

4.15 The Working Group noted that all the new fisheries notifications listed in Table 16 were for subareas and divisions where conservation measures had been in place during 1997/98 but where no fishing had occurred.

4.16 To aid its discussions of new fisheries notifications for 1998/99, the Working Group continued to use the checklist approach developed at its last meeting. The checklist identifies items of information required by Conservation Measure 31/X and additional points in SC-CAMLR-XV, paragraph 8.17. Summaries in tabular form were then developed for each notification and these are given below.

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

4.17 South Africa submitted a notification (CCAMLR-XVII/10) for new fisheries for *Dissostichus* spp. in Subarea 48.6 and Division 58.4.4. A summary is given in the following table.

Information Required	Information Supplied
Type of fishery	New
Member	South Africa
Species	<i>Dissostichus</i> spp.
Area	Subarea 48.6 and Division 58.4.4

Table (continued)

Information Required	Information Supplied
Reference	CCAMLR-XVII/10
Relevant conservation measures	136/XVI, 138/XVI, 29/XVI, 63/XV, 133/XVI
1998/99 notification by 28 July 1998	Yes
Catch level (tonnes) for a viable fishery	Precautionary catch levels estimated by WG-FSA.
Fishery plan	Longlines; set grid catch limit for target species at 100 tonnes/fine-scale grid; confine fishery to South African flagged vessels; fishing seasons as defined in Conservation Measures 136/XVI and 138/XVI; vessels to comply with Conservation Measures 29/XVI, 63/XV and 133/XVI.
Biological information	
Effect on dependent species	
Information for calculation of potential yield	
Data collection plan	As defined in Conservation Measures 51/XII, 121/XVI and 133/XVI. Vessels to report total number and weight of <i>Dissostichus</i> discarded, including those in the 'jellymeat' condition.
Observer coverage	International scientific observer on board each vessel.
Position verification	VMS in accordance with Resolution 12/XVI.
Registration of vessels details	
Other information/comment	Collection of environmental data, 'sliding scale' biological sampling.

4.18 The Working Group noted that the notification outlined above is essentially a restatement of the intentions that South Africa made at the last meeting of the Commission. The South African notification addresses all the requirements of Conservation Measure 31/X and the points in SC-CAMLR-XV, paragraph 8.17.

4.19 The South African notification was the only notification received for a new fishery in Subarea 48.6. France, Spain and Uruguay have also submitted notifications for new fisheries in Division 58.4.4.

4.20 The Working Group noted that the South African notification contained a description of a 'sliding scale' for biological sampling. According to the notification, biological sampling will be dependent on catch levels. When the daily catch is less than 2 tonnes, all fish will be sampled for biological data. When the daily catch is between 2 and 5 tonnes, 40% of the catch will be randomly sampled. When the daily catch is greater than 5 tonnes, 20% of the catch will be randomly sampled. The Working Group considered that such an approach might be useful for providing guidance to observers and agreed that, if such a sampling scheme is conducted, South African scientists should advise the Working Group on the advantages and disadvantages of such a scheme.

New Longline Fisheries for
D. eleginoides in Division 58.4.4

4.21 Spain submitted a notification (CCAMLR-XVII/12) for an exploratory fishery for *D. eleginoides* in Division 58.4.4.

4.22 The Working Group noted that although the Spanish notification was titled ‘Notification of Spain’s intention to initiate an exploratory fishery,’ the notification should actually be for a new fishery under the definition in Conservation Measure 31/X. As such, the Working Group agreed to evaluate the notification as one for a new fishery. A summary of the notification is given in the following table.

Information Required	Information Supplied
Type of fishery	New (notified in accordance with 31/X)
Member	Spain
Species	<i>Dissostichus eleginoides</i>
Area	Division 58.4.4
Reference	CCAMLR-XVII/12
Relevant conservation measures	29/XVI, 31/X, 133/XVI, 138/XVI
1998/99 notification by 28 July 1998	Yes
Catch level (tonnes) for a viable fishery	580 tonnes
Fishery plan	Season from 1 April to 31 August 1999; maximum of two Spanish flagged vessels; by-catch limitation. Spanish longline.
Biological information	
Effect on dependent species	
Information for calculation of potential yield	
Data collection plan	In accordance with Conservation Measure 133/XVI.
Observer coverage	An international scientific observer, as well as a national observer, on board each vessel.
Position verification	
Registration of vessels details	

4.23 The Spanish notification addresses all the requirements of Conservation Measure 31/X and the points in SC-CAMLR-XV, paragraph 8.17.

4.24 France, South Africa and Uruguay also submitted notifications for new fisheries in Division 58.4.4.

4.25 Uruguay submitted a notification (CCAMLR-XVII/19) for a new fishery for *D. eleginoides* in Division 58.4.4. A summary is given in the following table.

Information Required	Information Supplied
Type of fishery	New
Member	Uruguay
Species	<i>Dissostichus eleginoides</i>
Area	Division 58.4.4
Reference	CCAMLR-XVII/19
Relevant conservation measures	29/XVI, 133/XVI, 138/XVI
1998/99 notification by 28 July 1998	Notified 20 August 1998.
Catch level (tonnes) for a viable fishery	580 tonnes
Fishery plan	Two Uruguayan vessels.
Biological information	
Effect on dependent species	
Information for calculation of potential yield	
Data collection plan	
Observer coverage	An international scientific observer on board each vessel.
Position verification	VMS in accordance with Resolution 12/XVI.
Registration of vessels details	Two Uruguayan-flagged vessels.

4.26 Uruguay's notification addresses all the requirements of Conservation Measure 31/X and the points in SC-CAMLR-XV, paragraph 8.17.

New Trawl and Longline Fisheries for *D. eleginoides*
in Subareas 58.6 and 58.7 outside EEZs and
Divisions 58.4.3 and 58.4.4

4.27 France submitted a notification (CCAMLR-XVII/9 Rev. 1) for new fisheries for *D. eleginoides* in Subareas 58.6 and 58.7 (outside EEZs) and Divisions 58.4.3, 58.4.4, 58.5.1 and 58.5.2. The notification was for both longline and trawl fisheries.

4.28 During the course of the Working Group's deliberations, Prof. Duhamel clarified that the notification no longer applied for Divisions 58.5.1 and 58.5.2. As such, the Working Group considered only the notifications for Subareas 58.6 and 58.7 (outside EEZs) and Divisions 58.4.3 and 58.4.4. A summary is given in the following table.

Information Required	Information Supplied
Type of fishery	New
Member	France
Species	<i>Dissostichus eleginoides</i>

Table (continued)

Information Required	Information Supplied
Area	Divisions 58.4.3, 58.4.4, Subareas 58.6, 58.7 outside EEZs of Australia, France and South Africa.
Reference	CCAMLR-XVII/9
Relevant conservation measures	2/III, 4/V, 19/IX, 29/XVI, 30/X, 63/XV, 118/XVI, 133/XVI, Resolutions 7/IX, 10/XII, 12/XVI
1998/99 notification by 28 July 1998	Yes
Catch level (tonnes) for a viable fishery	Minimum of 500 tonnes for all areas combined by longline plus 500 tonnes for trawls.
Fishery plan	Longlines and bottom trawls. Two French companies, both with fishing history in French EEZs in Area 58. Longlining operation: two vessels; Spanish longlining method; fish in Subareas 58.6, 58.7, Divisions 58.4.3, 58.4.4 outside EEZs; fish the whole of 1998/99 season – no scientific justification for closures; fishing depth = 500–2 000 m; minimum distance between sets – 2 n miles; minimum size for target species of 60 cm (-10%); night sets only; by-catch not to exceed 10% of total catch. Trawling operation. Demersal trawl; one vessel; fish in Subarea 58.6 and Division 58.4.4, outside EEZs; fishery depth 300–1 000 m. Fish the whole of 1998/99 season – no scientific justification for closures; minimum size for target species of 60 cm – (-10%).
Biological information	
Effect on dependent species	
Information for calculation of potential yield	
Data collection plan	As defined in conservation measures.
Observer coverage	International scientific observer on each vessel.
Position verification	VMS in accordance with Resolution 12/XVI.
Registration of vessels details	Trawler: <i>Kerguelen de Tremarec</i> (87 m). Longliners: <i>St-Jean</i> (45 m) and <i>Northern Pride</i> (50.75 m).

4.29 The French notification addresses all the requirements of Conservation Measure 31/X and the points in SC-CAMLR-XV, paragraph 8.17.

4.30 The French notification overlaps many other notifications. South Africa, Spain and Uruguay also submitted notifications for new fisheries in Division 58.4.4. South Africa submitted notifications for exploratory fisheries in Subareas 58.6 and 58.7 (outside EEZs).

4.31 The Working Group viewed the overlap between the French notification and the notifications by other Members with some concern because there could be trawl fisheries and longline fisheries simultaneously operating in the same area.

4.32 A mixed gear fishery raises some problems for conducting stock assessments with the GYM. Currently, separate assessments are conducted for longline and trawl fisheries. A mixed gear fishery cannot be assessed because each gear type has a different selectivity pattern. To conduct an assessment for a mixed gear fishery using the GYM, it would be necessary to have an estimate of the proportion of the total fishing effort that would be expended by each gear type. The Working Group noted that such an estimation might require an allocation of total effort between longline and trawl fisheries. In this regard, the Working Group agreed that the Commission needs to provide advice on issues of allocation between competing gear types. The Working Group also agreed that the sum of catch limits for each gear type in a mixed gear fishery should not exceed the estimated precautionary yield for the area over which the mixed gear fishery is operating.

4.33 Again, in relation to the French notification, the Working Group further noted that new trawl fisheries are not required to distribute fishing effort over a wide area and that 100-tonne catch limits for fine-scale rectangles are also not applicable to new trawl fisheries. Both these limitations apply to new longline fisheries (Conservation Measure 133/XVI). The Working Group agreed that such provisions should be applied to new trawl fisheries.

4.34 Since the French notification for a mixed fishery overlaps with those for longline fishing in Division 58.4.4 and Subarea 58.6 (outside the French and South African EEZs), there is likely to be a presence of vessels on the grounds fishing with different methods (longline and trawl). User conflict may then arise as a result.

4.35 The Working Group discussed France's notification that fishing operations would be conducted during the whole 1998/99 season. The implications of a year-long fishery on incidental mortality of seabirds are discussed in paragraph 7.116. Prof. Duhamel clarified that France would follow the Commission's direction with respect to the length of the fishing season, but noted that a year-long fishery would make it easier to monitor unregulated fishing in the Convention Area. If there is substantial unregulated fishing during a season closure, incidental mortality to seabirds could be increased. Prof. Duhamel also noted his concern that fishing only in winter would cause all catches to be taken during the *D. eleginoides* spawning season.

4.36 The Working Group noted that the French notification stated that an observer working under CCAMLR's International Scheme of Scientific Observation would 'possibly' be on board each vessel participating in the new fisheries. Prof. Duhamel clarified that a CCAMLR observer would definitely be on board each vessel participating in the new fisheries. There will also be a French observer on board each vessel.

Exploratory Fisheries Notified for 1998/99

4.37 Exploratory fisheries notifications for 1998/99 are listed in Table 16.

4.38 All notifications for exploratory fisheries in 1998/99 were for fisheries that were also in the exploratory stage during 1997/98. None of the fisheries that were considered to be new fisheries at the last meeting of the Commission have been notified as exploratory for the coming season.

4.39 The Working Group noted that in the preamble to Conservation Measure 65/XII, the Commission had agreed that exploratory fishing should not be allowed to expand faster than the acquisition of information necessary to ensure that the fishery can and will be conducted in accordance with the principles set forth in Article II. A vital element in ensuring this is the ability of the Scientific Committee to conduct stock assessments.

4.40 For *Dissostichus* spp., the assessment methods currently available to the Scientific Committee all require research survey estimates of biomass. For longline fisheries for *Dissostichus* spp., the Working Group has been unable to assess the status of the stocks using data from longline fishing only. The Working Group agreed that conducting research surveys was an essential element of the precautionary development of exploratory fisheries. The Working Group therefore recommended that research surveys to estimate biomass be included at the very early stages of the development of new and exploratory fisheries for *Dissostichus* spp. In this context, the Working Group welcomed the inclusion of plans for the early conduct of research surveys in the notification by Australia.

4.41 The Working Group continued to use the checklist approach when discussing notifications of exploratory fisheries. Summaries in tabular form were developed for each notification and these are given below.

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

4.42 South Africa submitted a notification (CCAMLR-XVII/14) for exploratory fisheries for *Dissostichus* spp. in Subareas 58.6 and 58.7 (outside EEZs). A summary is given in the following table.

Information Required	Information Supplied
Type of fishery	Exploratory
Member	South Africa
Species	<i>Dissostichus</i> spp.
Area	Subareas 58.6 and 58.7 (outside EEZs)
Reference	CCAMLR-XVII/14
Relevant conservation measures	51/XII, 63/XV, 112/XV, 113/XV, 114/XV, 116/XV, 117/XV, 121/XVI, 122/XVI
1998/99 notification by 28 July 1998	Notified 4 August 1998.
Catch level (tonnes) for a viable fishery	Decision rule precautionary catch levels.
Fishery plan	Limited to South African flagged longline vessels only. The fishing season to be in accordance with any season to be agreed by CCAMLR in respect of mitigating seabird mortality or any other reasons.
Biological information	As stipulated by Conservation Measures 117/XV, 121/XVI, 122/XVI. Propose a sampling regime based on a sliding scale dependent on catch levels. Where the daily catch is less than 2 tonnes, all fish will be sampled for biological data. At 2–5 tonnes, 40% of the catch will be randomly sampled, and at 5–10 tonnes sampling will reduce to 20% of catch.
Effect on dependent species	
Information for calculation of potential yield	Plan research cruises in Subareas 58.6 and 58.7.
Data collection plan	

Table (continued)

Information Required	Information Supplied
Observer coverage	An international scientific observer on board each vessel.
Position verification	VMS in accordance with Resolution 12/XVI.
Registration of vessels details	

4.43 The South African notification for exploratory fisheries in Subareas 58.6 and 58.7 (outside EEZs) coincides with notifications by France for new longline and trawl fisheries in these subareas.

Exploratory Trawl Fisheries for *Dissostichus* spp.
in Divisions 58.4.1 and 58.4.3

4.44 Australia submitted a notification (CCAMLR-XVII/11) for exploratory trawl fisheries for *Dissostichus* spp. in Divisions 58.4.1 and 58.4.3. A summary is given in the following table.

Information Required	Information Supplied
Type of fishery	Exploratory
Member	Australia
Species	<i>Dissostichus</i> spp.
Area	Divisions 58.4.1 and 58.4.3
Reference	CCAMLR-XVI/11
Relevant conservation measures	2/III, 30/X, 144/XVI
1998/99 notification by 28 July 1998	Yes
Catch level (tonnes) for a viable fishery	963 tonnes requested from Elan and BANZARE Banks.
Fishery plan	Trawling with survey; fishing depth to 1 500 m.
Biological information	
Effect on dependent species	Elephant seals should not be affected as estimated escapement rates exceed 85%.
Information for calculation of potential yield	
Data collection plan	As defined in Conservation Measures 51/XII, 121/XVI, 122/XVI and 144/XVI.
Observer coverage	International scientific observer on board each vessel.
Position verification	VMS in accordance with Resolution 12/XVI.
Registration of vessels details	Trawler <i>Austral Leader</i> (85.2 m). Noted that another vessel may operate either in addition to, or in lieu of, the <i>Austral Leader</i> .

4.45 The Australian notifications for exploratory trawl fisheries in Divisions 58.4.1 and 58.4.3 do not overlap with notifications from other Members.

4.46 The Working Group noted that the Australian notification is essentially the same as the notification made at the last meeting of the Commission and applies only to Elan and BANZARE Banks. During 1997/98 exploratory trawling on these banks was supposed to be conducted under the terms of Conservation Measure 144/XVI. Conservation Measure 144/XVI was clearly intended to permit exploratory fishing over the entirety of both banks, but a large portion of BANZARE Bank is included in Division 58.4.1 and this division was closed to directed fishing for *Dissostichus* spp. under the terms of Conservation Measure 120/XVI. Thus, the Australian notification is a resubmission that includes notification of intention to fish in a small portion of Division 58.4.1 (that portion covering BANZARE Bank).

Exploratory Longline Fishery for
Dissostichus spp. in Subarea 88.1

4.47 New Zealand submitted a notification (CCAMLR-XVII/13 Rev. 1) for an exploratory fishery for *Dissostichus* spp. in Subarea 88.1. A summary is given in the following table.

Information Required	Information Supplied
Type of fishery	Exploratory
Member	New Zealand
Species	<i>Dissostichus</i> spp.
Area	Subarea 88.1
Reference	CCAMLR-XVII/13
Relevant conservation measures	51/XII, 63/XVI, 65/XII, 29/XVI, 121/XVI, 122/XVI
1998/99 notification by 28 July 1998	Received 31 July 1998.
Catch level (tonnes) for a viable fishery	Decision rule precautionary catch levels.
Fishery plan	Limited to two New Zealand flagged longlining vessels; propose season from 15 December 1998 to 31 August 1999; propose variation to Conservation Measure 29/XVI to allow daytime setting in high latitudes south of 65°S in Subarea 88.1; propose that new non-target by-catch provisions of 200 tonnes be applied for <i>Macrourus</i> .
Biological information	
Effect on dependent species	
Information for calculation of potential yield	
Data collection plan	As defined by Conservation Measures 51/XII, 122/XVI and 121/XVI, and a data plan in accordance with the criteria set by the Scientific Committee for exploratory fisheries.
Observer coverage	International scientific observer and New Zealand fisheries observer on each vessel.

Table (continued)

Information Required	Information Supplied
Position verification	VMS in accordance with Resolution 12/XVI.
Registration of vessels details	

4.48 New Zealand's notification of an exploratory fishery in Subarea 88.1 does not overlap with notifications from other Members.

4.49 New Zealand's notification lays out a scheme for determining catch limits in fine-scale rectangles based on decision rules related to initial catch rates. Under the scheme, catch limits for fine-scale rectangles are increased when initial catch rates are high. The Working Group noted that similar schemes for determining catch limits in fine-scale rectangles had previously been suggested by South Africa (CCAMLR-XVI/8 Rev. 1) and New Zealand (CCAMLR-XVI/17).

4.50 The Working Group agreed that, in principle, there might be some merit in setting catch limits for fine-scale rectangles based on decision rules related to initial catch rates. However, the Working Group had some difficulty with the scheme outlined in New Zealand's notification. The Working Group recognised that the decision rules outlined in New Zealand's notification are based on information about *D. eleginoides* catch rates from the Falkland/Malvinas Islands. This could be problematic because the decision rules in Subarea 88.1 should also be based on information about catch rates of *D. mawsoni*. The Working Group determined that a detailed analysis of catch rates of *D. mawsoni* could not be undertaken at this meeting. In this regard, the Working Group reiterated the statement made in paragraph 4.81 of last year's report and agreed that 'it could consider the adaptive approach further if a paper considering further development of it were submitted for the Working Group's consideration at its next meeting.'

4.51 The notification by New Zealand indicates that there was a significant by-catch of *M. carinatus* (9.48 tonnes; 17% of the total catch (kilograms); 23% of the *Dissostichus* spp. catch (kilograms)) during exploratory fishing in the 1997/98 season. The significant by-catch resulted from the exploratory nature of the fishery during 1997/98. In this regard, the New Zealand notification proposed a 200-tonnes by-catch limit for *Macrourus* spp. in Subarea 88.1. The Working Group agreed to evaluate this proposal by studying haul-by-haul catch rates of *M. carinatus* from the exploratory fishery conducted by New Zealand during 1997/98.

4.52 The Working Group plotted the by-catch rate of *M. carinatus* (as percent of the total kilograms caught per set) against the catch per set (kilograms) of *Dissostichus* spp. (Figure 2). Figure 2 indicates that the by-catch rate of *M. carinatus* is frequently in the range of 10 to 20% when catches of *Dissostichus* spp. are greater than 1 tonne. The figure also suggests that by-catch rates of *M. carinatus* could be minimised by focusing fishing effort in areas where catch rates of *Dissostichus* spp. are highest. The Working Group noted that the actual level of by-catch was relatively constant across the range of *Dissostichus* spp. catches that were observed.

4.53 The Working Group could not determine whether a by-catch limit of 200 tonnes would be appropriate for *Macrourus* spp. Such a determination was not possible because there is almost no information on these fish. The Working Group did, however, note the principle of requiring trawlers move to other fishing locations when there is a relatively high by-catch rate that is contained in Conservation Measures 131/XVI and 144/XVI. The Working Group agreed that this principle should also be applied to new and exploratory longline fisheries.

4.54 Considering the results in Figure 2, the Working Group agreed that a by-catch rate of 10 to 15% should limit catches of *M. carinatus* but allow the exploratory fishery to conduct

prospecting operations. The Working Group also agreed that this by-catch limitation should be supplemented by a maximum level (in kilograms) of by-catch. The effect of simultaneously exceeding both the specified by-catch rate and the by-catch threshold in any one haul would cause fishing vessels to move to other fishing locations. The Working Group determined that a threshold level of 100 kg of by-catch of *Macrourus* spp. would be appropriate in Subarea 88.1.

4.55 The Working Group viewed by-catch limitations as an issue that should be addressed for all new and exploratory longline fisheries. As such, the Working Group then developed a general approach to minimising by-catch in new and exploratory longline fisheries (see paragraph 4.79). A critical component of the general approach to minimising by-catch in new and exploratory longline fisheries is that detailed biological data be collected on the by-catch species.

4.56 New Zealand's notification indicated that the 1997/98 fishing season in Subarea 88.1 was severely restricted by the presence of ice, both icebergs and sea-ice. The 1997/98 fishing season in Subarea 88.1 began in the late austral summer, and, due to the rapid growth northwards of the ice shelf in mid-March, there was only a four-week period that could be fished within the Ross Sea. In this regard, the New Zealand notification proposed that the 1998/99 fishing season start on 15 December 1998. The Working Group considered this proposal in relation to its impacts on incidental mortality to seabirds (paragraphs 7.117 to 7.119).

Calculation of Precautionary Catch Levels

4.57 The Working Group agreed to continue the approach it adopted at its last meeting and calculated precautionary catch limits for new and exploratory fisheries by extrapolating from estimated yields for *D. eleginoides* in Subarea 48.3 and Division 58.5.2. The extrapolations were discounted to take implicit account of incomplete knowledge of previously unexploited or lightly exploited areas and adjusted for the relative areas of fishable seabed.

4.58 The Working Group calculated precautionary catch limits for new and exploratory fisheries with the GYM. The calculations involved four main components.

- (i) Estimates of mean recruitment in each area under consideration were obtained by proportional adjustments for fishable seabed areas. For longline fisheries the adjustments used the relative areas of seabed between 600 and 1 800 m in Subarea 48.3 and in the areas under consideration. For trawl fisheries, the depth range used was 500 to 1 500 m.
- (ii) Other biological and fishery parameters were set equal to the values most appropriate for the area under consideration. For most areas, this meant using parameters from assessments for Subarea 48.3 for longline fisheries, or those for Division 58.5.2 for trawl fisheries (see Tables 17 and 18). Growth parameters (k and L) for *D. mawsoni* were taken from Burchett et al. (1984) for calculating precautionary catch limits in those areas where *D. mawsoni* would be the predominant target species (see Figure 1).
- (iii) The recent catch history for each area under consideration was updated to include the most recent information on regulated (Tables 1 and 2) and unregulated (Tables 3 to 10) catches.
- (iv) The GYM was run for each area under consideration, and precautionary yield estimates were multiplied by a factor less than 1.0 to account for the uncertainty of extrapolation to previously unfished or lightly fished areas.

4.59 The Working Group examined growth rate data from both *Dissostichus* spp. (Figure 3) to determine which would be most appropriate for use in stock assessments of *D. mawsoni*. Although both species appear to have similar growth rates, WG-FSA agreed to use the growth curve for *D. mawsoni* from Burchett et al. (1984) when assessing this species.

4.60 For *D. mawsoni*, size at maturity was assumed to be 100 cm TL (WG-FSA-98/37). The length–weight relationship, taken from the observer report from Subarea 88.1, was assumed to be $W = 4 \times 10^{-6} L^{3.2413}$. The length–weight relationship from Subarea 88.3 was very similar, $W = 6.973 \times 10^{-6} L^{3.129}$ (SC-CAMLR-XVII/BG/7).

4.61 It has been noted in earlier reports that *D. mawsoni* may be more pelagic than *D. eleginoides*, thus making it less vulnerable to capture in a bottom trawl survey (SC-CAMLR-XVI, Annex 5, paragraph 3.61; SC-CAMLR-XVI, paragraph 9.34).

4.62 The Working Group had considerable discussion about which seabed area calculations would be most appropriate for calculating the precautionary catch limits. This discussion is summarised in paragraphs 3.151 to 3.154. The seabed areas used to estimate adjusted mean recruitments are provided in Table 15.

4.63 At its last meeting, the Working Group identified all of the seabed area between 600 and 1 800 m in Subarea 48.3 as adult habitat for *D. eleginoides*. These adult fish were considered to produce the recruitments measured by the various trawl surveys around South Georgia. A substantial portion of the adult habitat area in Subarea 48.3 is, however, on Maurice Ewing Bank. Maurice Ewing Bank is on the northwestern boundary of Subarea 48.3 and is not immediately adjacent to juvenile habitat areas (0 to 500 m shelf areas) around South Georgia. In this regard, the Working Group acknowledged that there is considerable uncertainty about whether adult *D. eleginoides* on Maurice Ewing Bank actually contribute to recruitment around South Georgia. The Working Group recognised that if Maurice Ewing Bank is not included in the calculations of proportional seabed areas when scaling estimates of mean recruitment, precautionary yield estimates for new and exploratory fisheries would increase. However, given current knowledge about stock structure in Subarea 48.3, the Working Group agreed that it is still most appropriate and precautionary to include Maurice Ewing Bank in calculations of seabed area. This is the approach that the Working Group used at its last meeting.

4.64 The Working Group recognised that the Delcano Rise is another area where adult *Dissostichus* are captured on banks that are not immediately adjacent to juvenile habitat (the shelf around Crozet Island). The Working Group agreed that studies need to be conducted to determine whether adult fish on Maurice Ewing Bank and the Delcano Rise contribute to recruitment of juvenile fish around South Georgia and Crozet Island respectively. Scientists from Member countries were encouraged to undertake such work, particularly along the lines of the otolith chemistry study summarised in paragraph 3.119. The Working Group also agreed that during the intersessional period work should be conducted to more rigorously determine the effects of removing Maurice Ewing Bank from seabed area calculations on estimates of precautionary yield for new and exploratory fisheries.

4.65 The Working Group noted that the catches in the 1997/98 season, including unreported catches, are unlikely to substantially affect the precautionary long-term annual yields. However, these catches were substantially greater than the crude estimates of yield presented here. The Working Group agreed that sustained catches substantially above estimates of the long-term annual yield could cause the spawning stocks to collapse.

4.66 The Working Group used various sets of parameter estimates to run the GYM for areas where there are notifications for new and exploratory fisheries. The GYM parameter sets for new and exploratory fisheries are identified in Table 18.

4.67 The precautionary catch limit calculations were done separately for those parts of each subarea or division that were believed to be occupied by *D. mawsoni* and *D. eleginoides*. As

indicated, different growth parameters were used for each species. However, the Working Group reiterated a statement made in its last report and ‘expressed concern that the available knowledge about *D. mawsoni* was much less than that for *D. eleginoides*.’ This implied that precautionary catch levels calculated in the manner outlined in paragraph 4.65 would be more uncertain for *D. mawsoni* than for *D. eleginoides*. In these circumstances, it may be appropriate for a greater discount factor for uncertainty to be applied for *D. mawsoni*. The discount factor used for *D. eleginoides* was 0.45, matching the factor used by the Commission for calculating precautionary catch limits during the last two years. The discount factor used for *D. mawsoni* was 0.30.

4.68 The Working Group emphasised that there is no scientific basis for selecting a particular value for either discount factor.

4.69 The results of the GYM are given in Table 19. Areas where the parameters were the same and for which no catches occurred were pooled into single runs to save time. This resulted in three pooled runs being undertaken. These pooled runs used the appropriate recruitment densities prorated by the ratio of the combined area with the area from which the recruitment density originated. The resulting yield from a pooled run was then apportioned to a respective area according to the proportion of the total pooled area taken by that respective area. The seabed areas used to prorate recruitments are provided in Table 15. Limited time did not allow a comparison with results obtained from the seabed areas used at last year’s meeting. Discounted yields are presented in Table 20.

4.70 The Working Group reiterated last year’s account of the intrinsic uncertainties involved in the calculation of precautionary yields (SC-CAMLR-XVI, paragraph 4.109) and noted that the results in Tables 19 and 20 must be interpreted with considerable caution. The list of intrinsic uncertainties follows:

- (i) the values calculated for precautionary catch limits should not be taken to imply that such quantities of fish would actually be available for capture;
- (ii) the calculation procedure relies explicitly on extrapolation from assessments of existing fisheries to new and exploratory fisheries in previously unfished or lightly fished areas. In particular, it makes the assumption that the recruitment rate per unit area of fishable seabed is the same across all areas;
- (iii) there is greater uncertainty associated with the calculations for *D. mawsoni*, and the discount factors used are arbitrary; and
- (iv) the estimates of unreported catches are uncertain.

4.71 Despite these uncertainties, the Working Group agreed that the methods used to calculate precautionary catch limits were, scientifically, the best available given existing information.

4.72 The Working Group recommended that the precautionary yield estimates given in Table 19 for *D. eleginoides* and *D. mawsoni* be used when calculating catch limits for the new and exploratory fisheries operating during 1998/99.

Management Advice

4.73 Seven conservation measures relating to new fisheries were in force during 1997/98, but fishing was conducted under the terms of only three of these measures. Information about new fisheries during 1997/98 is contained in paragraphs 4.1 to 4.6. The Secretariat received nine notifications for new fisheries in 1998/99 (Table 16). All notifications for the 1998/99 season were for fisheries on *Dissostichus* spp. Information and Working Group comments on new fisheries for 1998/99 are in paragraphs 4.14 to 4.36.

4.74 Five conservation measures relating to exploratory fisheries were in force during 1997/98, but fishing was conducted under the terms of only three of these measures. Information about exploratory fisheries during 1997/98 is contained in paragraphs 4.7 to 4.13. The Secretariat received five notifications for exploratory fisheries in 1998/99 (Table 16). All notifications for the 1998/99 season were for fisheries on *Dissostichus* spp. Information and Working Group comments on exploratory fisheries for 1998/99 are in paragraphs 4.37 to 4.56.

4.75 The Working Group noted that there is substantial overlap between some of the new and exploratory fishery notifications for 1998/99 (Table 16) and reiterated its comments on assessing mixed gear fisheries (paragraphs 4.31 to 4.34). It is not currently possible to use the GYM to assess stocks of *Dissostichus* spp. that are simultaneously targeted by longliners and trawlers. The Working Group agreed that the Commission needs to provide advice on issues of allocation between competing gear types. The Working Group also agreed that the sum of catch limits for each gear type in a mixed gear fishery should not exceed the estimated precautionary yield for the area over which the mixed gear fishery is operating.

4.76 The Working Group agreed that new trawl fisheries should be required to distribute fishing effort over a wide area (paragraph 4.33). The Working Group also agreed that 100-tonne catch limits for fine-scale rectangles should also apply to new trawl fisheries. Both these limitations are currently applied to new longline fisheries.

4.77 The Working Group also raised the issue of other methods for distributing effort in new and exploratory fisheries (see also paragraph 3.154), and would welcome data which would assist in determining the size of fish aggregations.

4.78 The Working Group recommended that research surveys to estimate biomass be included at the very early stages of the development of new and exploratory fisheries for *Dissostichus* spp. (paragraph 4.40). In this regard, the Working Group noted that it has been unable to assess the status of *Dissostichus* spp. stocks using data from longline fishing only.

4.79 The Working Group agreed that there should be by-catch limitations on exploratory longline fisheries that are similar to those currently in force for exploratory trawl fisheries (paragraphs 4.54 and 4.55). The principle of by-catch limitations should be to require that longliners move to other fishing locations when there is a relatively high by-catch on any one haul. By-catch limitations should be operationally flexible and simple to understand. The Working Group agreed that by-catch limitations for exploratory longline fisheries should involve a maximum by-catch rate of 10 to 15% (as percent of the total kilograms caught per set) and a by-catch threshold level of 100 kg. Fishing vessels should be required to move to another location if the maximum by-catch rate and the by-catch threshold are simultaneously exceeded in any one haul. Moving to another location may simply involve fishing at a different depth. The Working Group noted that the terms of Conservation Measures 131/XVI and 144/XVI require trawlers to move at least 5 n miles when by-catch limits are exceeded. The Working Group noted that detailed catch, effort and biological data need to be collected on all by-catch species and, in this regard, agreed that a conservation measure specifying by-catch limitations on exploratory longline fisheries should specify data collection requirements for by-catch species that are commensurate with data collection requirements for the target species.

4.80 The Working Group calculated precautionary yield estimates for new and exploratory fisheries in 1998/99 using the same methods that were used last year. These methods are described in paragraphs 4.58 to 4.67. The Working Group agreed that the methods used to calculate precautionary yield estimates were, scientifically, the best available given existing information (paragraph 4.71). However, there were still significant uncertainties in the assessment method that imply a need to take account of the points discussed in paragraph 4.63.

4.81 Separate precautionary catch limits were calculated for *D. eleginoides* and *D. mawsoni*. The final step in the calculation involved multiplying by a factor that allowed for the uncertainty in extrapolation from known fisheries (Subarea 48.3 for longlines and Division 58.5.2 for trawl

fisheries) to previously unfished or lightly fished areas. A factor of 0.45 (as used by the Commission for the last two years) was used for *D. eleginoides* and 0.3 (making a greater allowance for uncertainty) was used for *D. mawsoni*. While it believed the factor should be less for *D. mawsoni* than for *D. eleginoides*, the Working Group emphasised that there was no scientific basis for selecting appropriate values for either of these factors.

4.82 Estimates of precautionary yield for each area under consideration are presented in Table 19. Discounted yields are presented in Table 20.

4.83 Management advice stemming from consideration of seabird by-catches in new and exploratory fisheries is given in paragraph 7.200(x).

Other Fisheries

Dissostichus eleginoides

4.84 Consideration of stock boundaries and management units for *D. eleginoides* is provided in paragraphs 3.149 to 3.154.

Methods Applied to the Assessment of *D. eleginoides*

4.85 Following on from the work conducted at previous meetings, the assessment of *D. eleginoides* at the 1998 meeting comprised three main areas of data analysis:

- (i) standardisation of CPUE data;
- (ii) determination of long-term annual yields using the GYM; and
- (iii) exploratory analysis of length data to investigate trends in size at capture.

Standardisation of CPUE Data

4.86 The aim of this study is to determine whether there are any time trends in CPUE after accounting for the effects of other factors/covariates which influence observed CPUE, such as season (month), nationality, bait and depth. GLM and generalised additive models (GAM) are used for this purpose. In 1997, the GLM/GAM methodology was applied to *D. eleginoides* CPUE datasets for Subareas 48.3 (South Georgia, longline fishery), 58.6 (Crozet, longline survey) and 58.7 (Prince Edward Islands, longline fishery) and Division 58.5.1 (Kerguelen, trawl fishery). Descriptions of the methodology are provided in SC-CAMLR-XVI, Annex 5, paragraphs 4.143 to 4.146, 4.288, 4.289, 4.303, 4.304 and 4.242 to 4.245 respectively. The main advance in this analysis at this year's meeting was updating the CPUE datasets to include data from the 1997/98 season. Any changes to the specific analyses for the various fisheries are described in the following sections of the report dealing with the subareas and divisions.

Determination of Long-term Annual Yields using the GYM

4.87 At last year's meeting, the GYM was used to assess the long-term annual yields of *D. eleginoides* in Subarea 48.3 and Division 58.5.2 on the basis of recruitment data derived from trawl surveys in these areas. It was also used to predict long-term annual yield for areas covered by new and exploratory fisheries for *D. eleginoides*. The sources of data for these new

and exploratory fisheries are described in SC-CAMLR-XVI, Annex 5, paragraph 4.99, including proportional adjustments of estimates of mean recruitment using relative seabed areas in appropriate fishable depth ranges.

4.88 At this year's meeting the GYM was used to update estimates of long-term annual yield in Subarea 48.3, Division 58.5.2 and areas under notifications of new and exploratory fisheries. Developments in the GYM since the 1997 meeting, including the status of its validation by the Secretariat, are described in WG-FSA-98/22 and paragraphs 3.139 to 3.141 of this report. Any variations in input data for runs of the GYM compared to last year are described in the following sections of the report dealing with the subareas and divisions.

Trends in Size at Capture

4.89 At last year's meeting an attempt was made to analyse trends in the size of fish caught in Subarea 48.3 since 1990. At that meeting it was not possible to correct length frequency data for size of catch and size of sample measured and the Working Group considered that uncorrected data were unlikely to be of much use (SC-CAMLR-XVI, Annex 5, paragraph 4.163). The Working Group requested that routines be developed by the Secretariat for the 1998 meeting to extract data corrected in the required manner.

4.90 WG-FSA-98/5, Appendix 3 reported on the progress made by the Secretariat in developing a routine for extracting the length frequency data. The approach outlined in the paper was endorsed by the Working Group and the data were duly extracted from the CCAMLR database. Analyses of length data were undertaken for the fishery in Subarea 48.3.

South Georgia (Subarea 48.3)

4.91 The catch limit of *D. eleginoides* in Subarea 48.3 for the 1997/98 season was 3 300 tonnes (Conservation Measure 124/XVI) for the period 1 April to 31 August 1998. A total of 11 vessels from Chile, South Africa, UK and Uruguay fished during the season. The fishery was closed on 22 August, with a total reported catch of 3 328 tonnes (CCAMLR-XVII/BG/4). The season was marred by the tragic sinking of the South African registered longliner *Sudur Havid* on 6 June with the loss of 17 lives.

Standardisation of CPUE

4.92 The GLM analyses were updated to include revised information from previous fishing seasons as well as new information from the 1997/98 fishing season. At the time of the Working Group meeting, a substantial proportion of the CPUE data remained to be submitted to the Secretariat (see Table 21). Nevertheless, the Working Group decided to include the data submitted for 1997/98 in order to investigate the trend in CPUE on the basis of the most recent information available. The basic approach used to fit the GLMs was the same as that used last year. Details of the methodology are provided in SC-CAMLR-XIV, Annex 5, Appendix G.

4.93 The Working Group discussed the results of a study comparing GLMs fitted to winter CPUEs and to data from the entire fishing season (WG-FSA-98/35). The study concluded that analyses of winter CPUEs provide better overlap between nationality and fishing season, making the parameters of the GLM easier to estimate. Additionally, the winter GLM showed trends that were very similar to those of the full-season GLM. The disadvantage of modelling winter CPUEs is that data from the 1993 fishing season can not be included in the analysis. The Working Group considered these tradeoffs and agreed to use the winter CPUE series in the GLM.

4.94 The GLMs were fitted to winter series haul-by-haul data with non-zero catches submitted on form C2 over the period 1992 to 1998. Data from years prior to 1992 were not available in haul-by-haul format so they could not be used in the analyses. Numbers per hook and kilograms per hook were used as response variables, and nationality, winter season, month, area, depth and bait type were considered as predictor variables. Winter seasons were defined as occurring from 1 March to 30 August; this definition was consistent with the approach in WG-FSA-98/35.

4.95 Nationality, winter season, month, area, depth and bait type were statistically significant sources of variation to haul-by-haul CPUE. These predictors were also significant in the Working Group's previous analyses.

4.96 The time series effect of winter season on kilogram per hook is plotted in Figure 4. This time series is adjusted for the presence of hauls with zero catches. This adjustment was made by estimating the probability of a non-zero catch in each fishing season and multiplying this probability by standardised CPUEs predicted from the GLMs.

4.97 The probabilities of zero catches for each fishing season are provided in Table 22. These probabilities should be viewed with some caution because very few vessels have actually reported zero catches. The Working Group noted that the C2 database may be biased because hauls with zero catches may not always be reported to CCAMLR. In this regard, the Working Group reiterated its request that Members make every possible effort to assure that zero catches are also recorded on the form C2 and reported to CCAMLR.

4.98 The time series effect of winter season on numbers per hook is plotted in Figure 5. This time series is also adjusted for the presence of hauls with zero catches.

4.99 Adjusted, standardised catch rates have decreased from 1994 to the present (Figures 4 and 5). The trends are similar for kilogram/hook and numbers/hook. The decline of both CPUE indices was most rapid between the 1994 and 1996 winter seasons and has slowed during the last three winter seasons. Both CPUE indices were less variable at the end of the time series than they were at the beginning of the time series.

4.100 Variability about the standardised CPUE indices provided in last year's report of the Working Group was exaggerated due to a plotting error. There are two standard errors plotted around the estimates in Figures 4 and 5.

4.101 The Working Group noted the declining trends in Figures 4 and 5 with concern. Whilst it was possible to analyse only a portion of the CPUE data for the most recent year, these results indicate that the CPUE has continued to decline between 1997 and 1998.

4.102 The Working Group noted that the *D. eleginoides* fishery began before the 1992 fishing season, but no haul-by-haul data are available for these earlier years. The Working Group cannot comment on how the standardised catch rates for 1998 compare to those years prior to 1992.

4.103 It was suggested that these declines could be fitted using an analytical model such as an age-structured stock reduction analysis (Kimura et al., 1984; Francis, 1990). Such an analysis would use the estimated catches and biological parameters used in the existing GYM. Future extensions to the stock reduction analysis could include fitting proportion at age from surveys, catch at age, age specific selectivities, etc.

Determination of Long-term Annual Yields using the GYM

4.104 The analysis undertaken at last year's meeting was updated using the latest version of the GYM, incorporating total reported catches for the 1997/98 season. An attempt was made to incorporate data from trawl surveys in 1997 by Argentina and the UK into the recruitment function using the length-density method (de la Mare, 1994). Due to problems reconciling the data from these surveys with available data on growth, it was not possible to incorporate the data at this meeting. The recruitment function used this year was therefore the same as that used last year.

4.105 In addition to the need to address problems associated with the 1997 survey length density data, the Working Group noted that to date the survey length-density data used in developing the recruitment function for *D. eleginoides* in Subarea 48.3 have not been extracted directly from survey data stored in the CCAMLR database. This is due to problems with the format in which such data have been stored in the past. The Working Group noted the progress made by the Secretariat since last year's meeting in developing a data format and procedure for handling research survey data submitted to CCAMLR (SC-CAMLR-XVI, Annex 5, paragraphs 9.2(iv) and 10.13).

4.106 The Working Group recommended that all available survey data be transferred into this format as soon as possible and analysed using the procedure for extracting length-density distributions developed at this year's meeting. This should include preparation of pooled density at length distributions (SC-CAMLR-XV, Annex 5, paragraphs 4.66 to 4.68).

4.107 The input parameters for the GYM are shown in Table 17. The only change from 1997 is the update of the catch vector to include 1997/98 data. As last year, the decision rule concerning the probability of depletion was binding. The yield at which there is a probability of 0.1 of falling below 0.2 of the median pre-exploitation spawning biomass level over 35 years was 3 550 tonnes. The median escapement for this level of catch was 0.53.

Comparison of GYM Output with the CPUE Trend shown by the GLM

4.108 Last year, WG-FSA had noted that the trends in median biomass predicted from the GYM indicated a smaller decline than that indicated by the GLM analyses of CPUE (SC-CAMLR-XVI, Annex 5, paragraphs 4.164 to 4.167). The new GLM analyses of CPUE data conducted this year had indicated a continued decline in CPUE between 1997 and 1998.

4.109 In an attempt to explain the results of the CPUE analyses, the GYM was used to examine the effects of the time series of observed recruitments and the catch history on the status of the spawning stock. This was achieved by running the GYM in the standard way (see Table 17 for the parameters for this year), but inserting the sequence of observed recruitments from 1981 to 1993 (SC-CAMLR-XVI, Annex 5, Table 18) and the catch vector from 1989 to 1998. The lognormal recruitment parameters were used to initialise the age structure and to project recruitments from 1994 to the present.

4.110 The decline in median ratio of spawning biomass at the end of the catch period over the median pre-exploitation spawning biomass shown by this run indicated that the decline in CPUE may be explained partly by the series of low recruitments in the early 1980s. However, the Working Group acknowledged the preliminary nature of this analysis and the need to develop this approach further in the future. In this regard, the Working Group highlighted a number of issues for future work required to interpret the CPUE analyses and for determining how to provide advice based on CPUE data:

- (i) Over what period should projections be undertaken in order to examine catch strategies given recent (and continued) catch histories greater than the long-term sustainable annual yield?
- (ii) What are the implications of incorporating a stock-recruitment relationship in estimating long-term annual yield?
- (iii) In general, how can the two methods (CPUE analyses and GYM) be used together to provide advice on short- and long-term management options.

Trends in Size at Capture

4.111 An exploratory analysis of length data for *D. eleginoides* in Subarea 48.3 was undertaken during the meeting. The Working Group noted the considerable amount of data which is now available, particularly resulting from the work of CCAMLR observers on vessels in this area.

4.112 Catch weighted length frequencies for the period 1992 to 1998 are shown in Figure 6. The Working Group noted changes in the form of the length distribution over time. The greatest change appeared to be between distributions for the period before 1994 and those after. This may be because the period of fishing sampled in the 1992 and 1993 seasons was the summer. Length samples for 1995 to 1998 were from the winter months.

4.113 Weighted mean lengths and maximum and minimum length over the same period are shown in Figure 7. The Working Group noted that the mean and maximum lengths in the catch did not show a consistent pattern of decline as might be expected from the decline in CPUE shown by the results of the GLM analysis. However, the Working Group noted that several elements of the fishing operation can influence length distributions of the catch, including season, hook selectivity and depth of capture (as shown in WG-FSA-98/58). Such effects would need to be considered in interpreting trends over time. It was not possible to undertake a comprehensive analysis of trends in size at capture using catch-weighted length frequencies in the time available.

4.114 The Working Group recommended that the routines for extracting catch-weighted length frequency data developed by the Secretariat prior to the 1998 meeting be further developed in the intersessional period. The data should be extracted in a form which allows graphical presentation of catch-weighted length frequencies and standardisation of data to examine trends over time. The Working Group recognised the complex nature of the data analyses required and the difficulty in completing such analyses at the Working Group meeting within the time available. Participants interested in the assessment of this fishery were encouraged to undertake analysis in the intersessional period and present the results for consideration at next year's meeting.

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

4.115 The estimate of yield from the GYM was 3 550 tonnes. This was very similar to the result obtained at last year's meeting (3 540 tonnes).

4.116 According to the analysis of available data for the most recent season the CPUE has continued to decline from 1997 to 1998. Preliminary analysis using the GYM indicated that the decline in CPUE may be partly explained by a series of low recruitments in the early 1980s.

Notwithstanding these results, the Working Group considered that the information available to the Working Group on which to base management advice for the 1998/99 season was very similar to that available at last year's meeting.

4.117 The Working Group therefore considered that the catch limit for the 1998/99 season should be less than the 3 550 tonnes indicated by the GYM in order to maintain a degree of caution appropriate to the uncertainty indicated by the results above. As last year, the Working Group was unable to advise on what lower catch limit is appropriate (SC-CAMLR-XVI, Annex 5, paragraph 4.170).

4.118 The Working Group reiterated its advice from last year that the development of advice to address the reconciliation of different indicators of stock status is a high priority.

South Sandwich Islands (Subarea 48.4)

4.119 Despite a catch limit of 28 tonnes (Conservation Measure 128/XVI), no fishing in this subarea was reported to the Commission during the 1997/98 season. No new information was made available to the Working Group on which to base an update of the assessment.

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

4.120 The Working Group recommended that Conservation Measure 128/XVI be carried forward for the 1998/99 season. 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.

Kerguelen Islands (Division 58.5.1)

Standardisation of CPUE for the Trawl Fishery

4.121 The Working Group also used a GLM to standardise an updated series of CPUE data from the trawl fishery for *D. eleginoides* in Division 58.5.1. This GLM analysis followed the approach used at the Working Group's last meeting.

4.122 The GLM was fitted to haul-by-haul data from the French and Ukrainian trawl fisheries operating off the western, northern, and eastern coasts of Kerguelen during the period 1990 to 1998. Tonnes per minute towed was used as the response variable, and nationality, year, month, area and depth were considered as predictor variables. Year was defined as split-year.

4.123 All five predictor variables were statistically significant sources of variation in haul-by-haul CPUEs from the trawl fishery.

4.124 Figure 8 illustrates the effects of year on standardised catch rates from the trawl fishery. The time series is adjusted for the presence of hauls with zero catches. This adjustment was made by estimating the probability of a non-zero catch in each fishing season and multiplying this probability by standardised CPUEs predicted from the GLMs. The probabilities of zero catches for each fishing season are provided in Table 23.

4.125 Adjusted, standardised catch per unit effort decreased between 1990/91 and 1993/94 and have been relatively stable since then (Figure 8). Nevertheless, the standardised CPUE index for the 1997/98 split-year is the lowest on record. Standardised CPUEs were less variable at the end of the time series than at the beginning.

4.126 The Working Group viewed the declining trend in standardised catch rates with concern and noted that the trend in nominal catch rates demonstrated a more precipitous decline in CPUE during the early part of the time series (Figure 8). Further concern was expressed over the apparent increase in the percentage of hauls with small catches (Table 23).

Longline CPUE

4.127 The total catch in the longline fishery in Division 58.5.1 during the 1997/98 season was 1 118 tonnes. It was not possible to undertake an analysis of longline CPUE data at this year's meeting because haul-by-haul data were only available for the most recent season.

Determination of Long-term Annual Yields using the GYM

4.128 The GYM was used to assess long-term annual yield in Division 58.5.1. Parameters have been adopted from Subarea 48.3 and are presented in Table 24. Recruitments were prorated from the estimate for Subarea 48.3 using the method described in paragraph 4.69. The catch history, including unreported catches, was used in the projection (see Table 24).

4.129 The results of the projection are shown in Table 19. The estimated long-term annual yield was 6 900 tonnes. The Working Group noted that this yield is higher than most years in the catch history, except for 1992, 1997 and 1998. Given this potentially high yield, the Working Group noted that verification of recruitment at this level to this division is necessary. The Working Group would welcome any data or analyses to help assess the status of recruits in this area.

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

4.130 The declining trend in CPUE in the trawl fishery demonstrated by the GLM analysis confirms previous studies of this stock (WG-FSA-93/15). Reduction of the French catch limit (from the 1996 season onwards) shows the concern in the management of the fishery in the French EEZ.

4.131 The French authorities have allocated a catch limit for trawling for the 1998/99 season (1 September 1998 to 31 August 1999). A maximum of 3 400 tonnes applies for two vessels only in the whole area, including a 1 000-tonne limit in the eastern sector.

4.132 The longlining catch limit in the western sector has already been established up to the end of 1998 (October–December). A catch limit of 500 tonnes applies for two foreign (Ukrainian) vessels only. The total value for the 1998/99 season in this sector will not exceed the value of the long-term sustainable yield estimated at the 1994 meeting (1 400 tonnes).

4.133 A catch limit of 1 100 tonnes will apply for the 1998/99 season for one French longliner in the eastern sector outside the area used by trawlers.

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

4.135 Management of this fishery, in common with other subareas in the Indian Ocean sector, will be severely compromised as long as illegal catches continue.

Heard and McDonald Islands (Division 58.5.2)

4.136 The catch limit of *D. eleginoides* in Division 58.5.2 for the 1997/98 season was 3 700 tonnes (Conservation Measure 131/XVI) for the period 8 November 1997 to the end of the Commission meeting in 1998. The catch reported for this division by the time of the Working Group meeting was 3 264 tonnes. This was expected to increase to 3 700 tonnes by the end of the Commission meeting.

Determination of Long-term Annual Yields using the GYM

4.137 The analysis undertaken at last year's meeting was updated using the latest version of the GYM, incorporating total reported catches for the 1997/98 fishing season. The estimate of unreported catch in the 1996/97 fishing season was revised from 18 400 tonnes to 17 099 tonnes, resulting from a reworking of the numbers in SC-CAMLR-XVI, Annex 5, Appendix D, paragraph 6. This reworking was based on new information regarding catch rates, the number of vessels, landing figures in Mauritius and a corrected application of the conversion factor.

4.138 There was some uncertainty in the level of unreported catch during the 1997/98 season which was estimated to be between 520 and 3 500 tonnes (see Table 8). One run was made using the upper estimate of unreported catch (3 500 tonnes).

4.139 The input parameters for the GYM runs are shown in Table 17.

4.140 The decision rule concerning the escapement of spawning stock after 35 years was binding. The future long-term annual yield at which the median escapement is 0.5 was 3 690 tonnes for the upper estimate of catch, provided that high levels of unreported catches do not continue.

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

4.141 The Working Group recommended that the catch limit for Division 58.5.2 in the 1998/99 season should be revised to 3 690 tonnes, representing the annual yield estimate from the GYM, assuming removals in 1997/98 were equal to the reported catches plus the upper estimate of unreported catches (Table 8).

4.142 The analysis resulting in this recommendation assumed that total removals of fish in 1998/99 and future seasons are reduced to the level of 3 690 tonnes.

4.143 The Working Group noted that estimates of unreported catches in Division 58.5.2 in the 1997/98 season were less than 20% of those estimated for the previous fishing season. It was nevertheless reiterated that there will be a much greater effect on the catch limit in future years if the level of removals continues to exceed catch limits.

Crozet Islands and Prince Edward Islands (Subareas 58.6 and 58.7)

4.144 The catch reported for these subareas in 1997/98 comprised 88 tonnes caught inside the Crozet Islands EEZ (Subarea 58.6) and 814 tonnes from inside the Prince Edward Islands EEZ (140 tonnes from Subarea 58.6 and 674 tonnes from Subarea 58.7). Only 1 tonne was reported for the exploratory fisheries held under Conservation Measures 141/XVI and 142/XVI, which set catch limits of 658 tonnes and 312 tonnes for Subareas 58.6 and 58.7 respectively.

4.145 The fishery in the Crozet Islands EEZ took place only in November 1997. A total of 77 sets were made in 12 small-scale units (0.5° x 1° square). No new analysis of the data was undertaken.

4.146 The GYM was used to assess the long-term annual yield for the purposes of the new and exploratory fisheries notified for these areas (paragraphs 4.27 to 4.36, 4.42 and 4.43). The catch history used in the model included estimates of unreported catches from these subareas.

4.147 The Working Group noted the estimated yields from the GYM of 8 766 tonnes and 1 520 tonnes for longlining in Subarea 58.6 and 58.7 respectively (Table 19). These assumed removals from the 1997/98 season of 1 994 tonnes and 1 574 tonnes for the two subareas respectively. Given these potentially high yields, the Working Group noted that the verification of recruitment to these subareas is necessary. The Working Group welcomed any data for analyses to facilitate assessment of the status of recruits in these subareas.

4.148 The results of the assessment and management advice for new and exploratory fisheries in these areas are provided in paragraphs 4.27 to 4.36 and Table 20.

Standardisation of CPUE for the Prince Edward Islands (Subarea 58.7)

4.149 The Working Group used a GLM to standardise an updated series of CPUE data from the longline fishery for *D. eleginoides* around the Prince Edward Islands. This GLM analysis followed the approach that was used at the Working Group's last meeting (SC-CAMLR-XVI, Annex 5, paragraphs 4.303 to 4.306).

4.150 The CPUEs were calculated as kilogram per hook. Year, month, vessel and depth were considered as predictor variables. The haul-by-haul data covered the period October 1996 to June 1998. As with last year, not all the data available could be used in the GLM analysis; this year, data for two vessels that fished in each of the three years were used.

4.151 The vessel, month and year factors were each highly statistically significant ($p < 0.01$), but depth was not. The effect of month is illustrated in Figure 9.

4.152 Figure 9 illustrates the effects of year on standardised catch rates from the longline fishery. No adjustment was necessary for zero catches. Standardised catch per unit effort has decreased very substantially between 1996 and 1998.

4.153 The Working Group expressed grave concern at the decline in CPUE shown in Figure 9. The major drop in CPUE between 1996 and 1997 occurred over a period in which the Working Group has estimated substantial unreported catches were taken from this region.

Management Advice for *D. eleginoides*
(Subareas 58.6 and 58.7)

4.154 The Working Group recalled its advice for Subareas 58.6 and 58.7 from last year that the total estimated catch, including the unreported component has represented a substantial proportion of the estimated median unexploited biomass from the GYM (SC-CAMLR-XVI, Annex 5, paragraphs 4.297 and 4.306).

4.155 This information, coupled with the major decline in the CPUE index since 1996 suggests that the estimate of annual yield provided by the GYM for the purposes of the new and exploratory fisheries for Subarea 58.7 (Table 19) should be viewed with considerable caution.

4.156 The extent to which the standardised CPUE data for the Prince Edward Islands EEZ are indicative of the situation in Subarea 58.6 is uncertain. However, the Working Group agreed that in view of the history of unregulated catch and the decline in CPUE indicated at last year's meeting, the annual yield estimate calculated for the purpose of new and exploratory fisheries for Subarea 58.6 should also be treated with caution.

4.157 Advice on new and exploratory fisheries notified for Subareas 58.6 and 58.7 is provided in paragraphs 4.27 to 4.36 (new trawl and longline fisheries for *D. eleginoides* in Subareas 58.6 and 58.7 outside EEZs).

4.158 The Working Group noted that estimates of unreported catches in these areas in the 1997/98 season were less than 15% of those estimated for the previous fishing season. It was nevertheless reiterated that there will be a much greater effect on the catch limit in future years if the level of removals continues to exceed the estimated yield.

Champscephalus gunnari

South Georgia (Subarea 48.3)

Commercial Catch

4.159 The commercial fishery for *C. gunnari* around South Georgia (Subarea 48.3) was open from the end of the Commission meeting in November 1997 until 1 April 1998. The catch limit agreed by the Commission for this period was 4 520 tonnes (Conservation Measure 123/XVI). 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.

4.160 WG-FSA-98/53 provides a summary of the commercial fishing on *C. gunnari* in Subarea 48.3 during the 1997/98 season. Only one vessel, the Chilean-registered stern trawler *Betanzos*, took part in this fishery. The vessel fished for 10 days between 25 December 1997 and 5 January 1998. The catch of *C. gunnari* was 5.04 tonnes out of a total catch of 5.25 tonnes. *C. gunnari* was caught on 20 out of 34 hauls. 67% of the catch was taken in just two hauls, confirming the patchy distribution of this species around South Georgia. Four species were taken as by-catch: *C. aceratus*, *Pseudochaenichthys georgianus*, *N. rossii* and *N. squamifrons*.

4.161 The vessel carried an observer, designated by the UK in accordance with the CCAMLR Scheme of International Scientific Observation. The observer noted that the vessel's fishing master had no prior experience of either fishing for the target species or fishing around South Georgia. The Working Group agreed that it was unclear whether the poor catches by the FV *Betanzos* were due to a low standing stock of the target species, or the inexperience of the fishing master in locating fishable concentrations of *C. gunnari*. It is therefore difficult to use the results of the limited fishing in 1997/98 to provide a reliable indication of the current viability of the fishery.

Assessment at this Meeting

4.162 The catch limit for the 1997/98 season of 4 520 tonnes was derived from a short-term cohort projection performed at last year's meeting (SC-CAMLR-XVI, Annex 5, paragraphs 4.199 to 4.208). This was based on a biomass estimate from a UK trawl survey in September 1997. In view of the extremely low catches and the lack of a new survey, an assessment of yield over the period 1998/99 and 1999/2000 was performed, using the short-term projection method. The data inputs are provided in Table 25. The resulting fishing mortality for the coming two years was 0.143. This resulted in a combined catch over two years of 8 490 tonnes, comprising 4 840 tonnes in the first year and 3 650 tonnes in the second year. Analysis with the GYM was not carried out this year because the survey results used last year were still considered current.

4.163 The projected yield estimate for the 1998/99 season was higher than that estimated at last year's meeting (4 140 tonnes), due to the negligible catch in 1997/98.

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

4.164 Most participants agreed that the management of the fishery for *C. gunnari* in Subarea 48.3 during the 1998/99 season should be similar to that in force last season, as detailed in Conservation Measure 123/XVI. The total catch limit should be revised to 4 840 tonnes in accordance with this year's short-term yield calculations.

4.165 Dr E. Marschoff (Argentina) noted that the low catch rates in this fishery and the high percentage of small fish taken indicate that the stock remains at a low level. While further research is needed on the causes of this situation the stock should be afforded maximum protection by closing the fishery.

4.166 In response, several participants recalled that the yields estimated from the short-term projections were based on the lower 95% confidence bound of the 1997 UK trawl survey, and that therefore they constituted conservative estimates of yield (SC-CAMLR-XVI, Annex 5, paragraph 4.211).

Kerguelen Islands (Division 58.5.1)

4.167 No commercial fishing for *C. gunnari* took place in this division during the 1997/98 season.

4.168 A brief survey was conducted in February 1998 which indicated that the previous strong cohort (4+ years old) had almost disappeared, but it seems that a new year 1+ cohort (~170 mm long fish) is present this year. Remains of fish from the 1+ cohort have occurred in many scats of fur seals since March 1998.

4.169 During 1998/99, France intends to conduct a full survey on *C. gunnari* to assess the abundance of this new cohort, which will then be aged 2+ years, using the same method as in the 1997 survey. No commercial fishing is envisaged in 1998/99 on this species.

4.170 If the presence of a strong year 2+ cohort is confirmed in 1998/99, fishing may take place on this species in the 1999/2000 season.

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

4.171 The Working Group supported the French plan to conduct a pre-recruit survey in the 1998/99 season and looked forward to seeing the analysis of the results at the next meeting.

Heard and McDonald Islands (Division 58.5.2)

Commercial Catch

4.172 The commercial fishery for *C. gunnari* around Heard Island (Division 58.5.2) is open from the end of the Commission meeting in November 1997 until the end of CCAMLR-XVII. The catch limit agreed by the Commission for this period was 900 tonnes to be taken on the Heard Plateau area only (Conservation Measure 130/XVI). 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 132/XVI).

4.173 Two vessels, *Austral Leader* and *Sil* took part in this fishery. *C. gunnari* was targeted sporadically between mid-May and September 1998, as commercial demand required, while the vessels were engaged in their principal fishery for *D. eleginoides*. A total of 115.2 tonnes was caught up to 24 September 1998. Another vessel, *Southern Champion*, will remain in the fishery until early November 1998, and may catch more *C. gunnari*.

4.174 Between 29 May and 4 June 1998, *Austral Leader* conducted a random stratified trawl survey for *C. gunnari* on Heard Island Plateau and Shell Bank, similar to that conducted in August 1997 and reported in WG-FSA-97/29. Compared to the previous survey, fish were much more concentrated on Gunnari Ridge, and densities were very low over the remainder of Heard Island Plateau. Densities on Shell Bank were much lower than in the previous year.

Assessment at this Meeting

4.175 An assessment of *C. gunnari* in the Heard Island Plateau area was made using the same short-term annual yield method adopted last year (SC-CAMLR-XVI, Annex 5, paragraph 4.181). Estimates of yield for Shell Bank were not made because of the very low abundance of this population. These results were reported in WG-FSA-98/54. During the meeting, the assessment was updated to include an estimate of catches taken since the survey was conducted, comprising 62.5 tonnes taken up to the beginning of WG-FSA which was advanced to 100 tonnes to allow for further catches up to the end of the season (6 November 1998).

4.176 The resulting fishing mortality for 1998/99 and 1999/2000 was 0.139. This resulted in a combined catch over two years of 1 984 tonnes, comprising 1 160 tonnes in the first year and

824 tonnes in the second year. Unlike the previous three years, the age 2 cohort in 1998 is very weak and is expected to contribute little to the biomass in subsequent years. If recruitment to age 2 in 1999 is also weak then the fishery in 2000 will be predominantly on age 5 fish. After this time, catch limits may need to be set by some other method to be determined by the Working Group, and be maintained thereafter unless a further survey demonstrates that abundant cohorts are recruited.

4.177 Despite the estimate of biomass on Heard Island Plateau being lower than in the survey of the previous year, the calculated yield is higher. This results from the fact that the fish in the 1998 survey were mostly concentrated in one area, and so the biomass estimate had a low variance and the lower 95% confidence limit of the estimate, which is used in the yield calculation, was consequently higher than in the previous year (Table 26).

Management Advice for
C. gunnari (Division 58.5.2)

4.178 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 1998/99 season should be similar to that in force last season, as detailed in Conservation Measure 130/XVI. The total catch limit should be revised to 1 160 tonnes in accordance with this year's short-term yield calculations. The fishery on Shell Bank should remain closed.

Other Species

Antarctic Peninsula (Subarea 48.1)

Notothenia rossii, *Gobionotothen gibberifrons*,
Chaenocephalus aceratus, *Chionodraco rastrospinosus*,
Lepidonotothen larseni, *Lepidonotothen squamifrons*
and *Champscephalus gunnari*

4.179 Finfish stocks in the Antarctic Peninsula region (Subarea 48.1) have been exploited from 1978/79 to 1988/89 with most of the commercial harvesting taking place in the first two years of the fishery. Given the substantial decline in biomass of the target species in the fishery, *C. gunnari* and *N. rossii* by the mid-1980s, Subarea 48.1 was closed for finfishing from the 1989/90 season onwards.

4.180 Surface areas of seabed within the 500 m isobath were presented (WG-FSA-98/14) for the lower South Shetland Islands from King George Island to Livingston Island; and recalculated for the Elephant Island region. Revised estimates were based on several integrated datasets and incorporated seafloor slope.

4.181 A random, stratified bottom trawl survey within the 500 m isobath was carried out by the US AMLR program in two regions of Subarea 48.1: Elephant Island and the lower South Shetland Islands. Information from the survey on the biology of several species (WG-FSA-98/15) and standing stock biomass (WG-FSA-98/17) were reported.

4.182 Information on species composition and catch levels of all species encountered during the survey of Subarea 48.1, length frequency distributions for 11 species, and length–weight relationships for six species are summarised in WG-FSA-98/15. Sufficient data were collected from Subarea 48.1 to construct maturity ogives for *C. gunnari*, *G. gibberifrons*, *C. aceratus*, *C. rastrospinosus* and *L. squamifrons*. Lengths at maturity were compared to previous studies and other regions.

4.183 Estimates of standing total stock biomass for eight species of finfish, and standing spawning stock biomass for six species of finfish are presented in Table 27. Biomass was estimated for Elephant Island and the lower South Shetland Islands separately, and combined as one system. Computations were based on updated estimates of seabed area (WG-FSA-98/14), as well as previously used seabed areas. Differences in stock biomass were observed for all species based on estimate of seabed area employed.

4.184 Comparable biomass estimates for the 1987, 1996 and 1998 trawl surveys are presented in Table 28. These estimates are based on the previously used seabed areas for all surveys because there was insufficient time available during the meeting to re-run the earlier analyses. Biomass estimates for most species were still less than the 1987 survey, indicating that stocks of fish in this area have not recovered since the early fishery.

4.185 Given the current low abundance of *C. gunnari* and the other species and the difficulties which CCAMLR had experienced previously in managing fisheries which exploit mixed-species assemblages, the Working Group did not attempt to calculate precautionary catch limits using the GYM during the meeting.

4.186 A feasibility longlining and potting survey using the longliner *Tierra del Fuego* was carried out in Subarea 48.1 for 12 days during February and March 1998 in accordance with the Conservation Measure 134/XVI for a new fishery for *D. eleginoides* and *D. mawsoni* (SC-CAMLR-XVII/BG/7). Total catch from the longlining activity was low (<1 tonne) and CPUE for both species were lower than the minimum required of 0.1 kg/hook that was established by the Commission (CCAMLR-XVI, paragraph 9.29). Total catch and catch rates from the pots were also low with the Antarctic crab (*P. anemerae*) predominating (WG-FSA-98/20). In spite of those results, the Working Group noted that this cruise provided interesting data on the distribution of the two *Dissostichus* species.

Management Advice

4.187 There appears to be little prospect for a substantial fishery given the low biomass estimates for the 1997/98 season and some of the uncertainties associated with decline in biomass compared to 1987. The Working Group therefore recommended that Conservation Measure 72/XII should remain in force for the species considered in this section until future surveys indicate an increase in fish biomass in the subarea.

4.188 In view of the low catch rates in the exploratory *Dissostichus* spp. fishery, the Working Group recommends that fishing for *Dissostichus* spp. should be prohibited in this area.

South Orkney Islands (Subarea 48.2)

4.189 A feasibility longlining and potting survey using the longliner *Tierra del Fuego* was carried out in Subarea 48.2 for three days during March 1998 in accordance with Conservation Measure 135/XVI for a new fishery for *D. eleginoides* and *D. mawsoni* (SC-CAMLR-XVII/BG/7). Total catch from the longlining activity was low (<1 tonne) and CPUE for both species were lower than the minimum required of 0.1 kg/hook that was established by the Commission (CCAMLR-XVI, paragraph 9.29). Total catch and catch rates from the pots were also low with the Antarctic crab (*P. anemerae*) predominating (WG-FSA-98/20). In spite of those results, the Working Group noted that this cruise provided interesting and useful data on the distribution of the two *Dissostichus* species.

Management Advice

4.190 In the absence of new information on stocks in this subarea, the Working Group noted that fisheries in Subarea 48.2 should remain closed in accordance with Conservation Measure 73/XII. In view of the low catch rates in the exploratory toothfish fishery the Working Group recommends that fishing for *Dissostichus* spp. should be prohibited in this area.

South Georgia (Subarea 48.3)

Squid (*Martialia hyadesi*)

4.191 A notification of the intention to conduct an exploratory fishery for the squid *M. hyadesi* in Subarea 48.3 by the Republic of Korea and the UK during the 1997/98 season was approved under Conservation Measure 145/XVI. No fishing was carried out due to adverse economic conditions. No new information was presented to the Working Group at this year's meeting.

4.192 The scientific basis on which both the notification and the current conservation measure were based has not changed. WG-FSA, WG-EMM and SC-CAMLR had detailed discussions on the subject of a squid fishery in 1997 (SC-CAMLR-XVI, Annex 5, paragraphs 4.2 to 4.6; SC-CAMLR-XVI, Annex 4, paragraphs 6.83 to 6.87; SC-CAMLR-XVI, paragraphs 9.15 to 9.18). The catch limit is considered to be precautionary, since it is only 1% of a conservative estimate of annual predator consumption (SC-CAMLR-XV, paragraph 8.3).

Management Advice

4.193 The Working Group recommended that a conservative management scheme as contained in Conservation Measure 145/XVI is still appropriate for this fishery.

Crabs (*Paralomis spinosissima* and *Paralomis formosa*)

4.194 There has been no fishing activity on crab stocks since January 1996.

Management Advice

4.195 The Working Group, recognising the great utility of the experimental harvest regime set out in Conservation Measure 90/XV in providing useful information for developing an assessment of the target species, reiterated the view expressed at its 1996 meeting that Conservation Measure 90/XV should remain in force, but that, if new vessels were to enter the fishery, the Commission might wish to revise Phase 2 in the light of the comments made in paragraph 4.183 of the 1996 report (SC-CAMLR-XV, Annex 5).

4.196 The Working Group also stated that since the crab stocks were not assessed, a conservative management scheme as contained in Conservation Measure 126/XV is still appropriate for this fishery.

Antarctic Coastal Area of Division 58.4.1
and Division 58.4.2

4.197 No new information was available to the Working Group to undertake any assessment on the stocks in these divisions.

Pacific Ocean Sector (Area 88)

Subareas 88.1 and 88.2

4.198 Notification of the intention to conduct an exploratory fishery for *D. eleginoides* and *D. mawsoni* in Subareas 88.1 and 88.2 during the 1997/98 season was lodged by New Zealand (CCAMLR-XVI/17). Details on the development of the fishery in Subarea 88.1 are given in paragraph 4.6. No fishing was carried out in Subarea 88.2.

Subarea 88.3

4.199 A feasibility longlining and potting survey using the longliner *Tierra del Fuego* was carried out in Subarea 88.3 for 10 days during February 1998 in accordance with Conservation Measure 140/XVI for a new fishery for *D. eleginoides* and *D. mawsoni* (SC-CAMLR-XVII/BG/7). Total catch from the longlining activity was low (<1 tonne) and CPUE for both species were lower than the minimum required of 0.1 kg/hook that was established by the Commission (CCAMLR-XVI, paragraph 9.29). Total catch and catch rates from the pots were also low with the Antarctic crab (*P. anemerae*) predominating (WG-FSA-98/20). In spite of those results, the Working Group noted that this cruise provided interesting and useful data on the distribution of the two *Dissostichus* species.

Management Advice for
Dissostichus spp. (Area 88)

4.200 In view of the low catch rates in the feasibility survey of *Dissostichus* spp. in Subarea 88.3, the Working Group recommended that fishing for *Dissostichus* spp. should be prohibited in that subarea.

General By-catch Provisions

4.201 In this section of the report the Working Group considered issues associated with the by-catch of fish. Information on the by-catch (incidental mortality) of seabirds can be found under Section 7 'Incidental Mortality Arising from Longline Fishing'.

4.202 The Working Group recalled its discussion in last year's meeting and recognised that the mixed strategy referred to in SC-CAMLR-XVI, Annex 5, paragraph 4.319 has been in operation during the past season. The mixed strategy has two components: (i) total removals of each by-catch species are limited by estimates of potential yield; and (ii) haul-specific by-catch limits are set at levels that permit prospecting but are not likely to cause the potential yield from Component 1 to be exceeded. It was agreed that this approach is appropriate and should be retained in the coming season for by-catch species generally but noted that variations may be possible in some circumstances, such as for the assessments of two by-catch species in Division 58.5.2 considered below.

4.203 The *C. gunnari* fishery conducted in Subarea 48.3 provided information on haul-by-haul by-catch levels in the semipelagic fishery for this species. It was noted that *G. gibberifrons* was not present in the catches and that the threshold level of 100 kg of by-catch in a single haul was not reached for any species.

Assessments of By-catch in Division 58.5.2

4.204 WG-FSA-98/55 detailed data available for estimating recruitment parameters for two by-catch species, *C. rhinocerotus* and *L. squamifrons*, in Division 58.5.2. Lognormal recruitment parameters were estimated by undertaking mixture analyses using data from three trawl surveys around Heard Island from 1990 to 1993 (Williams and de la Mare, 1995). Cohort strengths were determined from the results of these analyses using the method described in SC-CAMLR-XIV, Annex 5, paragraphs 5.44 to 5.49. The resultant parameters are given in Table 29.

4.205 Recruitment variability in *C. rhinocerotus* is approximately the same as used in last year's assessments while recruitment variability in *L. squamifrons* was estimated to be much greater than that used last year. The Working Group agreed to use these new estimates in assessments using the GYM in the same manner as is undertaken for *D. eleginoides*.

4.206 The input parameters for the GYM are given in Table 29. The results are displayed in Table 25. The estimates of long-term annual yield for *C. rhinocerotus* and *L. squamifrons* are 150 tonnes and 78 tonnes respectively. The Working Group agreed that these estimates are more reliable than those for last year because they are now based on recruitment estimates from the area in which fishing takes place.

Management Advice

4.207 The Working Group agreed that the mixed strategy for protecting by-catch species detailed in SC-CAMLR-XVI, Annex 5, paragraph 4.319 should be retained as a general policy unless acceptable assessments of long-term annual yield and methods to ensure these species are not targeted, have been determined.

4.208 The Working Group considered that the estimates of yield for *C. rhinocerotus* and *L. squamifrons* for Division 58.5.2 undertaken this year are more reliable than the indicative assessments provided last year. It therefore recommended that the catch limit in Division 58.5.2 for *C. rhinocerotus* should be 150 tonnes, and that for *L. squamifrons* should be 80 tonnes.

4.209 The Working Group agreed that as these assessments are equivalent to those of target species, the main mechanism for protecting these species needs only be the catch limit. Therefore the provisions in Conservation Measures 130/XVI and 131/XVI dealing with catches of these species in excess of 5% of the total catch in any one haul are no longer required. Because of their low long-term annual yields, however, it is still advisable to retain the 2-tonne limitation on individual hauls in Conservation Measures 130/XVI and 131/XVI to avoid directed fishing on these species.

CONSIDERATION OF ECOSYSTEM MANAGEMENT

Interactions with WG-EMM

5.1 Dr I. Everson (Convener, WG-EMM) outlined those aspects of ecosystem assessment conducted by WG-EMM at its 1998 meeting (Annex 4) directly related to WG-FSA's work.

5.2 The Working Group noted that WG-EMM had encouraged further work on the possible relationship between *C. gunnari* condition and krill density in Subareas 48.1 and 48.3 (Annex 4, paragraphs 7.32 and 12.3(xii)). Further work on this relationship should result in an index of *C. gunnari* condition as a function of the species' krill-dependence.

5.3 The Working Group also noted WG-EMM's view that declines in black-browed albatrosses in Subarea 48.3 are likely to result from incidental mortality in the longline fishery (Annex 4, paragraphs 8.10 and 12.4(xiv)). Further work on this problem was encouraged (see also section 7).

5.4 Information concerning the by-catch of fish in the krill fishery was reported to WG-EMM (SC-CAMLR-XVII, paragraph 7.11).

5.5 WG-FSA-98/11 summarised the activities of the ad hoc correspondence group established by WG-FSA in 1995 (SC-CAMLR-XV, Annex 4, paragraphs 6.1 to 6.4) to analyse all available data on fish by-catch in the krill fishery.

5.6 The Secretariat has established a comprehensive database on fish by-catch in the krill fishery. The inventory of this database and the results of preliminary analyses were reported to WG-FSA's 1997 meeting (WG-FSA-97/46). The Working Group tasked the Secretariat with compiling and validating all outstanding information on the by-catch of fish in the krill fishery (SC-CAMLR-XVI, Annex 5, paragraphs 5.4 to 5.6) during the 1997/98 intersessional period.

5.7 Only a limited number of corrections to the CCAMLR database were made and a single new dataset was provided. Analyses of the available data indicated that despite a comparatively long time series (>20 years), data exhibited a marked lack of coherence and consistency in terms of the sampling methods used and the level of attached detail on sample protocols provided. In particular:

- (i) data provided are a mixture of data from commercial krill catches and from research vessel catches using commercial equipment;
- (ii) there is incomplete reporting of null records (i.e. of hauls in which fish by-catches were not present) in relation to the reporting of catches in which fish were present;
- (iii) information on sampling protocols (especially the relationship between sample size and total sampling) is limited as is information on fishing gear characteristics or performance; and
- (iv) information is incomplete on the biological characteristics (especially size) of fish caught as by-catch.

5.8 Similarly, the data compiled to date do not facilitate analyses aimed at evaluating the geographical and seasonal distribution of fish by-catch in terms of species caught, the numbers of individual species taken and their associated spatial/temporal distribution.

5.9 The Working Group was concerned that in spite of these developments, it is still unable to provide a clear indication of the likely impact of krill harvesting on larval and juvenile fish. It reiterated the view that even a relatively low incidence of larval/juvenile fish in krill catches

could result in a substantial impact on the future abundance of key fish species in some areas. Consequently, there is a need for increased sampling effort on krill catches as well as for additional studies on the demography and distribution of larval/juvenile fish.

5.10 In order to evaluate effectively the potential scope and impact of krill fishing on fish by-catch, WG-FSA-98/11 suggested that scientific observers should be deployed aboard krill fishing vessels in accordance with the CCAMLR Scheme of International Scientific Observation to monitor fish by-catch.

5.11 This would require a dialogue with krill fishers on practical issues as well as the development of observation protocols. Members were encouraged to pursue these matters and report back to WG-FSA's next meeting.

5.12 Dr Everson suggested that it may be possible to sample a small number of blocks of frozen whole krill once landed. Such an approach would provide at least some direct indication of the proportion of small fish taken by the krill fishery. Additional insight would be forthcoming the greater the information provided on the sourcing of the blocks of frozen krill. The Working Group welcomed this suggestion and looked forward to pilot studies on its efficacy and implementation.

5.13 Members were again encouraged to undertake studies on the distribution and abundance of larval/juvenile fish. In this connection it was noted that planning for the 1999/2000 synoptic survey for krill is well advanced (Annex 4, paragraphs 9.49 to 9.93). In this connection, it was noted that no data collection plans had been submitted for the collection of information on larval and juvenile fish as part of the survey's net sampling program. Since such plans had been requested by the Working Group in 1997 (SC-CAMLR-XVI, Annex 5, paragraph 5.15), Members with an interest in collecting fish data as part of the krill survey were strongly urged to provide data collection plans to the survey planning workshop scheduled for March 1999 (Annex 4, paragraph 9.85).

5.14 Following previous submissions to both WG-EMM and WG-FSA (i.e. SC-CAMLR-XVI, Annex 5, paragraphs 5.8 to 5.9), WG-EMM-98/11 reported on efforts to monitor coastal fish populations using pellets of the Antarctic shag (*P. bransfieldensis*). The Working Group noted that WG-EMM had agreed that this approach should be approved as a CEMP standard method (Annex 4, paragraph 9.30) for a five-year trial period initially. The method is currently being refined and will be published and circulated to all Members.

5.15 The Working Group acknowledged the progress made by WG-EMM in the development of comprehensive ecosystem assessments and especially in the combination of key biotic indices (Annex 4, paragraphs 7.1 to 7.4) and the elucidation of possible links between harvested and dependent species to the environment. The Working Group encouraged further development of these approaches and looked forward to future collaboration with WG-EMM on such matters.

Ecological Interactions

5.16 WG-FSA-98/26 described measurements of *C. gunnari* otolith chord length and mass as predictors of fish length and mass. Both measures serve as good predictors of fish length, with the latter being slightly better. The same measures did not predict fish total mass as accurately, since fish mass is affected by fish condition, state of feeding and maturity stage. The Working Group agreed that this work showed promise and encouraged future application of the method over a wide area. It also recognised the important implication of such results for fish predator studies and its application to other fish species.

5.17 WG-FSA-98/49 identified several references describing ecological interactions between both *D. eleginoides* and *D. mawsoni* with other components of the Antarctic marine ecosystem. Further discussion in this regard is contained in paragraphs 3.127 and 3.128.

5.18 As in 1997, several observer reports from the *D. eleginoides* longline fishery had mentioned interactions between marine mammals and fishing vessels (Table 30) during the hauling of lines. Since it is apparent that the number of fish taken by marine mammals (especially killer whales) is likely to be substantial, the Working Group welcomed further studies of the potential interactions between marine mammals and longline fishing as well as of the feeding of marine mammals on both *D. eleginoides* and *D. mawsoni* in particular (see paragraph 5.13 above).

5.19 Observers noted frequent interactions between orcas and the fishing line during the haul in Subareas 48.1, 48.2, 48.3, 58.6, 58.7 and 88.3. When orcas were present, between 50% and 100% of the catch was taken. Generally, the head of the fish was left on the line.

5.20 It was also noted that on some occasions when sperm whales were present around the vessel during the haul, there were sections of lines without fish. Several observers suggested that unlike orcas, sperm whales remove whole fish from the line. However, direct evidence is still lacking for sperm whales taking *D. eleginoides*.

5.21 On some occasions there was evidence that Antarctic fur seals took fish, based on the presence of half-eaten fish on the line; on other occasions, however, fur seals present during hauling were reported as not taking fish. One observer reported an increase in take of fish by fur seals over the course of the cruise, suggesting that a learning process may have occurred.

5.22 There are two reports of single leopard seals *Hydrurga leptonyx* taking *D. eleginoides* from the longlines.

RESEARCH SURVEYS

Simulation Studies

6.1 Drs Gasiukov and Marschoff reported on progress made on the study of the influence of spatial correlation in the estimates of the *C. gunnari* stock (SC-CAMLR-XVI, Annex 4, paragraph 6.2). The Argentine survey results have been preliminarily analysed under the assumption of an isotropic field of densities. The autocorrelation and structure functions (variogram) as functions of the distance between stations were obtained. Preliminary results indicate that the correlation between stations at a distance in the order of 10 km is small enough to treat them as uncorrelated. This work will continue in the intersessional period relaxing the assumption of isotropy.

Recent and Proposed Surveys

Recent Surveys

6.2 Four recent surveys were undertaken in CCAMLR waters during 1997/98, covering Subareas 48.1, 48.2, 48.6 and 88.3 and Divisions 58.4.4 and 58.5.2. These surveys were carried out by Australia, Chile, Spain and USA.

6.3 The Australian survey was conducted around Heard Island between 20 May and 4 June 1998 on the *Austral Leader*. The objective was to sample two populations of *C. gunnari* (Heard Plateau and Shell Bank).

6.4 Chilean scientists on board the longliner *Tierra del Fuego* visited Subareas 48.1, 48.2 and 88.3 during a 43-day cruise in February and March. The cruise was conducted in accordance with Conservation Measures 134/XVI, 135/XVI and 140/XVI (SC-CAMLR-XVII/BG/7 Rev. 1 and WG-FSA-98/20).

6.5 Spain undertook a bottom longline research cruise on several seamounts between South Africa and the Antarctic Convergence, and in the CCAMLR area (Shona, Spiess, western slope of Bouvet Island, and Ob and Lena Banks). The cruise was carried out between 22 October and 1 December 1997 on board the longliner *Ibsa Quinto* (WG-FSA-98/48).

6.6 The US AMLR program reported on a bottom trawl survey around Elephant Island and the lower South Shetland Islands. Trawling operations were conducted on board the RV *Yuzhmorgeologiya* from 12 March to 1 April 1998 (WG-FSA-98/5 and 98/17).

Proposed Surveys

6.7 Australia plans a *C. gunnari* pre-recruitment survey for the 1998/99 season. This survey will probably occur during May to August 1999 on the Heard Island Plateau and Shell Bank areas. A similar pre-recruitment survey may be conducted on Pike Bank in 1998. The aim of both surveys is to estimate the biomass and recruitment of *C. gunnari*. These estimates will be used for stock assessment at the next meeting of WG-FSA.

6.8 France and USA notified four research surveys for finfish. The French scientific vessel *La Curieuse* plans to visit Division 58.5.1 in winter 1999. The USA intends to conduct three different cruises: the first, on board RV *Laurence M. Gould*, will sample various Antarctic fish in Subarea 48.1 between March and July 1999; the second will conduct studies, including sampling of silverfish on board RV *Nathaniel B. Palmer* in the same subarea during May and June 1999; and the third cruise on RV *Yuzhmorgeologiya* will be to conduct bottom trawls for finfish studies in Subareas 48.1 and 48.2.

INCIDENTAL MORTALITY ARISING FROM LONGLINE FISHING

IMALF Intersessional Activities

7.1 The Secretariat reported on the intersessional activities of ad hoc WG-IMALF. The report was submitted as WG-FSA-98/5. The IMALF group worked in accordance with the plan of intersessional activities developed immediately after the completion of CCAMLR-XVI (November 1997) by the Secretariat in consultation with Prof. J. Croxall (UK) and other members of WG-IMALF. As in previous years, the intersessional work of the IMALF group was coordinated by the Secretariat's Science Officer.

7.2 The report of intersessional activities of WG-IMALF contained records of all activities planned and their results. It was considered item by item to evaluate outcomes and to decide which tasks were complete, which needed continuing or repeating, and which were in essence annual standing requests. Major items of future work would be considered later under that agenda item. The remaining tasks which needed intersessional work would appear in the plan of intersessional activities for 1998/99 (Appendix F).

7.3 The Working Group noted the large volume of work accomplished intersessionally by ad hoc WG-IMALF, details of which were presented in a number of WG-FSA papers. 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 1997/98 fishing season.

7.4 The membership of ad hoc WG-IMALF was reviewed intersessionally and a number of new members were added. The revised list of members is appended (Appendix E). WG-FSA welcomed new members and noted that some CCAMLR Member countries which are involved in longline fishing and/or seabird research in the Convention Area (e.g. Norway, Ukraine, Uruguay and USA) are not represented in WG-IMALF. It was agreed that technical coordinators and the Scientific Observer Data Analyst should be ex-officio members of ad hoc WG-IMALF. Members were asked to review their representation in ad hoc WG-IMALF intersessionally and to facilitate attendance of as many of their members as possible at the meeting.

7.5 The Chairman of the Scientific Committee suggested that taking into account the large volume of intersessional work, and especially the work of WG-IMALF during annual meetings of WG-FSA, the latter should consider the appointment of a scientist who would lead discussions at annual meetings and also be involved in the coordination of intersessional activities. Ad hoc WG-IMALF considered the proposal and decided to recommend Prof. Croxall and Mr Baker to act as Convener and Deputy Convener respectively of ad hoc WG-IMALF. It was also decided that, within the Secretariat, coordination of the intersessional work of ad hoc WG-IMALF should be continued by the Science Officer.

Research into Status of Seabirds at Risk

7.6 In response to CCAMLR's request for information on national research programs into the status of albatrosses, giant petrels and white-chinned petrels (SC-CAMLR-XVI, Annex 5, paragraphs 7.18 and 7.20; SC-CAMLR-XVI, paragraph 4.40), New Zealand tabled a summary of research currently underway on New Zealand seabirds vulnerable to fisheries interactions, and a list of papers resulting from this work which have either been published or are in press (WG-FSA-98/28). Three other seabird research papers which provide interim results were also tabled (SC-CAMLR-XVII/BG/8, BG/9 and BG/13).

7.7 The Working Group noted that of the eight species listed in the table in WG-FSA-98/28, there is evidence that four forage in the CCAMLR area. These are the Antipodean wandering albatross (Walker and Elliott, unpub. data), grey-headed albatross and Campbell albatross (Waugh, unpub. data) and southern royal albatross (Woehler et al., 1990). The usefulness of the summary table was noted. Similar summaries from other nations would enable the Working Group to carry out an overall review of research programs being carried out on albatrosses and petrels which either breed or forage in the CCAMLR area.

7.8 The Secretariat was requested to ask all Members to supply in advance of the next meeting, relevant summary data (in a format similar to WG-FSA-98/28, listing at least species, site, nature and duration of study, scientists responsible and publications) on their research programs into the status of albatrosses, giant petrels and *Procellaria* petrels. The highest priority should be accorded to acquiring information from France, the only Member known to be undertaking relevant programs which has so far failed to respond to all requests for information. The Working Group would review this information at its 1999 meeting.

Reports on Incidental Mortality of Seabirds during Longline Fishing in the Convention Area

1997 Data

7.9 At the 1997 meeting of WG-FSA, the data entry and analysis of the 1996/97 observer data for Subarea 58.7 was only partially completed. The task of entering and completing the analysis was given a high priority during the intersessional period; this is reported on in WG-FSA-98/10.

7.10 Of the 15 observer logbooks supplied for Subarea 58.7, only eight complied with the format of the CCAMLR Scientific Observers Logbook. An attempt was made to get the information required to calculate the seabird catch rates and numbers of hooks observed; however, this information was not collected and could not be calculated from the available data. Table 31 (which replaces SC-CAMLR-XVI, Annex 5, Table 41) summarises the available information on seabird catch rates and the numbers of birds observed; some information was obtained from the observer cruise reports.

7.11 The observed species composition for birds killed in the longline fishery for Subarea 58.7 during the 1996/97 season is given in Table 32 (which replaces SC-CAMLR-XVI, Annex 5, Table 42). White-chinned petrels (*Procellariaequinoctialis*) (66%) and grey-headed albatrosses (*Diomedea chrysostoma*) (11%) were still the most common species killed. Of white-chinned petrels and grey-headed albatrosses, 83% and 86% respectively were males, increasing the potential significance of the mortality (Ryan and Boix-Hinzen, in press).

7.12 The estimated total incidental catch of seabirds for each vessel in Subarea 58.7 (Table 33) was calculated using the observed catch rate (birds/thousand hooks) for each vessel multiplied by the total number of hooks set during the fishing season. For those vessels where catch rates could not be calculated, a total catch rate (average by-catch across all vessels for which by-catch rates were available) was used. The total catch rate was calculated from the total number of hooks observed and the total observed seabird mortality. The total seabird by-catch rate for Subareas 58.6 and 58.7 was 0.49 and 0.58 birds/thousand hooks for night and day setting respectively (Table 31). An estimated 696 birds were killed during night setting and 866 birds were killed during daylight setting. The total revised estimated seabird mortality (1 562 birds) for the 1997 season was then divided into species (Table 34) using the observed catch rates for each species (Table 32). This estimated total by-catch of 1 562 birds is 69% greater than the observed total mortality of 923 birds (see SC-CAMLR-XVI, Annex 5, paragraph 7.67). This reflects the difference between the number of dead birds actually seen by the observers and the estimated total which is the extrapolation to the complete haul from the proportion watched by observers.

1998 Data

Data Submission

7.13 As reported in WG-FSA-98/10 and paragraph 3.27, a total of 29 cruises of longline vessels was conducted within the Convention Area during the 1997/98 season, with scientific observers (international and national) on board all vessels. Comments on the quality and timeliness of observer data submissions are provided in paragraphs 3.43 and 3.44.

Data Validation

7.14 The reliability of data in the scientific observer database has been an issue in the past. With the current system there is insufficient time to validate recently-entered data in time for analysis at the meeting. Reconciling submitted data with information in the scientific observer reports is a critical part of the validation process. This and other validation procedures need to be completed before analysis is undertaken.

Data Analysis

7.15 As a result of the problems with data submission and validation, even preparing basic summaries of the submitted data on seabird by-catch is barely feasible by the end of the first week of the WG-FSA meeting.

7.16 Undertaking appropriate analyses (e.g. comparing by-catch rates in terms of vessel, season, area, year, species and mitigation measure) at the meeting is impossible under the present system. Such analyses are of fundamental importance for assessing the effectiveness of the existing CCAMLR measures and for identifying those measures (or elements thereof) which contribute to changes in seabird by-catch.

7.17 The Working Group therefore proposed that analyses involving the elements and addressing the topics outlined in paragraph 7.16 above, be undertaken as a priority element of the intersessional program.

7.18 Such analyses would not, therefore, be able to use the data for the current year as these will not be submitted in time. At the meeting, however, it should prove possible to summarise the current year's data at a level adequate to undertake a preliminary assessment and to identify for WG-FSA and Scientific Committee any topics of particular concern.

7.19 It would still be possible at WG-FSA to consider data analyses, and recommendations therefrom, contained in papers submitted to the meeting based on the current year's data.

7.20 Concern was raised that the assessments of seabird by-catch undertaken for WG-FSA were not comprehensive, in terms of covering all regulated longline fishing occurring in the Convention Area.

7.21 At present most, if not all data from Areas 48 and 88 are reported in full (i.e. logbook and scientific observer data) to the Secretariat and are thereby available for analysis and assessment.

7.22 Within Area 58, however, most of the current longline fishing is undertaken within the French and South African EEZs in Division 58.5.1 and Subareas 58.6 and 58.7. Only summarised observer data from the French EEZ are submitted to the Secretariat. Although all logbook and observer data from the South African EEZ are submitted to the Secretariat, a substantial proportion of this currently lacks data on the proportion of hooks observed, thereby precluding some analyses essential for overall estimates of seabird by-catch.

7.23 At present it is impossible, therefore, for WG-FSA to undertake any comprehensive analysis – and to make any comprehensive assessment – of seabird by-catch in Area 58 as a whole.

7.24 It was agreed to request appropriate French scientists to see if the detailed data on seabird by-catch, collected by observers, could be submitted to CCAMLR in a form consistent with that acquired from other longline fisheries.

Results

Subareas 48.1, 48.2 and 88.3

7.25 On the 52 hauls (24 in Subarea 48.1, 7 in Subarea 48.2 and 21 in Subarea 88.3, with a fish catch of <1 tonne in each), no seabird capture or mortality was reported (WG-FSA-98/19). During the fishing period (14 February to 18 March 1998) standard (10-minute) observations of seabirds around the ship during hauling recorded a total of 436 seabirds of 13 species, with

black-browed albatross (47%), Wilson's storm petrel (18%), brown skua (9%) and grey-headed albatross (9%) predominating. Very few interactions (especially in Subarea 88.3) between seabirds and the vessel, even during hauling, were noted (WG-FSA-98/19).

Subarea 88.1

7.26 In the 43-day cruise in February/March 1998, 82 sets were made, 24 (29%) during the day. Observation of 18% of hooks produced no reports of seabird by-catch (WG-FSA-98/10).

Subarea 48.3

7.27 WG-FSA-97/10 Rev. 2 indicates that a total of 79 seabirds was observed killed (66 at night, 11 in daytime, 2 unknown) and 249 seabirds were caught alive (227 at night, 22 in daytime) on the 3 154 thousand hooks observed (24.4% of the total set) in Subarea 48.3 (Table 35).¹

7.28 Although most seabird by-catch, whether of birds observed killed or caught alive, occurred at night, the by-catch rates in daytime (0.043 birds/thousand hooks) are nearly double those at night (0.023 birds/thousand hooks), with an overall rate of 0.025 birds/thousand hooks. Last year the equivalent values for Subarea 48.3 were 0.93 birds/thousand hooks in daytime, 0.18 birds/thousand hooks at night and 0.23 birds/thousand hooks overall.

7.29 Of the overall observed by-catch, 95% (75 birds) relates to only four vessels: *Koryo Maru 11* (42%), *Isla Sofía* (first cruise: 32%), *Argos Helena* (11%), *Tierra del Fuego* (first cruise: 10%). Similarly, of birds caught alive, 67% relate to two vessels; *Isla Sofía* (first cruise: 35%), *Argos Helena* (32%). All these vessels were fishing in April and May, all the seabird by-catch occurred in these months, 97% (77 birds) in April.

7.30 However, not all vessels fishing in April and May had high by-catch rates. Thus, on the *Illa da Rua* (first cruise) only one bird was killed and one caught alive, *Northern Pride* reported 20 birds caught but only one killed and *Arctic Fox* (first cruise) only killed one bird and caught three others.

7.31 Failure consistently to use streamer lines is likely to have been an important contributory factor to the high seabird mortality rate of *Isla Sofía* (no streamer lines used at night; used on only 75% of daytime sets) and *Argos Helena* (used on only 20% of daytime and 57% of night-time sets). However, this cannot explain the high by-catch rates on the *Koryo Maru 11* and *Tierra del Fuego* which used streamer lines comprehensively.

7.32 The high rates of live capture of seabirds is likely particularly to be influenced by offal discharge on the same side as the haul. This was likely to be the case for the *Isla Sofía*, *Argos Helena* and *Tierra del Fuego*, but would not account for the relatively high catch rates of live birds by the *Koryo Maru 11* and *Northern Pride*.

7.33 The species comprising the observed by-catch (Table 36) were white-chinned petrel (83%), black-browed albatross (12%), southern giant petrel (3%), wandering albatross (1%) and southern fulmar (1%). Eight of the 10 albatrosses (80%) were killed during the day; 65 of the 66 white-chinned petrels (98%) were killed at night.

¹ All birds killed on sets which begin during daytime or night-time (as defined by CCAMLR in Conservation Measure 29/XVI, footnote 3) are defined as daytime or night-time for the purposes of these analyses. A small proportion of sets started at night continued into daytime and vice versa, resulting in some small amount of potential misallocation of birds.

7.34 Using the observed by-catch data together with the proportion of hooks observed (Table 35) enables estimation of the overall seabird mortality in Subarea 48.3 in 1998 (Table 37). As last year, it should be emphasised that only a small proportion of hooks was observed on some vessels and cruises and therefore some quite large extrapolations are made from small original samples. This is particularly so for *Isla Sofía* and *Argos Helena*, with only 6% and 7% of hooks observed respectively and with substantial by-catch in the observed sample. Bearing this in mind, the overall estimated by-catch of 640 birds is still a very substantial reduction from the 5 755 birds estimated killed in 1997 in this subarea.

7.35 In comparison with 1997, in 1998, 5% fewer hooks were set, 6% fewer were set in daytime but 11% fewer were observed. There was only 12% of the seabird by-catch with daytime, night-time and overall by-catches reduced to 13%, 5% and 11% respectively of 1997 values. The proportion of albatrosses in the by-catch was reduced from 40% to 13% of the total, whereas the proportion of white-chinned petrels increased from 55% to 83% of the total.

7.36 Although there was some improvement in confining line setting to night-time and an improved use of streamer lines, it is likely that a major factor in reducing seabird by-catch in 1998 was the one-month delay (until 1 April) in the start of the fishing season. Thus in Subarea 48.3 in 1997, of 712 birds observed killed, 67% were caught in March, 30% in April and 3% in May to August. For 1998, of 79 birds observed killed, 97% were caught in April and 3% in May.

7.37 A comprehensive analysis is planned intersessionally into the relationships between vessel, daytime and night-time setting, time of year and seabird by-catch.

7.38 Overall, the Working Group noted that there had been a substantial (order of magnitude) improvement in the level and rate of seabird incidental mortality in Subarea 48.3 in 1998, compared with 1997. This is due to much higher levels of compliance with CCAMLR conservation measures.

Division 58.4.4

7.39 Two white-chinned petrels were caught by a Spanish longliner conducting a research cruise on Ob Bank in the period October to December 1997 (WG-FSA-98/48).

Division 58.5.1

7.40 CCAMLR-XVII/BG/41 includes summary reports of incidental mortality of seabirds on three cruises by two longliners. The *St Paul* reported no seabird by-catch from 30 sets (215 117 hooks) in December 1997. The *Reshetniak* reported 15 deaths (all white-chinned petrels; all but one at night) on 381 sets (962 400 hooks) in October to December 1997 and 11 deaths (all white-chinned petrels; all at night) on 285 sets (706 800 hooks) in February 1998. The overall catch rate of seabirds by the *Reshetniak* is stated to be 0.016 birds/thousand hooks. In addition, data from the lines of two unregulated Mustad autoline vessels were obtained, one having caught six white-chinned petrels on a haul of c. 3 750 hooks, the other catching six white-chinned petrels, one black-browed albatross and one grey-headed albatross on a haul of c. 3 500 hooks. This gave a minimum by-catch rate of 1.93 birds/thousand hooks.

Subareas 58.6 and 58.7

7.41 The most comprehensive data for this subarea available at the meeting are those summarised in WG-FSA-98/42. This reports the results of 11 longline fishing trips for *D. eleginoides* to the Prince Edward Island EEZ during 1997/98 (Table 38). The total fishing effort was approximately 4.3 million hooks, up 13% from the 1996/97 season (WG-FSA-97/51).

7.42 Observers reported that 498 seabirds from five species were killed during 1997/98 (Table 39). White-chinned petrels comprised almost all birds killed (96% of the total), with smaller numbers of giant petrels (3%), yellow-nosed albatrosses, and crested penguins. The average catch rate was 0.117 birds/thousand hooks, but this varied greatly among trips (Table 38). Only three trips, by two vessels, had by-catch rates exceeding 0.1 birds/thousand hooks. Two vessels, *Aquatic Pioneer* and *Koryo Maru 11*, had catch rates exceeding 0.3 birds/thousand hooks when fishing in February/early March.

7.43 Most birds killed were reported to have sodden plumage when hauled aboard, suggesting they were killed during setting. No observers reported birds being killed during hauling, but one northern giant petrel was badly injured.

7.44 As in 1996/97 (WG-FSA-97/51), there was great variation in bird by-catch within and between trips. Most sets caught no birds (85%), whereas a few sets caught large numbers of birds (maximum 30, all white-chinned petrels). Twenty sets caught five or more birds, and although they comprised <2% of sets, they accounted for more than half (52%) of birds killed. Important sources of variation include: fishing season, time of setting, wind strength, moon phase, distance from the Prince Edward Islands and vessel.

7.45 Fishing season: Seabird by-catch occurred primarily during summer, with by-catch rates peaking during the chick-rearing period for white-chinned petrels (Figure 10). No white-chinned petrels were caught during July/August, and the by-catch rate for this species decreased markedly by mid-March (0.375 birds/thousand hooks for the first half of March compared with 0.047 for the second half of March). Only two were caught in April/May (by-catch rate 0.003). Most giant petrels were caught in November (87%), whereas all three yellow-nosed albatrosses were caught in February. The crested penguins were all caught by the *Koryo Maru 11* in three incidents on successive trips in January and February.

7.46 Time of setting: Although permit holders were supposed to set lines only at night, in accordance with Conservation Measure 29/XVI, 15% of sets (17% of hooks) were set during the day or spanned nautical dawn or dusk (Table 38). This is an improvement on the situation in 1996/97, when more than half the hooks were set during the day (WG-FSA-97/51), and probably is the single factor most responsible for the marked reduction in by-catch of albatrosses and, to a lesser extent, giant petrels. During 1997/98 by-catch rate of giant petrels during day sets was almost 20 times greater than during night sets. White-chinned petrels are caught both during day and night sets, but the by-catch rate averaged higher for day sets (0.159 birds/thousand hooks) than night sets (0.102). The comparative by-catch rates for all other species combined were 0.0167 for day sets and 0.003 for night sets. Six of the 20 sets that caught five or more birds were made during the day. There was no clear pattern in by-catch rate during the night; the apparent peak in by-catch of white-chinned petrels three to four hours before dawn was strongly influenced by a small number of sets that caught >10 birds on the two trips with high by-catch rates (Figure 11). Surprisingly few birds were caught during sets around dawn compared with those around dusk (Figure 11).

7.47 Wind strength during setting: Seabird by-catch rates were considerably higher when there were gale force winds (force 8 on the Beaufort scale), and were reduced in calm or near calm conditions (force 0–1). These data are based on summer fishing effort only (November to March), but this pattern persists throughout the year, and is still apparent even if the two high catch rate trips are excluded (especially with regard to low by-catch during calm conditions).

Of the 20 sets that caught five or more birds, all occurred at wind speeds force 3, with 12 force 5 and four force 8. Observers reported that streamer lines often were ineffective when setting in high winds, and in some cases could not be deployed when winds were very strong. Less than 10% of hooks were set in gale force winds.

7.48 Distance from the Prince Edward Islands: Most birds were caught within 100 km of the islands, where more than 60% of fishing effort took place. By-catch rates of white-chinned petrels decreased almost linearly with distance from the islands (0.151 at <100 km; 0.074 at 100–200 km; 0.003 at >200 km), but if the two high catch rate trips are excluded, the distinction between the <100 km (0.07) and 100–200 km (0.06) zones disappears. All giant petrels and penguins were caught within 100 km of the islands, whereas the three yellow-nosed albatrosses were caught 100 to 200 km from the islands.

7.49 Moon phase: The relationship between seabird by-catch and moon phase was not very strong. The greatest by-catch rate occurred during half moon conditions, but this was influenced by the two trips with high catch rates. Excluding these trips, summer by-catch rates showed a slight elevation for moon states above 0.2 (moonless = 0; full moon = 1). All three yellow-nosed albatrosses were caught on moonlit sets (moon phase 0.8–1.0), as were the giant petrels (0.4–0.8), but the four penguins were caught when there was little or no moonlight (0.0–0.3). Of the 20 sets that caught five or more birds, nine of the 14 night sets took place with at least some moonlight. However, six of these sets also occurred with strong winds, suggesting that moonlight alone may be insufficient to cause serious by-catch problems.

7.50 Differences between vessels: There were strong inter-vessel differences in seabird by-catch rates. All sets that caught four or more birds (n = 29 sets) were made by only two vessels (the *Aquatic Pioneer* and *Koryo Maru 11*). The two trips by the *Koryo Maru 11* and one of the four trips by the *Aquatic Pioneer* accounted for 87% of all birds caught, despite representing less than one third of all fishing effort (32% of hooks set). Inter-vessel differences were most marked during the period of high by-catches in February to mid-March. At this time three vessels were fishing in the area (Table 38), but despite similar fishing times and locations, the catch rate of one vessel, the *Eldfisk*, was four to six times less than that of the other two vessels.

7.51 Overall, as reported in WG-FSA-98/42, there was a marked reduction in observed seabird by-catch in the *Dissostichus* spp. fishery at the Prince Edward Islands compared with 1996/97 (WG-FSA-97/51). Excluding white-chinned petrels, the by-catch rate of all other seabird species decreased 15 fold, from 0.079 birds/thousand hooks to 0.005. The biggest change was among albatrosses, whose by-catch rates decreased by two orders of magnitude (from 0.066 to less than 0.001 birds/thousand hooks). Giant petrels showed a more modest three-fold decrease, from 0.011 to 0.004 birds/thousand hooks. The mortality of crested penguins was surprising, as penguins are seldom observed to be caught on longlines. At least some of the penguins caught had swallowed hooks, suggesting that they were foraging from the longline. Most of these reductions in seabird by-catch compared to 1996/97 probably result from the reduction in the amount of daylight setting. However, the creation of a fishery exclusion zone to a radius of 5 n miles from the Prince Edward Islands, may have also made a contribution.

7.52 White-chinned petrels remain the main seabird by-catch problem particularly because they are caught at night. Their by-catch rate in 1997/98 (0.111 birds/thousand hooks) was almost half that in 1996/97 (0.210; WG-FSA-97/51), irrespective of the difference in the proportion of day sets between the two periods. The decreased catch rate presumably results from the more widespread use of effective streamer lines in 1997/98. However, the exclusion zone (see paragraph 7.51) may also have contributed to this.

7.53 The authors of WG-FSA-98/42 were requested to undertake analysis to assess the relative contribution that the exclusion zone may have made to the reduction in by-catch rates between 1997 and 1998.

7.54 Three factors were obvious influences on the by-catch of white-chinned petrels. Season was the most important, with most birds caught during the end of the chick-rearing period in both 1996/97 and 1997/98. The marked decline in by-catch from mid-March occurs more than a month before adult birds leave the waters around the Prince Edward Islands, but corresponds with the end of chick feeding. Within the late chick-rearing period, wind strength (possibly by preventing the effective deployment of streamer lines) and differences between vessels appear to be most important factors determining by-catch.

7.55 In respect of these results, WG-FSA-98/42 recommended that the fishery be closed during February until mid-March; the Working Group endorsed the suggestion.

7.56 WG-FSA-98/42 also recommended that fishers should be discouraged from setting lines when winds exceed force 7. However, given that some vessels were able to avoid catching birds at this time, such a recommendation was felt to be inappropriate at this time.

7.57 The Working Group noted that data for Subareas 58.6 (outside the French EEZ) and 58.7 in WG-FSA-98/42 are, as in WG-FSA-97/51 from last year, based on the absolute numbers of birds observed killed. In addition to being underestimates because an unknown proportion of birds caught at the set are lost prior to hauling, not all hooks set are observed during hauling. Table 35 indicates that, in Subareas 58.6 (outside the French EEZ) and 58.7, for the five cruises with data, the average proportion of hooks observed was 61%. For four of these cruises, the observed total of 265 birds killed is 75% of the estimated total (for all hooks set) of 354 birds.

7.58 The Working Group thanked the authors of WG-FSA-98/42 for such a comprehensive report which addressed especially interactions between catch rates and other variables of interest to the Working Group.

7.59 It was noted that an important element of the IMALF intersessional work program would be to analyse existing by-catch data to evaluate the importance of various environmental, fishing and mitigation variables on seabird by-catch (paragraph 7.16).

7.60 The summarised results of observations on seabird by-catch on a single cruise in November 1997 are reported in CCAMLR-XVII/BG/41. On 77 sets (325 673 hooks) the *St Paul* killed four birds (two white-chinned petrels and two black-browed albatrosses) at an overall mortality rate of 0.012 birds/thousand hooks.

Compliance with Conservation Measure 29/XVI

7.61 This section summarises information on the extent to which there was compliance with the main elements of Conservation Measure 29/XVI in 1998 and compares this with the situation in 1997.

7.62 Thawed bait (Conservation Measure 29/XVI, paragraph 1). Last year (1997), there was no evidence of frozen bait being used but data reporting (in the reports of scientific observers) was incomplete or inconclusive. This year (1998), one vessel (*Sudur Havid*) reported using frozen bait. The completeness of reporting on this topic from other vessels is uncertain at present.

7.63 Line weighting (Conservation Measure 29/XVI, paragraph 2). Last year, no vessel using the Spanish method of longline fishing was in compliance with the conservation measure (see paragraph 7.145 and Figure 12). Data for this year show a similar pattern (Figure 12).

7.64 Night setting (Conservation Measure 29/XVI, paragraph 3). In Subareas 48.3 and 88.1, the proportion of sets commenced during daylight were 8% (126 of 1 557 sets) and

29% (24 of 52 sets) respectively (Table 35). This compares with values of 14% (173 of 1 214 sets) and 50% (one of two sets) for Subareas 48.3 and 88.1 respectively in 1997 (SC-CAMLR-XVI, Annex 5, Table 40). In Subareas 58.6 and 58.7, the proportion of sets commencing in daylight in 1998 was 15% (paragraph 3.53) compared with 55% in 1997 (SC-CAMLR-XVI, Annex 5, paragraph 7.67).

7.65 Offal discharge (Conservation Measure 29/XVI, paragraph 4). In 1998, the proportion of vessels discharging offal during the haul from the same side as line hauling (Table 35), i.e. failing to comply with the conservation measure, was 55% (six of 11 vessels; two holding offal on board during the haul) for Subarea 48.3, 0% (one vessel; holding offal on board during the haul), for Subarea 88.1 and 0% (three of three vessels, but information on two other vessels *Zambezi* and *Sudur Havid*, which discharged on the same side as hauling last year, is not available to the Secretariat at present) for Subareas 58.6 and 58.7. Equivalent values for 1997 are 90%, 0% and 33% for Subareas 48.3, 58.6/58.7 and 88.1, respectively (SC-CAMLR-XVI, Annex 5, Tables 38 to 40).

7.66 Live bird release and hook removal (Conservation Measure 29/XVI, paragraph 5). Observers provided information on whether hooks were removed from live birds caught on the haul for around half of the trips. On four trips, the crew removed hooks from all seabirds caught, while on three other trips hooks were only removed from a proportion of the seabirds.

7.67 Streamer lines (Conservation Measure 29/XVI, paragraph 6). In 1998, streamer lines were used on vessels in Subarea 48.3 on 61% of night-time and 81% of daytime hauls (Table 35). For 1997, comparable values were 37% and 27%. In Subareas 58.6 and 58.7, data (Table 35) suggest that streamer lines were set on about 80% of night-time hauls. Data for daytime hauls and for 1997 are insufficiently available in the database to make any estimates. In Subarea 88.1, streamer lines were used on 96% of night-time and 100% of daytime sets (100% for both in 1997).

7.68 These data on streamer lines simply reflect that such a line was used, rather than whether it complied with the specification in Conservation Measure 29/XVI. Table 40 summarises the specifications of streamer lines present on vessels, and shows whether the streamer lines meet the minimum standards described in Conservation Measure 29/XVI. The information was taken from both observer cruise reports and observer logbooks. See also further discussion on streamer line design in paragraphs 7.156 to 7.160.

7.69 Streamer lines which meet the specifications were present on vessels during nine of the 27 trips (33%). Streamer lines that fall short of the minimum specifications were present on 16 trips. No information was available for one trip, and no streamer line was present on another trip.

7.70 There was reasonable compliance (78%) with height above water of the attachmentpoint of the streamer line to the vessel, but only 26% of trips had a streamer line which met the minimum length. Streamer lines on most trips had at least the minimum number of streamer lines (70%) and met the minimum number of spacings (67%), but compliance with minimum length of streamer lines was poor (33%). Eight observers noted that the vessel had spare streamer line material on board.

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

7.71 The Working Group estimated the levels of seabird by-catch that might be associated with the unregulated longline fisheries in the Convention Area in 1997/98.

7.72 An estimate of total seabird by-catch for any fishery requires information on seabird by-catch rates from a sample of the particular fishery and an estimate of the total number of hooks deployed by the fishery. For unregulated fisheries information is not available either for seabird catch rate or for total hooks set. To estimate these parameters, catch rates of seabirds (Table 31) and *Dissostichus* spp. (Table 2) from the regulated fishery and estimates of total fish catches from the unregulated fishery have been used (Tables 3 to 10).

Seabird By-catch

7.73 As no information is available on seabird by-catch rates from the unregulated fishery, estimates have been made using both the average catch rate for all cruises from the appropriate period of the regulated fishery and the highest catch rate for any cruise in the regulated fishery for that period. Justification for using the worst catch rate from the regulated fishery is that unregulated vessels are under no obligation to set at night, to use streamer lines or to use any other mitigation measure. Therefore catch rates, on average, are likely to be considerably higher than in the regulated fishery.

7.74 In view of the fact that:

- (i) seabird by-catch rates in the regulated fishery were substantially lower in 1998 than 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 was more realistic to use the seabird by-catch rates from 1997.

7.75 This year, therefore, followed the identical procedure to that used last year. However, the seabird by-catch values used are revised totals following the incorporation of additional data not available at last year's meeting. Last year, the mean and maximum summer rates used (for Subareas 58.6 and 58.7) were 0.363 birds/thousand hooks and 1.446 birds/thousand hooks, respectively. The revised summer values for the complete 1997 dataset are 1.049 birds/thousand hooks and 1.88 birds/thousand hooks (Table 31). Winter mean and maximum values last year were 0.009 birds/thousand hooks and 0.02 birds/thousand hooks, respectively; the revised values are 0.017 birds/thousand hooks and 0.07 birds/thousand hooks.

Unregulated Effort

7.76 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:

$$\text{Effort(U)} = \text{Catch(U)}/\text{CPUE(R)},$$

where U = unregulated and R = regulated.

Subarea 48.3

7.77 The Working Group identified no catch from unregulated fishing in this subarea this year, so no estimate of unregulated seabird by-catch is necessary (paragraphs 3.20 to 3.41).

Subareas 58.6 and 58.7

7.78 For this fishery, the year has been divided into two seasons, a summer season (S: September–April) and a winter season (W: May–August), corresponding to periods with substantially different bird by-catch rates. Fish catch rates are from South African and French data for their fisheries in Subareas 58.6 and 58.7 (Table 2). 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.

7.79 The seabird catch rates, from Table 31, were:

summer: mean 1.049 birds/thousand hooks; maximum 1.88 birds/thousand hooks; and
winter: mean 0.017 birds/thousand hooks; maximum 0.07 birds/thousand hooks.

Divisions 58.5.1 and 58.5.2

7.80 For the fisheries in these areas fishery catch rates are from the French data for their fisheries in Division 58.5.1 (Tables 1 and 2). The same alternative proportionate splits of catches and effort between summer and winter as in Subareas 58.6 and 58.7 were used.

7.81 The seabird by-catch rates used were the same values as used above for Subareas 58.6 and 58.7. There are two empirical values for this division, both from 1998 (CCAMLR-XVII/BG/41). One, of 1.93 birds/thousand hooks, is from a single set of two unregulated vessels; this value is very close to the value of 1.88 birds/thousand hooks used in Subareas 58.6 and 58.7. The other, of 0.016 birds/thousand hooks, is for a single cruise of a regulated vessel. It did not seem appropriate to use this value to represent the by-catch rate of unregulated vessels. Therefore analysis was confined to the use of the same values as for Subareas 58.6 and 58.7.

Results

7.82 The results of these estimations are shown in Table 41.

7.83 For Subareas 58.6 and 58.7, 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 8 500 to 11 000 birds in summer (and 50 to 100 in winter) to a potential higher level (based on the maximum by-catch rate of regulated vessels) of 15 000 to 20 000 birds in summer (and 200 to 400 in winter).

7.84 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 34 000 to 45 000 birds in summer (and 200 to 350 in winter) to a potential higher level (based on the maximum by-catch rate of regulated vessels) of 60 000 to 80 000 birds in summer (and 1 000 to 1 500 in winter).

7.85 The overall estimates of seabird by-catch are shown in Table 42.

7.86 As last year, it was emphasised that the values in Table 42 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.

7.87 Given the uncertainties involved, it cannot be concluded that there is any real difference between the lower/higher range of 50 000 to 89 000 birds potentially killed in 1998 compared with similar values of 31 000 to 111 000 birds potentially killed in 1997 (SC-CAMLR-XVI, Annex 5, paragraph 7.91 and Table 48). However, there is a probable change in the distribution of the potential bird by-catch in the unregulated fishery, which was mainly in Subareas 58.6 and 58.7 in 1997, whereas it is mainly in Divisions 58.5.1 and 58.5.2 in 1998.

7.88 On the basis of the species composition of the observed seabird by-catch in Subareas 58.6 and 58.7 in 1997 (63% white-chinned petrel, 22% albatross species (15% grey-headed albatross), 4% giant petrel species) the 1998 estimated potential by-catch in the unregulated fishery in the Convention Area would equate to 31 000 to 56 000 white-chinned petrels, 11 000 to 20 000 albatrosses and 2 000 to 4 000 giant petrels.

7.89 It was noted that these estimates are at least one order of magnitude higher than those reported to the Working Group for regulated fisheries in the same region.

7.90 For grey-headed albatrosses, for which accurate censuses are available of annual breeding populations (c. 21 500 pairs, but only about half the population breeds each year) for their breeding islands within Subareas 58.6, 58.7 and Divisions 58.5.1 and 58.5.2 (Gales, 1998), it may be roughly estimated that unregulated fishing in 1998 killed 9 to 15% of its breeding population.

7.91 For white-chinned petrels, available data are much less precise but the breeding populations at the Prince Edward, Crozet and Kerguelen Islands total less than 500 000 breeding birds (Croxall et al., 1984) so that an annual removal of 30 000 to 50 000 birds would have a substantial effect.

7.92 Breeding populations of giant petrels in Subareas 58.6, 58.7 and Divisions 58.5.1 and 58.5.2 total 20 000 breeding birds (WG-FSA-97/22), so that potential by-catch levels would equate to 10 to 20% of this.

7.93 The Working Group noted that levels of mortality in the unregulated fisheries will not be sustainable for these populations of petrel and albatross species breeding in the Convention Area.

7.94 With the estimated levels of seabird by-catch in the unregulated fisheries in the southern Indian Ocean in 1997 and 1998, it is likely that the local populations of white-chinned petrels, albatrosses and giant petrels would already be becoming reduced in numbers, perhaps to the extent that estimated seabird by-catch rates might be expected to decline from this cause alone.

7.95 The Working Group urged the Commission to take the strongest possible measures to address the problem of unregulated fishing in the Convention Area.

Assessment of Incidental Mortality of Seabirds in Relation to New and Exploratory Fisheries

Data from New and Exploratory Fisheries Proposed in 1997

7.96 The feasibility survey undertaken in Subareas 48.1, 48.2 and 88.3 between 14 January and 18 March 1998 all reported no seabird by-catch. Observations of birds around the vessel

during the set (WG-FSA-98/19) indicated the highest index of relative abundance was in Subarea 48.1 (11.1 birds per haul; black-browed albatross commonest), followed by Subarea 48.2 (7.6 birds per haul; brown skua commonest) and Subarea 88.3 (5.0 birds per haul; Wilson's storm petrel and black-browed albatross commonest).

Streamer lines (albeit not those specified by CCAMLR) and thawed bait were used throughout. Offal was not discharged during the set; offal treatment at other times is not specified in the logbook or observers report. However, when fishing in Subarea 48.3, this vessel was discharging offal on the same side as the haul.

The assessments last year of seabird risk from longline in these areas (SC-CAMLR-XVII, Annex 5, paragraph 7.126) were:

- Subarea 48.1 – average risk;
- Subarea 48.2 – average to low risk; and
- Subarea 88.3 – low risk.

These potential risks are broadly in line with the relative abundance of relevant species recorded in WG-FSA-98/19.

7.97 Similarly, in Subarea 88.1, no seabirds were observed caught during the hauls observed (19% of total hauls made). A total of 84% of total sets made were observed and no direct interactions between seabirds and baited hooks were recorded. During 75% of the settings observed the number of seabirds observed astern of the vessel was five or less. Albatrosses were only recorded in the northern part of the subarea. Bird counts during the day were generally higher than at night. The maximum number of seabirds observed around the vessel was 109, of which 98 were cape petrels. Other species observed in Subarea 88.1 included black-browed albatross, light-mantled sooty albatross, southern giant petrel and southern fulmar. These species were generally observed in low numbers.

The vessel made 29% of the sets during day, which is a contravention of Conservation Measure 29/XVI. These daytime sets were made because of the dangers associated with submerged icebergs. The vessel limited setting time to night time once it was made aware of the contravention. A streamer line which met the minimum standards outlined in Conservation Measure 29/XVI was used at all times, and offal was not discharged during setting or hauling.

New and Exploratory Fisheries Proposed in 1998

7.98 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 (SC-CAMLR-XVI, Annex 5, paragraph 7.118).

7.99 For assessment purposes advice was requested on known and potential interactions with seabirds, relating to the:

- (i) timing of fishing seasons;
- (ii) need to restrict fishing to night time; and
- (iii) magnitude of general potential risk of by-catch of albatrosses and petrels.

7.100 Last year the Working Group undertook the first comprehensive assessment on this basis. It assessed new and exploratory fisheries for most subareas and divisions of the Convention Area. For comparison, it also undertook assessments of areas with established longline fisheries (Subarea 48.3 and Division 58.5.1) (SC-CAMLR-XVI, Annex 5, paragraphs 7.126 and 7.127).

7.101 This year, the Working Group reviewed and revised those assessments from last year for areas where new and exploratory fishery proposals had been received for 1998.

7.102 The Working Group believed that, ideally, all statistical subdivisions of the Convention Area should be subject to assessments of risk from longline fishing, so that prospective applicants for new and exploratory fisheries would have advance information on the nature of potential problems. Accordingly, Division 58.4.1, an area not assessed last year, was included in this process even though this year's proposal was for a trawl fishery.

7.103 In the light of the revisions to last year's assessments and the new assessment of Division 58.4.1, the Working Group, to maintain consistency overall, undertook interim revisions of all other assessments made last year and made preliminary assessments for Subarea 48.5 and Division 58.4.2, the only two areas remaining unassessed. Full details of all assessments relating to the new and exploratory fishing proposals are set out below; the overall risk classifications of these and of the reassessments and interim assessments are summarised in Figure 1.

7.104 The Working Group would expect to undertake reassessments annually, on the basis of new data on seabird distribution and especially taking account of data on seabird by-catch obtained from the new and exploratory fisheries.

7.105 As part of its intersessional work, ad hoc WG-IMALF intends to review the distribution of all seabirds known to be at risk of by-catch in longline fisheries in the Convention Area. Arising from this risk, assessments will be carried out for all CCAMLR subareas and divisions to provide the basis for future advice for new and exploratory fisheries.

7.106 The Working group 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 can be devised, should permit longline fishing activities to be carried out in any season and area with negligible seabird by-catch. Nonetheless, the Working group carried out seabird risk assessments for all areas proposed for new and exploratory fisheries in 1999.

7.107 Last year, in addition to basic general reference material on the breeding and at-sea distribution of Southern Ocean seabirds, more specific information was provided on breeding, distribution and population sizes of albatrosses and petrels in WG-FSA-97/22, 97/23, 97/28 (now Gales, 1998) and on at-sea distribution from satellite-tracking studies in WG-FSA-97/56 (now Croxall, 1998). The species particularly at risk were assumed to be all species of albatross, both species of giant petrel and *Procellaria* petrels (in the Convention Area white-chinned petrel, *P. aequinoctialis* and, in some areas, grey petrel, *P. cinerea*). No further information on distribution at sea was tabled at the meeting this year. However, recently published information (Nicholls et al., 1997) indicates that the short-tailed shearwater, *Puffinus tenuirostris*, forages in CCAMLR waters. This species is now also considered to be at risk, together with the sooty shearwater, *P. griseus*.

7.108 The estimates of site-specific breeding populations and of total world breeding populations are principally derived from WG-FSA-97/22 and 97/28 (now Gales, 1998), together with data summarised in Croxall et al. (1984), Marchant and Higgins (1990), and Woehler et al. (1990).

7.109 In the assessments that follow, known potential for interaction was based exclusively on the known ranges of breeding birds determined by recent satellite-tracking studies. These are, therefore, minimum estimates of the home range of breeding populations. Within the Convention Area there have been no recent satellite-tracking studies of giant petrels. The only such data for white-chinned petrels are currently unpublished (Weimerskirch et al., in press); there are no data for grey petrels, but recent data for short-tailed shearwater (Nicholls et al., 1998).

Inferred potential for interaction is based on:

- (i) ranges for breeding populations analogous to those determined by satellite-tracking at other breeding sites; and
- (ii) at-sea distributions derived from seabird at-sea sightings during the breeding season as published in distribution atlases.

7.110 To assess distributions for 'other species' (see definition below), the following references were used: Abrams (1983), Brothers et al. (1997), Marchant and Higgins (1990), Tickell (1993) and Woehler et al. (1990). Advice was also sought from Mr T. Reid, an experienced Australian fisheries and seabird observer. For the areas under review the distributions are as follows:

wandering albatross	all, but only northern part of Subarea 88.1
Gibson's albatross	no data
royal albatross	Subareas 58.5, 58.6 and 58.7 only
black-browed albatross	all, but only northeast part of Subareas 48.6, 88.1; rare in Division 58.4.4
Campbell albatross	Subarea 88.1 and Division 58.4.1 only
grey-headed albatross	all, but only northern part of Subarea 48.6
Indian yellow-nosed albatross	Subareas 58.5, 58.7 and Division 58.4.1
Atlantic yellow-nosed albatross	no data
shy albatross	Subareas 58.6 and 58.7, Divisions 58.4.1, 58.4.3, 58.5.1 and 58.5.2
white-capped albatross	no data
Salvin's albatross	Subareas 58.6 and 88.1
Chatham albatross	Subarea 88.1
sooty albatross	Subareas 58.6 and 58.7, Divisions 58.4.1 and 58.4.4
light-mantled albatross	all
Amsterdam albatross	no data, no records for Division 58.4.1
Antipodean albatross	Subarea 88.1, no records for Division 58.4.1
southern giant petrel	all
northern giant petrel	all, but only northern half of Subareas 48.6 and 88.1,
white-chinned petrel	all, but only northeast half of Subarea 88.1; only extreme north of Subarea 48.6
grey petrel	all, but only northern part of Subareas 48.6 and 88.1

sooty shearwater	Subareas 48.6 and 88.1, Divisions 58.4.1, 58.4.2, 58.4.3 and 58.5.2
short-tailed shearwater	Subarea 88.1, Divisions 58.4.1, 58.4.2, 58.4.3, and 58.5.2

7.111 Some new data on bird populations and distributions contributed to the assessments and reassessments this year and influenced the advice provided. The Working Group requested that in future new information be highlighted and that assessments and advice that differ from previous years be so identified. It was noted that the proposed ad hoc WG-IMALF intersessional comprehensive assessment of all parts of the Convention Area should provide WG-FSA with a new benchmark for these assessments.

7.112 The overall assessments were made against a five-point scale of potential risk of interaction between seabirds, especially albatrosses, and longline fisheries. The five levels are:

- (i) low (1);
- (ii) average-to-low (2);
- (iii) average (3);
- (iv) average-to-high (4); and
- (v) high (5).

7.113 For the purposes of these assessments the following definitions were applied:

- (i) ‘Breeding species in this area’ means those seabird species considered to be at risk and which breed within the relevant area, subarea or division under consideration;
- (ii) ‘Breeding species known to visit this area’ means seabird species which breed within CCAMLR waters and are considered to be at risk, and which are known to visit the relevant area, subarea or division under consideration, as determined by satellite tracking studies;
- (iii) ‘Breeding species inferred to visit this area’ means seabird species which breed within CCAMLR waters and are considered to be at risk, and which are thought to visit the relevant area, subarea or division under consideration, as determined by at-sea distributions derived from either at-sea sightings during the breeding season, or as published in the scientific literature; and
- (iv) ‘Other species’ means seabird species which breed outside CCAMLR waters and are considered to be at risk, and are known to occur in significant numbers in the relevant area, subarea or division under consideration.

7.114 An additional criterion, used in this year’s (but not last year’s) assessments, was the potential for longline fishing in an area, as deduced from inspection of bathymetric maps of the area in question. The map used (see Figure 13) was generally very helpful in making assessments. However, difficulties were encountered with areas with uneven distribution of potential fishing grounds. Areas which had been, or were being, considered as subdivided in respect of fishery assessments (e.g. Subareas 88.1 and 48.6) were therefore also assessed for seabird risk in relation to the subdivisions; comments on other areas are included as appropriate.

7.115 The advice section is based purely on consideration of reducing seabird by-catch by vessels operating under CCAMLR regulations (see SC-CAMLR-XVI, Annex 5, paragraphs 7.125 and 7.128).

7.116 The areas assessed were those where proposals for new and exploratory fisheries were received by CCAMLR in 1998:

Subarea 48.6	(South Africa)
Division 58.4.1	(Australia) - trawl
Division 58.4.3	(Australia, France)
Division 58.4.4	(South Africa, Spain, Uruguay, France)
Division 58.5.1	(France)
Division 58.5.2	(France)
Subarea 58.6	(France, South Africa)
Subarea 58.7	(France, South Africa)
Subarea 88.1	(New Zealand).

The French proposal for Divisions 58.5.1 and 58.5.2 was subsequently withdrawn.

(i) Subarea 48.6:

Breeding species in this area: southern giant petrel (until c. 1981).

Breeding species known to visit this area: none.

Breeding species inferred to visit this area: wandering albatross and light-mantled albatross from Prince Edward Islands; black-browed albatross, grey-headed albatross, sooty albatross, white-chinned petrel from elsewhere within the Convention Area.

Other species: shy albatross, sooty shearwater (Abrams, 1983).

Assessment: moderately well-known area in terms of visiting species. Its very large area, however, suggests interaction potential is probably underestimated. The northern part of the area (north of c. 55°S) contains extensive potential fishing grounds and is also the area in which most seabirds potentially at risk occur.

Advice: 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.

It was noted that South Africa (CCAMLR-XVII/10) proposes to fish from 1 April to 31 August. This does not conflict with the above proposal.

(ii) Division 58.4.1:

Breeding species in this area: none.

Breeding species known to visit this area: light-mantled albatross.

Breeding species inferred to visit this area: all species breeding at Heard/McDonald Islands; wandering albatross, grey-headed albatross, yellow-nosed albatross, sooty albatross, light-mantled albatross, northern giant petrel, southern giant petrel, white-chinned petrel from Kerguelen; yellow-nosed albatross from Amsterdam Island.

Other species: short-tailed shearwater; sooty shearwater.

Assessment: although no breeding populations are within the area, this is a potentially important foraging area for five albatross species (two threatened, one

near-threatened), southern giant petrel, northern giant petrel, white-chinned petrel and short-tailed shearwater from important breeding areas for the species concerned.

Advice: average risk; apply all elements of Conservation Measure 29/XVI.

It was noted that Australia (CCAMLR-XVII/11) is proposing only to trawl in this area, and that longline fishing is **not** currently proposed.

It was also noted that 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.

(iii) Division 58.4.3:

Breeding species in this area: none.

Breeding species known to visit this area: wandering albatross from Crozet Islands.

Breeding species inferred to visit this area: black-browed albatross, light-mantled albatross, southern giant petrel from Heard/Macdonald Islands; grey-headed albatross, black-browed albatross, light-mantled albatross, northern giant petrel, white-chinned petrel, grey petrel from Kerguelen; white-chinned petrel, grey petrel from Crozet Islands.

Other species: short-tailed shearwater, sooty shearwater.

Assessment: although no breeding populations are within the area, this is a potentially important foraging area for four albatross species (two threatened, one near-threatened), southern giant petrel and white-chinned petrel from important breeding areas for the species concerned.

Advice: average risk; prohibit longline fishing during the breeding season of albatrosses, giant petrels and white-chinned petrels (September–April); maintain all elements of Conservation Measure 29/XVI.

It was noted that France (CCAMLR-XVII/9) proposes to fish the whole of the 1998/99 season, and states that there is no scientific justification for closures. The proposal by Australia (CCAMLR-XVII/11) is for a trawl fishery only.

(iv) Division 58.4.4:

Breeding species in this area: none.

Breeding species known to visit this area: wandering albatross, light-mantled albatross from Crozet.

Breeding species inferred to visit this area: grey-headed albatross, yellow-nosed albatross, southern giant petrel, white-chinned petrel, grey petrel from Crozet; wandering albatross, grey-headed albatross, yellow-nosed albatross, light-mantled albatross, southern giant petrel, white-chinned petrel, grey petrel from Prince Edward Islands.

Other species: short-tailed shearwater, sooty shearwater.

Assessment: although no breeding populations are within the area, this is a potentially important foraging area for four albatross species (three threatened, one

near-threatened), southern giant petrel, white-chinned petrel and grey petrel from very important breeding areas for the species concerned.

Advice: average risk; prohibit longline fishing during the main breeding season of albatrosses and petrels (September–April); maintain all elements of Conservation Measure 29/XVI.

It was noted that:

- (a) France (CCAMLR-XVII/9) proposes to fish the whole of the 1998/99 season, and states that there is no scientific justification for closures;
 - (b) Spain (CCAMLR-XVII/12) and South Africa (CCAMLR-XVII/10) propose to fish from 1 April to 31 August. This will overlap the recommended season closure by one month; and
 - (c) Uruguay (CCAMLR-XVII/19) did not specify when it intended to fish, but indicated that it would comply with Conservation Measure 29/XVI.
- (v) Division 58.5.1:

Breeding species in this area: wandering albatross (1 455 pairs; 17% world population), grey-headed albatross (7 900 pairs; 9% world population), black-browed albatross (3 115 pairs; 0.5% world population), yellow-nosed albatross (50 pairs; 0.1% world population), sooty albatross (c. 5 pairs), light-mantled albatross (c. 4 000 pairs; 19% world population), northern giant petrel (1 800 pairs; 17% world population), white-chinned petrel (100 000+ pairs – second most important site), grey petrel (5 000–10 000 pairs) at Kerguelen.

Breeding species known to visit this area: wandering albatross from Crozet Islands, black-browed albatross from Kerguelen, Amsterdam albatross from Amsterdam Island.

Breeding species inferred to visit this area: all the remaining species breeding at Kerguelen; most, if not all, species breeding at Heard/McDonald Islands; many species breeding at Crozet Islands.

Other species: unknown.

Assessment: important foraging area for six albatross species (four threatened, one near-threatened), southern giant petrel, white-chinned petrel and grey petrel, for several of which Kerguelen is a very important breeding site. Most albatross and petrel species breeding at Heard and McDonald Islands will also forage in this area, as will birds of many of the species breeding at Crozet.

Advice: high risk; prohibit longline fishing during the main albatross and petrel breeding season (i.e. September–April); ensure strict compliance with Conservation Measure 29/XVI.

- (vi) Division 58.5.2:

Breeding species in this area: black-browed albatross (750 pairs; 0.1% world population), light-mantled albatross (c. 350 pairs; 1.5% world population), southern giant petrel (2 350 pairs; 7% world population) at Heard/McDonald Islands.

Breeding species known to visit this area: wandering albatrosses from Crozet; black-browed albatrosses from Kerguelen; Amsterdam albatross from Amsterdam Island.

Breeding species inferred to visit this area: all species breeding at Heard/McDonald Islands; wandering albatross, grey-headed albatross, yellow-nosed albatross, sooty albatross, light-mantled albatross, northern giant petrel, white-chinned petrel from Kerguelen; yellow-nosed albatross from Amsterdam Island.

Other species: short-tailed shearwater, sooty shearwater.

Assessment: important foraging area for six albatross species (four threatened, one near-threatened and including one of the only two albatross species which are critically endangered – Amsterdam albatross) and for both species of giant petrel and white-chinned petrels from globally important breeding sites at Kerguelen, Heard and Amsterdam Island.

Advice: average-to-high risk; prohibit longline fishing within the breeding season of the main albatross and petrel species (September–April). Ensure strict compliance with Conservation Measure 29/XVI.

It was noted that longline fishing is currently prohibited within the EEZ around Heard/McDonald Islands.

(vii) Subarea 58.6:

Breeding species in this area: wandering albatross (1 730 pairs; 20% world population), grey-headed albatross (5 950 pairs; 6% world population), black-browed albatross (1 000 pairs; 0.1% world population), Salvin's albatross (4 pairs), Indian yellow-nosed albatross (4 500 pairs; 12% world population), sooty albatross (1 200 pairs; 8% world population), light-mantled albatross (2 200 pairs; 10% world population), southern giant petrel (1 000 pairs; 3% world population), northern giant petrel (1 300 pairs; 13% world population), white-chinned petrel (thousands of pairs), grey petrel (thousands of pairs) at Crozet Islands.

Breeding species known to visit this area: wandering albatross, sooty albatross, light-mantled albatross from Crozet Islands.

Breeding species inferred to visit this area: in addition to all the Crozet Islands breeding species, wandering albatross from Prince Edward Islands and Kerguelen; black-browed, yellow-nosed, sooty, light-mantled albatrosses, northern giant petrel, southern giant petrel, white-chinned petrel, grey petrel from the Prince Edward Islands; grey-headed albatross, white-chinned petrel, grey petrel from Kerguelen.

Other species: unknown.

Assessment: known and potential interactions with seven species of albatross (five threatened, one near-threatened), for many of which Crozet is one of the most important world breeding sites, as it is for giant, white-chinned and grey petrels. Also substantial potential for fishery interactions with albatrosses and petrels from the Prince Edward Islands and albatrosses from a variety of other breeding sites in their non-breeding season. Even outside the French EEZ (within which commercial longline fishing is presently prohibited), this is one of the highest risk areas in the Southern Ocean.

Advice: high risk; prohibit longline fishing during the main albatross and petrel breeding season (i.e. September–April); ensure strict compliance with Conservation Measure 29/XVI.

It was noted that:

- (a) France (CCAMLR-XVII/9) proposes to fish the whole of the 1998/99 season, and states that there is no scientific justification for closures;
- (b) South Africa (CCAMLR-XVII/14) proposes to fish from 1 April to 31 August. This will overlap the recommended season closure by one month.

(viii) Subarea 58.7:

Breeding species in this area: wandering albatross (3 070 pairs, 36% world population – most important site), grey-headed albatross (7 720 pairs; 8% world population), yellow-nosed albatross (7 000 pairs; 19% world population), sooty albatross (2 750 pairs; 18% world population), light-mantled albatross (240 pairs; 1% world population), southern giant petrel (1 750 pairs; 5% world population), northern giant petrel (500 pairs; 5% world population), white-chinned petrel (10 000+ pairs), grey petrel (thousands of pairs) at Prince Edward Islands.

Breeding species known to visit this area: wandering albatrosses from Crozet Islands.

Breeding species inferred to visit this area: all species breeding at the Prince Edward Islands; grey-headed albatross, black-browed albatross, yellow-nosed albatross, southern giant petrel, northern giant petrel, white-chinned petrel, grey petrel from Crozet Islands.

Other species: unknown.

Assessment: known and potential interactions with five species of albatross (four threatened), for most of which the Prince Edward Islands is one of the most important world breeding sites, as it is for giant petrels. Also substantial potential for fishery interactions with albatrosses and petrels from the Crozet Islands and albatrosses from various other breeding sites in their non-breeding season. This small area is one of the highest risk areas in the Southern Ocean. It should be noted that within South Africa's EEZ, commercial longline fishing is currently permitted all year.

Advice: high risk; prohibit longline fishing during the main albatross and petrel breeding season (September–April); ensure strict compliance with Conservation Measure 29/XVI.

It was noted that:

- (a) France (CCAMLR-XVII/9) proposes to fish the whole of the 1998/99 season, and states that there is no scientific justification for closures; and
- (b) South Africa (CCAMLR-XVII/14) proposes to fish from 1 April to 31 August. This will overlap the recommended season closure by one month.

(ix) Subarea 88.1:

Breeding species in this area: none.

Breeding species known to visit this area: Antipodean albatross from Antipodes Island, light-mantled albatross from Macquarie Island.

Breeding species inferred to visit this area: light-mantled albatross from Auckland, Campbell and Antipodes Islands; grey-headed albatross and Campbell albatross from Campbell Island; wandering albatross and black-browed albatross from Macquarie Island.

Other species: short-tailed shearwater, sooty shearwater.

Assessment: the northern part of this area lies within the foraging range of three albatross species (two threatened) and is probably used by other albatrosses and petrels to a greater extent than the limited available data indicate. 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 (subject to any variation in respect of the proposal in paragraph 7.117).

New Zealand Proposal in respect of Subarea 88.1

7.117 The Working Group noted New Zealand's request for a variation from Conservation Measure 29/XVI for the exploratory fishery in Subarea 88.1 (CCAMLR-XVII/13 Rev. 1). New Zealand proposes line weighting as an alternative to night setting in the area south of 65°S. This is because during the austral summer (December–March), there are no periods of darkness at these latitudes. The Working Group recognised the need to develop alternative mitigation measures to provide fishers with more options with regard to minimisation of incidental capture of seabirds. This is particularly pertinent to high latitude fisheries. The Working Group noted that line weighting has the best potential as an alternative mitigation measure. Understanding of line weighting is in a developmental phase and additional information on longline sink rates and seabird interactions is urgently needed.

7.118 The Working Group was supportive of the variation but recommended an alternative performance measure than that proposed. Instead of using a sinking depth of 10 m at the end of the aerial section of the streamer line as a performance measure, the Working Group recommended that a sink rate be used, and proposed 0.4 m/sec as the target, with a minimum standard of 0.3 m/sec for all parts of the line. Results from experiments undertaken on an autoliner in the *D. eleginoides* fishery around the Falkland/Malvinas Islands showed that a sink rate greater than 0.3 m/sec will minimise incidental capture of black-browed albatrosses which are efficient at taking bait during line setting (WG-FSA-98/44). However, other species at risk, such as grey-headed albatross and white-chinned petrel, are more efficient bait-takers than black-browed albatross and no seabird mortality occurred when the line sink rate was maintained at or above 0.4 m/second on a vessel using the Spanish fishing system (Brothers, 1995).

7.119 The Working Group stressed that this variation to Conservation Measure 29/XVI should be treated as an experiment to progress knowledge of the relationship between line weighting and line sink rates. Target sink rates may alter in future as a better understanding of the relationship between seabird mortality and sink rates is developed. In addition, the Working

Group noted that because line weighting is in an experimental phase, manual addition and removal of weights will probably be the means of achieving the target sink rate in the short term. More efficient and safe ways of weighting longlines need to be developed.

Reports on Incidental Mortality of Seabirds during Longline Fishing outside the Convention Area

7.120 Many species of seabird, especially albatrosses, giant petrels and white-chinned petrels, breeding in the Convention Area are abundant and widely distributed outside the Convention Area, especially in adjacent areas to the north. They are regularly reported outside their breeding season, sometimes in substantial numbers, as by-catch in longline fisheries in these regions. Some species, especially wandering albatrosses and white-chinned petrels, forage widely outside the Convention Area, even when breeding within it; they are frequently caught in longline fisheries outside the Convention Area at this time.

7.121 In continuing recognition of the significance of the incidental mortality of seabirds from the Convention Area during longline fishing operations outside the Convention Area, CCAMLR has a standing request to Members to report on the details of the nature and magnitude of such information. The Working Group welcomed the information summarised below as supplied by South Africa, New Zealand and Australia. Such information was also supplied by Taiwan (via the Secretariat).

7.122 Mr Cooper reported that a comprehensive global review of seabird by-catch from longline fisheries produced for the FAO International Plan of Action on the Reduction of Incidental Catch of Seabirds in Longline Fishing (IPOA) and currently in draft form, highlights the paucity of information on by-catch for a number of nations close to the Convention Area, especially the South American countries of Argentina, Brazil, Chile and Uruguay, in whose waters species breeding in the CCAMLR area have been reported (Schiavini et al., 1998; Neves and Olmos, 1998; Stagi et al., 1998) or are thought to be at risk.

7.123 WG-FSA-98/25 provides summarised data collected between 1990 and 1997 regarding the by-catch in southern bluefin tuna and related tuna longline fisheries in the New Zealand 200 n mile EEZ. This annual review (as prepared for the 1998 meeting of CCSBT-ERSWG) briefly reviews the history of the southern bluefin tuna fisheries in the New Zealand EEZ, the protocols of fisheries monitoring and by-catch rates and species compositions of sharks and other non-target fish species, marine mammals and marine reptiles and seabirds.

7.124 The data from observed captures of seabirds during the tuna longline fishing operations in New Zealand are detailed in WG-FSA-98/25. A summary of one of the main datasets and of the composition of the seabird by-catch is provided in Tables 43 and 44. The mean by-catch rates for seabirds has varied greatly over the years for each fleet (domestic, foreign licensed and chartered fleet), particularly in the northern region. Highest by-catch rates for both fleets in this region however were recorded in 1996/97; for domestic vessels (1 453 929 hooks deployed) 82 seabirds were observed caught, at a mean by-catch rate of 1.10 birds/thousand hooks (s.e. = 0.19). Japanese vessels, operating under charter agreements, deployed 1 385 820 hooks in the northern region in 1996/97 and 178 seabirds were observed caught, a by-catch rate of 1.40 birds/thousand hooks (s.e. = 0.31). It was noted that a significant proportion of the 82 seabirds observed caught on the domestic vessels were caught during the haul and alive when brought aboard.

7.125 Data and analyses provided by Australia (WG-FSA-98/31) report on the rates and nature of seabird mortality in the Japanese tuna longline fishery around Australia between 1988 and 1995. Whilst Japanese fishing effort in the region has declined over the 1990s, the estimated catch rate of seabirds by this pelagic fleet during this time has been in the order of

0.15 birds/thousand hooks, equivalent to the deaths of 1 000 to 3 500 birds each year in the area. These estimates are underestimates as not all birds killed remain on hooks to be hauled aboard the vessels.

7.126 The observed seabird catch rate in the zone varied annually, seasonally and spatially. Most birds are killed during summer (even though most effort is expended during winter), in the southern regions of the zone, and when lines are set during daylight. Uncertainties in the observed and estimated catch rates prevent confident assessment of trends over time but seabird catch rates do not appear to be continuing to decrease. The authors conclude that the process of the incidental collection of seabird by-catch data (by observers who are primarily engaged to undertake fish sampling duties) renders the seabird by-catch data inadequate for reliable assessment of trends of total numbers of birds killed over time.

7.127 Of the birds retained by observers in the zone, 74% were albatrosses, the species composition of the by-catch varying with both season and area. Sixteen species of birds killed on longlines around Australia were identified, including black-browed, shy, grey-headed, yellow-nosed and wandering albatrosses, southern giant petrels, flesh-footed shearwaters and white-chinned petrels. Most species of birds killed were characterised by unequal representation of sex and age cohorts, and these unequal representations were not consistent between fishing grounds and season. The provenance of 55 birds was evident from band records, and 34 (62%) of these birds killed off the Australian coast, representing five species, originated from five islands within the CCAMLR Convention Area (South Georgia, South Shetland, Marion, Crozet and Kerguelen Islands). Information from satellite tracking of individuals breeding within the CCAMLR area also shows that several species, including wandering and black-browed albatrosses and white-chinned petrels, move to adjacent areas where they are at risk to longlining.

7.128 WG-FSA-98/30 provides a 1997 update of the seabird interactions with longline fishing in the Australian Fishing Zone (AFZ), for the Japanese and Australian domestic pelagic tuna fleets, as well as providing details of observations aboard a demersal autoliner operating off northern Tasmania. Whilst the data are sparse, domestic longline vessels continue to catch seabirds, at relatively high catch rates in some areas, although efforts to reduce rates of seabird catch included night setting with reduced deck lighting and use of bird poles. There were no observations of seabird deaths during the single voyage (60 500 hooks) aboard the demersal autoliner. The reasons for this lack of interactions are not clear; further investigation is under way.

7.129 The overall mean catch rate for the Japanese pelagic tuna fleet for the AFZ during 1997 was lower than in previous years (0.02 birds/thousand hooks) reflecting, among other factors, a shift in fishing to concentrate effort during the winter and in the northern regions. However, catch rates around Tasmania, an area of characteristically high catch rates, did not reflect a decrease from previous years. Four banded albatrosses were observed killed off Tasmania during 1997, two originating from islands within the Convention Area (Kerguelen and Marion Islands).

7.130 WG-FSA-98/32 reports on assessments of the influence of environmental variables and mitigation measures on the seabird catch rates in the Japanese tuna longline fishery within the AFZ. Logistic regression analyses were used to examine how the probabilities of birds being caught varied with factors associated with fishing tactics, equipment and weather conditions. In this zone, seabirds were most likely to be killed on longlines that were set during summer, in southern zones and during daylight hours. However, changes in catch rates resulting from changes in use of mitigation measures were problematic due to interrelationships between the measured factors. Interpretation and accurate assessments were further complicated by ongoing changes to fishing practices and equipment, and due to changes in the priority that fisheries observers placed on the collection of seabird data. The data for this fishery, in terms of assessments of ways to reduce seabird by-catch, are insufficiently robust to allow appropriate statistical analysis to examine the efficacy of mitigation measures.

7.131 The authors suggest that, for more confident determination of factors influencing seabird catch rates and assessments of methods aimed at reducing their capture rates, dedicated observations coupled with statistical assessments and manipulation of variables where possible and appropriate, are essential. Results of this approach suggest that appropriate use of bird lines, bait casting machines and thawed bait are effective in reducing seabird catch rates on longlines.

7.132 A synthesis of the information detailed in the above papers is provided in WG-FSA-98/29, which the Working Group recommended as an excellent overview for those interested in this topic. This document presents the experiences of a decade of seabird catch rates on Japanese longlines set within the AFZ since 1988 as a case study, together with a brief assessment of the efficacy of mitigation measures. The processes to accelerate the implementation of the effective mitigation measures are also documented together with brief details of other actions being pursued by the Australian Federal Government including the current Threat Abatement Plan, as well as international actions which complement the domestic actions.

7.133 As demonstrated, Australia is well advanced in its understanding of the nature of seabird by-catch in pelagic longline fisheries and also in its efforts to ameliorate the threat posed by this fishery. However, following the cessation of Japanese longline fishing in the AFZ in 1997 due to failure of the members of CCSBT (New Zealand, Japan and Australia) to reach agreement over tuna quota limits, the opportunities to maintain the advances made over the last 10 years are reduced. The implications of this to seabird conservation in other oceanic sectors, including the Convention Area, were noted with concern by the Working Group.

7.134 WG-FSA-98/43 presents data collected during fishing operations on both a Mustad autoliner and a Spanish longline vessel around the Falkland/Malvinas Islands between December 1997 and January 1998. For the Mustad vessel 200 000 hooks were observed deployed in 20 sets, during which 25 seabirds (24 black-browed albatrosses and one northern giant petrel) were killed. For the vessel using the Spanish system, no birds were seen to be killed during the three sets observed (30 000 hooks). The Working Group noted with regret that the UK had not provided CCAMLR with any data regarding incidental mortality during longline fishing operations in this area for the current year.

7.135 In 1997, WG-FSA noted that improved information on longline fishing effort and direct observations on by-catch rates of seabirds was needed for all longline fisheries to the north of the Convention Area. In particular, attention was drawn to the magnitude of the reported effort by Taiwanese vessels in the Southern Ocean in recent years (SC-CAMLR-XVI, Annex 5, paragraph 7.109). Following approaches by the Secretariat in 1998, the Overseas Fisheries Development Council (OFCD) in Taipei provided information on the distribution of fishing effort to the north of the Convention Area and south of 35°S for the years 1993, 1994 and 1995 (WG-FSA-98/38). In these years, 50 565 930 hooks, 56 403 739 hooks and 26 443 679 hooks respectively, were set, probably not entirely in the area south of 35°S. It was noted with concern that the distribution of fishing effort was co-extensive with the foraging ranges of a number of threatened albatross species breeding within the Convention Area. This fishery may present a significant risk to these birds and more accurate fine-scale fishing effort statistics are required to estimate the potential magnitude of interactions. As noted last year (SC-CAMLR-XVI, Annex 5, paragraph 7.107), there remains no direct information on seabird by-catch rates for this fleet. Enhanced links and information exchange between the OFCD and CCAMLR are encouraged by the Working Group.

7.136 The Working Group noted with interest the seabird identification chart and Taiwanese translation of the booklet *Longline Fishing: Dollars and Sense* produced by the OFCD, which were available at the meeting. Mr Cooper reported that South Africa is producing an Afrikaans language translation of the booklet. The Working Group applauded these initiatives and encouraged the OFCD to collect and report on by-catch rates and their progress with implementation of mitigation measures.

Effectiveness of Mitigation Measures

7.137 The Working Group noted the existence of a draft technical paper for the FAO IPOA which reviewed longline mortality of seabirds worldwide and extensively reviewed mitigation measures. The Working Group expected to consider this paper, once it is published, at its 1999 meeting.

7.138 The Working Group reviewed new information relating to methods for mitigating seabird by-catch in longline fisheries, with special emphasis on those aspects and topics covered by Conservation Measure 29/XVI.

Offal Discharge

7.139 Several papers (e.g. WG-FSA-98/44) and observer reports documented that jettisoning offal close to line hauling sites can have serious consequences for by-catch of seabirds. Despite this practise being prohibited under Conservation Measure 29/XVI, many vessels fishing in the Convention Area are still failing to comply.

7.140 Analysis of the observer data and observer reports for trips undertaken in 1997 and 1998 shows that for all but one of the 12 trips where observers recorded a catch of live seabirds greater than 0.1 birds/thousand hooks, offal was discharged on the same side as the line was hauled. Only one of these vessels was known to retain offal on board during hauling. All of these vessels were using the Spanish longline fishing method. In contrast, for the 11 trips where no live seabirds were caught, five of the vessels were discharging on the opposite side to the haul. Of the six that had a discharge point on the same side, four retained their offal on board during hauling. Seven of these 11 trips were undertaken by autoliners.

7.141 The Working Group reconfirmed that paragraph 4 of Conservation Measure 29/XVI should be retained as it stands. It further recommended that vessels discharging offal during the haul on the same side as the line hauling site should no longer be allowed to fish in the Convention Area (see also SC-CAMLR-XVI, paragraph 4.5(iii)) – and drew this especially to the attention of those involved in licensing of vessels to fish in national EEZs.

7.142 It was noted that discharge of spilled bait from autoliners should not take place during line setting in order to reduce bird attraction.

7.143 The Working Group noted with approval the report by Mr Purves that the *Koryo Maru II* had reconfigured its waste-pipe system so as to discharge on the opposite side of the vessel from the line haul site. This had achieved a substantial reduction in interactions with and mortality of seabirds.

7.144 The Working Group asked that the *Koryo Maru II* be requested to make available an engineer's diagram of the reconfigured waste-pipe system (to divert offal discharge to the side opposite the line hauling site), to assist other vessels in reconfiguration to rectify offal discharge problems. All Members should be requested by the Secretariat to submit any other relevant information on similar vessel reconfigurations.

Line Weighting

7.145 Conservation Measure 29/XVI states that for vessels using the Spanish method of longline fishing, weights of at least 6 kg mass should be used, spaced at intervals of no more than 20 m. However, as WG-FSA-98/44 indicates, no vessel fishing in 1997 was complying with this element of the conservation measure; a similar situation prevailed in 1998 (paragraph 7.63; see Figure 12).

7.146 It is possible that the weighting regime specified for the Spanish method of longlining in Conservation Measure 29/XVI is close to the limit of what is possible operationally. However, further investigation of seabird by-catch rates with other weighting and spacing regimes is needed before any changes to the existing conservation measure could be recommended. Such information is unlikely to be acquired from analysis of data already in the scientific observer database. Therefore experimental work on longliners during fishing will be essential in order to indicate what combination of weighting and spacing could, using the Spanish method, eliminate seabird by-catch.

7.147 Similar experimentation on Mustad autoliners into appropriate line weighting and spacing to ensure line sink rates that would preclude seabird by-catch is also essential. This should take account of effects due to variations in vessel speed at setting.

7.148 It was noted that full compliance with an appropriate line weighting regime might enable vessels to have much greater flexibility in streamer line use and design and possibly to become exempt from night-setting requirements.

7.149 WG-FSA-98/44 and 98/51 presented information on line weighting regimes for autoline vessels. WG-FSA-98/51 found that the mid-section of the unweighted autoline took a mean time of 63 seconds to reach 10 m. The streamer line used on the vessel which met the minimum standards outlined in Conservation Measure 29/XVI covered the longline for a mean time of 26.3 seconds. When weights (either 2.5 or 5 kg) were added to the line at intervals of 400 m, there was no detectable affect on the sink rate. WG-FSA-98/44 showed that line sink rates varied with distance between weights on the line. Lines with weights at <50 m intervals on lines sank much faster (0.3–0.4 m/sec) than lines with weight spacings that exceeded 70 m (0.1–0.15 m/sec). Weight spacings of 4 kg every 40 m on the lines of the autoline vessel in question were thought to reduce the capture of black-browed albatrosses to near zero levels.

7.150 The Working Group noted that line weighting is potentially a very effective mitigating measure. Indeed, achieving rapid sinking of the baited longline is probably the measure which offers at present the best opportunity substantially to reduce, if not eliminate, seabird by-catch in longline fisheries. If an appropriate weighting and spacing regime can be used, no seabirds should be caught, even in daytime sets. However, at present, addition of weights to lines is a cumbersome process for fishers. The Working Group strongly encouraged longline gear manufacturers to develop automated methods for adding and removing weights to the line, or to manufacture longlines with weights incorporated within them.

7.151 The Working Group recognised that effective progress on these issues would require interaction and collaboration with fishing companies and fishers. It was agreed that technical coordinators were well placed to assist in developing appropriate dialogue.

7.152 Line floats are increasingly used as part of longline setting operations. They have the capacity to increase seabird catch rates substantially. Therefore, consideration should be given to adding a provision governing their use to Conservation Measure 29/XVI. Until it is possible to prescribe a minimum line sink rate that must be achieved, use of line floats should either be prohibited or permitted only with a prescribed minimum length of line attaching the float to the fishing line. A minimum buoy line length of c. 10 m is suggested, irrespective of individual float buoyancy capacity.

7.153 The Working Group agreed that the current Conservation Measure 29/XVI requirement for weighting regimes should remain unchanged for the time being.

Line Setter

7.154 Members of the Working Group were aware that Mustad had recently developed a line setter for autoline vessels. The line setter operates by pulling the main line through the baiting

machine allowing slack line to enter the water. This differs from the present setting method where the drag of the line in the water and the forward movement of the vessel pull the line from the vessel under tension. The line setter has the potential to:

- (i) decrease the time interval for which baited hooks are available to seabirds and improve the performance of a line weighting regime;
- (ii) assist in minimising bait loss that may result as a consequence of weights being attached to the line and disruption of a smooth setting process; and
- (iii) improve the operation of the Mustad underwater setting funnel by removing line wear problems and assisting in maintaining the line within the funnel during rough weather. The combined use of a line setter and a Mustad funnel has significant potential for assisting in reducing seabird mortality.

7.155 The Working Group noted that it would appreciate receiving information on the line setter from Mustad; the Secretariat was asked to pursue intersessionally. The importance of assessing the effect of line setters on line sink rate was emphasised.

Streamer Line

7.156 The Working Group noted information provided in WG-FSA-98/19 with regard to a proposal for a new streamer line design. The information presented covered data collected in 1997 when no seabirds were caught with the new streamer line design. However, the vessel using the new design was operating in areas where there are few seabirds susceptible to being caught. In the absence of rigorous statistical comparison of the new design and the CCAMLR design the Working Group saw no reason to change the existing specifications of the conservation measure.

7.157 Many scientific observers reported difficulties with the construction, deployment and effectiveness of streamer lines of the CCAMLR design. Tangling with fishing lines and lack of effectiveness in high winds were frequently mentioned as problems (see also SC-CAMLR-XVI, Annex 5, paragraph 7.132).

7.158 As last year (SC-CAMLR-XVI, Annex 5, paragraph 7.133), it was felt that many of the difficulties experienced were likely to result from some combination of incorrect construction and/or use of the streamer line, especially by inexperienced operators. It was re-emphasised that familiarity with the advice in WG-FSA-95/58 (concerning construction and use of CCAMLR-design streamer lines), which was the basis for the advice in the CCAMLR booklet *Fish the Sea Not the Sky*, was essential for correct use of these lines.

7.159 Overall, however, the Working Group agreed that the provisions provided in Conservation Measure 29/XVI relating to streamer line designs were adequate. It noted that there are specific provisions in the conservation measure for the testing of new streamer line designs.

7.160 Some flexibility in streamer line design (in respect of swivels) is already permitted in Conservation Measure 29/XVI (paragraph 6). Further relaxation of specifications was not thought desirable (or feasible to define) at this stage. If improvements in line sink rate are achieved through appropriate line weighting, then considerable scope for revising streamer line specification might exist.

Underwater Setting

7.161 There are a number of existing initiatives developing underwater setting devices for both pelagic and demersal operations. It was noted that both Norway and South Africa were undertaking testing of the Mustad underwater setting tube in terms of efficacy of reducing bird by-catch. Ongoing South African testing is taking place on a commercial longliner in Subareas 58.6 and 58.7. To date, no birds have been caught during daytime sets when using the Mustad tube on this vessel. Mr Cooper indicated that preliminary results from a Norwegian vessel fishing in the North Sea are that birds continued to be caught when the tube is used. Available information on this methodology had been comprehensively reviewed as part of the draft background paper for the FAO IPOA.

7.162 The Working Group understood that design and operational improvements have been made to the Mustad underwater setting funnel and line setter and asked the Secretariat to solicit a report on the modifications and results of at-sea trials.

7.163 Progress on the development of underwater setting devices in New Zealand and Australia was noted (WG-FSA-98/24). These underwater setting devices are designed specifically for pelagic longline fishing and are not suitable at present for demersal longlining operations due to the short snood lengths utilised in demersal longlines. It was noted that one of the pelagic devices (underwater setting chute) has potential for modification to enable its use on demersal vessels. Results of at-sea trials are not yet available.

Timing of Setting

7.164 It was noted that there had been some improvement with night setting requirements this year, and that this, along with commencing the fishing season one month later than previously in many areas probably contributed to the reduction in the number of birds reported killed this year.

7.165 It was re-emphasised that effective line weighting regimes might remove the necessity for night setting.

General

7.166 Experiences reported in WG-FSA-98/44 suggested that research should be undertaken on the effects of artificial bait, snoodline colour and mainline colour on seabird capture potential.

7.167 The Working Group endorsed the suggestion in WG-FSA-98/45 that research should be undertaken to investigate bait taking by different seabird species in relation to bait depth, propeller wash turbulence and streamer lines.

7.168 The Working Group recommended that research on the effects of line sink rates (taking account of vessel speed) on seabird by-catch should be undertaken as a very high priority.

7.169 The Working Group recommended that Conservation Measure 29/XVI should be retained as it stands, especially its provisions in relation to offal discharge, night-time setting and line weighting, subject to any modification relating to the New Zealand proposal for Subarea 88.1 (see paragraphs 7.117 to 7.119).

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

FAO International Plan of Action (IPOA)

7.170 The Working Group noted the existence of a draft background paper reviewing the incidental catch of seabirds by longline fisheries on a worldwide basis, prepared as supporting information for the FAO IPOA (SC-CAMLR-XVII/BG/5; paragraph 7.122). The Working Group requested that the final published version of the background document be circulated for consideration at its next meeting.

7.171 Last year the Commission requested the Secretariat to arrange for comments from ad hoc WG-IMALF to be forwarded to FAO in time for consideration of the IPOA at the FAO Consultation, to be held in Rome from 26 to 30 October 1998 (CCAMLR-XVI, paragraph 12.4). In accordance with FAO's timetable, the revised IPOA will then be submitted for adoption at the next meeting of the FAO Committee on Fisheries (COFI), to be held in February 1999.

7.172 In consultation with the Chairman of the Scientific Committee it was decided that, taking into account the timing of various CCAMLR meetings, it would be possible to arrange for the intersessional comments of ad hoc WG-IMALF to be considered at WG-FSA and then sent to FAO. After consulting with Members of the Scientific Committee, Mr Cooper was nominated as CCAMLR observer at the FAO meeting (26 to 30 October 1998). Mr Cooper will inform FAO of recent CCAMLR activities in relation to the reduction of seabird by-catch in longline fisheries in the CCAMLR Convention Area and submit comments of CCAMLR scientists regarding the FAO IPOA. Mr Cooper will also try to report direct to the CCAMLR Scientific Committee, during its 1998 meeting, on the outcome of the FAO meeting.

7.173 The CCAMLR Scientific Committee and the Commission will take the opportunity to consider further the draft of the FAO IPOA during their forthcoming meetings with a view to sending their comments to FAO for consideration at the COFI meeting in February 1999.

7.174 By correspondence ad hoc WG-IMALF members had made comments on an earlier draft of the IPOA (WG-FSA-98/34). These comments were reviewed in the light of the revisions to the plan.

7.175 Support was expressed by the Working Group regarding the inclusion of timeframes in the draft IPOA and that nations produce Assessment Reports to ascertain whether there is a need to develop National Plans of Action. Additional comments from the Working Group on the draft FAO IPOA considered that the Assessment Reports and the subsequent National Plans of Action should be independently assessed to ensure consistency and appropriateness of decisions, particularly in relation to reviewing the initial Assessment Reports to determine whether or not National Plans of Action are required. It was also suggested that technical measures which are of unknown effectiveness be relegated to a separate section.

7.176 The Working Group supported suggestions that a Seabird Technical Advisory Group be formed to give FAO advice, in respect of the IPOA, concerning scientific, technical and educational matters relating to seabird populations and seabird by-catch issues, especially measures for by-catch mitigation.

7.177 All these suggestions were incorporated into the document to be forwarded to FAO at its meeting in Rome, Italy (WG-FSA-98/34 Rev. 2).

7.178 The Working Group recommended to the Commission that, once the IPOA is adopted, it encourages all nations which engage in longline fishing in CCAMLR waters to prepare Assessment Reports, and if justified, National Plans of Action, following the guidelines contained in the IPOA.

Convention on Migratory Species

7.179 The Working Group noted the progress outlined in WG-FSA-98/36 in relation to the development of a regional agreement for southern hemisphere albatrosses.

7.180 The Working Group commended the listing of all southern hemisphere albatrosses on the Appendices to the Convention on the Conservation of Migratory Species of Wild Animals (CMS) and expressed support for the development of a regional agreement covering southern hemisphere albatrosses. The Working Group encouraged an early meeting in Chile of the proposed ad hoc working group to examine options for regional cooperation.

7.181 It was noted that the 6th Conference of Parties (CoP) for the CMS will be held in Capetown, South Africa, from 4 to 16 November 1999. The occurrence of the CoP in Capetown provides an excellent opportunity for further meetings focusing on the development of a regional agreement.

7.182 The CCAMLR Secretariat advised that they had contacted the CMS Secretariat intersessionally enquiring whether the data collected by CCAMLR would be useful to the CMS in their work. No response has been received as yet.

Australian Threat Abatement Plan

7.183 The Working Group noted the tabling of the Australian document *Threat Abatement Plan for the incidental catch (or by-catch) of seabirds during oceanic longline fishing operations*. The objective of Threat Abatement Plan is to reduce seabird by-catch in all fishing areas, seasons and fisheries to below 0.05 birds/thousand hooks, based on current fishing levels. This represents a reduction of up to 90% of seabird by-catch within the AFZ, and should be achievable within the five-year life of the plan. The ultimate aim of the threat abatement process is to achieve a zero by-catch of seabirds, especially threatened albatross and petrel species, in longline fisheries. However, using currently available mitigation methods, it is not possible to achieve this goal in the short term.

7.184 Specific actions in the plan prescribe the mitigation measures which must be used by domestic and foreign longline vessels in longline fisheries, fishing areas and fishing seasons in the AFZ to minimise the by-catch of seabirds. These include the following measures for pelagic longline fishing in the AFZ:

- (i) night setting of hooks as one of three mandatory options available for selection by fishers;
- (ii) use of lines which are sufficiently weighted to cause the baits to sink out of reach of diving birds immediately after they are set, as part of one of three mandatory options to be selected by fishers;
- (iii) the use of thawed bait, as part of one of three mandatory options to be selected by fishers; and
- (iv) a requirement that from 1998 all vessels operating in the AFZ will carry bird lines and use them when appropriate. Use of bird lines below 30°S will remain mandatory.

7.185 It should be noted that currently there are no commercial demersal longline operations for *Dissostichus* spp. occurring within the AFZ. However, the Threat Abatement Plan addresses the potential for this to occur in the future and includes appropriate actions. The plan states that if a new demersal fishery is to be established, particularly around sensitive areas such

as Heard and McDonald Islands (which are within CCAMLR waters), then suitable mitigation measures will be developed before the fishery proceeds. It is intended that any mitigation measures developed will be, at a minimum, in accordance with current CCAMLR conservation measures.

Commission for the Conservation of Southern Bluefin Tuna (CCSBT)

7.186 SC-CAMLR-XVII/BG/4 reports on the third meeting of the CCSBT Ecologically Related Species Working Group (ERSWG) which met in Japan from 9 to 12 June 1998. This working group was established to advise CCSBT on matters relating to ecologically-related species. The prime focus of this group to date has been the incidental mortality of seabirds in the southern bluefin tuna fishery. CCAMLR papers WG-FSA-98/25, 98/31, 98/32 and 98/33 were among the papers tabled at that meeting. As SC-CAMLR-XVII/BG/4 states, some of the key outcomes included a paper describing the member countries priorities for mitigation research, a paper describing ways to determine the effect of time of day on southern bluefin tuna catch, and a set of guidelines for the construction and deployment of streamer lines, for endorsement by CCSBT. The ad hoc WG-IMALF commented that the outcomes achieved at ERSWG may be of relevance to CCAMLR, and looked forward to receiving the full report once it had been considered by CCSBT.

Global Environment Facility (GEF)

7.187 The Working Group was informed by Mr Cooper of preliminary plans by BirdLife International to apply for funding from the Marine Topics program of GEF, a funding initiative emanating from the Convention on Biological Diversity, specifically to enable conservation actions in developing countries. Funding would be sought to hold an expert workshop in South Africa to assess the need and desirability of transferring relevant expertise on seabird by-catch to developing countries, such as on mitigation measures, observer programs and research needs and protocols. Such an initiative would support the FAO IPOA and follows directly from a recommendation made at the Workshop on Incidental Mortality of Albatrosses in Longline Fisheries held in 1995. In this regard, the Working Group noted with approval the workshop held in Chile in March 1998 to train scientific observers (SCOI-98/8).

Approaches to Eliminating Seabird By-catch in Longline Fisheries in the Convention Area

7.188 The Working Group briefly reviewed the practices and policies which can contribute to enhancing progress on this issue.

7.189 The Working Group believes that eliminating seabird by-catch associated with longline fisheries requires effective progress on a number of related topics. These include seabird research, fish research, fishing technology, education and legislation.

7.190 Important improvements can be achieved in the long term by the development of new fishing methods, particularly those involving underwater setting. When successful, such methods should remove the need for most, if not all, of the existing constraints on longline fishing arising from the need to use other types of mitigating measure (including closed seasons and areas) to protect seabirds.

7.191 In the meantime, however, research into improvements to, and better use of, existing mitigating measures is at least of equal importance. The highest priority should be given to devising line weighting arrangements that ensure line sink rates that will effectively preclude seabirds gaining access to baits.

7.192 Once such systems have been developed and implemented successfully, vessels using them would very likely be exempt from the use of other types of mitigating measure to protect seabirds, especially those relating to night setting and closed seasons and areas.

7.193 In most foreseeable circumstances, ensuring compliance in the use of mitigation measures will be an important part of the management of longline fisheries. The Working Group endorsed the suggestions of the Scientific Committee last year (SC-CAMLR-XVI, paragraph 4.52) that better compliance could be achieved through:

- (i) access to the fishery only of vessels able and equipped to comply fully with CCAMLR conservation measures (e.g. constructed to allow offal discharge on the opposite side from the haul);
- (ii) in-port inspection to ensure understanding by fishers of the relevant CCAMLR conservation measures and to ensure that vessels possess appropriate fishing and related gear to be able to comply with them;
- (iii) preferential access to fisheries of vessels which have a good level of compliance with conservation measures (coupled with ready access to appropriate assistance to help vessels with a poorer record of compliance).

7.194 Complementary to many of these provisions is appropriate education of fishing companies, vessel captains, fishing masters and crew. Special training courses for these and for scientific observers and national technical coordinators would be valuable. Additional support involving specialists well-versed in the at-sea use of seabird mitigating measures would be desirable. The Working Group recommended that CCAMLR and its Members should support initiatives to secure international funding to facilitate such undertakings.

7.195 The Working Group recommended that CCAMLR should review its own materials aimed at improving education of those involved in longline fishing. To address fishing crews may require simpler and more graphic material than currently provided, perhaps by means of posters or videos. To inform fishing gear manufacturers and fishing companies of the more technical and scientific issues, a periodic newsletter on relevant developments and issues might be appropriate (see WG-FSA-98/45, paragraph 10).

7.196 Further desirable complementary initiatives include developing national (e.g. the Australian Threat Abatement Plan; see paragraphs 7.183 to 7.185) and international plans of action or agreements to tackle the relevant issues. Important international agreements would include those currently being developed by FAO (see paragraphs 7.170 to 7.178) and under the CMS (see paragraphs 7.179 to 7.182).

7.197 One of the major problems in tackling issues relating to longline fishing is regulating activities on the high seas and by countries not signatory to relevant international instruments. Effective action (including investigating potential for trade sanctions) in relation to issues like fishing overcapacity (tackling national/regional subsidies for building longliners) and reflagging of vessels to avoid liability under national legislation, will need pursuing. In relation to these and to improve the management of longline fisheries, ratification (and entry into force) of 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 (UNIA) should be afforded a high priority since this agreement aims to harmonise management measures on the high seas, especially when such measures have been promulgated by regional fisheries management bodies such as CCAMLR.

In addition, both the FAO Compliance Agreement and Code of Conduct for Responsible Fisheries contain elements which are consistent with CCAMLR's objectives and which provide a global framework for successive international agreements on fisheries management consistent with the 1982 UN Convention on the Law of the Sea (UNCLOS) and the UNIA. The Working Group recommended that CCAMLR should encourage its Members and all other countries fishing in the Convention Area to ratify and promote the entry into force of these instruments as soon as possible.

Advice to the Scientific Committee

7.198 The Scientific Committee was requested to note the following recommendations/advice.

7.199 General:

- (i) The appointment of Prof. Croxall as Convener and Mr Baker as Deputy Convener of ad hoc WG-IMALF (paragraph 7.5).
- (ii) The intention of ad hoc WG-IMALF to review information on research programs into the status of albatrosses, giant petrels and *Procellariapetrels* at its 1999 meeting; to enable this, all Members were requested to submit relevant summary data intersessionally (paragraph 7.8).
- (iii) International and national initiatives relating to reducing seabird by-catch in longline fisheries by FAO, CMS, CCSBT and Australia (paragraphs 7.170 to 7.187).
- (iv) Comments on the draft FAO IPOA which are to be forwarded to the FAO (paragraphs 7.170 to 7.178 and WG-FSA-98/34 Rev. 2).
- (v) A proposal to seek funding from the Global Environmental Facility (GEF) to facilitate reduction of bird by-catch in developing countries (paragraph 7.187).

7.200 Data on incidental mortality of seabirds during longline fishing in the Convention Area:

1997

Intersessional revision of results from Subareas 58.6 and 58.7 (paragraphs 7.9 to 7.12), showing that:

- (i) Species most abundantly killed by regulated fisheries were white-chinned petrels (66%) and grey-headed albatrosses (11%) (paragraph 7.11 and Table 32).
- (ii) Catch rate (birds/thousand hooks) was estimated as 0.49 and 0.58 for day and night setting, respectively, in Subareas 58.6 and 58.7 (paragraph 7.12 and Table 31).
- (iii) An estimated 696 birds were killed during night setting and 866 during day setting. This total estimated mortality of 1 560 is 69% greater than the observed total mortality of 923 birds (paragraph 7.12 and Tables 33 and 34).

1998 – General

- (iv) Continuing difficulties with timely data submission and validation preclude the undertaking of comprehensive analysis of the current year's data (paragraphs 7.15 and 7.16). The main analysis should be undertaken intersessionally

(paragraphs 7.17, 7.37 and 7.59), complemented by preliminary assessment of the current year's data at the WG-FSA meeting (paragraphs 7.18 and 7.19).

- (v) Request for all data for longline fisheries in the Convention Area in order to undertake comprehensive analysis and assessment (paragraphs 7.22 to 7.24).
- (vi) Results from the 1998 fishing feasibility study in Subareas 48.1, 48.2, 88.1 and from the new fishery in Subarea 88.3 showed no by-catch of seabirds (paragraphs 7.25 and 7.26).

1998 – Results for Subarea 48.3:

- (vii) 79 seabirds (83% white-chinned petrels, 12% black-browed albatross) were observed killed at an overall catch rate of 0.025 birds/thousand hooks (paragraphs 7.27, 7.28 and 7.33 and Tables 35 and 36), compared with 712 seabirds at a catch rate of 0.23 birds/thousand hooks in 1997.
- (viii) An estimated 640 birds were killed, a substantial reduction (88% fewer) of the estimated 1997 kill of 5 755 (paragraph 7.34 and Table 37).
- (ix) These results represent a major improvement compared with 1997, due to the much higher levels of compliance with CCAMLR conservation measures (paragraphs 7.35 and 7.40).
- (x) The one-month delay (until 1 April) in the start of the fishing season is thought to be a major factor in reducing bird by-catch in 1998 (paragraph 7.36).

1998 – Results for Subareas 58.6 and 58.7

- (xi) 498 seabirds of five species (mainly white-chinned petrels (96%)) were observed killed with an average catch rate of 0.117 birds/thousand hooks (paragraph 7.42 and Tables 38 and 39), compared with 834 seabirds at a catch rate of 0.52 birds/thousand hooks in 1997.
- (xii) Important factors associated with higher rates of seabird by-catch were daytime setting (though reduced three-fold from last year), high winds, distance from breeding island, vessel and time of year (paragraphs 7.45 to 7.50 and Figure 10).
- (xiii) By-catch occurred mainly during summer, peaking during February to mid-March, the chick-rearing period of white-chinned petrels (paragraph 7.45 and Figure 11).
- (xiv) Seabird by-catch rates were considerably reduced compared with 1997; this was probably because of improved compliance with Conservation Measure 29/XVI, especially with respect to night setting and use of streamer lines (though the 5 n miles fishing exclusion zone around the Prince Edward Islands may have contributed) (paragraphs 7.51 and 7.52).
- (xv) The fishery in Subarea 58.7 should be closed during February to mid-March during the chick-rearing period of white-chinned petrels (paragraph 7.55).

7.201 Compliance with Conservation Measure 29/XVI:

- (i) No vessels were in compliance in respect of line weighting, for the second successive year (paragraph 7.63 and Figure 12).

- (ii) Improvements in the prevalence of night setting, compared with 1997, were noted in all subareas (paragraph 7.64).
- (iii) Despite some improvements since 1997 (principally relating to retaining offal during the haul) many vessels are still discharging offal during the haul on the same side as line hauling (paragraph 7.65).
- (iv) Streamer lines were used on more vessels than last year, but most streamer lines do not meet CCAMLR specifications (paragraphs 7.67 to 7.70 and Table 40).

7.202 Assessment of potential levels of by-catch of seabirds in the Convention Area due to unregulated longline fishing:

- (i) The estimate of potential seabird by-catch for 1998 (taken exclusively in the Indian Ocean sector) was between 50 000 and 89 000 seabirds (potentially comprising 31 000 to 56 000 white-chinned petrels, 11 000 to 20 000 albatrosses and 2 000 to 4 000 giant petrels) (Tables 41 and 42). This compares with estimated values for 1997 of 31 000 to 111 000 seabirds.
- (ii) These levels of mortality would be unsustainable for the populations of these species breeding within the Convention Area in the southern Indian Ocean.
- (iii) The Commission was asked to take the most stringent measures possible to combat unregulated fishing in the Convention Area.

7.203 Incidental mortality of seabirds in relation to new and exploratory fisheries:

- (i) Fishing feasibility studies proposed in 1997 and undertaken in Subareas 48.1, 48.2, 88.1 and 88.3 resulted in no reported seabird by-catch (paragraphs 7.96 and 7.97).
- (ii) Most statistical subdivisions of the Convention Area, including all with proposals this year for new and exploratory fisheries, were reassessed in terms of risk of by-catch of species and groups of seabirds at risk (paragraphs 7.101 to 7.116 and Figure 13). In respect of this year's proposals (paragraph 7.116) potential conflict between proposed fishing seasons and advice on seasons closed to fishing to protect seabirds was:
 - (a) minor for Division 58.4.4 (Spain and South Africa), Subarea 58.6 (South Africa) and Subarea 58.7 (South Africa);
 - (b) substantial for Divisions 58.4.3 (France), 58.4.4 (France), Subarea 58.6 (France) and Subarea 58.7 (France); and
 - (c) uncertain for Division 58.4.4 (Uruguay).
- (iii) Detailed advice was provided in respect of the New Zealand request for a variation from Conservation Measure 29/XVI for exploratory fishing in Subarea 88.1 (paragraphs 7.117 to 7.119). Otherwise it was agreed that Conservation Measure 29/XVI should be retained for longline fisheries in all parts of the Convention Area.

7.204 Incidental mortality of seabirds during longline fishing outside the Convention Area:

- (i) Information on seabird by-catch outside the Convention Area, especially that submitted by Australia and New Zealand, continues to indicate that substantial by-catch occurs of species and populations breeding within the Convention Area (paragraphs 7.122 to 7.134 and Tables 43 and 44).

- (ii) Efforts to obtain information on fishing effort and on bird by-catch by Taiwanese pelagic longliners for tuna in the Southern Ocean were noted and further dialogue encouraged (paragraph 7.135).

7.205 Effectiveness of mitigation measures:

Ad hoc WG-IMALF considered new information relating to methods for mitigating seabird by-catch in longline fisheries and offered new advice relating to:

- (i) offal discharge, including bait spillage and vessel reconfiguration (paragraphs 7.139 to 7.144);
- (ii) the importance of adequate line weighting as potentially the most effective of existing mitigating measures (paragraph 7.150), the need to develop more efficient methods to weight lines and the high priority of research on effects of line sink rates (paragraph 7.168);
- (iii) the potential need to add a provision to Conservation Measure 29/XVI governing the use of line floats (paragraph 7.152);
- (iv) the need to investigate the use of line-setting devices (paragraph 7.154);
- (v) development and testing of underwater setting tubes by Australia, New Zealand, Norway and South Africa was noted and encouraged (paragraphs 7.161 to 7.163);
- (vi) the need for research into artificial bait, gear colour and bait-taking behaviour of seabirds (paragraphs 7.166 and 7.167).

7.206 Approaches to eliminate seabird by-catch in longline fisheries in the Convention Area:

The Working Group prepared a brief review of policies and practices (involving seabird and fish research, fishing gear development, education and legislation) which it believed essential to resolving this issue (paragraph 7.189) recommending:

- (i) sustained development of underwater setting, as the likely medium- to long-term solution (paragraph 7.190);
- (ii) enhanced work to develop line weighting regimes to ensure sink rates that will preclude seabirds accessing baits (paragraph 7.191) and the implications of this for exemption from other mitigating measures (paragraph 7.192);
- (iii) improving compliance with the existing suite of mitigation measures (paragraph 7.193);
- (iv) improved training and education of fishing companies, vessel captains, fishing masters, crew, scientific observers and technical coordinators (paragraph 7.194);
- (v) development of a range of national and international plans of action, e.g. those under FAO, CMS and the Australian Threat Abatement Plan (paragraph 7.196); and
- (vi) action relating to improved regulation of high seas fishing (especially through harmonisation of management measures) with CCAMLR encouraging Members (and other countries fishing in the Convention Area) to ratify and promote entry into force of instruments such as UNIA, FAO Compliance Agreement and Code of Conduct for Responsible Fisheries (paragraph 7.197).

OTHER INCIDENTAL MORTALITY

8.1 From the reports of scientific observers the only report of a marine mammal entanglement with a longline vessel was of a dead seal, recorded during hauling on the *Koryo Maru 11* in Subarea 48.3 (Table 30). The observer reported it was probably a Weddell seal, although the specimen was not brought on board.

8.2 The Working Group noted that there were no reports from observers of seabirds killed in collision with net monitor cables. The use of these cables had been banned in the Convention Area since the 1994/95 fishing season (Conservation Measure 30/X). France and Australia both indicated that no trawlers fishing in their EEZs used net monitor cables.

8.3 One grey-headed albatross was killed by collision with a trawl warp line on a trawler in Division 58.5.1 (CCAMLR-XVII/BG/41).

8.4 The Working Group noted that New Zealand had constructed a marine mammal exclusion device for use on trawl vessels, and had undertaken trials in a flume tank (CCAMLR-XVII/BG/7). The device appears to have considerable potential and the Working Group asked to be kept informed of future progress.

8.5 During the longline fishing feasibility survey in Subarea 48.1 by the *Tierra del Fuego*, the observer reported seeing a group (c. 20) of freshly dead black-browed albatrosses floating on the water to the north of Elephant and Clarence Islands, South Shetland Island group. Several birds were inspected and all appeared to have had at least their internal organs removed. One hour previously, an unflagged Japanese-design trawler had been seen leaving the area (at 60°53'S 55°14'W). Later in the cruise, at 60°20'S 46°56'W, a similar incident was observed, involving a group of freshly dead Adélie penguins which had been similarly treated. A trawler of similar design to the previous observation was seen to leave the area at the same time.

FUTURE WORK

Elasmobranch By-catch

9.1 The Working Group reviewed the need to study elasmobranch by-catch in the light of discussions initiated at CCAMLR-XVI between Mr R. Shotton (FAO observer) and Drs Miller (Chair of the Scientific Committee) and Ramm. Mr Shotton had outlined a FAO initiative to review the elasmobranch by-catch in world fisheries, and to present findings at a meeting in October 1998. As part of this review, FAO had expressed interest in a baseline study of elasmobranch by-catch in the Southern Ocean.

9.2 The Working Group confirmed the long-term need to document and assess, in general, by-catch in fisheries within the Convention Area, and to collect information which would allow the assessment of stocks of species caught as by-catch. Several steps were envisaged:

- (i) quantify the data available in the CCAMLR database and the national archives of Members;
- (ii) identify the needs for additional data and develop strategies for collecting such data; and
- (iii) analyse data on by-catch and, in particular, assess the stocks of species dominant within the by-catch.

9.3 Dr V. Siegel (Germany) identified the need to develop taxonomic keys so as to allow data collectors to accurately record information at the level of species. The Working Group agreed that this was an important prerequisite to any study of by-catch, and especially to studies of elasmobranchs within CCAMLR waters. Dr Siegel offered assistance with the development of suitable taxonomic keys for elasmobranchs.

Fishery Data Manual

9.4 The Working Group discussed the Secretariat's proposal to publish the data reporting requirements for CCAMLR fisheries as a loose-leaf publication (WG-FSA-98/12). The fishery data are central to the analyses of the Scientific Committee and its working groups. However, unlike other major CCAMLR datasets (e.g. CEMP data and observer data), there are no published guidelines on the methods for collecting the fishery data. Instead, detailed information on data forms and codes, as presented in WG-FSA-98/12, is distributed each year by the Secretariat prior to the fishing seasons.

9.5 The proposed loose-leaf publication would be produced in the four languages of the Commission, and would be aimed at ensuring the accurate completion and timely submission of fisheries data. The publication would follow the successful loose-leaf format of the *Scientific Observers Manual*. The loose-leaf format allows material to be updated for the production cost of the replacement pages, rather than the cost of the whole publication. In addition, an electronic version of this publication would be held on the CCAMLR website where it could be browsed and downloaded as required. The proposed title for this publication was *FisheryData Manual*.

9.6 The Working Group agreed that the data reporting requirements for CCAMLR fisheries should be produced as loose-leaf publication, and suggestions were made concerning presentation and format. Most of these related to the need to make the manual user-friendly. The data forms should be brought to the front of the document, with examples on how to complete the forms. The instructions should be easily referenced so that users, including fishers, encountering problems may easily find the appropriate information. A table listing the current data forms should be included, and updated each year.

Workshop on *Champscephalus gunnari*

9.7 Last year, the Working Group had identified a high priority need for further developments of long-term management strategies for *C. gunnari*. This need was endorsed by the Scientific Committee and a three-and-a-half day workshop was planned in association with the 1998 meeting of WG-FSA. The terms of reference of the workshop were outlined in SC-CAMLR-XVI, paragraph 5.62.

9.8 The Scientific Committee recommended that the workshop should proceed pending the submission of data and appropriate papers by 1 August 1998, and that the decision to hold the workshop would be taken by the Convener of WG-FSA, in consultation with the Chairman of the Scientific Committee and the Data Manager (SC-CAMLR-XVI, paragraph 5.61). Consequently, the workshop was postponed in August 1998 because key participants had been unable to prepare data and information by the time of the deadline.

9.9 The Working Group reviewed the needs for such a workshop, and confirmed that the development of long-term management strategies for *C. gunnari* remained a high priority. The Working Group also recognised that the terms of reference were ambitious, and that much work was required prior to holding such a workshop. However, the current assessments of *Dissostichus* spp. had also identified other high priority needs for further work. The Working

Group agreed that work on *Dissostichus* spp. should take precedence over work on *C. gunnari*, given the state of fisheries for *Dissostichus* spp., and the low catches of *C. gunnari* reported in recent years.

9.10 The Working Group agreed that a workshop to develop long-term management strategies for *C. gunnari* could be postponed until after 1999, and encouraged participants to undertake as a matter of urgency the necessary analyses required under the major biological components of the terms of reference. These were:

- (i) to review the fisheries on *C. gunnari* in various subareas and divisions, including trends in catches and changes in stock composition in terms of length and age;
- (ii) to review information on the biology and demography of the species, including age, growth, and reproduction and diet;
- (iii) to review information on stock identity, structure and movements, including distribution, movements, segregation by age and stock separation;
- (iv) to review estimates of absolute and relative abundance and year class strength;
- (v) to review the historical assessment methods, including short- and long-term methods and highlight their shortcomings; and
- (vi) to evaluate interactions of *C. gunnari* with other components of the ecosystem, including krill and fur seals, to investigate past fluctuations in natural mortality and explore the potential to predict changes in M.

High-priority Intersessional Work on *Dissostichus* spp.

9.11 This year's assessments had identified high priority areas for future work, and the Working Group agreed that this work should be afforded equally high priority to that on *C. gunnari*, if not higher for the reasons stated above. These areas of work are:

- (i) consider the currency of assessments for both *D. eleginoides*, as well as other species;
- (ii) subject to the advice of the Scientific Committee and the Commission, define a start date for fisheries for *Dissostichus* spp. and review the 35-year period of which stock trajectories are projected with the GYM, especially in terms of reconciling the outputs of the GYM and information derived from CPUE;
- (iii) identify stocks and define the home ranges;
- (iv) analysis and interpretation of CPUE data;
- (v) develop and validate growth models for *D. eleginoides* and *D. mawsoni* in different parts of their range;
- (vi) derive recruitment indices from mixture analyses and analysis of their sensitivity to expected outcomes from growth and mortality functions; and
- (vii) define ways of apportioning assessments in areas where both trawling and longlining may occur.

9.12 Recognising the high priority need for further work on *Dissostichus* spp., the Working Group examined the idea of holding a thematic session during the 1999 meeting of WG-FSA. If such a session was feasible, then key new work on *Dissostichus* spp. could be reviewed during the meeting, and would alleviate the need for a workshop prior to the meeting. The success of the thematic session would hinge on the success of intersessional activities, and the ability to report findings in papers focused on key elements of the assessments.

9.13 The Working Group recommended that the role of subgroup coordinators at this year's meeting be extended to the intersessional period, and that these people be tasked with coordinating the relevant and high priority aspects of the work identified at the meeting. The Working Group concluded that such an approach was likely to ensure the success of the thematic session. It was recommended that the Convener of the Working Group and Chairman of the Scientific Committee in consultation with Working Group members, will appoint coordinators for the following activities:

- (i) compilation of catch data (from regulated and unregulated fishing activities);
- (ii) review of observer reports and information;
- (iii) review of new and exploratory fisheries activities and notifications;
- (iv) assessment of *D. eleginoides*;
- (v) assessment of *C. gunnari*;
- (vi) review, and where necessary assess, the biology and demography of species considered by the Working Group; and
- (vii) compilation of data necessary for ad hoc WG-IMALF activities.

9.14 It was recognised that the appointment of these coordinators should be undertaken as soon as possible after the 1998 meeting of the Scientific Committee. However, it was acknowledged that their work would be triggered by the arrival of the data necessary for them to address the various topics identified.

Work during the Intersessional Period

9.15 The Working Group identified a number of tasks which should be carried out by participants and the Secretariat during the intersessional period. These tasks are summarised below. References are given to paragraphs in the report which contain details of these tasks.

9.16 The following tasks were identified as part of developing the CCAMLR database:

Secretariat:

- (i) Investigate and correct problems in the survey data (paragraph 3.6).
- (ii) transfer of all available survey data to the newly designed database (paragraph 3.7).
- (iii) Develop data entry program for use by scientific observers in the field (paragraphs 3.63 and 3.64).

- (iv) Develop electronic data submission procedures for fishery and observer data (paragraph 3.62).
- (v) Process all available data from the split-year prior to the meeting.
- (vi) Process, where possible, all available data from current fishing season prior to the meeting.
- (vii) Resolve problems with the haul-by-haul data submitted by Ukraine (paragraph 3.19, see WG-FSA-98/5).
- (viii) Maintain a register of collections of scales and otoliths from *Dissostichus* spp. (paragraph 3.104).
- (ix) Develop and publish the *Fishery Data Manual* (paragraph 9.6).

Members:

- (x) Collect detailed bathymetry data and submit to the CCAMLR database (paragraph 3.12).
- (xi) Submit observer logbook data and reports within the deadlines set by the Commission (paragraph 3.44).
- (xii) Submit examples of electronic data entry systems for consideration by the Secretariat (paragraph 3.64).
- (xiii) Assist the Secretariat with the development of electronic data submission procedures for fishery and observer data (paragraph 3.62).
- (xiv) Revise the sampling protocol of Mr Ashford and Prof. Duhamel (paragraph 3.66).
- (xv) Encourage technical coordinators to participate in the meetings of WG-FSA (paragraph 3.79).
- (xvi) Submit recent survey data and support documentation to the Secretariat so that these data could be used in future analyses of the Working Group – note that survey data need to be submitted in a format, and using data codes, compatible with those in use in the CCAMLR database (paragraph 3.7).
- (xvii) Resolve problems with the haul-by-haul data submitted by Ukraine (paragraph 3.19).
- (xviii) Develop strategies for collecting data on fish by-catch in krill fisheries using port sampling and laboratory analysis of samples collected by fishers (paragraph 5.12).
- (xix) Provide feedback on the experience on the draft protocol method for estimating conversion factors (paragraph 3.76).

9.17 The following tasks were identified as part of the work in stock assessment analyses and modelling:

Secretariat:

- (i) Establish and maintain a register of tests on the GYM (paragraph 3.142) and other models used by CCAMLR (paragraph 3.146).
- (ii) Maintain an up-to-date suite of software so as to fully document and operate validation procedures and models (paragraph 3.146).
- (iii) Develop the routine for extracting weighted length-frequency data and perform routine length-frequency analyses.
- (iv) Document the history of assessments (paragraph 9.10(v)).
- (v) Continue collecting information on *D. mawsoni*.
- (vi) Update estimates of seabed areas in relation to notifications of new and exploratory fisheries.

Members:

- (vii) Quantify the gene flow of *Dissostichus* spp. between fishing grounds and, in particular, determine the origin of the stock of *D. eleginoides* found in the Maurice Ewing Bank in Subarea 48.3 (paragraph 9.11(iv)).
- (viii) Analyse and interpret CPUE data from fisheries for *Dissostichus* spp. (paragraph 9.11).
- (ix) Develop and validate growth models for *D. eleginoides* and *D. mawsoni* in different parts of their range (paragraphs 3.108 and 9.11(v)).
- (x) Derive recruitment indices for *Dissostichus* spp. using mixture analyses and analysis of their sensitivity to expected outcomes from growth and mortality functions (paragraph 9.11(vi)).
- (xi) Collect information on mesh/hook selectivity for *Dissostichus* spp. (paragraph 3.87).
- (xii) Conduct further validation of the GYM (paragraph 3.142) and other models used by CCAMLR (paragraph 3.146).
- (xiii) Identify the scope for a study on by-catch in trawl and longline fisheries for *Dissostichus* spp. (paragraph 9.2).
- (xiv) Examine decision rules related to by-catch in new and exploratory fisheries (paragraph 4.51).
- (xv) Examine the short-term implications of the current management strategies for *C. gunnari* (paragraph 9.9).
- (xvi) Reconcile yield estimates for *Dissostichus* spp. derived from short-term and long-term projections (paragraph 9.11(ii)).
- (xvii) Evaluate the performance of management strategies against fixed starting dates for fisheries for *Dissostichus* spp. (paragraph 9.11(ii)).
- (xviii) Analyse changes in length-frequency distribution of *D. eleginoides*.

- (xix) Examine ways of apportioning catch limits in new and exploratory fisheries with mixed gear (paragraph 9.11).
- (xx) Quantify the catch of *Dissostichus* spp. in illegal and unregulated fisheries.
- (xxi) Evaluate ways of determining the currency of particular assessments (paragraph 3.90).
- (xxii) Conduct a stock reduction analysis on *Dissostichus* spp. fisheries (paragraph 9.11).
- (xxiii) Conduct surveys in regions where there was little, or no, information on *Dissostichus* spp. (paragraph 3.86).
- (xxiv) Task subgroup coordinators at this year's meeting with coordinating the relevant and high priority aspects of the work identified for the intersessional period (paragraph 9.13).

9.18 The tasks listed below were identified as part of the work on the assessment of incidental mortality of seabirds and marine mammals arising from fishing operations. The list comprises those tasks which are not standing requests or repetition or continuation of items which appeared in the 1998 plan of intersessional work. The latter items will be so identified in the 1999 work plan, which is attached as Appendix F. The following tasks were identified:

Secretariat:

- (i) Intersessional analysis of scientific observer data in order to evaluate interactions between vessel, season, area, year, species and mitigation measure in relation to seabird by-catch (paragraphs 7.16, 7.37 and 7.59). This will require the completion of entry and validation of observer logbook data for the 1997/98 season.
- (ii) Acquisition of information by the Secretariat from Mustad on line setting devices (paragraph 7.155).
- (iii) Appropriate circulation of the CCAMLR booklet *Fish the Sea Not the Sky* (paragraph 3.78).
- (iv) Potential CCAMLR workshop for technical coordinators (paragraph 3.79).

Members:

- (v) Review research programs into the status of albatross, giant petrel and *Procellaria* petrel populations (paragraph 7.8).
- (vi) Intersessional analysis of scientific observer data in order to evaluate interactions between vessel, season, area, year, species and mitigation measure in relation to seabird by-catch (paragraphs 7.16, 7.37 and 7.59). This will require the completion of entry and validation of observer logbook data for the 1997/98 season.
- (vii) Acquisition of any outstanding data from EEZs to ensure comprehensive assessments can be undertaken (arising from paragraphs 7.24 and 7.37).
- (viii) Analysis of data from Subareas 58.6 and 58.7 to assess the influence of the exclusion zone around the Prince Edward Islands on local seabird by-catch rates (paragraph 7.53).

- (ix) Intersessional work assessing risk of seabird by-catch in all statistical subareas and divisions of the Convention Area (paragraphs 7.104 and 7.105).
- (x) Research into optimum configuration of line weighting regimes and equipment in order to achieve longline sink rates to eliminate seabird by-catch (paragraphs 7.146, 7.147, 7.150 and 7.167).
- (xi) Promote and encourage work into the effects of:
 - (a) artificial bait, snood line colour and mainline colour on seabird capture rates (paragraph 7.166); and
 - (b) bait taking by seabirds in relation to bait depth and sink rates (paragraph 7.167).
- (xii) Review scientific observer logbook forms (paragraph 3.48).
- (xiii) Report experiences with video recording of line hauling operations (paragraph 3.61).
- (xiv) Potential CCAMLR workshop for technical coordinators (paragraph 3.79).

9.19 The following tasks should be carried out by participants of the task group on reporting forms and instructions for scientific observation:

- (i) review the comments of scientific observers, revise logbook forms and instructions, publish and distribute updates by February 1999 (paragraph 3.48);
- (ii) urge vessel owners and captains to provide as much protection as possible for observers against adverse weather conditions (paragraph 3.61); and
- (iii) encourage technical coordinators and scientific observers in promoting awareness of the details of CCAMLR conservation measure in force (paragraph 3.77) and the booklet *Fish the Sea Not the Sky* (paragraph 3.78).

9.20 As was the practice in the past, a plan of work on the incidental mortality of marine animals in fisheries will be considered during CCAMLR-XVII by Members of the IMALF Coordinating Group. The Secretariat will report on the work of the coordinating group to the next meeting of WG-FSA.

Convenership

9.21 The Working Group thanked Dr Holt for convening the meeting following the resignation of Dr de la Mare. The Working Group discussed the convenership of the meetings for 1999 and 2000, and noted Mr Williams' willingness to serve as the next Convener of WG-FSA.

9.22 The Working Group also examined the need for a coordinator of ad hoc WG-IMALF, and appointed Prof. Croxall as Convener of WG-IMALF, and Mr Baker as Deputy-Convener.

9.23 The Working Group congratulated these appointees.

OTHER BUSINESS

Publication of CCAMLR Work in the Journal *Reviews in Fish Biology and Fisheries*

10.1 The Working Group considered a letter from Prof. T. Pitcher (Founding Editor of *Reviews in Fish Biology and Fisheries*) to the Secretariat in April 1998. Dr Miller indicated that this letter should have been circulated earlier to provide members of WG-FSA and WG-EMM time to reflect on its contents. This would have also provided members of the Scientific Committee with an opportunity to comment, and procedurally would have been a more correct approach. In his view, nevertheless, there would still be considerable merit in the Working Group considering the letter's contents despite the fact that it had been brought to the participants attention rather late in the meeting's proceedings.

10.2 Prof. Pitcher's letter offered to publish a short review of the scientific highlights from CCAMLR's work in the journal *Reviews in Fish Biology and Fisheries*. The format would be analogous to the journal's 'Points of View' section, and would include four to five pages of text plus one figure and table. As with all contributions to that journal, the paper would be fully peer reviewed before acceptance. The Secretariat had decided to refer the matter to the working groups and Scientific Committee at the annual meetings. No further correspondence had taken place regarding this matter. Prof. Moreno, who is a member of the Editorial Board of that journal, explained the proposal in further detail.

10.3 The Working Group agreed that the idea of publicising highlights of CCAMLR's work in a highly cited scientific journal was attractive, and would promote CCAMLR's work to the broader scientific community. The Working Group also agreed that there should be no binding agreement to publish highlights annually. Possible topics for short review would include the application of GYM. The Working Group referred this matter to the Scientific Committee for consideration.

10.4 Prof. Moreno also encouraged participants to consider submitting reviews to the journal, and the Working Group identified a review of CCAMLR's approach to resource management as a possible candidate paper.

10.5 The Working Group recognised the need to raise the scientific profile of CCAMLR Science though enhancing the journal's citations index in a journal of the calibre of *Reviews in Fish Biology and Fisheries*. The Working Group indicated that in its view the Scientific Committee should also strive to ensure that *CCAMLR Science* be included in the 'Current Contents'.

Symposium on the Biology of Polar Fish

10.6 Dr Everson informed the meeting that the annual symposium for the year 2000 of the Fisheries Society of the British Isles would be held in Cambridge and that the theme is 'Biology of Polar Fish'. The program is still being prepared, but it is anticipated that, subject to demand, there will be sessions on harvested species. He agreed to include all participants at WG-FSA on the mailing list for information.

Workload of the Secretariat

10.7 The Working Group recognised that in recent years the size and complexity of its reports had continually increased; a situation aggravated by the fact that the meetings of WG-FSA and ad hoc WG-IMALF have run together as one. This has put considerable strain on the

Secretariat Staff and in particular Ms Genevieve Tanner who has prepared the draft report this year to her usual highly professional standard. Despite the allocation of additional Secretariat resources, the Working Group was concerned that her workload had risen to an undesirable level and discussed possible ways whereby the workload might be reduced. Arising from this, it was agreed that in future all draft text should be submitted in electronic format and rapporteurs should assume more responsibility for the initial editing and development of text.

ADOPTION OF REPORT

11.1 The report of the meeting was adopted.

CLOSE OF THE MEETING

12.1 Dr Miller, on behalf on the Working Group, thanked Dr Holt for stepping in at short notice, and convening the meeting. Dr Holt's work had been difficult and very well done, and the Working Group expressed its appreciation.

12.2 Dr Holt thanked the Working Group. He had appreciated the large amount of work that the Secretariat had done in supporting the meeting, and thanked all staff involved. He also thanked ad hoc WG-IMALF for its significant contribution to the meeting, and ex-conveners of WG-FSA for their help during the meeting.

12.3 The Convener then closed the meeting.

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Table 1: Catches (tonnes) by species and area reported for the split-year 1997/98 (1 July 1997 to 30 June 1998). Source: STATLANT data.

Species	Area/Subarea/Division										
	48	48.1	48.2	48.3	58.5.1	58.5.2	58.6	58.7	88.1	88.3	All Areas
<i>A. rostrata</i>				1				2			3
<i>C. gunnari</i>				6		68					74
<i>C. rhinoceratus</i>					1	5					6
<i>D. eleginoides</i>		<1	<1	3 258	4 741	2 418	175	576	<1	<1	11 168
<i>D. mawsoni</i>		1							41		42
<i>E. superba</i>	80 981										80 981
<i>L. squamifrons</i>						3					3
<i>Macrourus</i> spp.		<1	<1	21	12		15	22	9		79
Nototheniidae		<1	<1	<1					<1	<1	<1
Osteichthyes spp.		1	<1	6				<1			7
<i>M. hyadesi</i>				53							53
Lithodidae				<1				<1	<1		<1
<i>P. spinosissima</i>				<1							<1
Rajiformes spp.		<1	<1	14	18	1	3	<1	4	<1	40
Total	80 981	2	<1	3 359	4 772	2 495	193	600	54	<1	92 456

Table 2 : Catches (tonnes) of *Dissostichus* spp. and *C. gunnari* by statistical areas and gear reported for the 1997/98 fishing season (i.e. the period between the end of the Commission meeting in 1997 and the time of the WG-FSA meeting in 1998).

Conservation Measure	Subarea/ Division	Location	Fishing Method	Catch Limit (tonnes)	Reported Catch (tonnes)
<i>Dissostichus eleginoides:</i>					
Established/Assessed fisheries:					
124/XVI	48.3	South Georgia	Longline	3 300	3 328
128/XVI	48.4	South Sandwich Is	Longline	28	0
131/XVI	58.5.2	Heard Island	Trawl	3 700	3 264 ^a
-	58.5.1	Kerguelen EEZ	Trawl		3 624 ^b
-	58.5.1	Kerguelen EEZ	Longline		1 118 ^c
-	58.6	Crozet EEZ	Longline		88 ^b
-	58.6	Prince Edward Is EEZ	Longline		140 ^d
-	58.7	Prince Edward Is EEZ	Longline		674 ^d
Exploratory fisheries:					
141/XVI	58.6	Outside EEZs	Longline	658	1.0
142/XVI	58.7	Outside EEZ	Longline	312	<1
<i>Dissostichus</i> spp.:					
143/XVI	88.1	North of 65°S	Longline	338	0
		South of 65°S	Longline	1 172	39
144/XVI	58.4.3		Trawl	963	0
New fisheries:					
134/XVI	48.1	North of 65°S	Longline	1 863	<1
		South of 65°S	Longline	94	<1
					(Closed due to results of survey)
135/XVI	48.2	North of 65°S	Longline	429	<1
		South of 65°S	Longline	972	<1
					(Closed due to results of survey)
136/XVI	48.6	North of 65°S	Longline	888	0
		South of 65°S	Longline	648	0
137/XVI	58.4.3	North of 60°S	Longline	1 782	0
		South of 60°S	Longline	0	0
138/XVI	58.4.4	North of 60°S (outside EEZ)	Longline	580	0
		South of 60°S	Longline	0	0
139/XVI	88.2	North of 65°S	Longline	25	0
		South of 65°S	Longline	38	0
140/XVI	88.3	North of 65°S	Longline	0	0
		South of 65°S	Longline	455	<1
<i>Champscephalus gunnari:</i>					
123/XVI	48.3	South Georgia	Trawl	4 520	5 ^e
130/XVI	58.5.2	Heard Island	Trawl	900	115 ^f

^a Advised by Australia at the time of the meeting. Expected to reach 3 700 tonnes (i.e. the catch limit) before the end of the Commission meeting in 1998.

^b Catch reported by France for French vessels

^c Catch reported by France for Ukrainian (997 tonnes) and French (121 tonnes) vessels

^d Catch reported by South Africa for the period from the end of the Commission meeting in 1997 to 10 October 1998

^e As reported in WG-FSA-98/53

^f Advised by Australia at the time of the meeting

Table 3: Reported catches (in tonnes) of *D. eleginoides* and *D. mawsoni* by Members and Acceding States in EEZs and in the CCAMLR Convention Area, and estimates of unreported catches from the CCAMLR Convention Area by Members and Acceding States in the 1997/98 split-year. Catches for the 1996/97 split-year are given in brackets.

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	8 692	(6 796)	1 479 ⁹	(1 275)	5 640 ¹²	(17 600) ⁴	15 811	(25 671)
Argentina	5 651	(9 395)	0	(0)	5 760 ¹³	(19 670) ⁵	11 411	(29 065)
France	0	(0)	3 832	(3 674)	0	(0)	3 832	(3 674)
Australia	575 ¹	(1 000) ¹	2 418	(837)	0	(0)	2 993	(1 837)
South Africa	0	(0)	1 149 ¹¹	(2 386) ⁸	1 200 ¹⁴	(0)	2 349	(2 386)
UK	1 624 ⁶	(1 164) ⁶	590	(398)	0	(0)	2 214	(1 562)
Portugal (EC)	0	(0)	0	(0)	1 200 ¹⁵	(?) ⁷	1 200	(?)
Uruguay	?	(?)	262 ⁹	(0)	800 ¹⁶	(0)	1 062	(?)
Ukraine	0	(0)	997 ²	(1 007) ²	0	(0)	997	(1 007)
Spain	0	(0)	196 ⁹	(291)	0	(?) ⁷	196	(291)
Rep. of Korea	0	(0)	170 ⁹	(425)	0	(0)	170	(425)
Peru	156	(4 000)	0	(0)	0	(0)	156	(4 000)
Japan	0	(0)	76 ⁹	(333) ³	0	(?) ⁷	76	(333)
New Zealand	0	(10)	41 ¹⁰	(<1)	0	(0)	41	(10)
USA	0	(0)	0	(0)	0	(?) ⁷	0	(?)
Norway	0	(0)	0	(0)	0	(?) ⁷	0	(?)
All countries	16 698	(22 365)	11 210	(10 626)	14 600	(37 270)	42 508	(70 261)

¹ From Macquarie Island

² From French EEZ in Division 58.5.1

³ From joint venture in French EEZ in Subarea 58.6

⁴ Based on the following estimates: 18 vessels sighted of 22 vessels departing Chile, 14 vessels fishing at any time, effort: 2 104 days fishing, mean daily catch rate: 8.56 tonnes

⁵ Based on the same catch and effort data as ⁴, but pro-rata by the number of Argentinian vessels sighted

⁶ From Falkland/Malvinas Islands

⁷ Vessels running the flag of the respective Member were sighted fishing in Area 58

⁸ From South African EEZ in Subareas 58.6 and 58.7

⁹ From Subarea 48.3

¹⁰ From Subarea 88.1; catch consisted mostly of *D. mawsoni*

¹¹ From South African EEZ in Subareas 58.6 and 58.7 and from Subarea 48.3

¹² Based on the following estimates: three vessels observed in Division 58.5.1, five vessels observed in Walvis Bay and Mauritius, assumed that eight vessels were fishing at some time during the season taking into account that some of these vessels were also involved in the regulated fishery in Subarea 48.3 for part of the year, effort: 940 days fishing, mean daily catch rate: 6 tonnes

¹³ Based on the following estimates: four vessels observed or arrested in Division 58.5.1, three vessels landing catches in Walvis Bay, assumed that seven vessels were fishing at some time during the season, effort: 960 days fishing, mean daily catch rate: 6 tonnes

¹⁴ Based on the following estimates: one vessel sighted in Division 58.5.1 probably fishing for the whole season, effort: 200 days fishing, mean daily catch rate: 6 tonnes

¹⁵ Based on the following estimates: two vessels sighted in Division 58.5.1 fishing for part of the season, effort: 200 days fishing, mean daily catch rate: 6 tonnes

¹⁶ Based on the following estimates: one vessel landing catch in Walvis Bay, assumed the vessel was fishing for part of the season when not involved in the regulated fishery in Subarea 48.3, effort: 133 days fishing, mean daily catch rate: 6 tonnes

Table 4: Estimated landings (in tonnes) of *D. eleginoides* in southern African ports and Mauritius in the 1996/97 split-year, the 1997/98 split-year and the beginning of the 1998/99 split-year.

Port	Product Weight 1996/97	Estimated Green Weight 1996/97	Product Weight 1997/98	Estimated Green Weight 1997/98	Product Weight Jul–Sep 1998	Estimated Green Weight Jul–Sep 1998
Walvis Bay	7 100 ¹	1 2 070 ¹	3 222 ¹	5 477 ¹	422 ¹	717 ¹
Cape Town	13 939 ⁵	23 696 ¹	780 ⁵	1 326 ¹	88 ⁵	150 ¹
Unknown	3 199 ¹	5 438 ¹				
Mauritius	6 900 ²	11 730 ¹	11 780 ⁴	20 026 ¹	4 320 ⁴	7344 ¹
Mauritius	9 000 –12 000 ³	15 300 – 20 400 ¹				

¹ Catches/landings conversion factor of product to green weight: 1.7

² Information from Australian commercial sources. Catches mostly from Kerguelen Plateau

³ Information from Japanese Seafood Daily Newspaper, September 1997

⁴ Minimum estimate from known landings

⁵ Landings in Cape Town include catches from unregulated fishing up to the end of the 1996/97 split-year. Landings thereafter were from the licensed fishery only.

Table 5: Estimated effort, mean catch rates/day and total catches by subarea/division in the unregulated fishery on *D. eleginoides* in the 1997/98 split-year. Estimates for the 1996/97 split-year are given in brackets.

Area/ Subarea/ Division	Estimated Start of Unregulated Fishery	No. of Vessels Sighted in Unregulated Fishery ¹	No. of Vessels Surveilling	Estimated No. of Vessels Fishing	No. of Days Fishing per Fishing Trip	Estimated Effort in Days Fishing (1)	Mean Catch Rate per Day (tonnes) (2)	Estimated Unreported Catch (1) x (2)	Estimated Total Catch
48.6 48.3	No information 1991	0	4	0	-	-	-	0	3 258 (2 389)
58.7	Apr/May 1996	8 (23) ²	5 (5)	10 (32) ⁴	40 ⁴ (32) ⁴	370 (1 540)	2.5 ⁴ (7.7) ⁴	925 (11 900)	1 501 (14 129)
58.6	Apr/May 1996	6 (35)	3 (3)	30–35 ⁸ (40)	40 (40)	504 (2 700)	3.5 (7–10)	1 765 (18 900) ⁶	1 940 (19 233)
58.5.1	Dec 1996	26 (7)	6 (6)	35–40 ⁸ (40)	40 (40)	2 365 (270)	5 (7–10)	11 825 (2 000)	16 566 (6 681)
58.5.2	Feb/Mar 1997	3 (10)	2 (2)	30 ⁸ (35)	40 (35)	1 400 (825–1 360)	5 (8–10) (8–15)	7 000 (7 200) (12 000)	9 418 (8 037) ⁷ (12 837) ⁷
58.4.4 58	Sep 1996	0 40–50 (90)	0	2 ⁹	45	180	5	900	900

¹ Double sightings in one zone not counted

² Size of vessels ranging from 364 tonnes (39.7 m) to 1 103 tonnes (73.5 m)

³ Number of vessels actually seen fishing

⁴ Data from licensed operations

⁵ Some transshipment suspected, catch rates ranged from 2.8 to 23 tonnes/day

⁶ Minimum estimate based on vessels sighted and their landings

⁷ Based on lower and upper limit of the range of catch and effort estimates

⁸ Estimated number of vessels not in areas throughout period, but moving between areas

⁹ Industry sources

Table 6: Estimated total catch (in tonnes) by subarea/division of *D. eleginoides* and *D. mawsoni* in the CCAMLR Convention Area for the 1997/98 split-year.

Subarea/ Division	Estimated Total Catch	Reported Catch 1997/98	Estimated Unreported Catch	Unreported Catch in % of the Estimated Total Catch
48.3	3 258	3 258	Probably low	Probably low
58.7	1 501	576	925	61.6
58.6	1 940	175	1 765	91.0
58.5.1	16 566	4 741	11 825	71.4
58.5.2	9 418	2 418	7 000	74.3
88.1	41	41	Probably very low	Probably very low
58.4.4	900	0	900	Probably very low
48.1	<1	<1	Probably very low	Probably very low
48.2	<1	<1	Probably very low	Probably very low
88.3	<1	<1	Probably very low	Probably very low
All subareas	33 625	11 210	22 415	66.7

Table 7: A revision of total catch estimates of *D. eleginoides* taken in Subareas 58.6 and 58.7 for 1996 and 1997 and an estimation of total catch taken in 1998.

Subarea	November 1995 to September 1996	November 1996 to September 1997	November 1997 to September 1998
58.7	6 136	6 951	1 574
58.6	9 531	19 233	1 994

Table 8: Estimates of total catch of *D. eleginoides* taken in Subareas 48.3, 58.6 and 58.7 and Divisions 58.5.1 and 58.5.2 from November 1997 to September 1998.

Subarea/ Division	CCAMLR Area Reported Catch	Estimated Unreported Catch	Estimated Total Catch
48.3	3 328	0	3 328
58.7	674	900	1 574
58.6	229	1 765	1 994
58.5.1	4 741	11 825	16 566
58.5.2	3 264	520–3 500	3 784–6 764

Table 9: Imports of *D. eleginoides* (in tonnes) into Japan and USA for the 1997 calendar year. Market statistics were only available for some products and an estimation of the total market is based on comparisons with figures for the 1998 calendar year.

Source	Japan ¹	USA ²	Total	% of Market	Estimated Total for Both Markets ³
Chile	22 255	159	22 415	62	
Argentina	2 569	2 539	5 109	14	
South Africa	2 072	492	2 564	7	
China	1 449	0	1 449	4	
France	1 200	0	1 200	3	
Mauritius	13	856	869	2	
Namibia	178	274	453	1	
Panama	0	376	377	1	
Reunion	300	0	300	1	
Belize	4	285	289	1	
Spain	0	242	242	1	
Australia	61	146	207	1	
Falklands/Malvinas	115	0	115	0	
St Helena	3	100	102	0	
Uruguay	5	75	80	0	
Norway	0	61	61	0	
USA	43	0	43	0	
UK	20	0.5	21	0	
New Zealand	0	0.7	1	0	
Total	30 287	5 608	35 896		69 978

¹ Market statistics only for fillets; conversion factor of 2.2 to convert product weight to green weight.

² Market statistics only for possible toothfish products (not separated as HAG (headed and gutted) and fillets); product weight shown in table; no conversion factor applied yet.

³ Assumes that green weight of fillets is ca. 50% of the total Japanese market green weight for toothfish based on 1998 statistics. This would give an estimated total for the Japanese market of 60 574 tonnes green weight. It was also assumed that the proportion of fillets to HAG product on the US market was the same as for 1998 statistics. For 13.3% of product a conversion factor of 2.2 was used (as for fillets) and for 86.7% of product a conversion factor of 1.7 was used (as for HAG product). This would give an estimated total for the US market of 9 404 tonnes green weight.

Table 10: Imports of *D. eleginoides* (in tonnes) into Japan and USA for 1998 from different sources showing their market share.

Source	Japan ¹	USA ²	Total ³	% of Market
Chile	13 436	1 481	14 917	44.0
Mauritius	4 603	180	4 782	14.0
Argentina	1 606	1 456	3 062	9.0
France	2 514	0	2 514	7.0
Australia	1 225	228	1 453	4.0
South Africa	1 226	61	1 287	4.0
Namibia	552	451	1 003	3.0
Uruguay	790	209	999	3.0
Belize	773	41	814	2.0
Panama	506	157	663	2.0
Reunion	647	0	647	2.0
China	393	0	393	1.0
Norway	380	0	380	1.0
Falklands/Malvinas	232	0	232	1.0
Gambia	147	0	147	0.4
St Helena	138	0	138	0.4
Spain	94	0	94	0.3
Thailand	0	43	43	0.1
Maldives	0	41	41	0.1
Canada	37	0	37	0.1
USA	35	0	35	0.1
S Korea	34	0	34	0.1
Guinea-Bissau	0	31	31	0.1
Cayman Islands	0	27	27	0.1
Seychelles	0	23	23	0.1
Mauritania	14	0	14	0.04
Netherlands	10	0	10	0.03
New Zealand	6	0	6	0.02
Guyana	0	1	1	0.01
Total	29 396	4 428	33 825	

¹ Japanese market statistics for the period: January to August 1998

² USA market statistics for the period: January to June 1998

³ Conversion factors of 1.7 was used for HAG (headed and gutted) and 2.2 for fillets to estimate product to green weight

Table 11: Summary of fishing operations covered by scientific observers on board vessels in the Convention Area in 1997/98. Nationality: AUS – Australia, CHL – Chile, GBR – United Kingdom, NZL – New Zealand, URY – Uruguay, ZAF – South Africa; Fishing method: A – autoliner, OTB – bottom trawl, OTM – midwater trawl, Sp – Spanish; Target species: ANI – *C. gunnari*, TOP – *D. eleginoides*; Type of product: FLT – fillet, HAG – headed and gutted, HAT – headed and tailed.

Vessel Name (Nationality)	Observer	Dates of Fishing	Fishing Method	Target Species	Sets/Hauls Deployed	No. of Hooks		Type of Product	Conversion Factor (from report)	
						Set (1 000s)	Baited (%)		Observer	Vessel
Subareas 48.1, 48.2 and 88.3:										
<i>Tierra del Fuego</i> (CHL)	Sinconegui, Argentina	9/2–23/3/98	Sp	TOP	52	114.7		HAG	1.7764	1.7764
Subarea 48.3:										
<i>Arctic Fox</i> (ZAF)	Thurston, UK	7/5–26/6/98	A, Sp	TOP	159	1 012.8	85	HAG	1.49, 1.52	1.45
<i>Arctic Fox</i> (ZAF)	Fulton, UK	13/7–3/9/98	A	TOP	121	830.4	85	HAG	1.55	1.45
<i>Argos Helena</i> (GBR)	du Plessis, Sth Africa	1/4–21/8/98	Sp	TOP	175	1 366.8	100	HAG	1.67	1.43
<i>Betanzos</i> (CHL)	King, UK	17/12/97–5/1/98	OTM							
<i>Illa de Rua</i> (URY)	Harrison, UK	8/4–10/6/98	Sp	TOP	86	977.6	100	HAG	1.7858	1.4085
<i>Illa de Rua</i> (URY)	Mynard, UK	29/6–22/8/98	Sp	TOP	83	806.6	100	HAT	1.48	1.4085
<i>Isla Camila</i> (CHL)	Marshall, UK	23/6–22/8/98	Sp	TOP	72	620.6	100	HAG	1.85	1.4085
<i>Isla Camila</i> (CHL)	Watson, UK	1/4–6/6/98	Sp	TOP	90	654.2	100	HAG	1.923	1.4085
<i>Isla Sofia</i> (CHL)	Ansell, UK	1/4–20/5/98	Sp	TOP	71	584.0	100	HAG	1.78, 1.69	1.4085
<i>Isla Sofia</i> (CHL)	Cooke, UK	3/6–23/8/98	Sp	TOP	91	750.2	100	HAG	1.408	1.454, 1.411
<i>Jacqueline</i> (GBR)	Heinecken, Sth Africa	31/5–22/8/98	Sp	TOP	86	841.5	100	HAG	1.75	1.43
<i>Koryo Maru II</i> (ZAF)	Quelch, UK	3/4–29/6/98	Sp	TOP	87	1 002.84	100	HAT	1.80	1.66, 1.35
<i>Magallanes III</i> (CHL)	Elton, UK	7/7–18/8/98	Sp	TOP	80	573.6	98	HAG	1.67	1.43
<i>Northern Pride</i> (ZAF)	Johnson, UK	17/4–19/6/98	Sp	TOP	59	734.6	100	HAG	1.538	1.538
<i>Northern Pride</i> (ZAF)	Day, UK	8/7–13/8/98	Sp	TOP	36	607.5	100	HAG	1.40	1.54
<i>Sudur Havid*</i> (ZAF)	Lewis, UK	20/4–6/6/98	Sp	TOP	37	500	100	HAG	1.55	1.55
<i>Tierra del Fuego</i> (CHL)	Hoogesteger, UK	1/4–3/6/98	Sp	TOP	153	767.0	100	HAG	1.64	1.428
<i>Tierra del Fuego</i> (CHL)	Berkiet, UK	17/6–18/8/98	Sp	TOP	110	761.3	100	HAT	1.623	1.428
Division 58.5.2:										
<i>Austral Leader</i> (AUS)	Aoki/Kalish, Australia	4/5–4/6/98	OTB	TOP	92			HAT, FLT	1.73, 2.38	1.69, 2.40
				ANI	48			-	-	-
<i>Austral Leader</i> (AUS)	Barron, Australia	3/7–7/8/98	OTB	TOP	144			HAT	1.77	1.69
				ANI	19			-	-	-
<i>Sil</i> (AUS)	Stanley/Parkinson, Australia	6/6–7/7/98	OTB	TOP	68			WHO	1	1
				ANI	5			WHO	1	1

continued ...

Table 11 (continued)

Vessel Name (Nationality)	Observer	Dates of Fishing	Fishing Method	Target Species	Sets/Hauls Deployed	No. of Hooks		Type of Product	Conversion Factor (from report)	
						Set (1 000s)	Baited (%)		Observer	Vessel
Subareas 58.6 and 58.7:										
<i>Aquatic Pioneer</i> (ZAF)	Pienaar, Sth Africa	15/11/97–10/1/98	A	TOP	143	532.7	80	HAG	1.73	1.6
<i>Aquatic Pioneer</i> (ZAF)	Pienaar, Sth Africa	1/2–12/3/98	A	TOP	90	420.7	82	HAG		1.6
<i>Aquatic Pioneer</i> (ZAF)	Enticott, UK	1/4–5/5/98	A	TOP	95	365.2	80	HAG	1.84	1.6
<i>Aquatic Pioneer</i> (ZAF)	Enticott, UK	23/6–27/7/98	A	TOP	159	338.7	80	HAT	1.83	1.6
<i>Eldfisk</i> (ZAF)	Le Roux, Sth Africa	10/1–10/2/98	A	TOP	164	312.8– 471.7	82	HAG	1.62	1.51
<i>Eldfisk</i> (ZAF)	Osborne, Sth Africa	3/3–18/4/98	A	TOP	240	884.0	85			
<i>Eldfisk</i> (ZAF)	Molenaar, Sth Africa	19/8–15/9/98	A	TOP	138	415.0	65	HAT	1.4	1.6
<i>Koryo Maru 11</i> (ZAF)	Stoffberg, Sth Africa	19/11/97–16/1/98	Sp	TOP	101	553.0	100	HAG	1.84	1.84
<i>Koryo Maru 11</i> (ZAF)	Heinecken, Sth Africa	2/2–11/3/98	Sp	TOP	70	434.1	100		2.01	1.6
<i>Koryo Maru 11</i> (ZAF)	Stoffberg, Sth Africa	23/7/98–	-	-	-	-	-	-	-	-
Subarea 88.1:										
<i>Lord Auckland</i> (NZL)	Purves, Sth Africa	22/2–26/3/98	A	TOP	82	241.0	74	HAG?, FLT	1.71, 2.37	1.71, 2.37

* *Sudur Havid* sank on 6 June 1998 with the loss of 17 lives (see paragraph 3.71)

Table 13: Information for all vessels in Subarea 48.3 during the 1996/97 and 1997/98 seasons for which data on vessel's conversion factor, observer-determined conversion factor and reported catch are all available. HAG – headed and gutted, HAT – headed and tailed.

Vessel Name	Dates of Fishing	Reported by Vessel			Reported by Observer			Difference in Catch	
		Processing Method	Conversion Factor	Catch (A) (kg)	Processing Method	Conversion Factor	Catch using Observer's Conversion Factor (B) (kg)	B - A	Correction Factor
1997/98 season:									
<i>Arctic Fox</i>	7/5/98–21/8/98	HAG	1.45	321 531	HAT	1.52 ¹	337 053	15 522	
<i>Illa de Rua</i>	8/4/98–10/6/98	HAT	1.408	262 166	HAT	1.785 ²	332 362	70 196	
<i>Isla Sofia</i>	3/6/98–31/7/98	HAG	1.408	129 501	HAG	1.443 ³	132 720	3 219	
<i>Koryo Maru 11</i>	3/4/98–29/6/98	HAT	1.66	197 237	HAT	1.80 ³	213 871	16 634	
<i>Tierra del Fuego</i>	1/4/98–3/6/98	HAT	1.43	277 404	HAT	1.62	314 262	36 858	
			Sum	1 187 839			1 330 269		1.120
1996/97 season:									
<i>Cisne Verde</i>	24/3/97–24/5/97	HAT	1.673	185 718	HAT	1.678 ²	186 273	555	
<i>Cisne Verde</i>	22/6/97–29/8/97	HAG	1.54	184 387	HAG	1.54	184 387	0	
<i>Elqui</i>	18/3/97–1/9/97	HAG	1.47	577 259	HAG	1.671 ⁵	656 190	78 931	
<i>Ercilla</i>	16/4/97–31/8/97	HAG	1.47	451 210	HAG	1.70 ¹	521 807	70 597	
<i>Ibsa Quinto</i>	18/4/97–31/8/97	HAG	1.82	294 520	HAG	1.82	294 520	0	
<i>Isla Isabel</i>	13/3/97–11/8/97	HAG	1.408	289 384	HAG	1.684 ⁴	346 110	56 726	
<i>Jacqueline</i>	15/4/97–31/8/97		1.64	267 189		1.64 ²	267 189	0	
			Sum	2 249 667			2 456 477		1.092
Total catches reported (tonnes):		Revised catches using correction factors:							
1996/97 season	3 812							4 163	
1997/98 season	6 201							6 944	

- ¹ Mean of three observer determinations on this vessel
- ² Mean of two observer determinations on this vessel
- ³ Mean of four observer determinations on this vessel
- ⁴ Mean of 32 observer determinations on this vessel
- ⁵ Mean of seven observer determinations on this vessel

Correction factor = (sum of catch using observer's CF)/(sum of catches reported by vessels)

Table 14: Disposal of wastes and oil pollution. Nationality: CHL – Chile, GBR – United Kingdom, NZL – New Zealand, URY – Uruguay, ZAF – South Africa; Fishing method: A – autoliner, T – trawl, Sp – Spanish; Band: Y – packaging bands used; Gear: Y – gear disposed overboard; Garbage: Y – garbage disposed overboard, N – garbage stored on board; Hooks in heads: Y – hooks in fish heads disposed overboard; - no information.

Vessel Name (Nationality)	Dates of trips	Fishing Method	Band	Oil	Debris		Hooks in Heads
					Gear	Garbage	
Subareas 48.1, 48.2, 88.3: <i>Tierra del Fuego</i> (CHL)	9/2–23/3/98	Sp	-	-	-	-	-
Subarea 48.3:							
<i>Arctic Fox</i> (ZAF)	13/7–3/9/98	A	-	-	-	-	-
<i>Arctic Fox</i> (ZAF)	1/5–6/7/98	A	-	-	-	-	-
<i>Argos Helena</i> (GBR)	2/4–21/8/98	Sp	-	-	-	-	-
<i>Betanzos</i> (CHL)	25/12/97–10/1/98	T	Y	-	-	Y	-
<i>Illa de Rua</i> (URY)	8/4–11/6/98	Sp	-	-	-	-	-
<i>Illa de Rua</i> (URY)	29/6–22/8/98	Sp	-	-	-	-	Y
<i>Isla Camila</i> (CHL)	26/3–8/6/98	Sp	-	-	-	-	-
<i>Isla Camila</i> (CHL)	16/6–22/8/98	Sp	-	-	-	-	Y (20%)
<i>Isla Sofía</i> (CHL)	1/4–20/5/98	Sp	-	-	-	-	-
<i>Isla Sofía</i> (CHL)	2/6–23/8/98	Sp	-	-	-	-	Y
<i>Jacqueline</i> (GBR)	28/5–22/8/98	Sp	-	-	-	-	-
<i>Koryo Maru II</i> (ZAF)	23/3–13/7/98	Sp	-	-	-	-	-
<i>Magallanes III</i> (CHL)	7/8–18/8/98	Sp	-	-	-	Y	-
<i>Northern Pride</i> (ZAF)	17/4–19/6/98	Sp	-	-	-	-	Y
<i>Northern Pride</i> (ZAF)	2/7–26/8/98	Sp	-	-	-	-	-
<i>Sudur Havid</i> (ZAF)	6/4–6/6/98	Sp	-	-	-	-	Y
<i>Tierra del Fuego</i> (CHL)	17/6–7/8/98	Sp	-	-	-	-	-
<i>Tierra del Fuego</i> (CHL)	25/3–8/6/98	Sp	-	-	-	-	Y
Subareas 58.6, 58.7:							
<i>Aquatic Pioneer</i> (ZAF)	9/11/97–16/1/98	A	Y	-	-	-	-
<i>Aquatic Pioneer</i> (ZAF)	26/1–19/3/98	A	-	-	-	-	-
<i>Aquatic Pioneer</i> (ZAF)	26/3–22/5/98	A	-	-	-	-	-
<i>Aquatic Pioneer</i> (ZAF)	17/7–1/8/98	A	-	-	-	-	-
<i>Koryo Maru II</i> (ZAF)	9/11/97–21/1/98	Sp	-	-	Y	-	-
<i>Koryo Maru II</i> (ZAF)	29/1–16/3/98	Sp	-	-	-	-	-
<i>Eldfisk</i> (ZAF)	10/1–10/2/98	A	-	-	-	-	-
<i>Eldfisk</i> (ZAF)	26/2–23/4/98	A	-	-	-	-	Y
Subarea 88.1:							
<i>Lord Auckland</i> (NZL)	21/2–26/3/98	A	-	-	-	N	-

Table 15: Seabed areas (km²) between 500–600 m, 600–1 500 m and 1 500–1 800 m and within the fishable depth ranges for trawling (500–1 500 m) and longlining (600–1 800 m) in Subareas 48.1, 48.6, 58.6, 58.7 and 88.1, and Divisions 58.4.1, 58.4.3, 58.4.4, 58.5.1 and 58.5.2. See WG-FSA-98/6 for the methodology. The regions are shown on the map contained in Figure 1.

Subarea/ Division	Map Ref.	Region	Depth Range (m)			Fishing Depth Range (m)	
			500–600	600–1 500	1 500–1 800	500–1 500	600–1 800
48.3	a	Maurice Ewing Bank (north of 52.3°S)	0	12 739	21 869	12 739	34 608
	b	South Georgia	2 415	21 320	10 705	23 735	32 025
		Total	2 415	34 059	32 574	36 474	66 633
48.6	a	North of 60°S	244	10 452	17 618	10 696	28 070
	b	South (60°S–72°S)	6 974	36 868	19 278	43 842	56 146
		Total (to 72°S)	7 218	47 320	36 896	54 538	84 216
58.4.1	a	BANZARE Bank	0	14 401	40 766	14 401	55 167
	b	Outside BANZARE Bank	43 524	198 567	77 410	242 091	275 977
		Total	43 524	212 968	118 176	256 492	331 144
58.4.3	b	Inside EEZ	0	0	3 053	0	3 053
	a	Elan Bank	0	9 054	9 551	9 054	18 605
	c	BANZARE Bank	203	39 640	35 546	39 843	75 186
		Total	203	48 694	48 150	48 897	96 844
58.4.4	c	Ob Bank (west of 42.6°E)	171	1 428	772	1 599	2 200
	d	Lena Bank (42.6–46°E)	1 223	5 905	1 565	7 128	7 470
	e	East of Lena Bank (46–49.3°E)	278	3 581	1 490	3 859	5 071
	f	Marion Dufresne (east of 49.3°E)	49	4 673	3 329	4 722	8 002
		Total	1 721	15 587	7 156	17 308	22 743
58.5.1	a	Inside EEZ	31 382	85 523	32 551	116 905	118 074
	b	Outside EEZ	34	2 938	3 416	2 972	6 354
		Total	31 416	88 461	35 967	119 877	124 428
58.5.2	b	Inside EEZ (Australia)	10 960	81 827	28 196	92 787	110 023
	a	Outside EEZ (Australia)	14	629	454	643	1 083
		Total	10 974	82 456	28 650	93 430	111 106

continued ...

Table 15 (continued)

Subarea/ Division	Map Ref.	Region	Depth Range (m)			Fishing Depth Range (m)	
			500–600	600–1 500	1 500–1 800	500–1 500	600–1 800
58.6	b	Delcano Rise West (40–43.3°S, outside EEZ)	169	3 942	6 316	4 111	10 258
	a	Delcano Rise West (40–43.3°S, inside EEZ)	245	6 345	5 700	6 590	12 045
	c	Delcano Rise East (43.3–48°S, outside EEZ)	0	4 508	12 997	4 508	17 505
	d	Delcano Rise East (43.3–48°S, inside EEZ)	0	1 720	11 655	1 720	13 375
	f	Crozet Islands (outside EEZ)	0	0	0	0	0
	e	Crozet Islands (inside EEZ)	1 550	13 041	5 071	14 591	18 112
	a b	Delcano Rise West (40–43.3°S, total area)	414	10 287	12 016	10 701	22 303
	c d	Delcano Rise East (43.3–48°S, total area)	0	6 228	24 652	6 228	30 880
	e f	Crozet Islands (total area)	1 550	13 041	5 071	14 591	18 112
		Total	1 964	29 556	41 739	31 520	71 295
58.7	a	SW Indian Rise (outside EEZ)	0	76	427	76	503
	b	SW Indian Rise (inside EEZ)	34	3 121	3 089	3 155	6 210
	c	Prince Edward and Marion Islands (outside EEZ)	0	0	0	0	0
	d	Prince Edward and Marion Islands (inside EEZ)	239	3 426	2 516	3 665	5 942
	a b	Southwest Indian Rise (total area)	34	3 197	3 516	3 231	6 713
	c d	Prince Edward and Marion Islands (total area)	239	3 426	2 516	3 665	5 942
			Total	273	6 623	6 032	6 896
88.1		Coast (south of 72°S – from WG-FSA-98/50)	99 288	112 040	10 623	211 328	122 663
		Coast (65–72°S)	12 923	66 577	21 380	79 500	87 957
	a	Coast (65°S to edge of permanent ice)	112 211	178 617	32 003	290 828	210 620
	c	Balleny Is	308	7 372	5 210	7 680	12 582
	b	East of Balleny Is (and 65–70°S)	132	1 851	2 016	1 983	3 867
	d	North of 65°S	0	3 168	7 670	3 168	10 838
			Total	112 651	191 008	46 899	303 659

Table 16: Notifications for new and exploratory fisheries for *Dissostichus* spp. during 1998/99.

Gear	Subarea/Division	New	Exploratory
Longline:	48.6	South Africa*	
	58.4.3	France	
	58.4.4	France, Spain, South Africa*, Uruguay	
	58.6	France	South Africa*
	58.7	France	South Africa*
	88.1		New Zealand*
Trawl:	58.4.1		Australia*
	58.4.3		Australia*
	58.4.4	France	
	58.6	France	

* Denotes fisheries for both *D. eleginoides* and *D. mawsoni*

Table 17: Parameters input to the GYM for evaluation of precautionary yield of *D. eleginoides* for longline fisheries in Subarea 48.3 and a trawl fishery in Division 58.5.2.

Category	Parameter	Subarea 48.3 Longline	Division 58.5.2 Trawl
Ages	Recruitment	4	4
	Plus class accumulation	35	35
	Oldest in initial age structure	55	55
Resolution	Increments per year	365	365
Natural mortality	Mean annual M	0.16	0.12–0.20
Fishing mortality	Length selection (lr50)		
	Range of recruitment Age selection function Age (selectivity)	0.(0.), 5.27(0.0), 5.28(1.0), 16.27(1.0), 16.28(0.)	0.(0.), 3.(0.), 3.5(0.07), 4.5(0.311), 5.5(0.699), 6.5(1.0), 7.5(1.038), 8.5(0.849), 9.5(0.579), 10.5(0.341), 11.5(0.179), 12.5(0.085), 13.5(0.037), 14.5(0.015), 15.(0.)
von Bertalanffy growth	Upper bound annual F	5	5
	Tolerance (error) for F	1E-05	1E-05
Weight–length ($W = aL^b$)	Birthday	01 November	01 November
	Time 0	0	0
	L	170.8 cm	170.8 cm
	K	0.088	0.088
Spawning biomass	a	2.5E-05	2.5E-05
	b	2.8	2.8
Recruitment	Maturity ogive – Lm50	93 cm	
	Range: 0–full maturity Maturity at age	78–108 cm	0.(0.), 1.39(0.0002), 2.32(0.0009), 3.10(0.0027), 4.13(0.0096), 4.82(0.0213), 5.76(0.0564), 6.56(0.117), 7.67(0.270), 8.45(0.418), 9.49(0.617), 10.7(0.792), 11.59(0.871), 12.58(0.924), 14.07(0.964), 16.08(0.985), 18.9(0.995), 21.48(1.0)
Simulation details	Spawning season	1 August – 1 August	1 July – 1 July
	Mean log _e (recruits)	14.219	14.585
	SE of mean of log _e (recruits)	0.194	0.159
Simulation details	SD log _e (recruits)	0.698	0.422
	Trials per test	1 001	1 001
	Years before start	1	1
	Year prior to first catch	1989	1996
	Known catch vector (tonnes)	8 501, 4 206, 7 309, 5 589, 6 605, 6 171, 4 362, 2 619, 3 328	18 960, 7 200
	Years to project stock	35	35
	Seed	-24 189	-24 189
	Depletion level	0.2	0.2

Table 18: Parameter sets used to run the GYM for new and exploratory fisheries.

Subarea/Division	Fishing Method	Parameters for <i>D. eleginoides</i>	Parameters for <i>D. mawsoni</i>
48.6	Longline	Table 17, Column 3	Table 24, Column 5
58.4.1 BANZARE Bank	Trawl	Table 17, Column 4	
58.4.3	Longline Trawl	Table 17, Column 3 Table 17, Column 4	
58.4.4	Longline Trawl	Table 17, Column 3 Table 17, Column 4	
58.6	Longline Trawl	Table 17, Column 3 Table 17, Column 4	
58.7	Longline Trawl	Table 17, Column 3 Table 17, Column 4	
88.1	Longline	Table 17, Column 3	Table 24, Column 5

Table 19: Results of the GYM runs for *D. eleginoides* in Subarea 48.3, Division 58.5.2, Subarea 58.7 and Division 58.5.1 and for areas for which notification was received for new and/or exploratory fisheries for *Dissostichus* spp. These results use the new seabed areas in Table 15. E – *D. eleginoides*, M – *D. mawsoni*.

Subarea/Division	Fishing Method	Species	Seabed Areas	Catch History			Recruitments ²		Yield Estimates		Outside EEZ	
				1996	1997	1998	Longline	Pooled	Escapement	Depletion	Escapement	Depletion
48.3	Longline	E	66 633	see Table 17			14.219		3 753	3 548		
58.5.2	Trawl	E	93 430	see Table 17			14.585		3 692	4 044		
58.5.1	Longline	E	124 428	see Table 24			14.844		6 900	6 990		
58.6	Longline	E	71 295	9 531	19 233	1 994	14.287		8 766	10 000	3 414	3 894
58.6	Trawl		31 520				13.498		2 342	2 398	640	656
58.7	Longline	E	12 655	6 137	6 951	1 574	12.558		1 520	1 600	60	64
58.7	Trawl		6 896				11.979		491	405	5	4
88.1 North of 65°S	Longline	E	10 838				12.403		600	645		
88.1 South of 65°S	Longline	M	227 069			39	15.445		6 602	11 283		
Pooled 1	Longline	E	202 824 ¹				15.332	1	11 170	15 055		
48.6 North of 60°S	Longline	E	28 070					1	1 546	2 084		
58.4.3	Longline	E	96 844					1	5 333	7 188	5 165	6 962
58.4.4	Longline	E	22 743					1	1 253	1 688		
Pooled 2	Trawl		80 606				14.437	2	3 246	3 600		
58.4.1	Trawl		14 401					2	580	643		
58.4.3	Trawl		48 897					2	1 969	2 184	1 969	2 184
58.4.4	Trawl		17 308					2	697	773		
Pooled 3	Longline	M	332 123 ¹				15.825	3	9 612	13 088		
48.6 South of 60°S	Longline	M	56 146					3	1 625	2 213		

¹ Other areas were included in these runs but only the estimates pertinent to new and exploratory fisheries are presented in this table.

² Mean of log_e recruitment function

Table 20: Discounted yields for new and exploratory fisheries – 0.45 was applied to estimates of yield for *D. eleginoides* and 0.3 to estimates for *D. mawsoni* contained in Table 19.

Subarea/Division	Fishing Method	<i>D. eleginoides</i>		<i>D. mawsoni</i> 0.30
		Total Area 0.45	Outside EEZ 0.45	
48.6 North of 60°S 48.6 South of 60°S	Longline Longline	696		487
58.4.1 BANZARE Bank	Trawl	261		
58.4.3	Longline	2 400	2 324	
58.4.3	Trawl	886	886	
58.4.4	Longline	564		
58.4.4	Trawl	314		
58.6	Longline	3 945*	1 536	
58.6	Trawl	1 054*	288	
58.7	Longline	684*	27	
58.7	Trawl	182*	2	
88.1 North of 65°S 88.1 South of 65°S	Longline Longline	270		1 981

* These yields do not apply to the current notifications for new and exploratory fisheries.

Table 21: CPUE data to be submitted to the Secretariat.

Time	Estimated Catch	C2 Data	% of Catch Reported as C2
March 1997	313 525	325 025	104
April 1997	627 731	559 562	89
May 1997	706 690	736 697	104
June 1997	798 449	736 638	92
July 1997	855 760	782 725.7	91
August 1997	636 569	597 278	94
April 1998	550 242	382 102	69
May 1998	764 472	449 569.5	59
June 1998	455 933	235 651	52
July 1998	872 526	228 892	26
August 1998	684 621	167 274	24

Table 22: Percentage of longline hauls with zero catches for *D. eleginoides* from Subarea 48.3.

Winter Season	No. of Vessels	Mean % Hauls with Catch = 0
1992	2	9.28
1993		
1994	1	3.03
1995	2	5.12
1996	7	3.13
1997	7	2.74
1998	5	2.96

Table 23: Percentages of trawl hauls with small catches of *D. eleginoides* from Division 58.5.1.

Year	Total % Hauls with Catch = 0	Total % Hauls with Catch < 0.5 tonnes
1990	0.00	5.75
1991	0.00	4.44
1992	0.00	2.01
1993	0.00	4.59
1994	0.56	5.38
1995	1.59	7.38
1996	2.35	7.18
1997	1.93	8.06
1998	2.54	9.92

Table 24: Parameters input to the GYM for evaluation of long-term annual yield of *D. eleginoides* for longline fisheries in Subarea 58.7 and Division 58.5.1 and *D. mawsoni* for longline fisheries in Subarea 88.1. Parameters are mostly based on Subarea 48.3 (see text for details), except for maturity, length and weight at age, spawning and fishing selectivity in Subarea 58.7.

Category	Parameter	Subarea 58.7 <i>D. eleginoides</i> Longline	Division 58.5.1 <i>D. eleginoides</i> Longline	Subarea 88.1 <i>D. mawsoni</i> Longline
Ages	Recruitment	4	4	4
	Plus class accumulation	35	35	35
	Oldest in initial age structure	55	55	55
Resolution	Increments per year	365	365	365
Natural mortality	Mean annual M	0.16	0.16	0.16
Fishing mortality	Length selection (lr50)	65 cm		
	Range of recruitment	60–70 cm		
	Age selection function		0.(0.), 5.27(0.0), 5.28(1.0), 16.27(1.0), 16.28(0.)	0.(0.), 5.27(0.0), 5.28(1.0), 16.27(1.0), 16.28(0.)
	Age (selectivity)			
von Bertalanffy growth	Upper bound annual F	5	5	5
	Tolerance (error) for F	1E-05	1E-05	1E-05
von Bertalanffy growth	Birthday	01 Nov	01 Nov	01 Nov
	Time 0	0	0	0
	L	210.0 cm	170.8 cm	185.2 cm
	K	0.088	0.088	0.056
Weight-length (W = aL ^b)	a	1.E-05	2.5E-05	4.0E-06
	b	3.0021	2.8	3.2413
Spawning biomass	Maturity ogive – L _{m50}	85 cm	93 cm	100 cm
	Range: 0–full maturity	70–100 cm	78–108 cm	95–105 cm
	Maturity at age			
	Spawning season	1 Aug – 1 Aug	1 Aug – 1 Aug	1 Aug – 1 Aug
Recruitment	Mean log _e (recruits)	12.558	14.8435	15.4450
	SE of mean of log _e (recruits)	0	0	0
	SD log _e (recruits)	0.698	0.698	0.698
Simulation details	Trials per test	1 001	1 001	1 001
	Years before start	1	1	1
	Year prior to first catch	1995	1979	1979
	Known catch vector (tonnes)	6137, 6951, 1574	167, 28, 124, 118, 2219, 4975, 1415, 2378, 35, 1557, 1760, 2516, 8250, 2944, 5772, 5588, 5709, 12180, 16560	39
	Years to project stock	35	35	35
	Seed	-24 189	-24 189	-24 189
	Depletion level	0.2	0.2	0.2

Table 25: Parameters input to the short-term yield calculations for *C. gunnari* in Subarea 48.3 and Division 58.5.2.

Category	Parameter	Subarea 48.3		Division 58.5.2	
Survey	Date (days since birthday)	29 September 1997 (29)		1 June 1998 (213)	
	Biomass – lower one-sided 95% confidence bound	31 563 tonnes		10 462 tonnes	
Age structure	Estimated numbers at age	2	1.194 10 ⁸	2	4.882 10 ⁵
		3	1.284 10 ⁸	3	2.532 10 ⁷
		4	2.332 10 ⁷	4	2.880 10 ⁷
		5	9.192 10 ⁶	5	6.561 10 ⁵
		6	9.369 10 ⁵		
Natural mortality	Mean annual M	0.42		0.4	
Fishing mortality	Age when fully recruited to fishery	3.0		3.0	
	Age when selection to fishery begins (ramps linearly to full selection)	2.5		2.5	
von Bertalanffy growth	Birthday	01 September		01 September	
	Time 0	0		0.234	
	L	455.0 mm		411.0 mm	
	K	0.332		0.410	
Weight-length (W = aL ^b)	a (kg)	6.172 10 ⁻¹⁰		2.629 10 ⁻¹⁰	
	b	3.388		3.515	
Projection	Days of known catch since survey (until 1 November in current year)	426		152	
	Catch since survey	0 tonnes		100 tonnes	

Table 26: Abundance estimates and confidence intervals for icefish from the Heard Island survey from May to June 1998 for the Heard Island Plateau population and the Shell Bank population.

Stratum	Delta Lognormal Maximum Likelihood			Sample Statistics with Bootstrap				
	Abundance (tonnes)	Std. Error	95% Confidence Interval		Abundance (tonnes)	Std. Error	95% Confidence Interval	
			Lower	Upper			Lower	Upper
Shell Bank:								
Shell inner	537.2	454.5	62.7	65 796	455.0	354.0	14.6	1 212.3
Shell outer					1.03	1.03	0.0	3.09
Shell inner/outer					456.0	355.9	15.2	1 236.9
Heard Island Plateau:								
Plateau	4 772.1	1 468.4	2 747.6	11 929	4 327.2	890.7	2 778.7	6 045.5
Gunnari Ridge	27 219	19 051	6 174	567 543	12 867.2	4 047.5	5 690.6	2 0671.1
Gunnari Ridge/ Plateau	31 991	19 107	10 517	572 313	17 194.4	4 484.4	9 460.0	26 445.7

Table 27: Estimates of total and spawning stock biomass (MT) and 95% confidence intervals for Elephant Island, the lower South Shetland Islands and combined regions from a trawl survey carried out in March 1998. Estimates were based on seabed areas presented in WG-FSA-98/14.

Species	Area	Total Biomass		Spawning Stock Biomass	
		Mean	95% CI	Mean	95% CI
<i>C. gunnari</i>	Elephant Is	2 765	(1 088–12 471)	70	(49–143)
	South Shetland Is	5 616	(2 280–40 410)	1 032	(578–3 105)
	Combined	8 166	(4 036–24 586)	676	(445–1 184)
<i>G. gibberifrons</i>	Elephant Is	10 272	(4 205–29 306)	5 080	(1689–15 943)
	South Shetland Is	20 283	(6 732–136 452)	2 169	(679–7 489)
	Combined	38 709	(17 882–119 902)	12 359	(4 949–27 077)
<i>C. aceratus</i>	Elephant Is	965	(531–165 881)	487	(259–24 264)
	South Shetland Is	3 080	(1 171–7 636)	800	(459–1 852)
	Combined	4 440	(2 782–615 956)	1 789	(1 070–91 199)
<i>N. coriiceps</i>	Elephant Is	341	(193–1 152)	311	(157–801)
	South Shetland Is	6 674	(2 018–81 782)	5 699	(1 943–50 501)
	Combined	3 232	(1 719–9 186)	3 177	(1 626–9 650)
<i>C. rastrispinosus</i>	Elephant Is	551	(254–1 887)	288	(144–785)
	South Shetland Is	2 962	(1 541–29 302)	1 648	(986–6 571)
	Combined	3 011	(1 785–6 323)	1 598	(1 057–2 710)
<i>L. squamifrons</i>	Elephant Is	998	(233–15 189)	180	(61–794)
	South Shetland Is	1 676	(695–7 060)	281	(153–590)
	Combined	3 068	(1 289–11 579)	513	(275–1 141)
<i>N. rossii</i>	Elephant Is	78	(62–136)		
	South Shetland Is	255	(103–1 381)		
	Combined	344	(211–602)		
<i>L. larseni</i>	Elephant Is	62	(35–143)		
	South Shetland Is	164	(96–346)		
	Combined	237	(157–406)		

Table 28: Total biomass estimates (in tonnes) and their upper and lower 95% confidence intervals of finfish in the vicinity of Elephant Island in 1987, 1996 and 1998. Estimates were based on seabed areas presented in Kock and Harm (1995).

Species	1987		1996		1998	
	Mean	95% CI	Mean	95% CI	Mean	95% CI
<i>C. gunnari</i>	2 059	929–8 406	606	374–1 268	2 692	1 059–12 147
<i>N. rossii</i>	630	223–3 414	32	16–48	59	33–109
<i>G. gibberifrons</i>	21 309	10 982–45 679	5 157	2 679–212 193	10 051	4 141–26 266
<i>C. aceratus</i>	5 530	3 234–12 251	2 124	1 169–13 015	1 111	567–254 219
<i>C. rastrispinosus</i>	475	28–985	282	135–856	853	391–2 933
<i>L. larseni</i>	533	317–944	182	131–269	70	39–160
<i>L. squamifrons</i>	139	48–809	312	65–5 564	1 208	28–18 374

Table 29: Parameters input to the GYM for evaluation of precautionary yield of the by-catch species, *C. rhinoceratus* and *L. squamifrons* in Division 58.5.2.

Category	Parameter	<i>C. rhinoceratus</i>	<i>L. squamifrons</i>
Ages	Recruitment	3	4
	Plus class accumulation	12	25
	Oldest in initial age structure	20	35
Resolution	Increments per year	365	365
Natural mortality	Mean annual M	0.1–0.34	0.1–0.3
Fishing mortality	Length selection (l_{r50})	270–300 mm	170 mm
	Range of recruitment	60 mm	0 mm
	Upper bound for annual F	5	5
	Tolerance (error) for F	1E-05	1E-05
von Bertalanffy growth	Birthday	01 Jan	01 Jan
	Time 0	0	0.1075
	L	583 mm	670 mm
	K	0.163	0.078
Weight–length ($W = aL^b$)	a	5.142E-10	2.934E-9
	b	3.398	3.240
Spawning biomass	Maturity ogive – L_{m50}	350 mm	300–350 mm
	Range from 0–full maturity	280 mm	330 mm
	Maturity at age		
	Spawning season	1 Mar – 1 Mar	1 Nov – 1 Nov
Recruitment	Mean \log_e (Recruits)	14.412	13.652
	SE of mean of \log_e (recruits)	0.174	0.374
	SD \log_e (recruits)	0.549	0.991
Simulation characteristics	Trials per test	1 001	1 001
	Years before start	1	1
	Year prior to first catch	1	1
	Known catch vector (tonnes)		
	Years to project stock	20	20
	Seed	-24 189	-24 189
Decision rules	Depletion reference point	0.2	0.2

Table 30: Data on marine mammal incidental mortality and interactions with fisheries from observer reports. Nationality: CHL – Chile, GBR – United Kingdom, NZL – New Zealand, URY – Uruguay, ZAF – South Africa; Species: ANT – *Antimora rostrata*, KIW – killer whale, SEA – Antarctic fur seal, SEL – leopard seal, SLW – Weddell seal, SPW – sperm whale, TOP – *D. eleginoides*; Y – yes, N – no, - no information.

Vessel Name (Nationality)	Dates of Trips	Mammals (Species)		Observations	Fish Loss Observed (Species)
		Killed	Entangled		
Subareas 48.1, 48.2, 88.3: <i>Tierra del Fuego</i> (CHL)	9/2–23/3/98	0	0	Y	N
Subarea 48.3:					
<i>Arctic Fox</i> (ZAF)	1/5–6/7/98	0	0	Y	N
<i>Arctic Fox</i> (ZAF)	13/7–3/9/98	0	0	Y	Y (KIW) (TOP)
<i>Argos Helena</i> (GBR)	2/4–21/8/98	0	0	Y	Y (KIW) (TOP)
<i>Betanzos</i> (CHL)	25/12/97–10/1/98	0	0	Y	N
<i>Illa de Rua</i> (URY)	8/4–11/6/98	0	0	Y	Y (SPW) (KIW) (T)
<i>Illa de Rua</i> (URY)	29/6–22/8/98	0	0	Y	Y (SEA) (KIW) (TOP)
<i>Isla Camila</i> (CHL)	26/3–8/6/98	0	0	Y	Y (KIW) (TOP)
<i>Isla Camila</i> (CHL)	16/6–22/8/98	0	0	Y	Y (KIW) (TOP) (SEL)
<i>Isla Sofía</i> (CHL)	1/4–20/5/98	0	0	Y*	Y (KIW) (TOP)
<i>Isla Sofía</i> (CHL)	2/6–23/8/98	0	0	Y	Y (KIW) (TOP)
<i>Jacqueline</i> (GBR)	28/5–22/8/98	0	0	Y*	Y (KIW) (SEA) (TOP)
<i>Koryo Maru 11</i> (ZAF)	23/3–13/7/98	1 (SLW?)	0	Y	Y (KIW) (TOP)
<i>Magallanes III</i> (CHL)	7/8–18/8/98	0	0	Y	Y (SPW) (KIW) (TOP)
<i>Northern Pride</i> (ZAF)	17/4–19/6/98	0	0	Y*	Y (SPW) (KIW) (TOP)
<i>Northern Pride</i> (ZAF)	2/7–26/8/98	0	0	Y	N
<i>Sudur Havid</i> (ZAF)	6/4–6/6/98*	0	0	Y	Y (KIW) (TOP)
<i>Tierra del Fuego</i> (CHL)	25/3–8/6/98	0	0	Y	Y (KIW) (TOP)
<i>Tierra del Fuego</i> (CHL)	17/6–7/8/98	0	0	Y	Y (KIW) (SEA) (SEL) (TOP)
Subareas 58.6, 58.7:					
<i>Aquatic Pioneer</i> (ZAF)	9/11/97–16/1/98	0	0	Y	Y (KIW) (TOP)
<i>Aquatic Pioneer</i> (ZAF)	26/1–19/3/98	0	0	Y	Y (KIW) (TOP)
<i>Aquatic Pioneer</i> (ZAF)	26/3–22/5/98	0	0	Y	Y (KIW) (TOP)
<i>Aquatic Pioneer</i> (ZAF)	17/7–1/8/98	0	0	Y	Y (KIW) (TOP)
<i>Koryo Maru 11</i> (ZAF)	9/11/97–21/1/98	0	0	Y	Y (KIW) (TOP) (ANT)
<i>Koryo Maru 11</i> (ZAF)	29/1–16/3/98	0	0	Y	Y (KIW) (TOP)
<i>Eldfisk</i> (ZAF)	10/1–10/2/98	0	0	Y	N
<i>Eldfisk</i> (ZAF)	26/2–23/4/98	0	0	Y*	-
Subarea 88.1:					
<i>Lord Auckland</i> (NZL)	21/2–26/3/98	0	0	Y	

* Quantitative information available

Table 31: Incidental mortality of seabirds in the longline fisheries for *D. eleginoides* in Subarea 58.7 during the 1996/97 season. Fishing method: A – autoliner, Sp – Spanish; Offal discharge at haul: O – opposite side to hauling, S – same side as hauling; D – daytime setting (including nautical dawn and dusk), N – night-time setting.

Vessel Name	Dates of Fishing	Fishing Method	Streamer Line in Use (%)		Offal Discharge at Haul	Sets Deployed				Number of Hooks (1 000s)					Hooks Baited (%)	Number of Birds Observed Dead			Observed Catch Rates of Dead Birds (birds/1 000 hooks)		
										Observed			Set Total	% Observed		N	D	Total	N	D	Total
						N	D	Total	%N	N	D	Total									
<i>Aliza Glacial</i> *	7/12/96–7/1/97	A			O	29	122	151	19				106.7		1	9	10				
<i>Aquatic Pioneer</i> *	31/10–10/12/96	A			O	25	76	101	24				287.1				137				
<i>Aquatic Pioneer</i>	13/1–22/2/97	A	100	100	O	61	21	82	74	214	73	287	287	100	337	78	415	1.57	1.07	1.45	
<i>Aquatic Pioneer</i>	26/4–11/6/97	A	11	71	O	88	21	109	81	313	75.5	388.5	388.5	100	80	4	4	0	0.05	0.01	
<i>Aquatic Pioneer</i>	22/7–22/8/97	A	7	62	O	38	16	54	70	63.6	26.9	90.5	205.5	44	60	1	1	0	0.04	0.01	
<i>Garoya</i>	5/4–10/5/97	Sp	29	65	O	17	29	46	36	8.6	14.3	22.9	147.1	15	68	37	43	0.69	2.59	1.88	
<i>Koryo Maru 11</i> *	10/11/96–5/1/97	Sp	100	100	S	29	19	48	60				248.1		14	28	42				
<i>Koryo Maru 11</i>	17/1–22/3/97	Sp	75	93	S	8	73	81	15	29.5	207	236.5	297.9	79	100	120	130	0.34	0.58	0.55	
<i>Mr B</i>	22/10–28/11/96	A	0	0		10	35	45	22	3.9	20.6	24.5	58	42	2	9	11	0.51	0.44	0.45	
<i>Mr B</i> *	29/1–14/2/97	A	0	40		3	5	8	37				4.7		0	0	0	0	0	0	
<i>Sudur Havid</i>	15/5–16/6/97	Sp	2	89	S	47	19	66	71	37.5	16.4	53.9	281.6	19	100	3	4	0.03	0.18	0.07	
<i>Sudur Havid</i>	4/7–24/7/97	Sp	30	0	S	20	0	20	100	62.3	0	62.3	74	84	100	0	1	0.02	0	0.02	
<i>Zambezi</i> *	19/3–16/5/97	A	4	50	O	63	56	119	52				414	83	2	35	37				
<i>Zambezi</i> *	28/5–12/7/97	A			O	3	0	3	100				11.6	85	0	0	0	0	0	0	
<i>Zambezi</i> *	25/7–29/9/97	A	44	33	O	63	3	66	95				165	71							
Total						504	495	999	56				2 976.8					0.49	0.58	0.52	

* Fields missing due to incomplete logbook information

Table 32: Species composition of birds killed in longline fisheries in Subarea 58.7 during the 1996/97 season. D – daytime setting (including nautical dawn and dusk), N – night-time setting, ALZ – albatross unidentified, DCR – yellow-nosed albatross, DIC – grey-headed albatross, DIM – black-browed albatross, DIX – wandering albatross, MAH – northern giant petrel, MAI – southern giant petrel, PCI – grey petrel, PHE – light-mantled sooty albatross, PRO – white-chinned petrel, PTZ – petrels unidentified, SKZ – skuas, UNK – unknown.

Vessel Name	Dates of Fishing	Number Birds Killed by Group						Species Composition (%)													
		Petrels		Albatross		Total		DIX	DIM	DIC	DCR	PHE	ALZ	MAI	MAH	PCI	PRO	PTZ	SKZ	UNK	
		N	D	N	D	N	D														
<i>Aliza Glacial</i>	7/12/96–7/1/97	0	4	1	5	1	9			2 (20)	2 (20)		2 (20)	1 (10)						3 (30)	
<i>Aquatic Pioneer</i> *	31/10–10/12/96	112		25		137			2 (1)	15 (11)	8 (6)			3 (2)	1 (1)				108 (78)	1 (1)	
<i>Aquatic Pioneer</i>	13/1–22/2/97	336	75	0	3	336	78			2 (0.5)		1 (0.25)		6 (1)	2 (0.5)				403 (97)		1 (0.25)
<i>Aquatic Pioneer</i>	26/4–11/6/97	0	0	0	4	0	4			4 (100)											
<i>Aquatic Pioneer</i>	22/7–22/8/97	0	1	0	0	0	1							1 (100)							
<i>Garoya</i>	5/4–10/5/97	6	5	0	32	6	37	2 (5)		30 (70)				3 (7)	6 (14)	1 (2)			1 (2)		
<i>Koryo Maru 11</i>	10/11/96–5/1/97	14	13	0	15	14	28			11 (26)	4 (10)			7 (16)					20 (48)		
<i>Koryo Maru 11</i>	17/1–22/3/97	10	71	0	49	10	120							49 (38)	1 (1)				4 (3)	76 (58)	
<i>Mr B</i>	22/10–28/11/96	2	8	0	1	2	9							1 (9)		1 (9)			9 (82)		
<i>Mr B</i>	29/1–14/2/97	0	0	0	0	0	0														
<i>Sudur Havid</i>	15/5–16/6/97	1	3	0	0	1	3							3 (75)							1 (25)
<i>Sudur Havid</i>	4/7–24/7/97	1	0	0	0	1	0							1 (100)							
<i>Zambezi</i>	19/3–16/5/97	2	5	0	30	2	35		1 (3)	29 (78)				1 (3)					6 (16)		
<i>Zambezi</i>	28/5–12/7/97	0	0	0	0	0	0														
<i>Zambezi</i> *	25/7–29/9/97	0		0		0															
Total (%)		669		165		834		2 (0.2)	3 (0.4)	93 (11.1)	14 (1.7)	1 (0.1)	52 (6.2)	27 (3.2)	10 (1.2)	1 (0.1)	554 (66.3)	77 (9.2)	1 (0.1)	1 (0.1)	

* Data obtained from observer cruise report

Table 33: Estimated seabird mortality by vessel for Subarea 58.7 during the 1996/97 season.

Vessel Name	Hooks Set (1 000s)	% Night Sets	Estimated Seabird Mortality during Line Setting		
			Night	Day	Total
<i>Aliza Glacial*</i>	106.70	19.00	10	50	60
<i>Aquatic Pioneer*</i>	287.10	24.00	34	127	160
<i>Aquatic Pioneer</i>	287.00	74.00	333	80	413
<i>Aquatic Pioneer</i>	388.50	81.00	0	4	4
<i>Aquatic Pioneer</i>	205.50	70.00	0	2	2
<i>Garoya</i>	147.10	36.00	37	244	280
<i>Koryo Maru 11*</i>	248.10	60.00	73	58	130
<i>Koryo Maru 11</i>	297.90	15.00	15	147	162
<i>Mr B</i>	58.00	22.00	7	20	26
<i>Mr B*</i>	4.70	37.00	0	0	0
<i>Sudur Havid</i>	281.60	71.00	6	15	21
<i>Sudur Havid</i>	74.00	84.00	1	0	1
<i>Zambezi*</i>	414.00	52.00	105	115	220
<i>Zambezi</i>	11.60	100.00	0	0	0
<i>Zambezi*</i>	165.00	95.00	76	5	81
Total	2 976.80	56.00	696	866	1562

* Estimates are based on the total observed catch rates

Table 34: Estimated seabird mortality by species for Subarea 58.7 during the 1996/97 season.

Species	Setting		Total
	Night	Day	
Wandering albatross	2	2	4
Black-browed albatross	2	3	6
Grey-headed albatross	77	96	174
Yellow-nosed albatross	12	15	26
Light-mantled sooty albatross	1	1	2
Albatross unidentified	43	54	97
Southern giant petrel	22	28	50
Northern giant petrel	8	10	19
White-chinned petrel	461	574	1 035
Grey petrel	1	1	2
Petrels unidentified	64	80	144
Skuas unidentified	1	1	2
Unidentified	1	1	2
Total	696	866	1 562

Table 35: Incidental mortality of seabirds in the longline fisheries for *D. eleginoides* in Subareas 48.1, 48.2, 48.3, 58.6, 58.7, 88.1 and 88.3 during the 1997/98 season. Fishing method: A – autoliner; Sp – Spanish; Offal discharge at haul: O – opposite side to hauling; S – same side as hauling; D – daytime setting (including nautical dawn and dusk); N – night-time setting.

Vessel Name	Dates of Fishing	Fishing Method	Sets Deployed				No. of Hooks (1 000s)			Hooks Baited (%)	No. of Birds Caught						Observed Seabird Mortality (Birds/1 000 hooks)			Streamer Line in Use (%)		Offal Discharge at Haul
			N	D	Total	%N	Ob- served	Set	% Ob- served		Dead		Alive		Total		N	D	Total	N	D	
											N	D	N	D	N	D						
Subareas 48.1, 48.2, 88.3:																						
<i>Tierra del Fuego*</i>	9/2–23/3/98	Sp	52								0		0		0		0	0	0			
Subarea 48.3																						
<i>Arctic Fox</i>	7/5–26/6/98	Sp/A	156	3	159	98	155.4	1012.8	15	85	1	0	3	0	4	0	0.01	0	0.01	23	33	S
<i>Arctic Fox*</i>	13/7–3/9/98	Sp/A	121	0	121	100	6.9	830.4	1	85	0	0	0	0	0	0	0	0	0			S
<i>Argos Helena</i>	2/4–21/8/98	Sp	170	5	175	97	104.2	1360.1	7	100	8	1	73	7	81	8	0.08	0.18	0.09	57	20	S
<i>Illa de Rua</i>	8/4–9/6/98	Sp	75	11	86	87	458.4	977.6	46	100	0	1	0	1	0	2	0	0.02	0.002	100	100	O
<i>Illa de Rua</i>	29/6–22/8/98	Sp	68	15	83	81	466.1	806.6	57	100	0	0	5	1	5	1	0	0	0	94	100	O
<i>Isla Camila*</i>	26/3–8/6/98	Sp	90	0	90	100	317.6	654.2	49	100	2	0	0	0	2	0	0	0	0	94	100	S
<i>Isla Camila</i>	23/6–19/8/98	Sp	69	3	72	96	59.4	620.6	9	100	0	0	1	0	1	0	0	0	0	94	100	S
<i>Isla Sofia</i>	1/4–20/5/98	Sp	67	4	71	94	40.6	584.0	6	100	20	5	81	7	101	12	0.52	2.10	0.62	0	75	S
<i>Isla Sofia</i>	2/6–23/8/98	Sp	90	1	91	98	167.7	750.2	22	100	0	0	15	0	15	0	0	0	0	24	100	S
<i>Jacqueline</i>	28/5–22/8/98	Sp	81	3	84	96	276.8	841.5	32	100	0	0	3	1	3	1	0	0	0	77	100	S
<i>Koryo Maru 11</i>	3/4–29/6/98	Sp	86	1	87	99	402.0	1002.8	40	100	32	1	1	1	33	2	0.08	0.27	0.08	94	100	O
<i>Magallanes III</i>	7/8–18/8/98	Sp	49	31	80	61	12.0	573.6	2	98	0	0	2	0	2	0	0	0	0	8	90	S
<i>Northern Pride</i>	17/4–18/6/98	Sp	59	0	59	100	119.2	734.6	16	100	1	0	20	0	21	0	0.01	0.01	0.01	89	0	O
<i>Northern Pride</i>	8/7–12/8/98	A	32	4	36	89	29.2	607.5	4	100	0	0	1	0	1	0	0	0	0	96	75	O
<i>Sudur Havid*</i>	6/4–6/6/98	Sp	37				500			100	2		2								S	
<i>Tierra del Fuego</i>	1/4–2/6/98	Sp	129	24	153	84	424.0	767.0	55	100	4	4	11	4	15	8	0.01	0.05	0.02	96	95	S
<i>Tierra del Fuego</i>	17/6–7/8/98	Sp	89	21	110	80	114.5	761.3	15	100	0	0	11	1	11	1	0	0	0	5	52	S
Total			91%				13384.8										0.03	0.04	0.03			
Subareas 58.6, 58.7:																						
<i>Aquatic Pioneer*</i>	9/11/97–16/1/98	A	143				532.7			80	11		0		11		0.02					O
<i>Aquatic Pioneer*</i>	26/1–19/3/98	A	90				420.7			82	194		194		0.419					O		
<i>Aquatic Pioneer*</i>	26/3–22/5/98	A	95	0	95	100	326.6	365.2	56		1		1					100		O		
<i>Aquatic Pioneer*</i>	17/6–1/8/98	A	159				338.7			80			1							O		
<i>Eldfisk</i>	9/1–12/2/98	A	164	0	164	100	136.2	312.8	43	82	18	0	0	0	18	0	0.13	0.13	0.13	50		O
<i>Eldfisk</i>	26/2–23/4/98	A	240	0	240	100	164.0	884.0	18	85	8	0	1	0	9	0	0.05	0	0.05	84		O
<i>Koryo Maru 11*</i>	9/11/97–21/1/98	Sp	101	0	101	100	491.7	553.0	89	100	80				0.16					S		
<i>Koryo Maru 11</i>	3/2–10/3/98	Sp	57	13	70	81	434.1	434.1	100	100	104	55	11	2	115	57	0.29	0.68	0.37	85	92	O
Total			96%				3842.4										0.20	0.68	0.32			
Subarea 88.1:																						
<i>Lord Auckland</i>	21/2–25/3/98	Auto	58	24	82	71	44.2	241.0	18	74	0		0		0		0	0	0	96	100	S

* Data obtained from observer cruise report

Table 36: Species composition of birds killed in longline fisheries in Subareas 48.3, 58.6 and 58.7, and adjacent areas during the 1997/98 season. D – daytime setting (including nautical dawn and dusk), N – night-time setting, DAC – cape petrel, DIC – grey-headed albatross, DIM – black-browed albatross, DIP – royal albatross, DIX – wandering albatross, FUG – southern fulmar, MAH – northern giant petrel, MAI – southern giant petrel, PHE – light-mantled sooty albatross, PHU – sooty albatross, PRO – white-chinned petrel, PTZ – petrels unidentified, UNK – unknown.

Vessel Name	Dates of Fishing	No. Birds Killed by Group						Species Composition (%)												
		Albatross		Petrels/ Fulmars		Total		DIX	DIP	DIM	DIC	PHU	PHE	MAI	PRO	MAH	DAC	PTZ	FUG	UNK
		N	D	N	D	N	D													
Subarea 48.3:																				
<i>Arctic Fox</i>	7/5–26/6/98	0	0	1	0	1	0							1 (100)						
<i>Argos Helena</i>	2/4–21/8/98	0	1	8	0	8	1			1 (11)				8 (89)						
<i>Illa de Rua</i>	8/4–9/6/98	0	1	0	0	0	1			1 (100)										
<i>Isla Camila</i>	23/6–19/8/98	0		0		0														
<i>Isla Sofia</i>	1/4–20/5/98	1	5	19	0	20	5	1 (4)		5 (20)			1 (4)	18 (72)						
<i>Koryo Maru 11</i>	3/4–29/6/98	1	0	31	1	32	1			1 (3)				32 (97)						
<i>Northern Pride</i>	17/4–18/6/98	0	0	1	0	1	0												1 (100)	
<i>Northern Pride</i>	8/7–12/8/98	0		0		0														
<i>Tierra del Fuego</i>	1/4–2/6/98	1	0	3	4	4	4			1 (12)				7 (88)						
Total %								1 (1)		9 (12)			2 (3)	65 (83)						1 (1)
Subareas 58.6 and 58.7:																				
<i>Eldfisk</i>	9/1–12/2/98	0	0	18	0	18	0							18 (100)						
<i>Eldfisk</i>	26/2–23/4/98	0	0	8	0	8	0							8 (100)						
<i>Koryo Maru 11</i>	3/2–10/3/98	0	0	104	55	104	55							142 (89)				17 (11)		
Total %														168 (91)				17 (19)		

Table 37: Estimated seabird mortality by vessel for Subarea 48.3 during the 1997/98 season.

Vessel Name	Hooks Set (1 000s)	% Night Sets	Estimated Seabird Mortality during Line Setting		
			Night	Day	Total
<i>Arctic Fox</i>	1 012.80	98.00	10	0	10
<i>Arctic Fox*</i>	830.40	100.00	20	0	20
<i>Argos Helena</i>	1 360.10	96.00	104	10	114
<i>Illa de Rua</i>	977.60	87.00	0	3	3
<i>Illa de Rua</i>	806.60	100.00	0	0	0
<i>Isla Camila</i>	620.60	96.00	0	0	0
<i>Isla Camila*</i>	654.20	100.00	15	0	15
<i>Isla Sofía</i>	584.00	94.00	285	74	359
<i>Isla Sofía</i>	750.20	100.00	0	0	0
<i>Jacqueline</i>	841.50	100.00	0	0	0
<i>Koryo Maru 11</i>	1 002.80	99.00	79	3	82
<i>Magallanes III</i>	573.60	98.00	0	0	0
<i>Northern Pride</i>	734.60	100.00	7	0	7
<i>Northern Pride</i>	607.50	89.00	0	0	0
<i>Sudur Havid*</i>	500.00	95.77	11	1	12
<i>Tierra del Fuego</i>	761.30	100.00	0	0	0
<i>Tierra del Fuego</i>	767.00	84.00	6	6	13
Total	13 384.80	96.00	544	96	640

* Estimates are based on the total observed catch rates

Table 38: Fishing cruises for *D. eleginoides* to the Prince Edward Islands EEZ (Subareas 58.6 and 58.7) from July 1997 to June 1998, reporting fishing effort, proportion of daytime sets, numbers of birds caught and bird by-catch rates. Data from WG-FSA-98/42. A – autoliner, Sp – Spanish.

Vessel Name	Fishing Method	Dates of Fishing	No. of Sets	No. of Hooks	% of Sets during the Day ¹	Number of Birds Killed	By-catch Rate (birds/1 000 hooks)
<i>Aquatic Pioneer</i>	A	15/11/97–9/1/98	143	533 205	18.2	11	0.021
<i>Aquatic Pioneer</i>	A	1/2–12/3/98	90	420 710	5.6	192	0.456
<i>Aquatic Pioneer</i>	A	1/4–14/5/98	95	341 560	15.8	0	0.000
<i>Aquatic Pioneer</i>	A	28/7–22/8/97	54	212 500	31.5	1	0.005
<i>Eldfisk</i>	A	9/1–13/2/98	164	496 181	5.5	38	0.077
<i>Eldfisk</i>	A	3/3–17/4/98	240	889 360	3.8	13	0.015
<i>Koryo Maru II</i>	Sp	19/11/97–15/1/98	101	533 002	55.4 ²	81	0.152
<i>Koryo Maru II</i>	Sp	3/2–10/3/98	70	434 100	20.0 ²	161	0.371
<i>Sudurhavid</i>	Sp	9–16/7/97	20	74 000	0.0	1	0.014
<i>Zambezi</i>	A	3–6/7/97	10	38 307	10.0	0	0.000
<i>Zambezi</i>	A	30/7–22/8/97	79	300 000	10.1	0	0.000
Total			1 066	4 272 925	15.0	498	0.117

¹ Defined as per CCAMLR regulations in terms of nautical twilight, with sets that spanned the twilight period being considered daylight sets.

² The proportion of daytime sets for the *Koryo Maru II* may have been overestimated because of slow setting speeds relative to single-line vessels.

Table 39: Seabirds killed in the longline fishery for *D. eleginoides* within the Prince Edward Islands EEZ (Subareas 58.6 and 58.7) during 1997/98, reported by fishery observers (see Table 35). Data from WG-FSA-98/42.

Species		n	%	By-catch Rate (birds/1 000 hooks)
White-chinned petrel	<i>Procellaria aequinoctialis</i>	476	95.6	0.111
Giant petrels	<i>Macronectes</i> spp.*	15	3.0	0.004
Crested penguins	<i>Eudyptes</i> spp.	4	0.8	0.001
Yellow-nosed albatross	<i>Thalassarche chlororhynchos</i>	3	0.6	0.001

* Both southern *M. giganteus* and northern *M. halli* giant petrels were reported, but species identifications are not all reliable.

Table 40: Summary of compliance in streamer line minimum specifications with Conservation Measure 29/XVI. Nationality: CHL – Chile, GBR – United Kingdom, NZL – New Zealand, URY – Uruguay, ZAF – South Africa; Fishing Method: A – autoliner, Sp – Spanish; Y – Yes, N – No, - no information.

Vessel Name (Nationality)	Fishing Method	Dates of Trips	Streamer Line Complied with CCAMLR Specifications (Y/N)	Compliance with Details of Streamer Line Specifications					Spare Streamer Line Material on Board (Y/N)
				Height Above Water of Attachment Point (m)	Total Length (m)	No. of Streamers per Line	Spacings of Streamers per Line (m)	Length of Streamers	
Subareas 48.1, 48.2, 88.3: <i>Tierra del Fuego</i> (CHL)	Sp	9/2–23/3/98	N	Y (11)	N (95)	Y (12)	N (6)	N	-
Subarea 48.3:									
<i>Arctic Fox</i> (ZAF)	A	13/7–3/9/98	No streamer line	nil	nil	nil	nil	nil	nil
<i>Arctic Fox</i> (ZAF)	A	1/5–6/7/98	N	Y (4)	N (50)	-	-	-	-
<i>Argos Helena</i> (GBR)	Sp	2/4–21/8/98	N	Y (5)	Y (150)	Y (7)	Y (5)	N	Y
<i>Illa de Rua</i> (URY)	Sp	8/4–11/6/98	Y	Y (4.5)	Y (160)	Y (5–7)	Y (5)	Y	-
<i>Illa de Rua</i> (URY)	Sp	29/6–22/8/98	Y	Y (4)	Y (150)	Y (5)	Y (5)	Y	Y
<i>Isla Camila</i> (CHL)	Sp	26/3–8/6/98	N	Y (>4.5)	-	-	Y (4)	Y	-
<i>Isla Camila</i> (CHL)	Sp	16/6–22/8/98	N	Y (8)	N (80)	-	-	N	Y
<i>Isla Sofía</i> (CHL)	Sp	1/4–20/5/98	N	N (3.95)	N (90)	Y (12)	Y (0.9–2.3)	N	-
<i>Isla Sofía</i> (CHL)	Sp	2/6–23/8/98	N	Y (4.89)	N (101)	Y (27)	Y (1.73–4.8)	Y	-
<i>Jacqueline</i> (GBR)	Sp	28/5–22/8/98	N	Y (5.5)	N (75)	Y (8–10)	Y (2.5)	N	Y
<i>Koryo Maru 11</i> (ZAF)	Sp	23/3–13/7/98	N	Y (5.2)	N (60)	Y (8)	Y (2.8–5.9)	Y	-
<i>Magallanes III</i> (CHL)	Sp	7/8–18/8/98	N	Y (4)	N (50)	Y (6–8)	Y (1–2)	N	-
<i>Northern Pride</i> (ZAF)	Sp	17/4–19/6/98	N	Y (6)	N (30)	Y (8)	Y (3)	N	-
<i>Northern Pride</i> (ZAF)	Sp	2/7–26/8/98	N	Y (5)	N (50)	Y (12)	Y (2)	Y	-
<i>Sudur Havid</i> (ZAF)	Sp	6/4–6/6/98	N	N (2)	N (30)	-	Y (2)	N	-
<i>Tierra del Fuego</i> (CHL)	Sp	25/3–8/6/98	N	Y (4)	Y (150)	Y (18)	Y (2)	N	-
<i>Tierra del Fuego</i> (CHL)	Sp	17/6–7/8/98	N	Y (4)	N (75)	Y (25)	Y (3)	N	-
Subareas 58.6, 58.7:									
<i>Aquatic Pioneer</i> (ZAF)	A	9/11/97–16/1/98	Y	Y (>4.5)	-	-	-	-	Y
<i>Aquatic Pioneer</i> (ZAF)	A	26/1–19/3/98	Y	-	-	-	-	-	-
<i>Aquatic Pioneer</i> (ZAF)	A	26/3–22/5/98	Y	-	N (80)	Y (6)	-	N	Y
<i>Aquatic Pioneer</i> (ZAF)	A	17/7–1/8/98	Y	Y (4.5)	Y (100–150)	Y (6–9)	Y (2.5)	-	Y
<i>Eldfisk</i> (ZAF)	A	10/1–10/2/98	Y	Y (4–5)	Y (150)	Y (5)	Y (5)	Y	Y
<i>Eldfisk</i> (ZAF)	A	26/2–23/4/98	N	Y (8)	N (80)	Y (6)	N (10)	-	-
<i>Koryo Maru 11</i> (ZAF)	Sp	9/11/97–21/1/98	-	-	-	Y (2)	-	-	-
<i>Koryo Maru 11</i> (ZAF)	Sp	29/1–16/3/98	Y	Y (6)	N (125)	Y (6)	Y (2.5)	Y	-
Subarea 88.1:									
<i>Lord Auckland</i> (NZL)	A	21/2–26/3/98	Y	Y (8)	Y (200)	Y (6)	Y (3)	Y	-

Table 41: Estimate of seabird by-catch in the unregulated *Dissostichus* spp. fishery in Subareas 58.6 and 58.7 and Divisions 58.5.1 and 58.5.2 in 1997/98. S – summer, W – winter.

Subarea/ Division	Total Unregulated Catch (tonnes)	Split S:W		Unregulated Catch (tonnes)		<i>Dissostichus</i> spp. Catch Rate (kg/hooks)	Unregulated Effort (1 000 hooks)		Seabird By-catch Rate (birds/1 000 hooks)				Estimated Total Unregulated Seabird By-catch			
		S	W	S	W		S	W	Mean		Max		Mean		Max	
									S	W	S	W	S	W	S	W
58.6, 58.7	2 690	80	20	2 152	538	0.2	10 760	2 690	1.049	0.017	1.88	0.07	11 287	46	20 229	188
58.6, 58.7	2 690	70	30	1 883	807	0.2	9 415	4 035	1.049	0.017	1.88	0.07	9 876	69	17 700	282
58.6, 58.7	2 690	60	40	1 614	1 076	0.2	8 070	5 380	1.049	0.017	1.88	0.07	8 465	91	15 172	377
58.5.1, 58.5.2	18 825	80	20	15 060	3 765	0.35	43 029	10 757	1.049	0.017	1.88	0.07	45 137	183	80 894	753
58.5.1, 58.5.2	18 825	70	30	13 178	5 648	0.35	37 650	16 136	1.049	0.017	1.88	0.07	39 495	274	70 782	1 130
58.5.1, 58.5.2	18 825	60	40	11 295	7 530	0.35	32 271	21 514	1.049	0.017	1.88	0.07	33 853	366	60 670	1 506

Table 42: Estimates of potential seabird by-catch in unregulated longline fishing in the Convention Area in 1998.

Subarea/ Division	Potential By-catch Level	Summer	Winter	Total
58.6, 58.7	Lower	8 500–11 000	100–50	8 600–11 050
	Higher	15 000–20 000	400–200	15 400–20 200
58.5.1, 58.5.2	Lower	34 000–45 000	350–200	34 350–45 200
	Higher	60 000–80 000	1 500–1 000	61 500–81 000
Total	Lower	42 500–56 000	450–250	43 000–56 000*
	Higher	75 000–100 000	1 900–1 200	77 000–101 000*

* Rounded to nearest thousand birds

Table 43: Seabird by-catch rates calculated from observer data for domestic owned and operated vessels operating in the tuna longline fishery in New Zealand waters, 1990/91 to 1996/97. Data from WG-FSA-98/25.

Fishing Year	Total No. Hooks*	% Hooks Observed	No. Birds Observed Caught	Birds/ 1 000 Hooks	Standard Error
Northern area:					
1990/91	5 730	0.0	-	-	-
1991/92	279 988	7.0	3	0.133	0.094
1992/93	788 713	0.0	-	-	-
1993/94	1 256 075	0.0	-	-	-
1994/95	1 334 483	4.9	8	0.128	0.057
1995/96	1 531 056	4.2	23	0.400	0.091
1996/97	1 453 929	5.5	82	1.104	0.198
Southern area:					
1990/91	7 340	0.0	-	-	-
1991/92	22 660	0.0	-	-	-
1992/93	52 370	0.0	-	-	-
1993/94	152 665	1.6	0	0.000	-
1994/95	789 530	11.0	14	0.159	0.058
1995/96	508 117	19.4	9	0.085	0.032
1996/97	342 547	40.0	4	0.034	0.020

* The total number of hooks do not include 148 160 hooks set during the years 1991/92 to 1996/97 which have invalid longitude values; most of these hooks were set in the northern area.

Table 44: Numbers of seabirds landed dead and returned for identification (699 birds in total), by species and area, for the licensed Japanese, chartered Japanese and New Zealand domestic owned and operated fleets, in tuna longline fisheries in New Zealand waters for 1988/89 to 1996/97. Data from WG-FSA-98/25.

Seabird Species		Number of Birds Returned for Identification						
		Japanese Licensed Vessels		Chartered Japanese Vessels		Domestic NZ Vessels		% Total
		Northern	Southern	Northern	Southern	Northern	Southern	
Albatross species:								
NZ white-capped albatross	<i>Diomedea cauta steadi</i>	1	5	6	89	1		15
NZ black-browed albatross	<i>Diomedea melanophrys impavida</i>	16	6	47	8	1	1	11
Antipodes I. wandering albatross	<i>Diomedea exulans antipodensis</i>	7		33	20			9
Southern Buller's albatross	<i>Diomedea bulleri bulleri</i>		17		33		3	8
Auckland I. wandering albatross	<i>Diomedea exulans gibsoni</i>	10		15	5		2	5
Southern black-browed albatross	<i>Diomedea melanophrys melanophrys</i>	11		17	1	1		4
Wandering albatross	<i>Diomedea exulans</i>	3	3		7			2
Salvin's albatross	<i>Diomedea salvini</i>	3		9				2
Southern royal albatross	<i>Diomedea epomophora epomophora</i>		3		6			1
Grey-headed albatross	<i>Diomedea chrysostoma</i>	1	5					1
Northern royal albatross	<i>Diomedea sanfordi</i>			1	1			<1
Snowy wandering albatross	<i>Diomedea exulans exulans</i>			1	1			<1
Chatham Is. albatross	<i>Diomedea cauta eremita</i>			1				<1
Light-mantled sooty albatross	<i>Phoebetria palpebrata</i>				39			6
Petrel species:								
Grey petrel	<i>Procellaria cinerea</i>	118	1	56	10	4		27
White-chinned petrel	<i>Procellaria aequinoctialis steadi</i>		2		47			7
Black petrel	<i>Procellaria parkinsoni</i>					4		1
Westland petrel	<i>Procellaria westlandica</i>		1					<1
Flesh-footed shearwater	<i>Puffinus carneipes</i>					6		1
Sooty shearwater	<i>Puffinus griseus</i>				3			<1
Northern giant petrel	<i>Macronectes halli</i>			5	1			1
Southern giant petrel	<i>Macronectes giganteus</i>	2						<1
Total of all seabird species		172	42	191	271	17	6	100

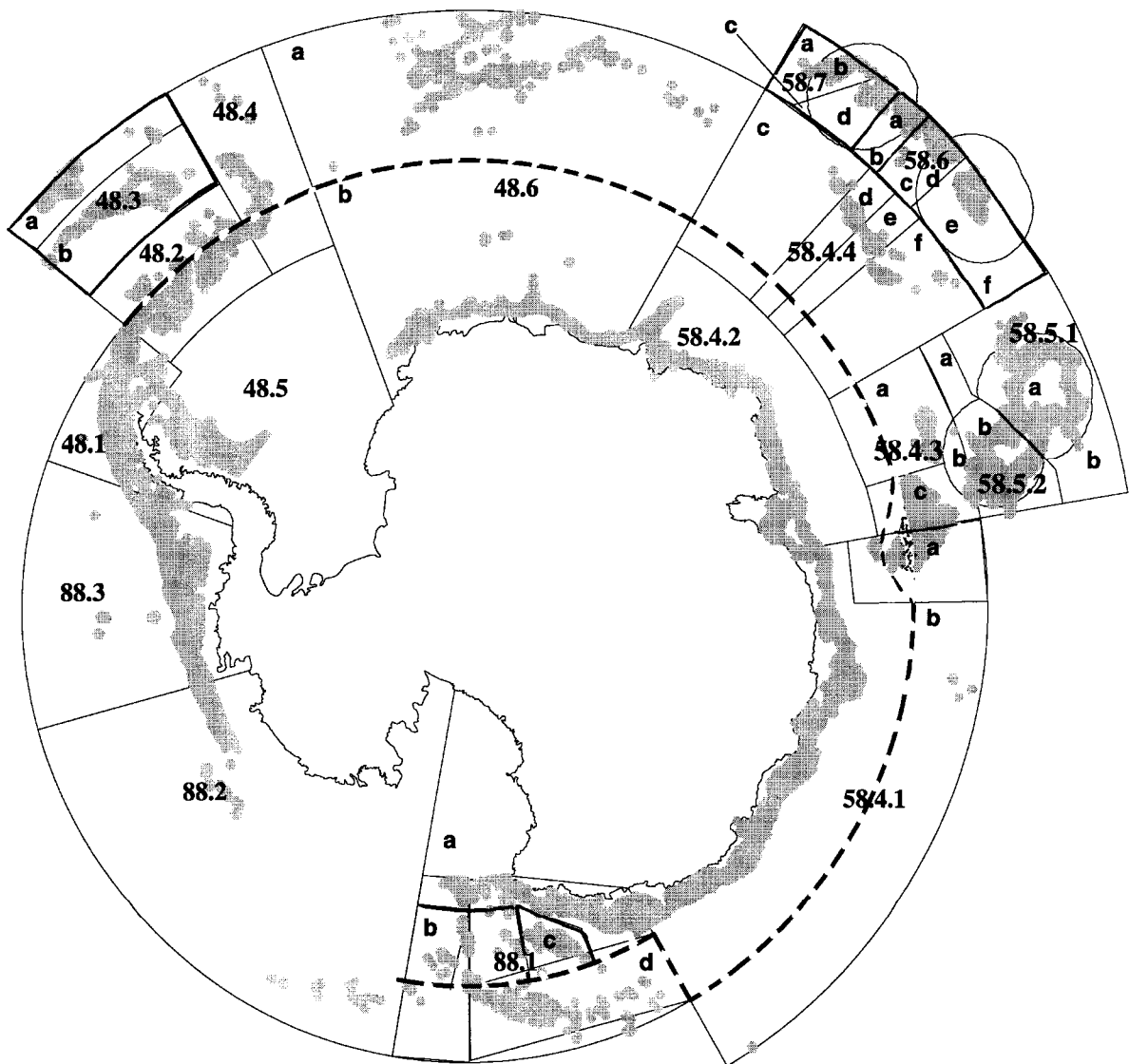


Figure 1: Delineation between *D. eleginoides* and *D. mawsoni* (dashed line), and bathymetric regions used in the analysis of catch limits for new and exploratory fisheries. The shaded patches represent seabed areas between 500 and 1 800 m. Corresponding seabed areas are given in Table 15. EEZ boundaries for Australia, France and South Africa are marked in order to address the new fisheries notified by France and the exploratory fishery notified by South Africa.

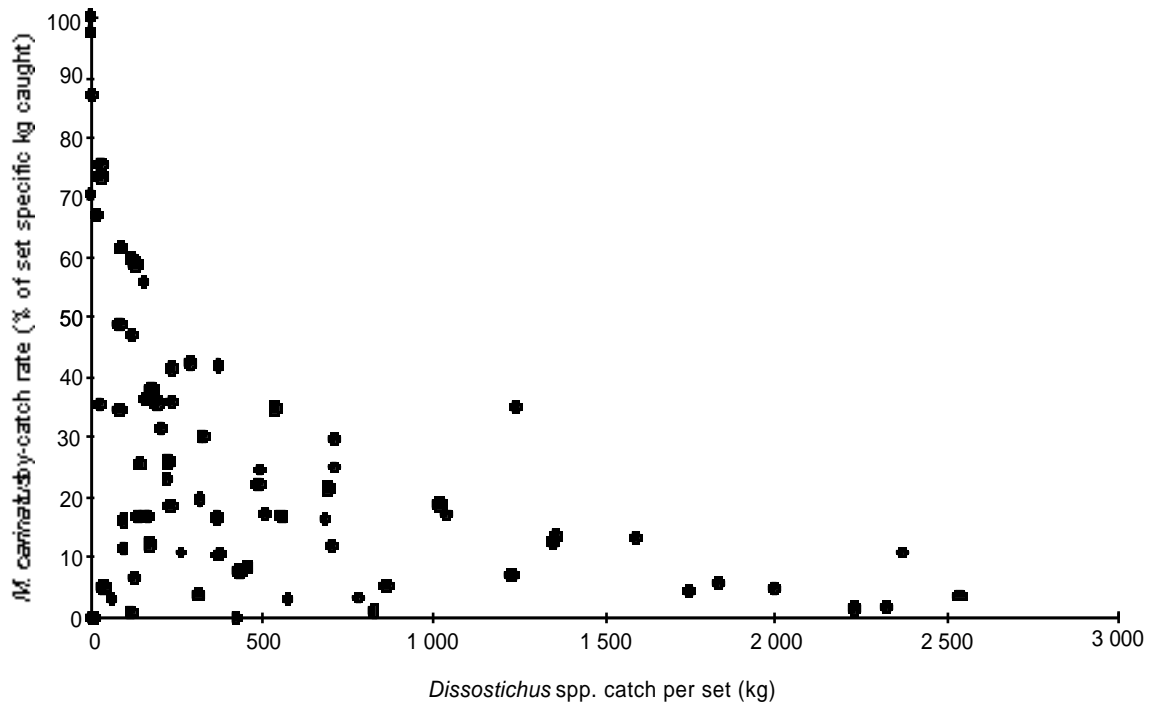


Figure 2: Set-specific by-catch rates of *M. carinatus* versus catches of *Dissostichus* spp. in Subarea 88.1. The data are from New Zealand's exploratory fishing operations during 1997/98.

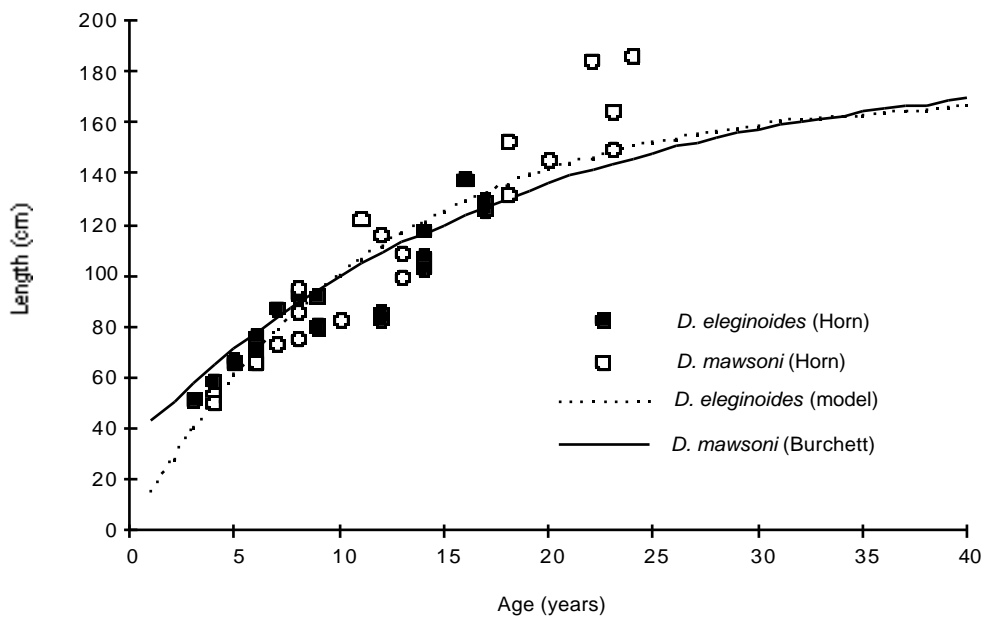


Figure 3: Comparison of growth between *D. eleginoides* and *D. mawsoni*. 'Horn' = data in WG-FSA-98/23; 'model' = growth curve used in the GYM; 'Burchett' = growth curve in Burchett et al. (1984).

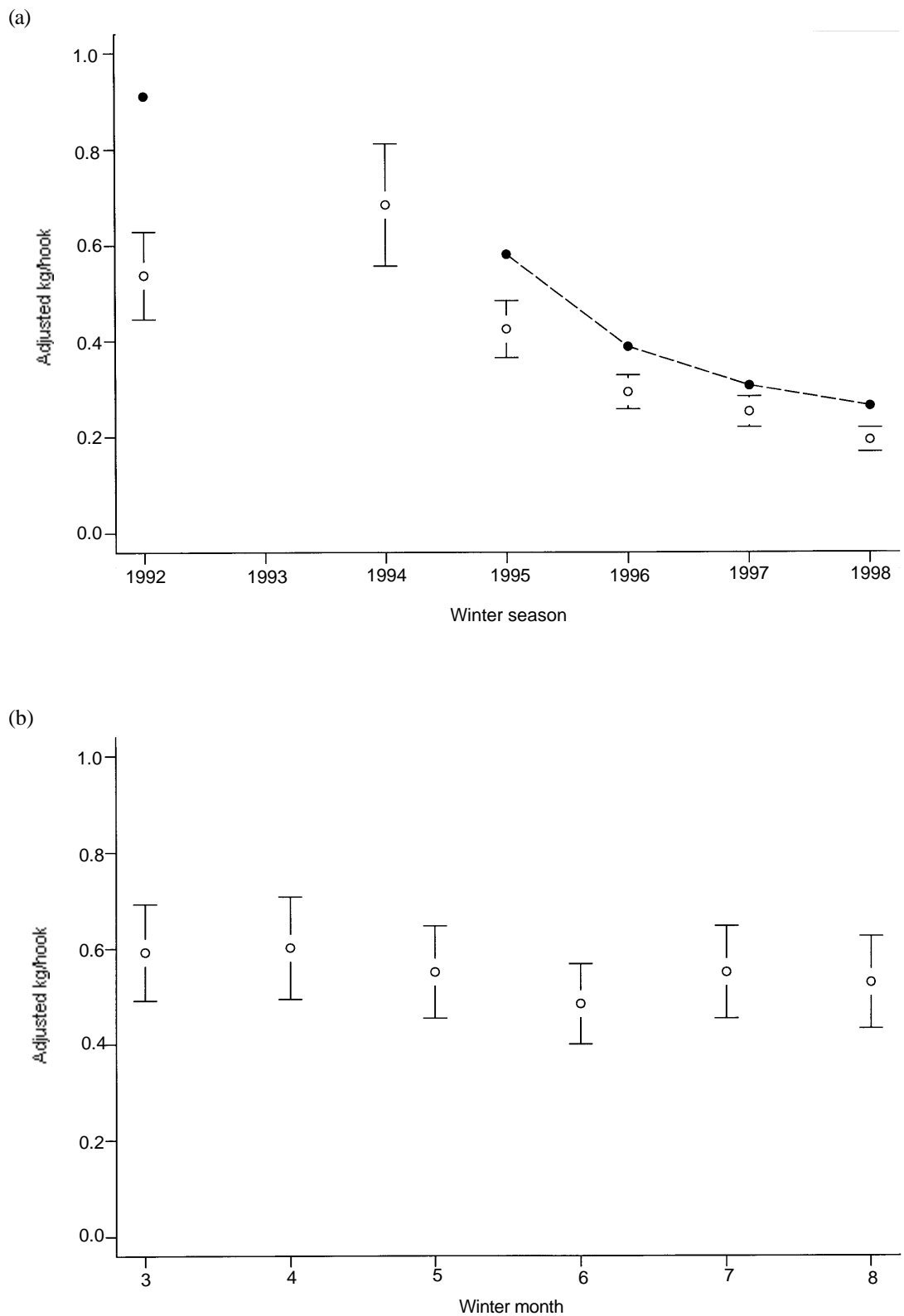


Figure 4: (a) Standardised (open circle) and unadjusted (closed circle) annual CPUEs (kg/hook) for Subarea 48.3 for GLM analysis.
 (b) Estimated month effects (with 95% confidence intervals).

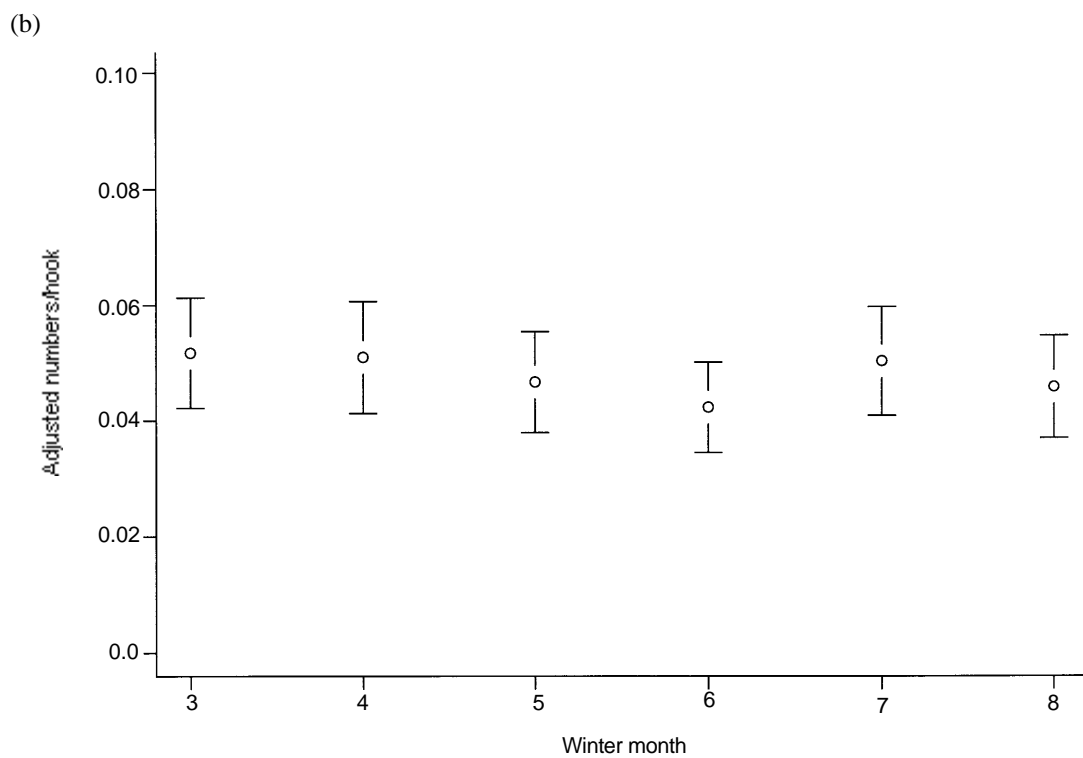
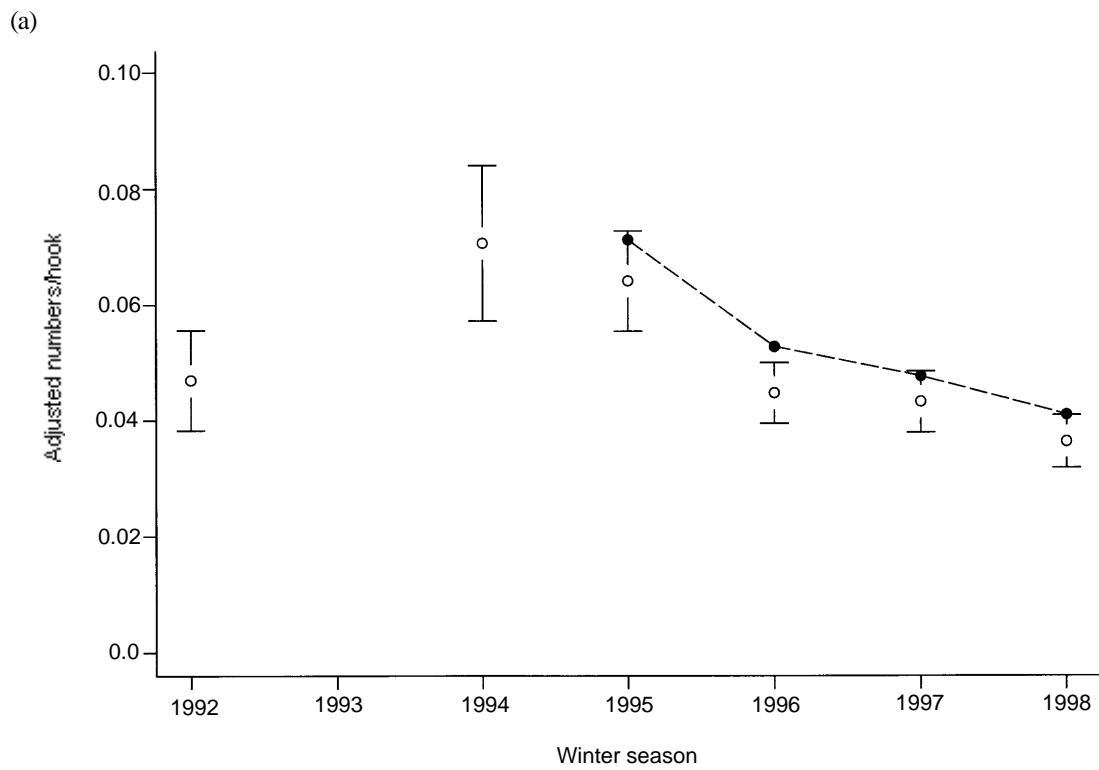


Figure 5: (a) Standardised (open circle) and unadjusted (closed circle) annual CPUEs (numbers/hook) for Subarea 48.3 for GLM analysis.
 (b) Estimated month effects (with 95% confidence intervals).

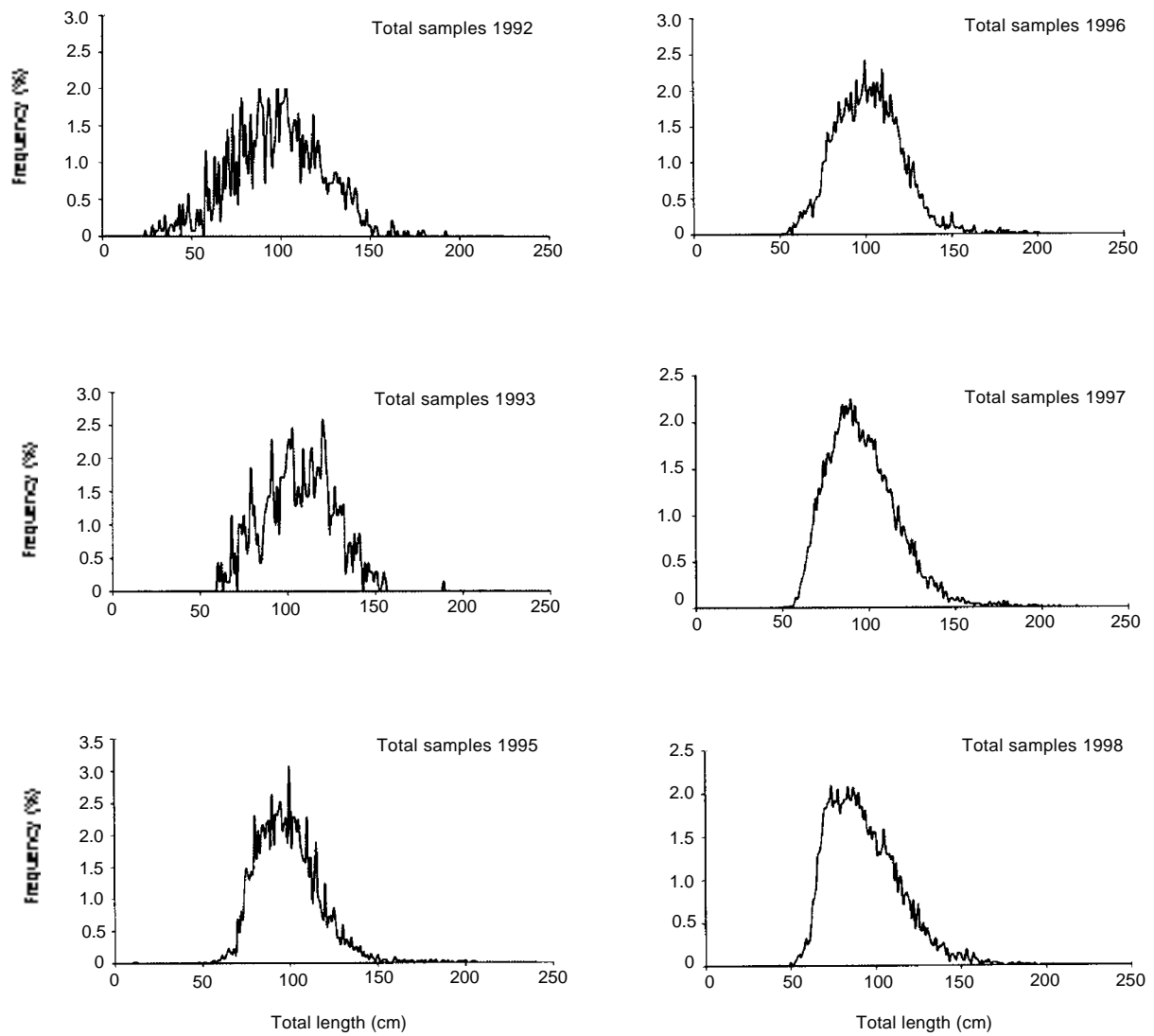


Figure 6: Annual size frequency distributions for *D. eleginoides* in Subarea 48.3.

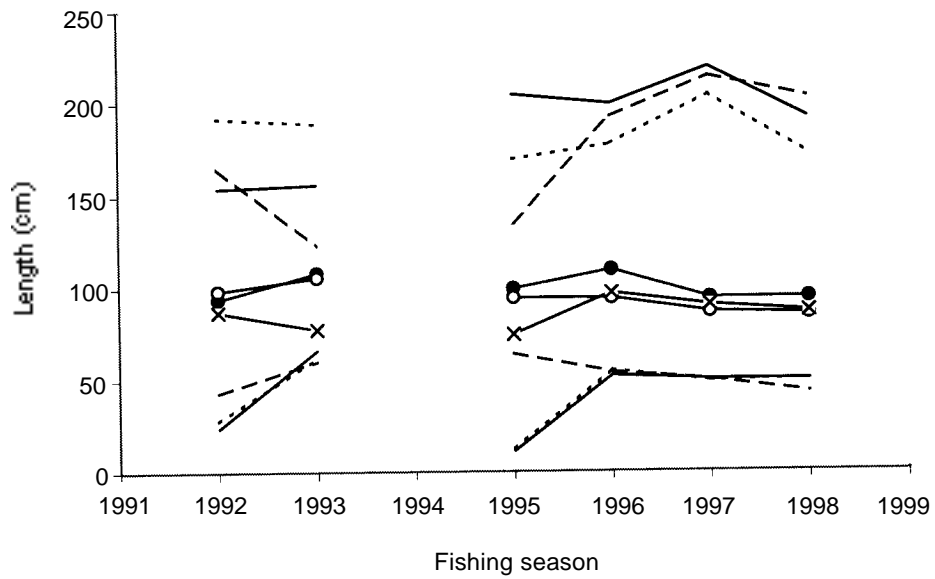


Figure 7: Annual (fishing season) weighted mean length of *D. eleginoides* in the fishery in Subarea 48.3. Minimum and maximum lengths recorded are also shown. Closed circle and solid line – female, open circle and dashed line – male, x and long dashed line – unknown.

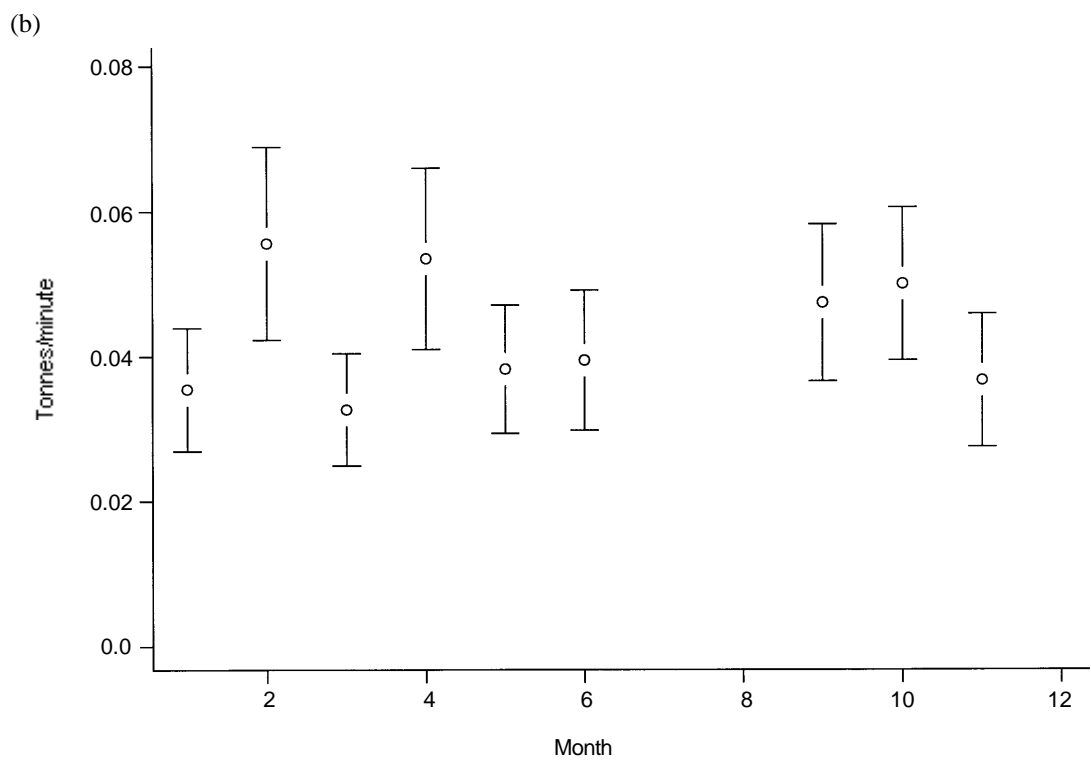
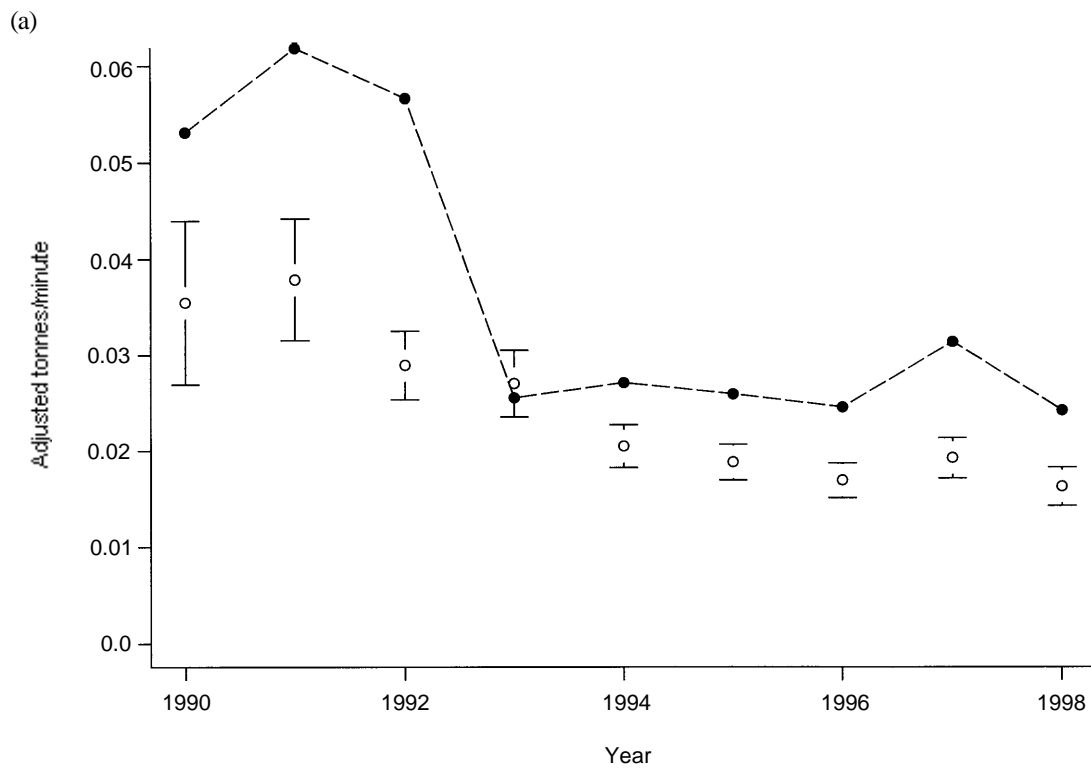


Figure 8: (a) Standardised (open circle) and unadjusted (closed circle) annual CPUEs (tonnes/minute) for Division 58.5.1 for GLM analysis.
 (b) Estimated month effects (with 95% confidence intervals).

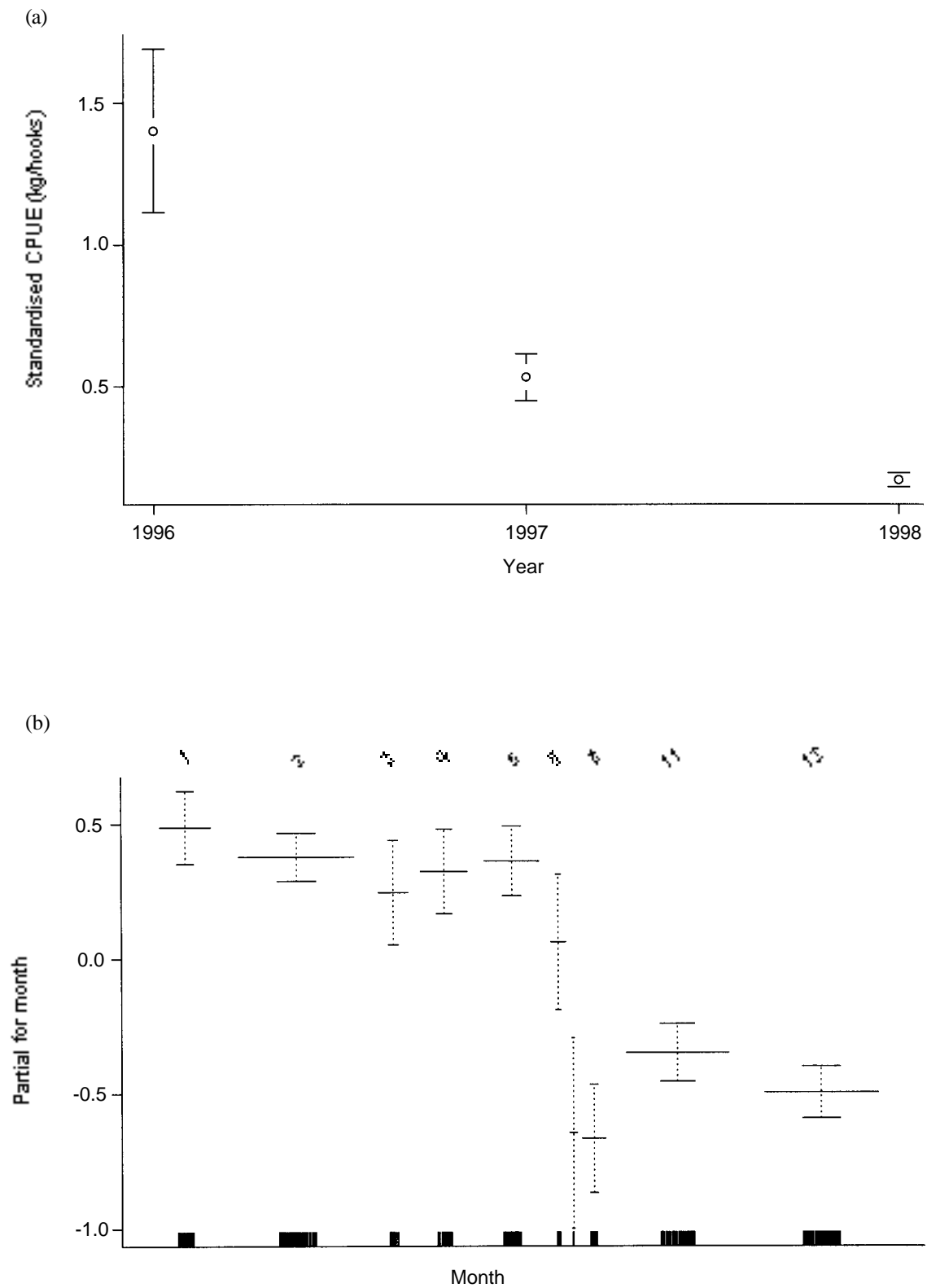


Figure 9: (a) Standardised annual CPUEs (kg/hook) for Subarea 58.7 for GLM analysis.
 (b) Estimated month effects (with 95% confidence intervals).

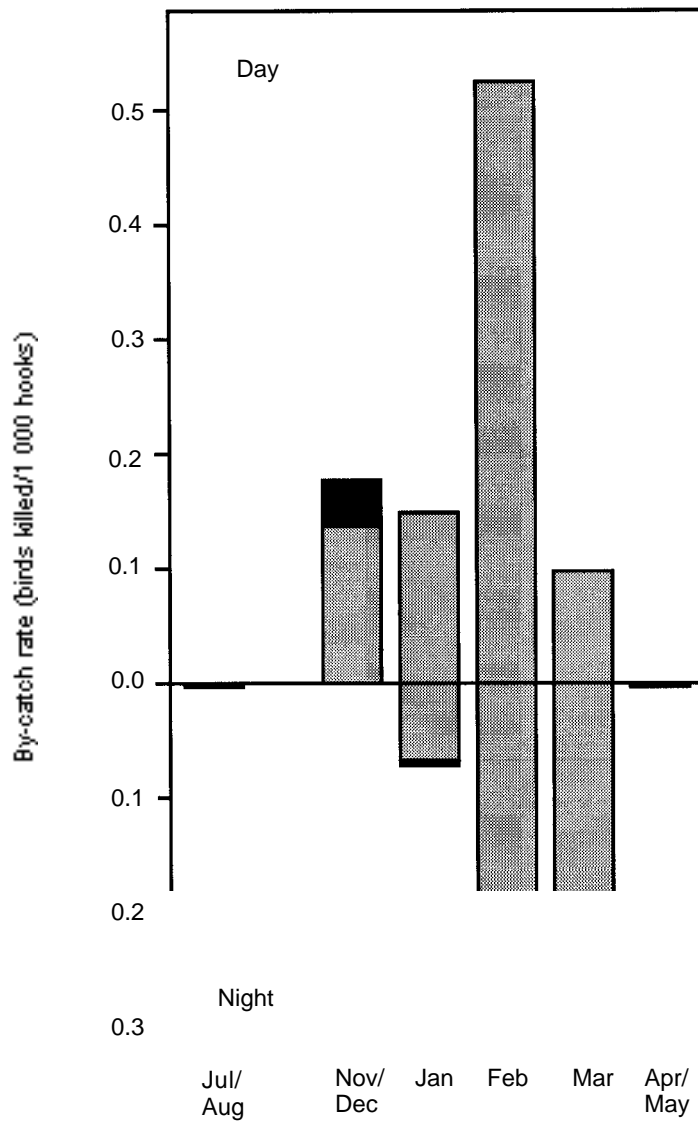


Figure 10: Seasonal differences in seabird by-catch in the longline fishery for *D. eleginoides* at the Prince Edward Islands, 1997/98. Data for day and night sets are shown: pale shading – white-chinned petrels, dark shading – all other species combined. Each period of one to two months represents at least 500 000 hooks set. Data from WG-FSA-98/42.

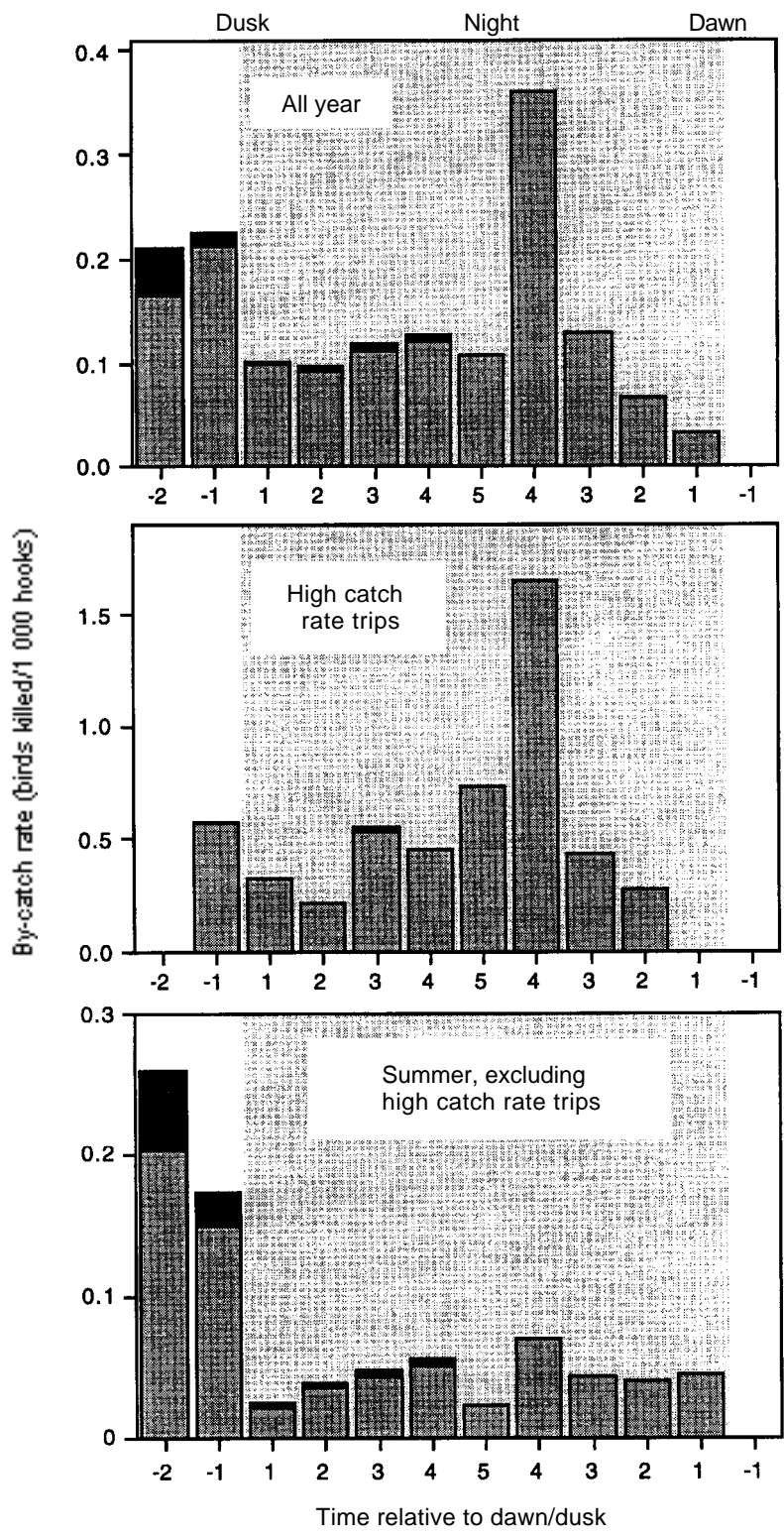


Figure 11: Seabird by-catch rate as a function of time of setting relative to local nautical dawn/dusk. Data for the whole of 1997/98 are presented, as well as two trips in February/March with high catch rates (>0.3 birds per 1 000 hooks) and comparative data from other summer trips (November to March). The shaded areas represent night sets; positive values are hours after dusk/before dawn; negative values hours before dusk/after dawn. Pale bars – white-chinned petrels, dark bars – all other species combined. Data from WG-FSA-98/42.

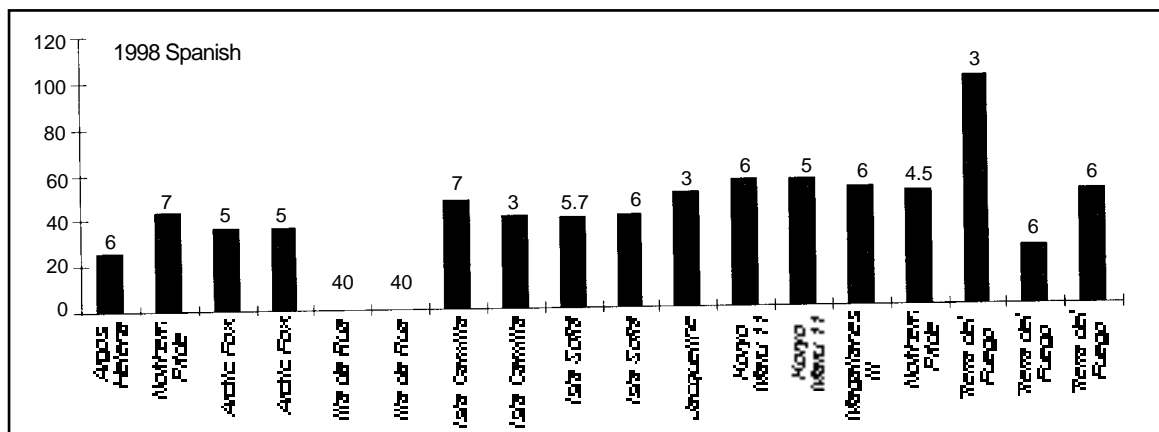
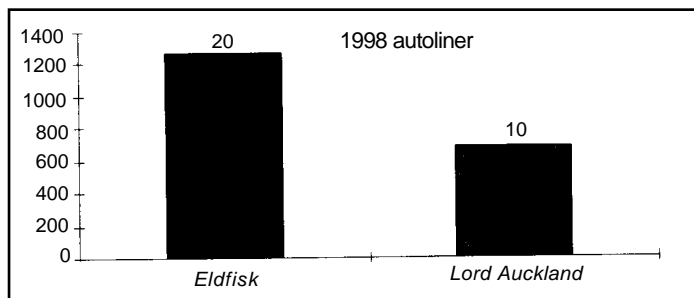
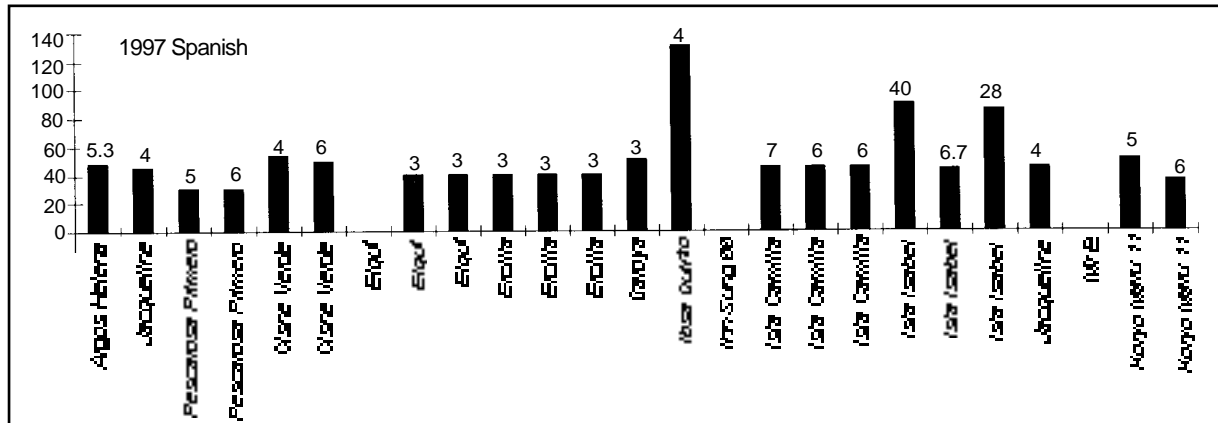
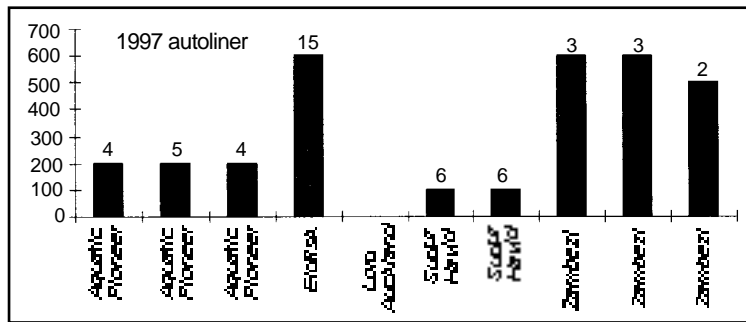


Figure 12: Summary of line weight spacings (y-axis in metres) and weights used (numbers over bars in kilograms) by Spanish and autoliner vessels in the 1997 and 1998 fishing seasons. Conservation Measure 29/XVI requires a weighting regime 6 kg/20 m on longlines for Spanish system vessels.

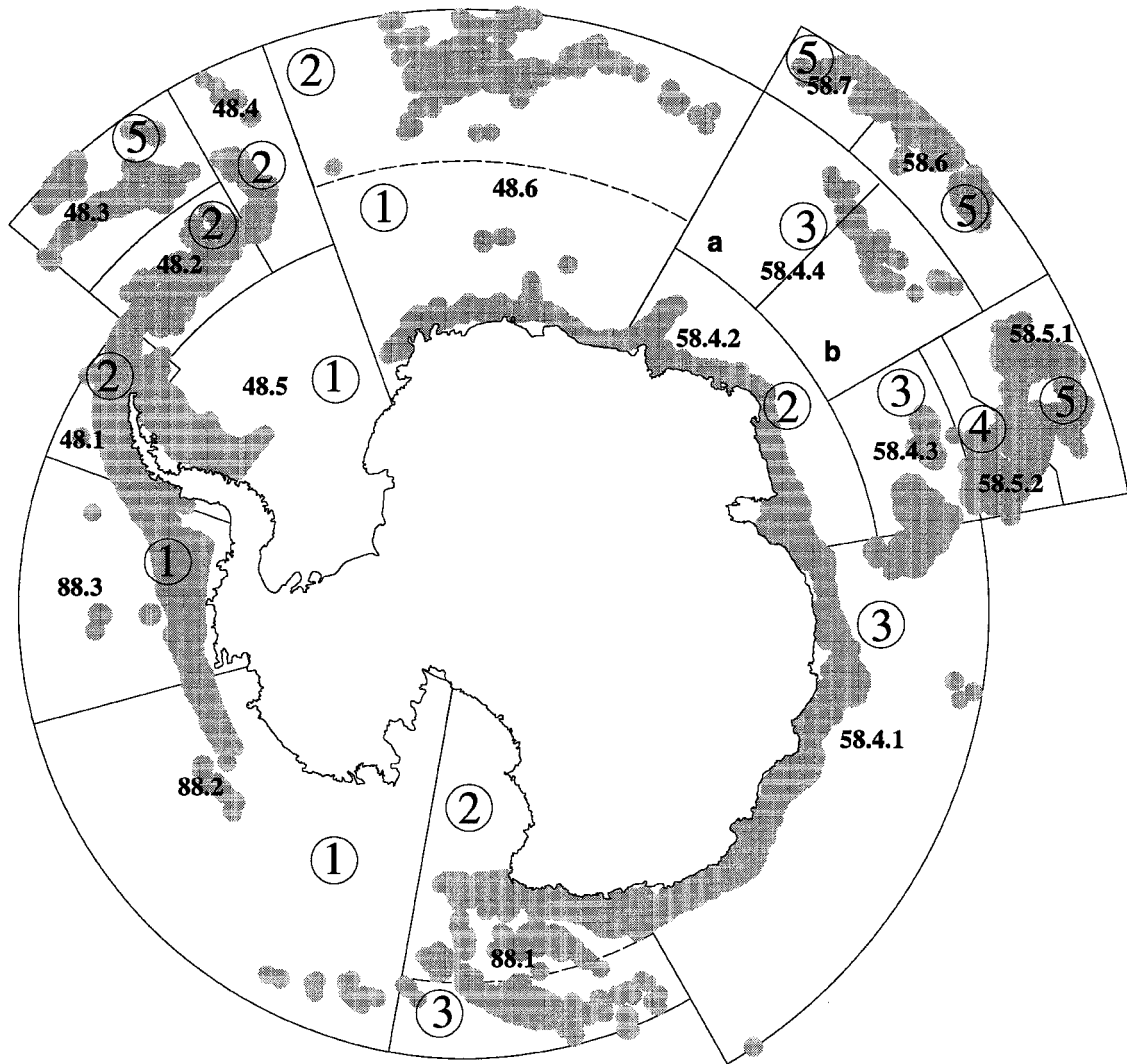


Figure 13: Assessment of the potential risk of interaction between seabirds, especially albatrosses, and longline fisheries within the Convention Area. 1 – low, 2 – average to low, 3 – average, 4 – average to high, 5 – high. Shaded patches represent seabed areas between 500 and 1 800 m.

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 12 to 22 October 1998)

1. Opening of the Meeting
2. Organisation of the Meeting and Adoption of the Agenda
3. Review of Available Information
 - 3.1 Data Requirements Endorsed by the Commission in 1997
 - 3.1.1 Data Inventory and Developments in the CCAMLR Database
 - 3.1.2 Database Data Entry and Validation
 - 3.1.3 Other
 - 3.2 Fisheries Information
 - 3.2.1 Catch, Effort, Length and Age Data
 - 3.2.2 Scientific Observer Information
 - 3.2.3 Research Surveys
 - 3.2.4 Mesh/Hook Selectivity and Related Experiments Affecting Catchability
 - 3.3 Status of Fisheries
 - 3.3.1 Resumption of Closed or Lapsed Fisheries
 - 3.3.2 General Scheme
 - 3.4 Fish and Squid Biology/Demography/Ecology
 - 3.5 Decision Rules and Biological Reference Points
 - 3.6 Developments in Assessment Methods and Scheme for Validating Models
 - 3.7 Consideration of Management Areas and Stock Boundaries
4. Assessments and Management Advice
 - 4.1 New and Exploratory Fisheries
 - 4.1.1 New Fisheries in 1997/98
 - 4.1.2 New Fisheries Notified for 1998/99
 - 4.1.3 Exploratory Fisheries in 1997/98
 - 4.1.4 Exploratory Fisheries Notified for 1998/99
 - 4.2 Other Fisheries
 - 4.2.1 Antarctic Peninsula (Subarea 48.1)
 - 4.2.2 South Orkney Islands (Subarea 48.2)
 - 4.2.3 South Georgia (Subarea 48.3) – Finfish
 - 4.2.4 South Georgia (Subarea 48.3) – Crabs
 - 4.2.5 South Sandwich Islands (Subarea 48.4)
 - 4.2.6 Antarctic Coastal Areas (Divisions 58.4.1 and 58.4.2)
 - 4.2.7 Ob and Lena Banks (Division 58.4.4)
 - 4.2.8 Kerguelen Islands (Division 58.5.1)
 - 4.2.9 Heard Island (Division 58.5.2)
 - 4.2.10 Pacific Ocean Sector (Area 88)
 - 4.2.11 Crozet Islands (Subarea 58.6) and Prince Edward and Marion Islands (Subarea 58.7)
 - 4.3 General By-catch Provisions

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 Research into the Status of Seabirds
 - 7.2 Incidental Mortality of Seabirds during Longline Fishing
 - 7.2.1 Regulated Fisheries in the Convention Area in 1997/98
 - 7.2.2 Unregulated Fisheries in the Convention Area in 1997/98
 - 7.2.3 Fisheries outside the Convention Area in 1997/98
 - 7.2.4 New and Exploratory Fisheries Notified for 1998/99
 - 7.3 Research into, and Experience with, Mitigating Measures
 - 7.4 Advice to the Scientific Committee
8. Other Incidental Mortality
9. Future Work
 - 9.1 Data Requirements
 - 9.2 Software and Analyses to be Prepared or Developed Prior to the Next Meeting
 - 9.3 Convenership of WG-FSA and Coordinator of Ad Hoc WG-IMALF
 - 9.4 Workshop on *C. gunnari*
10. Other Business
11. Adoption of Report
12. Close of Meeting.

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(Hobart, Australia, 12 to 22 October 1998)

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LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 12 to 22 October 1998)

WG-FSA-98/1	Provisional Agenda and Annotation to the Provisional Agenda for the 1998 Meeting of the Working Group on Fish Stock Assessment (WG-FSA)
WG-FSA-98/2	List of participants
WG-FSA-98/3	List of documents
WG-FSA-98/4	Data and resources available to WG-FSA-98 Secretariat
WG-FSA-98/5	Secretariat work in support of WG-FSA Secretariat
WG-FSA-98/6	Comparison of seabed areas Secretariat
WG-FSA-98/7	Introduction to the CCAMLR intranet Secretariat
WG-FSA-98/8	Inventory of CCAMLR datasets Secretariat
WG-FSA-98/9	Scientific observations of trawl operations during the 1997/98 season Secretariat
WG-FSA-98/10	A summary of observations on board longline vessels operating within the CCAMLR Convention Area Secretariat
WG-FSA-98/11	Fish by-catch in krill fisheries Secretariat
WG-FSA-98/12	Fishery data reporting requirements for 1999 Secretariat
WG-FSA-98/13	About the fecundity of Patagonian toothfish (<i>Dissostichus eleginoides</i>) in Subarea 48.3 (around South Georgia) M.M. Nevinsky and A.N. Kozlov (Russia)
WG-FSA-98/14	Surface areas of seabed within the 500 m isobath for regions within the South Shetland Islands (Subarea 48.1) C.D. Jones, S.N. Sexton and R.E. Cosgrove III (USA)
WG-FSA-98/15	Results from the 1998 bottom trawl survey of Elephant Island and the lower South Shetland Islands (Subarea 48.1) C.D. Jones (USA), K.-H. Kock and S. Wilhelms (Germany)

- WG-FSA-98/16
Rev. 1 Do the males of *Dissostichus eleginoides* grow faster, or only mature before females?
C.A. Moreno (Chile)
- WG-FSA-98/17 Standing stock biomass of eight species of finfish around Elephant Island and the lower South Shetland Islands (Subarea 48.1) from the 1998 US AMLR bottom trawl survey
C.D. Jones (USA), K.-H. Kock and S. Wilhelms (Germany)
- WG-FSA-98/18 Validation of the Generalised Yield Model
Secretariat
- WG-FSA-98/19 Seabird observations in Subareas 48.1, 48.2 and 88.3 and proposal for a new streamer line design
A. Gonzalo Benavides and P.M. Arana (Chile)
- WG-FSA-98/20 Fishing with pots in the Antarctic region (CCAMLR Statistical Subareas 48.1, 48.2 and 88.3)
P. Arana and R. Vega (Chile)
- WG-FSA-98/21 Introduction to the Generalised Yield (GY) model: a user guide
A.J. Constable and W.K. de la Mare (Australia)
- WG-FSA-98/22 Modifications to the Generalised Yield (GY) model since WG-FSA-97
A. Constable (Australia)
- WG-FSA-98/23 Estimates of age for samples of *Dissostichus eleginoides* and *Dissostichus mawsoni* from CCAMLR Subarea 88.1
P. Horn (New Zealand)
- WG-FSA-98/24 Report on progress in developing underwater setting devices for pelagic longline vessels
J. Molloy (New Zealand)
- WG-FSA-98/25 Annual review of by-catch in southern bluefin tuna and related tuna longline fisheries in the New Zealand 200 n mile Exclusive Economic Zone
S.J. Baird, M. Francis, L. Griggs and H. Dean (New Zealand)
- WG-FSA-98/26 Otolith and body size relationships in the mackerel icefish
I. Everson, B. Bendall and A. Murray (United Kingdom)
- WG-FSA-98/27 Size at sexual maturity of Patagonian toothfish
I. Everson and A. Murray (United Kingdom)
- WG-FSA-98/28 Research underway on New Zealand seabirds vulnerable to fisheries interactions
Delegation of New Zealand
- WG-FSA-98/29 Seabird mortality on longlines in Australian waters: a case study of progress and policy
R. Gales, N. Brothers, T. Reid, D. Pemberton and G.B. Baker (Australia)

- WG-FSA-98/30 Seabird interactions with longline fishing in the AFZ: 1997 seabird mortality estimates and 1988–1997 trends
N. Brothers, R. Gales and T. Reid (Australia)
- WG-FSA-98/31 Seabird mortality in the Japanese tuna longline fishery around Australia, 1988–1995
R. Gales, N. Brothers and T. Reid (Australia)
(*Biological Conservation*, 0 (1998) 1–20)
- WG-FSA-98/32 The influence of environmental variables and mitigation measures on seabird catch rates in the Japanese tuna longline fishery within the Australian Fishing Zone, 1991–1995
N. Brothers, R. Gales and T. Reid (Australia)
(*Biological Conservation*, in press)
- WG-FSA-98/33 Foraging movements of the shy albatross *Diomedea cauta* breeding in Australia; implications for interactions with longline fisheries
N. Brothers, R. Gales, A. Hedd and G. Robertson (Australia)
(*Ibis*, 140: 446–457)
- WG-FSA-98/34 Rev. 2 Comments of the Working Group on Fish Stock Assessment on the FAO International Plan of Action on the Reduction of Incidental Catch of Seabirds in Longline Fisheries
Secretariat
- WG-FSA-98/35 Examination of the CCAMLR toothfish GLM
G.P. Kirkwood and D.J. Agnew (United Kingdom)
- WG-FSA-98/36 Progress in Australian initiatives for the conservation of albatrosses
G.B. Baker, N. Montgomery and A. McNee (Australia)
- WG-FSA-98/37 Review of biological characteristics of the Antarctic toothfish (*Dissostichus mawsoni*) and its distribution in Antarctic waters
Secretariat
- WG-FSA-98/38 Information on longline fisheries to the north of the Convention Area
Secretariat
- WG-FSA-98/39 Preliminary results of investigations into the stock structure of Patagonian toothfish (*Dissostichus eleginoides*) around Macquarie Island
A. Reilly, B. Ward and R. Williams (Australia)
- WG-FSA-98/40 Determination of Patagonian toothfish *Dissostichus eleginoides* age, growth and population characteristics based on otoliths
J.M. Kalish and T.A. Timmiss (Australia)
- WG-FSA-98/41 Register of collections of otolith and scales of *Dissostichus eleginoides*
R. Williams (Australia)
- WG-FSA-98/42 Seabird by-catch in the Patagonian toothfish longline fishery at the Prince Edward Islands: 1997–1998
P.G. Ryan and M.G. Purves (South Africa)

- WG-FSA-98/43 Seabirds and the Patagonian toothfish longline fishery: fishing methods and operational issues
G. Robertson (Australia)
- WG-FSA-98/44 Seabirds and the Patagonian toothfish longline fishery: longline sink rates and implications for seabird conservation
G. Robertson (Australia)
- WG-FSA-98/45 Priorities for seabird research in the Patagonian toothfish longline fishery
G. Robertson (Australia)
- WG-FSA-98/46 Task group on reporting forms and instructions for scientific observations on board longline fishing vessels
Secretariat
- WG-FSA-98/46
ADDENDUM Task group on reporting forms and instructions for scientific observations on board longline fishing vessels
Secretariat
- WG-FSA-98/47 Study on stratification scheme efficiency when trawl surveying off South Georgia
R.S. Gasiukov and R.S. Dorovskikh (Russia)
- WG-FSA-98/48 Informe de la campaña de investigación biológico-pesquera de palangre de fondo en aguas del Atlántico sur-oriental y en los sectores Atlántico e índico de la CCRVMA (Subárea 48.6 y División 58.4.4)
(Report of the longline research cruise in the southeast Atlantic and in the CCAMLR Subarea 48.6 and Division 58.4.4)
L.J. López Abellán y J.F. González Jiménez
- WG-FSA-98/49 Brief review of the biology of *Dissostichus mawsoni*
A.L. DeVries and J.T. Eastman (USA)
- WG-FSA-98/50 Calculation of seabed areas for Subarea 88.1
Delegation of New Zealand
- WG-FSA-98/51 Longline sink rates on a bottom autoline vessel in New Zealand: draft
N.W. McL. Smith (New Zealand)
- WG-FSA-98/52 Criteria for aging the otoliths of *Dissostichus eleginoides* from South Georgia (Subarea 48.3) and an analysis of aging precision
J. Ashford (United Kingdom) and S. Wischniowski (Canada)
- WG-FSA-98/53 A summary of the commercial fishery for mackerel icefish *Champscephalus gunnari* in Subarea 48.3 during the 1997/98 season
G. Parkes, A. King and C. Jones (United Kingdom)
- WG-FSA-98/54 A revised estimate of short-term yield for the mackerel icefish (*Champscephalus gunnari*) off Heard Island based on a trawl survey in 1998
A. Constable and D. Williams (Australia)

WG-FSA-98/55	Pooled-length density data for assessments of yield from by-catch species around Heard Island D. Williams and A. Constable (Australia)
WG-FSA-98/56	Withdrawn
WG-FSA-98/57	Trends in relative abundance of fjord <i>Notothenia rossii</i> , <i>Gobionotothen gibberifrons</i> and <i>Notothenia coriiceps</i> in trammel net catches at Potter Cove, South Shetland Islands E. Barrera-Oro, E.R. Marschoff and R.J. Casaux (Argentina)
WG-FSA-98/58	Depth distribution and spawning pattern of <i>Dissostichus eleginoides</i> over the winter period in Subarea 48.3 D.J. Agnew, K. Kerkieta, L. Heaps, C. Jones, J. Pearce and A. Watson (United Kingdom)
WG-FSA-98/59	Withdrawn
WG-FSA-98/60	A protocol for randomised sampling of longlines in the Southern Ocean fishery for <i>Dissostichus eleginoides</i> : system of international scientific observation, CCAMLR J.R. Ashford (United Kingdom), G. Duhamel (France) and M. Purves (South Africa)
Other Documents	
WG-EMM-98/11	Monitoring changes in coastal fish populations by the analysis of pellets of the Antarctic shag <i>Phalacrocorax bransfieldensis</i> : a new proposed standard method R. Casaux and E. Barrera-Oro (Argentina)
SCOI-98/8	CCAMLR scientific observers: an account of a training experience Delegation of Chile
CCAMLR-XVII/9 Rev. 1	Notification of France's intention to initiate new fisheries Delegation of France
CCAMLR-XVII/10	Notification of South Africa's intention to initiate new fisheries Delegation of South Africa
CCAMLR-XVII/11	Notification of Australia's intention to initiate an exploratory fishery Delegation of Australia
CCAMLR-XVII/12	Notification of Spain's intention to initiate an exploratory fishery Delegation of Spain
CCAMLR-XVII/13 Rev. 1	Notification of New Zealand's intention to continue an exploratory fishery Delegation of New Zealand

CCAMLR-XVII/14	Notification of South Africa's intention to initiate an exploratory fishery Delegation of South Africa
CCAMLR-XVII/18	European Community discussion paper on a unified regulatory framework for CCAMLR based on stages of fishery development Delegation of the European Community
CCAMLR-XVII/19	Notification of Uruguay's intention to initiate a new fishery Delegation of Uruguay
CCAMLR-XVII/BG/3	Multilateral fisheries conservation and management arrangements: the use of trade measures Secretariat
CCAMLR-XVII/BG/4 Rev. 1	Implementation of conservation measures in 1997/98 Secretariat
CCAMLR-XVII/BG/17	Functionality of a full-sized marine mammal exclusion device Delegation of New Zealand
CCAMLR-XVII/BG/25	Beach litter accumulation and retention at sub-Antarctic Marion Island: trends in relation to longline fishing activity Delegation of South Africa
CCAMLR-XVII/BG/26	Marine pollutants and fishing gear associated with seabirds at sub-Antarctic Marion Island, 1996–1998: trends in relation to longline fishing activity Delegation of South Africa
SC-CAMLR-XVII/BG/1 Rev. 1	Catches in the Convention Area 1997/98 Secretariat
SC-CAMLR-XVII/BG/4	Report of the CCAMLR Observer to the Third Meeting of the Commission for the Conservation of Southern Bluefin Tuna's Ecologically Related Species Working Group CCAMLR Observer (K. Truelove, Australia)
SC-CAMLR-XVII/BG/5	International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries Submitted by FAO
SC-CAMLR-XVII/BG/7 Rev. 1	Results of the <i>Dissostichus</i> spp. new fisheries projects in the Antarctic region (CCAMLR Statistical Subareas 48.1, 48.2 and 88.3) Delegation of Chile
SC-CAMLR-XVII/BG/8	Survey and monitoring of black petrels on Great Barrier Island 1997 Delegation of New Zealand
SC-CAMLR-XVII/BG/9	Light-mantled sooty albatross on Campbell Island, 1995–96: a pilot investigation Delegation of New Zealand

- SC-CAMLR-XVII/BG/13 Southern royal albatross *Diomedea epomophora* census on Campbell Island, 4 January – 6 February 1996, and a review of population figures
Delegation of New Zealand
- SC-CAMLR-XVII/BG/14 Correspondence with the Secretariat of the Convention on Biological Diversity
Secretariat

DRAFT REPORT ON CONVERSION FACTORS

DRAFT REPORT ON CONVERSION FACTORS

Some difficulties occur in the WG-FSA assessments of stocks when it is necessary to validate the catch report because of the use of different and unvalidated conversion factors between the processed and the whole fish (green weight). To resolve the problem, tests must be executed on board factory vessels and a clear observers protocol be provided.

2. Mr R. Williams (Australia) tabled the protocol in use on board Australian trawlers and experienced participants proposed amendments to produce a draft standard protocol for evaluation prior to the next CCAMLR meeting.

PROTOCOL FOR ESTIMATING CONVERSION FACTORS

3. Make a detailed description of each processed product (e.g. whole, gutted, headed/gutted, headed/gutted/tailed, fillets with skin, fillets without skin and bones, collars, etc.) on a written form and a drawing of the cutting lines with position and angles on a diagram of the fish.

4. Explain the categories of the products (e.g. small, medium, large, etc.) and the methods of processing the fish (e.g. hand-cut, cut with Baader machine, etc.).

5. Conduct experiments once a week to obtain a series of conversion factors between product weight and green weight. This timing minimises bias caused by, for example, variation in GSI index with time and fishing ground effect while minimising disturbance of the factory process.

Method for Each Experiment (standardised report form to be decided)

6. (i) **Size of sample:** minimum of 25 fish or 200 kgs for *Dissostichus eleginoides*, 100 kgs or 400 fish for *Champsoccephalus gunnari*.

(ii) **Size range of fish:** take a sample that covers the range of lengths of the fish caught. If necessary, use size categories (e.g. small, medium, large) and report the range of length in each group.

(iii) **Ancillary data:** include information on the vessel and nationality and fishing method (longliner/trawler, autoline/Spanish system) and the haul/set number (to cross reference to the area of fishing, the fine-scale square, the length frequency distribution).

Method

7. Weigh a convenient sized batch of whole fish, depending on the capacity of the scales (compensated for ship's motion). Pass the batch through the factory processing system (with the help of the factory manager). Recover the processed fish and weigh the product(s). Repeat until sample is completely analysed. Record the number of fish in the sample, their length range, the green weight and processed weight on a suitable form, together with details of the type of cuts used to process the fish.

8. To help the WG-FSA an example of a form in use in the Australian fishery is given in Attachment 1.

MEMBERSHIP OF WG-IMALF
(as at October 1998)

Argentina:

Dr E. Marschoff

Australia:

Mr N. Brothers

Dr R. Gales

Dr G. Robertson

Dr A. Constable

Mr B. Baker

Ms B. Dettmann

Ms N. Montgomery

Ms K. Maguire

Brazil:

Dr E. Fanta

Chile:

Prof. C. Moreno

Dr R. Schlatter

France:

Prof. G. Duhamel

Dr H. Weimerskirch

Germany:

Dr K.-H. Kock

New Zealand:

Dr M. Imber

Mr B. Weeber

Ms J. Dalziell

Ms J. Molloy

South Africa:

Mr J. Cooper

Dr P. Ryan

United Kingdom:

Prof. J. Croxall

Secretariat:

Dr E. Sabourenkov

APPENDIX F

INTERSESSIONAL WORK PLAN FOR AD HOC WG-IMALF

PLAN OF IMALF INTERSESSIONAL WORK FOR 1998/99

The Secretariat will coordinate the intersessional work of the IMALF group. An interim review of work will be conducted in June 1999 and advised to ad hoc WG-IMALF at the time of WG-EMM (July 1999). The outcome of the intersessional work will be reviewed in August/September 1999 and reported to WG-FSA in October 1999.

	Task/Topic	Reference	Members' Assistance	Start/ Completion Deadlines	Action
1.	Planning and coordination of work:				
1.1	Circulation of CCAMLR-XVII reports on IMALF matters.			1 Dec 1998	Circulate all relevant sections of CCAMLR-XVII 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.			1 Dec 1998	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.			1 Dec 1998	Commend technical coordinators and all observers for their effort in the 1997/98 fishing season.
1.4	Membership of WG-IMALF.	7.4	Members	Nov 1998/ as required	Update membership during the year as required. Request appropriate Members to nominate their technical coordinators to IMALF and send them to the WG-FSA meeting.
1.5	Education and training of fishing companies and fishermen on issues of incidental mortality of seabirds.	3.79, 9.18(iv), (xiv)	Members	Dec 1998/ Aug 1999	Urge Members to improve education and training of fishers on issues of incidental mortality of seabirds; advise that some form of a CCAMLR workshop on the matter might be possible; report to IMALF-99.
1.6	Protection for observers on board against adverse weather conditions.	9.19(ii)	Technical coordinators	Jan 1999	Request technical coordinators to pass on the request to vessel owners and captains regarding the necessity to provide as much protection as possible for observers against adverse weather conditions.
1.7	Publication of the booklet <i>Fish the Sea Not the Sky</i> and other materials on IMALF activities on the proposed CCAMLR website.	3.78, 9.18(iii)		Jan-Feb 1999	Publish the booklet in 1999 on the CCAMLR website, in accordance with the website development plan.
1.8	Distribution of the booklet <i>Fish the Sea Not the Sky</i> .	3.78, 9.18(iii)	Technical coordinators	Jan 1999	Send copies of the booklet to technical coordinators, request scientific observers to pass on copies of the book to vessels/crews.

	Task/Topic	Reference	Members' Assistance	Start/ Completion Deadlines	Action
1.9	Awareness of CCAMLR conservation measures in force and the booklet <i>Fish the Sea Not the Sky</i> on board longline vessels.	9.19(iii)	Technical coordinators	Dec 1998/ Aug 1999	Request feedback information from technical coordinators.
1.10	Submission of scientific observers data from the 1998/99 fisheries.		Technical coordinators	Dec 1998/ as required	Liaise with technical coordinators, as necessary, on data submission for the 1998/99 season.
2.	Members' research and development activities:				
2.1	Information on national research programs into status of albatrosses, giant petrels and white-chinned petrels.	7.8, 9.18(v)	Members	Nov 1998/ Sep 1999	Circulate the 1998 summary prepared by New Zealand and request similar summaries from Argentina, Australia, Chile, France, New Zealand, South Africa, UK, USA; collate responses for IMALF-99.
2.2	Regular updates on population status of albatrosses and petrels.		All Members	Nov 1998/	Same as above with a specific reminder to France; collate responses for IMALF-99.
2.3	GYM analysis of seabird interactions with longline fisheries.		New Zealand	Nov 1998	Request New Zealand report when work is completed.
2.4	Information on the use of underwater longline setting devices in fisheries conditions.		Members	Nov 1998/ Sep 1999	Request information on underwater setting development from all named Members (Australia, New Zealand, Norway, South Africa); collate responses for IMALF-99.
2.5	Regular updates on the work on seabird capture rates in relation to artificial bait, snood line and mainline colour; bait depth and sink rates.	9.18(xi)	Members	Nov 1998/ Sep 1999	Standing item, request reports of work, collate responses for IMALF-99.
2.6	National research into optimum configuration of line-weighting regimes and equipment.	9.18(x)	Members	Nov 1998/ Sep 1999	Request Members to report on research undertaken; collate responses for IMALF-99.
2.7	Development of automated methods for adding and removing weights to and from the line.	7.150, 7.151	Technical coordinators	Nov 1998/ Sep 1999	Request technical coordinators to interact and collaborate on the matter with fishing companies; review the situation at IMALF-99.
2.8	Video recording of line-hauling operations.	9.18(xiii)	Members	Nov 1998/ Sep 1999	Request reports, collate responses for IMALF-99.
2.9	Information on the experimental longline hake fishery in South Africa.		South Africa	Nov 1998	Re-request report from South Africa.
2.10	Information on the performance of natural and artificial bait in relation to their attractiveness to seabirds.			As required	Request again a report from 'Mustad' (Norway), also other companies/groups involved in testing artificial bait.

	Task/Topic	Reference	Members' Assistance	Start/ Completion Deadlines	Action
2.11	Information on line-setting devices for autoline vessels.	9.18(ii), 7.154, 7.155		As required	Request information from 'Mustad' (Norway).
2.12	Risk assessment of seabird by-catch in the Convention Area.	9.18(ix), 7.105	Members	Nov 1998/ Aug 1999	Intersessional work led by Mr J. Cooper (South Africa) and Dr E. Woehler (SCAR), to improve basis for assessing risk of seabird by-catch by statistical areas; review results at WG-FSA.
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.	7.121, 7.136	Members, non-Contracting Parties, int. organisations	As required	Request information intersessionally from those Members known to be licensing fishing in areas adjacent to CCAMLR (e.g. Argentina, Chile, UK [in respect of Falkland/Malvinas Islands], South Africa, New Zealand, Australia and France; review situation at IMALF-99.
3.2	Information on incidental mortality outside the Convention Area of seabirds breeding within the area.	7.122–7.134 7.135	Members	As required	Repeat request to all IMALF members, especially to those mentioned under item 3.1 above.
3.3	Implementation of provisions of Conservation Measure 29/XVI in fisheries adjacent to the CCAMLR Convention Area.		Members, non-Contracting Parties, int. organisations	Nov 1998/ as required	Request information on use/implementation of provisions of Conservation Measure 29/XVI, review responses at IMALF-99.
4.	Scientific Observers Manual:				
4.1	Intersessional work of the task group on scientific observation forms and guidelines.	9.18(xii), 9.19(i)	Task group	Nov 1998/ Sep 1999	Coordinate work of the task group to address matters relating to: the utility and feasibility of data recording, time constraints and difficulties in fulfilling observer duties; and, amendments to and revisions of the <i>Scientific Observers Manual</i> .
4.2	Consultation with IMALF members on issues of relevance to the work of task group.		Members/ Task Group	Nov 1998/ as required	Consult on any issue of relevance to observation of seabirds as required, submit comments received to the task group for consideration.
4.3	Publication and circulation of updates to the <i>Scientific Observers Manual</i> .	3.48	Task Group	January 1999	Update the manual as recommended by WG-FSA, circulate replacement pages.

	Task/Topic	Reference	Members' Assistance	Start/ Completion Deadlines	Action
5.	Cooperation with international organisations:				
5.1	Participation at the 1999 meeting of CCSBT ERSWG; invite CCSBT to attend WG-FSA.		CCSBT Secretariat	Jan–Feb 1999/ Jul 1999	Standing request.
5.2	Cooperation with the Secretariat of the Convention on CMS on CCAMLR work on albatross conservation.		CMS Secretariat, South Africa	Sep 1999	Follow up the 1998 CCAMLR advice to the Secretariat of the Convention on CMS on CCAMLR work on albatross conservation.
5.3	Cooperation with the Secretariat of CBD on interactions between albatrosses and longline fisheries.		CBD Secretariat	3 months before CBD meeting	Follow up the 1998 CCAMLR advice to CBD of interactions between albatrosses and longline fisheries.
5.4	Cooperation with ICCAT and IOTC on specific issues regarding incidental mortality of seabirds.		CCAMLR observers	Nov 98	Remind observers of desired feedback on IMALF matters.
5.5	Cooperation with FAO with respect to the International Plan of Action on seabird interaction with longline fishing (IPOA) after its consideration at the COFI meeting in Feb 1999.	7.178, also 7.137	CCAMLR observer at COFI	Mar 1999	Provide report (including FAO documents relevant to IPOA) to the Secretariat for circulation to IMALF for information and consideration.
6.	Data acquisition and analysis:				
6.1	Comprehensive analyses of data from the 1997/98 fisheries.	9.18(i), (vi)	Dr Baker, Members	Dec 1998/ Aug 1999	Complete analyses of data (including the relationship between vessels, daytime and night-time setting, time of year and seabird by-catch) prepare report and circulate it prior to IMALF-99 for comments.
6.2	Preliminary analyses of data from 1998/99 fisheries.	7.18		Sep–Oct 1999	Summarise current year data at a level adequate to undertake a preliminary assessment at IMALF-99.
6.3	Acquisition of EEZ data.	9.18(vii)	France	Nov 1998/ Sep 1999	Discuss with French scientists how basic observer data, consistent with CCAMLR logbook data, can be acquired.
6.4	Analysis of Subareas 58.6/58.7 EEZ data.	9.18(viii)	South Africa	Nov 1998/ Sep 1999	Request South Africa to undertake analysis and report to IMALF-99, and to implement a requirement for national scientific observers to record the proportion of hooks observed.
6.5	Development of electronic forms and formats for the submission of the observer data.	3.62–3.64	Members	Nov 1998/ as required	Request Members to provide details of their national electronic data-entry programs; start developing standard CCAMLR program; report to WG-FSA-99.

APPENDIX G

1998 ASSESSMENT SUMMARIES

Assessment Summary: *Dissostichus eleginoides*, Subarea 48.3

Source of Information: This report

Year:	1993	1994	1995	1996	1997	1998	Max ²	Min ²
Recommended TAC			-	4000	5000	3540		
Agreed TAC	3350	1300	2800	4000	5000	3300		
Landings	2990	604	6171 ⁴	3871 ⁵	3924 ⁶	3328		
Survey Biomass	3353* 2460 ⁺		14923 ^{*a} 4831 ^{+a}				2012 ^{*b} 67259 ^{+b}	
Surveyed by		UK ^a Arg ^b						
Stock Biomass ³	11000- 17000							
Recruitment (age...)								
Mean F (.....) ¹								

Weights in tonnes

¹ ... weighted mean over ages (...)

² Over period 1982 to 1992

³ Estimated from cohort projections

⁴ Estimated by WS-MAD from various sources

⁵ For the period 1 March to 24 July 1996

⁶ For the period 1 March to 31 August 1997

* Shag Rocks

+ South Georgia

Conservation Measures in Force: 121/XVI, 122/XVI and 124/XVI

Catches: 3 328 tonnes in 1997/98 (1 April to 22 August). No unreported catches in 1997/98.

Data and Assessment: Revised standardisation of CPUE using GYM.

Assessment of long-term annual yield using GYM.

Exploratory analysis of length frequency data for trends in length at capture.

Fishing Mortality:

Recruitment:

State of Stock: GYM results similar to 1997 assessment, but CPUE has declined every year since 1993.

Forecast for 1998/99: Catch limit derived from GYM is 3 550 tonnes. Catch Limit may be less than this figure to allow for uncertainty resulting from sustained decline in standardised CPUEs being more rapid than median fishable biomass predicted by the GYM.

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.1

Source of Information: This report

Year:	1993	1994	1995	1996	1997	1998	Max ²	Min ²	Mean ²
Recommended TAC									
Agreed TAC									
Landings	2722	5083	5534	4869	4683	4742	7492	121	
Landings ⁴	2944	5772	5588	5709	12180	16560			
Survey Biomass									
Surveyed by									
Sp. Stock Biomass ³									
Recruitment (age...)									
Mean F (.....) ¹									

Weights in tonnes, recruits in

¹ ... weighted mean over ages (...)

² Over period 1982 to 1994

³ From VPA using (.....)

⁴ Including unreported catches

Conservation Measures in Force: None. Recommendation not to exceed 1 400 tonnes in western fishing grounds (CCAMLR-XII, paragraph 4.21).

Catches: Trawl: 3 624 tonnes reported by France for French vessels. Longline: 1 118 tonnes reported by France for Ukrainian (997 tonnes) and French (121 tonnes) vessels.

Data and Assessment: Total including unreported catches estimated to be 16 560 tonnes. Standardisation of CPUE data from trawl fishery. Estimation of long-term annual yield using GYM.

Fishing Mortality:

Recruitment:

State of Stock: Long-term annual yield from GYM (6 900 tonnes) is higher than most catches in the catch history, except for 1992, 1997 and 1998 (including unreported catches).

Forecast for 1998/99: 1998/99 catch limit for trawlers 3 400 tonnes with 1 000-tonne limit for the eastern sector. October to December 1998 catch limit for longliners is 500 tonnes. 1998/99 volume will not exceed 1 400 tonnes.

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.2

Source of Information: This report

Year:	1993	1994	1995	1996	1997	1998	Max ²	Min ²	Mean ²
Recommended TAC		297	297	297	3800	3700			
Agreed TAC				297	3800	3700			
Landings	0	0	0	0	1861 ⁴	3264 ⁵			
Landings ⁶					18960	7200			
Survey Biomass		11880							
Surveyed by									
Sp. Stock Biomass ³									
Recruitment (age...)									
Mean F (.....) ¹									

Weights in tonnes, recruits in

¹ ... weighted mean over ages (...)

² Over period 1982 to 1992

³ From VPA using (.....)

⁴ For fishing season ending 31 August 1997

⁵ Up to time of WG-FSA meeting in 1998

⁶ Including unreported catches

Conservation Measures in Force: 131/XVI – Catch limit 3 700 tonnes

Catches: 3 264 tonnes up to time of WG-FSA meeting, expected to rise to 3 700 tonnes by end of Commission meeting. Unreported catches in 1997/98 estimated to be 3 500 tonnes.

Data and Assessment: Estimation of long-term annual yield using GYM.

Fishing Mortality:

Recruitment:

State of Stock: Long-term annual yield from GYM is 3 690 tonnes, similar to 1997, but total catches, with unreported catches continue to exceed this level.

Forecast for 1998/99:

Assessment Summary: *Chamsocephalus gunnari*, Subarea 48.3

Source of Information: This report

Year:	1993	1994	1995	1996	1997	1998	Max ²	Min ²
Recommended TAC	9200-15200	0			4520	4840		
Agreed TAC	9200		1000	1300	4520			
Landings	0	13	10	0	5			
Survey Biomass		16088 ^{+a} 4870 ^{*a} 2012 ^{+b} 67259 ^{*b}			122561 ^a 69753 ^b			
Surveyed by		UK ^a Arg ^b			Arg ^a UK ^b			
Stock Biomass ³								
Recruitment (age 1)								
Mean F (.....) ¹								

Weights in '000 tonnes

¹ ... weighted mean over ages (...)

² Over period 1982 to 1992

³ From VPA (2+)

* Shag Rocks

+ South Georgia

Conservation Measures in Force: 19/IX and 123/XVI

Catches: 5 tonnes by trawler *Betanzos* in December 1997/January 1998.

Data and Assessment: Short-term yield calculation based on UK survey data, September 1997.

Fishing Mortality: 0.143 if catch limit is taken.

Recruitment:

State of Stock: Uncertain

Forecast for 1998/99: Catch limit forecast is 4 840 tonnes, mainly on 3+ and 4+ year classes, but some doubt as to survival of these year classes.

Assessment Summary: *Chamsocephalus gunnari*, Division 58.5.1

Source of Information: This report

Year:	1993	1994	1995	1996	1997	1998	Max ²	Min ²	Mean ²
Recommended TAC						0			
Agreed TAC									
Landings (Kerguelen)	0	12	3936		<1		25852	0	
Landings (Combined)									
Survey Biomass					3890 ^a				
					1837 ^b				
Surveyed by					France				
Sp. Stock Biomass ³									
Recruitment (age...)									
Mean F (.....) ¹									

Weights in tonnes, recruits in

¹ ... weighted mean over ages (...)

² Over period 1982 to 1994

³ From VPA using (.....)

^a Survey 1: 18 318 km²

^b Survey 2: 5 246 km²

Conservation Measures in Force: CCAMLR: None. Recommendation that the fishery be closed until at least the 1997/98 season, and any fishing in that season to be preceded by a pre-recruit biomass survey in the 1996/97 season (SC-CAMLR-XIV, Annex 5, paragraph 5.152).

- French minimum legal size: 25 cm.

Catches: No commercial catch in 1997/98.

Data and Assessment: No new data, but indications that 4+ year class has disappeared and that 1+ year class is strong.

Fishing Mortality:

Recruitment: May be high in 1999/2000 if current 1+ year class is confirmed as abundant.

State of Stock: Possibly increasing.

Forecast for 1998/99: No fishing in 1998/99, but pre-recruit survey envisaged.

Assessment Summary: *Chamsocephalus gunnari*, Division 58.5.2

Source of Information: This report

Year:	1993	1994	1995	1996	1997	1998	Max ²	Min ²	Mean ²
Recommended TAC		311			900	1160			
Agreed TAC		311	311		900				
Landings	0	0		216	115				
Survey Biomass		31701		7194–112745		9460–26446			
Surveyed by				Australia ⁴		Australia ⁵			
Sp. Stock Biomass ³									
Recruitment (age...)									
Mean F (.....) ¹									

Weights in tonnes, recruits in

¹ ... weighted mean over ages (...)

² Over period 1982 to 1992

³ From VPA using (.....)

⁴ August 1997

⁵ June 1998

Conservation Measures in Force: 130/XVI – Catch limit 900 tonnes

Catches: 115 tonnes caught in 1997/98 fishing season.

Data and Assessment: Survey in June 1998 and short-term yield calculation.

Fishing Mortality: 0.139 if catch limit is taken.

Recruitment: Fished stock comprises chiefly year classes 3+ and 6+. Year class 2+ due to recruit this year appears not to be strong.

State of Stock: Likely to decline after 1998/99 unless good recruitment of current year 2+ occurs.

Forecast for 1998/99: Catch limit of 1 160 tonnes.

**SECRETARIAT TASKS IN SUPPORT OF
THE SCIENTIFIC COMMITTEE FOR THE
1998/99 INTERSESSIONAL PERIOD**

**SECRETARIAT TASKS IN SUPPORT OF THE SCIENTIFIC COMMITTEE
FOR THE 1998/99 INTERSESSIONAL PERIOD**

The following is a list of tasks for the 1998/99 intersessional period endorsed by the Scientific Committee (SC-CAMLR-XVII, paragraphs 13.11 and 13.12). The 'Reference to Reports' column contains pertinent paragraph numbers from reports of WG-FSA (F), WG-EMM (E) and the Scientific Committee (S). The paragraph number references in parentheses refer to supplementary information.

Scientific Committee

Deadline	Reference to Reports	Task	Collaborators
Fisheries status and trends:			
11-Oct-99	ongoing (F3.13 F4.1 F4.7 S5.20 S9.1 S9.5)	Update information on catches in the Convention Area and prepare catch statistics for preceding fishing season and split-year.	Members
Scheme of International Scientific Observation:			
15-Dec-98	F3.71 (S3.2)	Acknowledge the contribution by scientific observers in collecting data.	Technical Coordinators
15-Dec-98	F3.77 (F3.78 F9.16 F9.18 F9.19)	Request scientific observers to promote awareness of CCAMLR conservation measures.	Technical Coordinators
31-Dec-98	F3.61 (F3.60 F9.18 F9.19 S3.5)	Request vessel owners and captains to provide as much protection as possible for scientific observers against adverse weather conditions.	Members
01-Feb-99	F3.64 (F9.16 S3.5 S13.7)	Develop a stand-alone database for processing scientific observer data.	Members
01-Mar-99	F3.48 (F3.51–3.59 F9.18 F9.19 S3.5 S3.10)	Update and distribute scientific observer logbook forms following the review of observers' comments.	Observer Task Group
01-Mar-99	S3.14 (S3.13 C8.16)	Request scientific observers to collect factual data on sightings of fishing vessels during a fishing voyage.	Members
01-Apr-99	F3.62 (F9.16 S3.5)	Develop electronic forms and formats for the submission of scientific observer data.	Members
31-May-99	F3.57 (F3.48 S3.5)	Review logbook forms and guidelines for observations on board longline vessels and circulate revisions to the task group.	Dr G. Robertson (Australia) and Technical Coordinators
01-Aug-99	ongoing (F3.44 F9.16 S3.3)	Submit scientific observer data.	Members

Deadline	Reference to Reports	Task	Collaborators
Scheme of International Scientific Observation (continued):			
11-Oct-99	F3.61 (F3.60 F9.18 F9.19 S3.5)	Investigate the use of videophotography to provide scientific observers with a continuous view and record of line hauling.	Members
11-Oct-99	F3.70 (F3.65–3.69 F9.16 S3.5)	Evaluate and prioritise the workload of scientific observers.	Members
11-Oct-99	F9.16 (F3.76 S3.6)	Provide feedback on experience on the draft protocol method for estimating conversion factors.	Technical Coordinators
11-Oct-99	F9.18	Consider the potential of a CCAMLR workshop for technical coordinators.	Technical Coordinators
Cooperation with international organisations:			
01-Mar-99	E9.100 (S6.20 S11.24)	Assist with the preparation of a keynote paper for the ICES/SCOR Symposium on Ecosystem Effects of Fishing.	Dr A. Constable (Australia)
30-Jun-99	F7.182 (F7.180–7.181)	Liaise with the Convention on Migratory Species.	WG-IMALF
06-Jul-99	S10.14 (S10.12–10.13)	Participate in the Eighteenth Session of the Coordinating Working Party on Fishery Statistics.	
19-Jul-99	E10.1 (S6.19 S10.12–10.13)	Promote CCAMLR as a leading international organisation in the development and implementation of an ecosystem approach to fisheries management.	Members
19-Jul-99	S13.7	Seek suggestions for the analysis of IWC data on sightings of cetaceans.	Members
11-Oct-99	F7.170 (F7.137 F7.171–7.178)	Consider the FAO paper on a worldwide review of seabird by-catch in longline fisheries.	Mr J. Cooper (South Africa) and WG-IMALF
11-Oct-99	F7.186	Consider the report of the third meeting of the CCSBT Ecologically Related Species Working Group.	WG-IMALF
Publications:			
31-Dec-98	S12.3	Reply to the offer to publish short reviews of the scientific highlights from CCAMLR's work in the journal <i>Reviews in Fish Biology and Fisheries</i> .	Scientific Committee Chairman and Prof. T. Pitcher (Editor, <i>RFBF</i>)
01-Feb-99	S12.5	Investigate the feasibility of listing <i>CCAMLR Science</i> in <i>Current Contents</i> and establishing a link to <i>Science Citations Index</i> for ranking with other science journals.	
01-Mar-99	F9.6 (F9.16 S5.131)	Revise and publish the data reporting requirements for CCAMLR fisheries as a loose-leaf publication.	

Deadline	Reference to Reports	Task	Collaborators
Publications (continued):			
30-May-99	E11.5 (E9.26 E9.30 S4.23–4.24 S6.2)	Publish and circulate revised CEMP standard methods (A3B, F2 and F5).	
30-May-99	F5.14	Refine and publish a new CEMP standard method for monitoring coastal fish populations using pellets of the Antarctic shag (<i>Phalacrocorax bransfieldensis</i>).	Drs R. Casaux and E. Barrera-Oro (Argentina)
30-Jun-99	S12.13 (S12.11–12.12)	Revise the book <i>Understanding CCAMLR's Approach to Management</i> and precis the information to produce a brief publication summarising the work of the Scientific Committee for the benefit of the Commission.	
CCAMLR website:			
01-Mar-99	S14.6 (S14.3–14.5)	Disseminate copies of the SC-CAMLR-XVII report via the website.	
19-Jul-99	E11.8 (E13.10–13.16 E12.6 S10.15–10.22)	Continue work on the website, including the development of a standard format for summary information on Members' activities in relation to WG-EMM and WG-FSA.	Members
01-Sep-99	S10.22	Link the website to other agencies within the Antarctic Treaty System and to those of Members of the Joint Committee on Antarctic Data Management.	
Meeting arrangements:			
30-Nov-98	S13.10 (S13.12)	Plan intersessional work in support of the Scientific Committee.	Scientific Committee Chairman and Working Group Conveners
16-Jul-99	S11.26	Invite all observers who attended meetings of the Scientific Committee and working groups in 1998 to attend the meetings in 1999.	
19-Jul-99	E11.8 (E13.5–13.6 S5.136 S6.21)	Investigate the holding of thematic sessions at meetings of WG-EMM.	Members
01-Aug-99	S18.5 (S18.6)	Advise that future consideration of papers tabled for the Scientific Committee will be limited to matters requiring action or advice from the Committee.	Members
01-Sep-99	S14.2	Revise the cost of producing the working group reports in line with expenditure incurred in 1998.	
11-Oct-99	F10.7 (S13.16)	Submit drafts to the Secretariat in electronic format and be responsible for the initial editing and development of the report.	Rapporteurs
11-Oct-99	F7.4 (S4.35)	Review representation in WG-IMALF and facilitate attendance of as many Members as possible at meetings.	Members

Deadline	Reference to Reports	Task	Collaborators
Meeting arrangements (continued):			
11-Oct-99	F9.20	Report on the intersessional work of WG-IMALF to the next meeting of WG-FSA.	WG-IMALF
11-Oct-99	ongoing (S13.16)	Maintain a pro-active approach to the Secretariat's resources and keep under review the re-allocation of existing resources, or the addition of resources, to spread the Secretariat's workload and relieve pressure points during meetings.	

Working Group on Ecosystem Monitoring and Management

Deadline	Reference to Reports	Task	Collaborators
Ecosystem background information:			
12-Oct-98	E7.33 (F5.11)	Analyse data on by-catch of fish in krill fisheries and report to WG-FSA-99.	Members
01-Feb-99	E2.6 (E12.2 S2.4)	Submit information on krill fishing activities which may have taken place or are being planned in the Convention Area.	Ukraine, Canada, Uruguay, Panama, China
19-Jul-99	E10.1	Collect information on new scientific approaches and practical aspects of ecosystem monitoring and management in other parts of the world which might be incorporated into CCAMLR's management.	Members
19-Jul-99	E2.9 (S2.5-2.6)	Collect information on past and current market prices for krill and market strategies.	Members
19-Jul-99	E8.10 (E8.11 E12.3)	Investigate the decline of macaroni and gentoo penguins and black-browed albatrosses in Subarea 48.3.	Members
19-Jul-99	E8.15 (E12.3 S4.19)	Examine the relationship between penguin population sizes at CEMP study colonies at Marion Island and those of the entire area.	Dr R. Crawford (South Africa)
19-Jul-99	S6.12	Liaise with fishers to determine the manner in which fishing practices may be varied in local areas important to predators.	Members
11-Oct-99	F5.11 (F5.12 F9.16 S6.24)	Investigate practical aspects of deploying scientific observers on vessels fishing for krill and conduct pilot studies on sampling by-catch in the krill fisheries.	Members
Ecosystem data management:			
01-Feb-99	ongoing (E2.3 E12.2 S2.2)	Submit catch and effort data for krill fisheries in waters adjacent to the Convention Area.	Members
31-Mar-99	E9.27	Submit data (B4) for Cape petrels at Bouvet Island and Antarctic petrels at Svarthamaren.	Dr S.-H. Lorentsen (Norway)

Deadline	Reference to Reports	Task	Collaborators
Ecosystem data management (continued):			
31-Mar-99	E9.28 (S13.7)	Submit data on Antarctic petrel population size and breeding success (B5).	Drs J. van Franeker (Netherlands) and P. Hodum (USA)
30-Jun-99	E5.10 (E12.2 S4.14)	Update information and data on Members' CEMP activities.	Members
30-Jun-99	E5.9	Submit CEMP data from Admiralty Bay.	Dr R. Holt (USA)
30-Jun-99	ongoing (E2.4 E2.13 E12.2 S2.3 S3.1)	Submit all available data from krill fisheries in the Convention Area, including fine-scale data, haul-by-haul data and observer data.	Members
01-Jul-99	S13.7	Update CEMP data.	
19-Jul-99	E6.4 (E12.2)	Identify needs for oceanographic data to monitor the Indian Ocean Sector of Antarctic waters and encourage Ukraine to provide appropriate data.	Ukraine and other Members
19-Jul-99	ongoing (S13.7)	Manage and develop CEMP database.	
Ecosystem analysis and assessment:			
31-Jan-99	E7.11 (E12.3 S6.7)	Develop and archive a comprehensive set of documentation for the krill yield model.	
01-Feb-99	E7.19 (E12.2 E12.3)	Request further information on analyses linking krill density to variations in atmospheric pressure.	Ukraine
01-Feb-99	E7.22 (E12.3)	Collect information on the origin of krill in Area 58.	Members
01-Feb-99	E7.29 (E12.3 S6.12)	Develop a functional relationship between predators, krill and the fishery.	Members
31-May-99	E8.3 (E7.1–7.4 E8.4–8.7 E12.3 S6.15)	Automate the generation of ecosystem assessment summaries and CSIs.	Members
30-Jun-99	E5.1	Develop methodology that can take account of missing values in assessing CEMP anomalies.	Members
30-Jun-99	E5.1	Update calculations of CEMP indices.	
30-Jun-99	E7.28 (E7.29 E12.3 S6.11)	Investigate the performance of the Schroeder Index and Agnew–Phegan Index.	
19-Jul-99	E4.37 (E3.7 E12.2)	Investigate use of krill length-density data from local areas in estimating large-scale trends in absolute recruitment.	Members
19-Jul-99	E6.10 (E12.3)	Formulate and test ecosystem predictions arising from the anticipated influence of the 1997/98 El Niño.	Members

Deadline	Reference to Reports		Task	Collaborators
Ecosystem analysis and assessment (continued):				
19-Jul-99	E6.8	(E12.7)	Develop spatial indices to determine variability in the characteristics of polynyas.	Dr M. Naganobu (Japan)
19-Jul-99	E7.2	(E7.1 E12.3)	Establish the most appropriate statistical approach to the calculation of covariance matrices for CSIs.	Drs A. Constable (Australia) and I. Boyd (UK)
19-Jul-99	E7.21	(E7.20 E12.7 S6.9)	Carry out further analyses with regard to predicting krill recruitment.	Members
19-Jul-99	E7.32	(E12.3)	Continue work on the correlation of <i>Chamsocephalus gunnari</i> condition index with krill density in Subareas 48.1 and 48.3.	Dr Everson
19-Jul-99	E7.8	(S6.6 F5.15–5.16)	Develop multivariate approaches including exploration of the sensitivity of such analyses to CSIs.	Members
19-Jul-99	E8.17	(E8.18)	Develop a framework for evaluating the status on the ecosystem.	Members
19-Jul-99	E8.18	(E8.19 E8.17)	Develop advice for managing the ecosystem.	Members
19-Jul-99	E9.11	(E9.12 E12.3)	Investigate the statistical properties and robustness of the per capita recruitment (PCR) index for krill.	Members
19-Jul-99	S13.7		Develop indices of local krill availability.	Members
CEMP standard methods:				
30-Jun-99	E9.48	(E12.4 S6.3)	Develop methods for environmental indices F1, F3 and F4.	Members
19-Jul-99	E8.5	(E8.6 E9.18 E12.3 E12.4 S4.18–4.21)	Review Method A3.	Members
19-Jul-99	E9.21	(E5.6 E9.19 E9.20 E12.4)	Review Method A5.	Subgroup on Methods
19-Jul-99	E9.23	(E9.22 E12.4)	Review Method A6.	Subgroup on Methods
19-Jul-99	E9.29		Revise Methods C3 and C4.	Dr I. Boyd (UK)
19-Jul-99	E9.35	(E12.4 S4.26–4.30 S13.7)	Develop a standard method for recording the behaviour of birds at sea.	SCAR and Members
19-Jul-99	E9.38	(E9.37 S4.33)	Develop a technique for monitoring the abundance of crabeater seals at CEMP sites.	SCAR Group of Specialists on Seals

Deadline	Reference to Reports	Task	Collaborators
Synoptic survey of Area 48:			
01-Mar-99	F5.13 (S6.24)	Provide data collection plans to the survey planning workshop (March 1999).	Members
01-Mar-99	S4.25	Consider the opportunity to acquire simultaneous data on the distribution and abundance of marine mammals and birds during the forthcoming synoptic survey.	Members
30-Jun-99	E9.83 (E9.81 S5.14 S13.7)	Develop appropriate data storage formats for all core data and meta-data.	Dr J. Watkins (UK)
19-Jul-99	E9.84 (E9.86–9.89 E12.5 S5.11)	Plan the survey.	Drs J. Watkins (UK), R. Hewitt (USA) and M. Naganobu (Japan)
19-Jul-99	ongoing (S13.7)	Collect and log acoustic data without any noise removal or thresholding techniques.	Members
19-Jul-99	S13.7	Continue studies on species discrimination in acoustic surveys.	Members
30-Jun-00	E9.81 (E9.82 E9.83 S5.13)	Analyse core data from the survey.	Members

Working Group on Fish Stock Assessment

Deadline	Reference to Reports	Task	Collaborators
Fisheries data management:			
31-Dec-98	F3.19 (F4.134 F9.16 S5.71)	Resolve difficulties with the submission of haul-by-haul data from the Ukrainian fishery in Division 58.5.1.	Ukraine and France
30-Sep-99	S13.7	Develop methods for electronically submitting data.	
11-Oct-99	F3.40	Investigate the stock-recruitment relationship for <i>D. eleginoides</i> in areas where there has been substantial unregulated fishing and for which current yield estimates are low.	Members
11-Oct-99	ongoing (F9.16)	Process all available data from the split-year prior to the meeting, as well as, where possible, all available data from current fishing.	
11-Oct-99	ongoing (S13.7)	Manage and develop fishery databases.	
11-Oct-99	ongoing (F4.97)	Ensure that 'zero' catches are recorded in the data (C2) submitted to CCAMLR.	Members
11-Oct-99	ongoing (F3.12 F9.16 S5.24)	Collect and submit bathymetry data.	Members

Deadline	Reference to Reports	Task	Collaborators
Stock analysis and assessment:			
31-Jan-99	F4.114 (F4.89–4.90 F9.17 S5.53 F13.7)	Revise the procedure for extracting length-frequency data.	Profs C. Moreno and P. Arana (Chile)
30-Jun-99	F3.148 (F3.142 F3.146 F9.17 E7.10 E12.3 S5.36)	Establish a central repository of stock assessment programs, including their development, use and validation.	Members
30-Jun-99	F9.17 (S5.48 S6.16)	Document the history of stock assessments conducted by WG-FSA and WG-EMM.	
30-Jun-99	F9.17	Collect further information on <i>Dissostichus mawsoni</i> .	
31-Jul-99	S5.42 (S5.52)	Acquire appropriate software for conducting a variety of depletion analyses in time for the next meeting of WG-FSA.	
11-Oct-99	F3.146 (F3.148 F9.17 E7.9 E7.10)	Validate new and developing stock assessment programs, and submit tests and datasets so as to develop a library of validation procedures.	Members
11-Oct-99	F3.90 (F3.91–3.92 F9.17 S5.26)	Address the currency of stock assessments and the frequency of their revision.	Members
11-Oct-99	F4.110	Formulate management advice based on analyses of CPUE.	Members
11-Oct-99	F4.129 (F4.147 S5.66 S5.80 S5.84)	Verify recruitment estimates for <i>D. eleginoides</i> in Division 58.5.1 and Subareas 58.6 and 58.7.	Members
11-Oct-99	F9.10 (F9.17 S5.133)	Analyse biological data on <i>Champscephalus gunnari</i> in preparation for future workshop.	Members
11-Oct-99	F9.11 (F9.17 S5.134–5.138)	Undertake intersessional work on <i>Dissostichus</i> spp. including development of stock assessment and management advice.	Members and technical coordinators
11-Oct-99	F9.17	Quantify the catch of <i>Dissostichus</i> spp. in illegal and unregulated fisheries.	Members
11-Oct-99	F9.17 (F9.2 S5.130)	Identify the scope for a study on by-catch in trawl and longline fisheries for <i>Dissostichus</i> spp.	Members
11-Oct-99	S5.116 (F4.52)	Provide information on by-catch species, including <i>Macrourus carinatus</i> , in order to assess their potential yield in Subarea 88.1.	New Zealand and other Members
11-Oct-99	S9.38	Undertake further work on stock boundaries for <i>Dissostichus</i> spp.	Members
New and exploratory fisheries:			
30-Jun-99	F3.9 (F9.17)	Update estimates of seabed areas using high resolution (1 x 1 minute grid) bathymetry dataset.	Drs D. Sandwell and W. Smith (USA)

Deadline	Reference to Reports	Task	Collaborators
New and exploratory fisheries (continued):			
01-Sep-99	F7.105 (F7.102–104 F7.111 F7.199 F9.18)	Review the distribution of all seabirds known to be at risk of by-catch in longline fisheries in the Convention Area and provide a basis for future advice for new and exploratory fisheries.	WG-IMALF
11-Oct-99	F3.87 (F9.17)	Collect information on mesh/hook selectivity so as to estimate the potential range of catch rates in new and exploratory fisheries from observations made during surveys.	Members
11-Oct-99	F4.20	Investigate the properties of a proposed 'sliding scale' for biological sampling for <i>Dissostichus</i> spp.	South Africa
11-Oct-99	F4.40 (F4.78 F9.17 S5.25 S9.28 S9.48)	Conduct research surveys to estimate biomass of <i>Dissostichus</i> spp. during the early stages of development of new and exploratory fisheries.	Members
11-Oct-99	F4.64 (F3.119 S5.33)	Identify stocks of <i>D. eleginoides</i> based on gene flow studies.	Members
11-Oct-99	F9.17 (F4.51 S9.32)	Examine decision rules for by-catch species in new and exploratory fisheries.	Members
11-Oct-99	S7.10	Consider the effectiveness of by-catch regulations in the light of new observer information and ways in which by-catches on longlines can be quantified.	Members
11-Oct-99	S9.27 (F4.14–4.16 S9.11)	Summarise Members' notifications for new and exploratory fisheries in 1999/2000.	Members
11-Oct-99	S9.33 (S9.32)	Examine the merit of setting catch limits for fine-scale rectangles based on decision rules related to initial catch rates.	Dr K. Sullivan (New Zealand)
Fishery surveys and data:			
31-Dec-98	F3.6 (F3.144 F9.16)	Correct problems with the dates of samples taken and depth records within the UK survey dataset.	Drs P. Gasiukov (Russia) and I. Everson (UK)
31-Dec-98	F3.7 (F4.106 F9.16 S5.23 S5.135 S13.7)	Transfer all available survey data to the newly-designed research survey database.	Members
30-Jun-99	F3.104 (F9.16 S13.7)	Develop a central register of collections of <i>Dissostichus</i> spp. otoliths and scales.	Mr R. Williams (Australia)
11-Oct-99	F3.108 (F9.17)	Investigate the use of scales and otoliths for age determination of <i>Dissostichus</i> spp.	Members
11-Oct-99	F3.118 (S5.33)	Provide information on the movement of <i>D. eleginoides</i> based on tagging studies.	Prof C. Moreno (Chile)
11-Oct-99	F3.135	Examine further the relationship between estimates of the standing stock of <i>Gobionotothen gibberifrons</i> derived from offshore trawl surveys and trammel nets set inshore.	Dr E. Barrera-Oro (Argentina) and Mr C. Jones (USA)
11-Oct-99	ongoing (S13.7)	Manage and develop research survey database.	

Working Group on Incidental Mortality Arising from Longline Fishing

Deadline	Reference to Reports	Task	Collaborators
Members' research and development activities:			
01-Feb-99	F7.144 (S4.52)	Circulate technical diagrams of the reconfigured waste-pipe system of the <i>Koryo Maru 11</i> to assist other vessels with offal discharge problems.	Mr M. Purves (South Africa)
01-Feb-99	F7.150 (F7.151 S4.52)	Encourage the development of automated methods for adding and removing weights to the line, or the manufacture of longlines with weights incorporated within them.	Technical Coordinators and gear manufacturers
01-Feb-99	F7.155 (F7.162 F7.205 F9.18 S4.52 S13.7)	Request information on line-setting devices and the results of at-sea trials.	Members and Mustad company
01-Feb-99	S13.7	Request information on the use of artificial bait.	Members and Mustad company
01-Sep-99	F7.8 (F9.18 S4.37 S13.7)	Provide summaries of research programs into the status of albatrosses, giant petrels and <i>Procellaria</i> petrels.	France and other Members
11-Oct-99	F7.168 (F7.167 F7.191 F7.205 F9.18 S4.52)	Undertake research on the effects of line sink rates on seabird by-catch, and investigate bait taking by different seabird species in relation to bait depth, propeller wash turbulence and streamer lines.	Members
11-Oct-99	F7.53 (F9.18)	Assess the relative contribution that the 5-n-mile exclusion zone around Prince Edward Islands may have made to the reduction in by-catch rates between 1997 and 1998.	Dr P. Ryan and Mr M. Purves (South Africa)
Data acquisition and analysis:			
01-Feb-99	F7.121 (F7.135 F7.136 F7.204 S13.7)	Request advice on the nature and magnitude of the incidental mortality of seabirds from the Convention Area during longline fishing operations outside the Convention Area.	Members and Non-Contracting Parties
01-Feb-99	F7.24 (F9.18 S4.41)	Request detailed data on seabird by-catch collected by observers within the French EEZ in Division 58.5.1.	France
01-Aug-99	F7.200 (F7.22-7.24)	Submit data for longline fisheries in the Convention Area for comprehensive analysis and assessment	Members
01-Sep-99	F7.17 (F7.16 F7.59 F9.18 S4.40)	Undertake analyses of seabird by-catch data.	Members

**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
AFZ	Australian Fishing Zone
AMD	Antarctic Master Directory
AMLR	Antarctic Marine Living Resources (USA)
APIS	Antarctic Pack-Ice Seals Program (SCAR-GSS)
ASIP	Antarctic Site Inventory Project
ASMA	Antarctic Specially Managed Area
ASPA	Antarctic Specially Protected Area
ASOC	Antarctic and Southern Ocean Coalition
ATCM	Antarctic Treaty Consultative Meeting
ATCP	Antarctic Treaty Consultative Party
ATSCM	Antarctic Treaty Special Consultative Meeting
AVHRR	Advanced Very High Resolution Radiometry
BAS	British Antarctic Survey
BIOMASS	Biological Investigations of Marine Antarctic Systems and Stocks (SCAR/SCOR)
CBD	Convention on Biodiversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCAS	Convention for the Conservation of Antarctic Seals
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CCSBT-ERSWG	CCSBT Ecologically Related Species Working Group
CDW	Circumpolar Deep Water
CEMP	CCAMLR Ecosystem Monitoring Program
CEP	Committee for Environmental Protection
CITES	Convention on International Trade in Endangered Species

CMS	Convention on the Conservation of Migratory Species of Wild Animals
COFI	Committee on Fisheries (FAO)
COMM CIRC	Commission Circular (CCAMLR)
COMNAP	Council of Managers of National Antarctic Programs (SCAR)
CPD	Critical Period–Distance
CPUE	Catch per Unit Effort
CS-EASIZ	Coastal Shelf Sector of the Ecology of the Antarctic Sea-Ice Zone (SCAR)
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)
DPOI	Drake Passage Oscillation Index
EASIZ	Ecology of the Antarctic Sea-Ice Zone
EEZ	Exclusive Economic Zone
EIV	Ecologically important value
ENSO	El Niño Southern Oscillation
EPOS	European <i>Polarstern</i> Study
FAO	Food and Agriculture Organisation
FFA	Forum Fisheries Agency
FFO	Foraging–Fishery Overlap
FIBEX	First International BIOMASS Experiment
FRAM	Fine Resolution Antarctic Model
FV	Fishing Vessel
GAM	Generalised Additive Model
GEBCO	General Bathymetric Chart of the Oceans
GIS	Geographic Information System
GLM	Generalised Linear Model

GLOBEC	Global Ocean Ecosystems Dynamics Research (US Global Change Research Program)
GLOCHANT	Global Change in the Antarctic (SCAR)
GMT	Greenwich Mean Time
GOOS	Global Ocean Observing System (SCOR)
GOSEAC	Group of Specialists on Environmental Affairs and Conservation (SCAR)
GOSSEO	Group of Specialists on Southern Ocean Ecology (SCAR/SCOR)
GPS	Global Positioning System
GRT	Gross Registered Tonnage
GYM	Generalised Yield Model
IAATO	International Association of Antarctica Tour Operators
IASOS	Institute for Antarctic and Southern Ocean Studies (Australia)
IASOS/CRC	IASOS Cooperative Research Centre for the Antarctic and Southern Ocean Environment
IATTC (I-ATTC)	Inter-American Tropical Tuna Commission
ICAIR	International Centre for Antarctic Information and Research
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
ICES FAST Working Group	ICES Fisheries Acoustics Science and Technology Working Group
ICSEAF	International Commission for the Southeast Atlantic Fisheries
IDCR	International Decade of Cetacean Research
IGBP	International Geosphere Biosphere Programme
IHO	International Hydrographic Organisation
IKMT	Isaacs-Kidd Midwater Trawl
IMALF	Incidental Mortality Arising from Longline Fishing
IMO	International Maritime Organisation
IOC	Intergovernmental Oceanographic Commission
IOCSOC	IOC Regional Committee for the Southern Ocean
IOFC	Indian Ocean Fisheries Commission

IOTC	Indian Ocean Tuna Commission
IPOA	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
IWC	International Whaling Commission
IWC-IDCR	IWC International Decade of Cetacean Research
JGOFS	Joint Global Ocean Flux Studies (SCOR/IGBP)
LMR	Living Marine Resources Module (GOOS)
LTER	Long-term Ecological Research (USA)
MARPOL Convention	the International Convention for the Prevention of Marine Pollution by Dumping of Wastes and other Matter
MBAL	Minimum biologically acceptable limits
MSY	Maximum Sustainable Yield
MV	Merchant Vessel
MVBS	Mean Volume Backscattering Strength
MVUE	Minimum Variance Unbiased Estimate
NAFO	Northwest Atlantic Fisheries Organisation
NASA	National Aeronautical and Space Administration (USA)
NCAR	National Center for Atmospheric Research (USA)
NEAFC	Northeast Atlantic Fisheries Commission
NMFS	National Marine Fisheries Service (USA)
NMML	National Marine Mammal Laboratory (USA)
NOAA	National Oceanic and Atmospheric Administration (USA)
NRT	Net Registered Tonnage
NSF	National Science Foundation (USA)

NSIDC	National Snow and Ice Data Center (USA)
OECD	Organisation for Economic Cooperation and Development
PCA	Principal Component Analysis
PCR	Per Capita Recruitment
PTT	Platform Transmitter Terminals
RMT	Research Midwater Trawl
ROV	Remotely-operated Vehicle
RTMP	Real-time Monitoring Program
RV	Research Vessel
SACCF	Southern Antarctic Circumpolar Current Front
SCAF	CCAMLR Standing Committee on Administration and Finance
SCAR	Scientific Committee on Antarctic Research
SCAR-ASPECT	Antarctic Sea-Ice Processes, Ecosystems and Climate (SCAR Program)
SCAR-BBS	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
SC-CAMLR	Scientific Committee for CCAMLR
SC CIRC	Scientific Committee circular (CCAMLR)
SC-CMS	Scientific Committee for CMS
SC-IWC	Scientific Committee for IWC
SCOI	CCAMLR Standing Committee on Observation and Inspection
SCOR	Scientific Committee on Oceanic Research
SD	Standard Deviation
SeaWiFS	Sea-viewing Wide field-of-view Sensor
SIBEX	Second International BIOMASS Experiment

SO-GLOBEC	Southern Ocean GLOBEC
SOI	Southern Oscillation Index
SO-JGOFS	Southern Ocean JGOFS
SOWER	Southern Ocean Whale Ecology Research Cruises
SPA	Sequential population analysis
SPC	South Pacific Commission
SSSI	Site of special scientific interest
SST	Sea-surface Temperature
TDR	Time Depth Recorder
TEWG	Transitional Environmental Working Group
TIRIS	Texas Instruments Radio Identification System
TS	Target Strength
TVG	Time Varied Gain
UN	United Nations
UNCED	UN Conference on Environment 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
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 <i>D. eleginoides</i>
WWD	West Wind Drift
WWW	World Wide Web
XBT	Expendable Bathythermograph