SC-CAMLR-XV

SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

REPORT OF THE FIFTEENTH MEETING OF THE SCIENTIFIC COMMITTEE

HOBART, AUSTRALIA
21 – 25 OCTOBER, 1996

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Abstract

This document presents the adopted record of the Fifteenth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 21 to 25 October 1996. Major topics discussed at this meeting include: the CCAMLR ecosystem monitoring program, krill, fish, crab and squid resources, marine mammal and bird populations, assessment of incidental mortality, ecosystem monitoring and management, and management under conditions of uncertainty. 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 FIFTEENTH MEETING
OF THE SCIENTIFIC COMMITTEE
(Hobart, Australia, 21 to 25 October 1996)

OPENING OF THE MEETING

1.1 The Scientific Committee for the Conservation of Antarctic Marine Living Resources met under the Chairmanship of Dr K.-H. Kock (Germany) from 21 to 25 October 1996 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 noted that Uruguay had become a full Member of the Commission since the last meeting.

1.4 The Chairman welcomed to the meeting observers from Finland, Greece, the Antarctic and Southern Ocean Coalition (ASOC), the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), the Intergovernmental Oceanographic Commission (IOC), and the International Whaling Commission (IWC) and encouraged them to participate in the meeting as appropriate.

1.5 A List of Participants is given in Annex 1. A List of Documents considered during the meeting is given in Annex 2.

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

- Prof. G. Duhamel (France), Fishery Status and Trends;
- Mr T. Ichii (Japan), Species Monitored in the CCAMLR Ecosystem Monitoring Program;
- Dr J. Croxall (UK), Assessment of Incidental Mortality;
- Dr R. Holt (USA), Marine Mammal and Bird Populations;
- Dr S. Nicol (Australia), Krill Resources;
- Prof. J. Beddington and Dr G. Parkes (UK), Fish Resources in Area 48;
- Mr R. Williams (Australia), Fish Resources in Areas 58 and 88;
- Lic. E Marschoff (Argentina), Fish Resources – General;
- Dr G. Watters (USA), Crab Resources;

- Dr I. Everson (UK), Squid Resources;
- Dr G. Kirkwood (UK), Ecosystem Monitoring and Management;
- Dr W. de la Mare (Australia), Management under Conditions of Uncertainty about Stock Size and Sustainable Yield;
- Dr D. Miller (South Africa), Scientific Research Exemption;
- Dr P. Penhale (USA), New and Exploratory Fisheries;
- Dr E. Balguerías (Spain), CCAMLR Data Management;
- Dr B. Fernholm (Sweden), Cooperation with Other Organisations; and
- Secretariat, all other matters.

Adoption of the Agenda

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

Report of the Chairman

1.8 The Chairman noted that Members had continued their work during the intersessional period with several meetings taking place. The Chairman expressed his gratitude to Norway for hosting the meeting of WG-EMM and the Subgroup on Monitoring Methods.

1.9 The second meeting of WG-EMM was held from 12 to 22 August 1996 in Bergen, Norway, and was chaired by its Convener, Dr Everson. Two subgroups associated with this Working Group also met during the intersessional period:

(i) the Subgroup on Statistics met in Cambridge, UK, from 7 to 9 May 1996 under the convenership of Dr D. Agnew (Data Manager); and

(ii) the Subgroup on Monitoring Methods met in Bergen, Norway, from 8 to 10 August 1996, prior to the WG-EMM meeting. It was convened by Dr K. Kerry (Australia).

1.10 WG-FSA met in Hobart, Australia, from 7 to 16 October 1996, and was chaired by its Convener, Dr de la Mare.

1.11 There was no meeting of ad hoc WG-IMALF. As was the case in 1995, a coordinating group conducted its work by correspondence during the intersessional period and its report was considered during WG-FSA.

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

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

1.14 In the 1995/96 season, it was a requirement of Conservation Measure 93/XIV that an observer designated under the Scheme of International Scientific Observation be on board each vessel fishing for *Dissostichus eleginoides* in Subarea 48.3. The Chairman reported that, in accordance with this requirement, Argentina, Chile, Germany, Russia and Ukraine had designated observers.

1.15 The Chairman advised that during the intersessional period there had been fisheries for *D. eleginoides* in Subarea 48.3 and Division 58.5.1 (around Kerguelen), for krill in Subareas 48.1, 48.2 and 48.3 and for crab in Subarea 48.3.

1.16 There was no reported fishing for *Electrona carlsbergi* or *Lepidonotothen squamifrons* although fisheries for these species were open in the 1995/96 season. There was also no reported fishing, although limited TACs were in place, for *Champsocephalus gunnari* in Subarea 48.3 and Division 58.5.2, for *D. eleginoides* in Subarea 48.4 and Division 58.5.2, or for *D. eleginoides* or *D. mawsoni* in Division 58.4.3.

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

- Krill Harvesting Workshop (14 to 16 November 1995, Vancouver, Canada) – Dr D. Agnew (Data Manager);

- CCSBT Ecologically Related Species (ERS) Working Group (18 to 20 December 1996, Wellington, New Zealand) – Dr N. Hermes (Australia);

- SCAR-COMNAP – Second Environment Workshop (25 to 29 March 1996, Texas, USA) – Dr Agnew;

- IWC Steering Workshop on Effects of Climate Change on Cetaceans (March 1996, Hawaii, USA) – Dr K.-H. Kock (Chairman, Scientific Committee);

- 1996 Annual Meeting of the IWC Scientific Committee (5 to 17 June 1996, Aberdeen, UK) – Dr Kock;

- ICCAT Tuna Symposium (10 to 18 June 1996, San Miguel Is, Azores, Portugal) – Spain;

- APIS Planning Meeting (29 to 31 July 1996, Cambridge, UK) – Dr I. Boyd (UK);

- CS-EASIZ (August 1996, Cambridge, UK) – Dr M. Fukuchi (Japan);

- XXIV SCAR (4 to 16 August 1996, Cambridge, UK) – Dr J. Croxall (UK) (birds), Dr D. Miller (South Africa) (GOSSOE) and Dr J. Bengtson (USA) (seals);

- First South Ocean Forum and Sixth Session of the IOC Regional Committee for the Southern Ocean (9 to 13 September 1996, Bremerhaven, Germany) – Dr Kock;

- Third International Penguin Conference (2 to 6 September 1996, Cape Town, South Africa) – Dr K. Kerry (Australia); and

- XXIII General Meeting of SCOR (16 to 20 September 1996, Southampton, UK) – Dr J. Priddle (UK).

FISHERY STATUS AND TRENDS

Krill

2.1 Catches referred to in this agenda item are reported catches.

2.2 The catch of krill (*Euphausia superba)* for the 1995/96 season totalled 101 707 tonnes (SC-CAMLR-XV/BG/1 Rev.2), i.e. 14% less than the 1994/95 figure (118 712 tonnes). This total is almost exclusively made up of catches taken by Japan, Poland and Ukraine (Tables 1 and 2). The majority of catches were taken in Subareas 48.1 and 48.3, with some also being taken in Subarea 48.2. No commercial catches were taken in Areas 58 and 88.

Table 1: National krill catches (in tonnes) since 1987/88 based on STATLANT returns.

Country	Split-year*								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
Chile	5938	5329	4500	3679	6065	3261	3834		
Germany			396						
Japan	73112	78928	62187	67582	74325	59272	62322	60303	60546
Latvia							71		
Republic of Korea	1525	1779	4039	1210	519				
Panama								141	495
Poland	5215	6997	1275	9571	8607	15909	7915	9384	20610
USSR**	284873	301498	302376	275495					
Russia					151725	4249	965		
South Africa							2		
Ukraine					61719	6083	8852	48884	20056
Total	370663	394531	374773	357537	302960	88774	83961	118712	101707

* The Antarctic split-year begins on 1 July and ends on 30 June. The column 'split-year' refers to the calendar year in which the split-year ends (e.g., 1989 refers to the 1988/89 split-year).

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

Table 2: Total krill catch (in tonnes) in 1995/96 by area and country. The catch for 1994/95 is indicated in brackets.

Subarea / Division	Japan		Panama		Poland		Ukraine		Total	
48.1	45719	(29070)			14927	(1278)	1738	(4677)	62384	(35025)
48.2	4	(10216)			24	(6563)	2706	(32054)	2734	(48833)
48.3	14823	(19751)	495	(141)	5659	(1543)	15612	(12155)	36589	(33590)
58.4.1		(1266)								(1266)
Total	60546	(60303)	495	(141)	20610	(9384)	20056	(48886)	101707	(118714)

2.3 Dr Holt enquired whether all Panama's catches were included in the table. The Secretariat explained that it had no additional information but that an official enquiry about these data would be made to Panama. It stressed, however, that it is difficult to obtain data from a non-Member country.

2.4 It appeared also that the survey catches reported by India from Area 58 are not included in Tables 1 and 2. The Secretariat was requested to contact India regarding these catches.

2.5 A summary of information provided by Members on their plans for krill fishing in 1996/97 is presented in Table 3.

Table 3: Plans for krill fishing by CCAMLR Members for the 1996/97 fishing season.

Member	Harvesting	Compared to 1995/96	Preferred Fishing Area	Planned Fishing Effort (Vessels)
Japan	yes	=	48.1	4
Poland	yes	=	?	4
Ukraine	yes	=	?	?
Russia	no			
Chile	no			

2.6 Dr Holt indicated that the USA expressed an interest in fishing for krill, although at present no actual plan had been formulated. Furthermore, information had been received at the WG-EMM meeting that Canada may be interested in fishing for krill for use in the fish farming industry.

2.7 Other comments on the development of the krill fishery are contained in paragraphs 11.22 to 11.25.

Fish

2.8 The total reported catch of finfish in the Convention Area in 1995/96 was 8 805 tonnes (Table 4), mainly (99 %) *D. eleginoides* (8 739 tonnes). The majority of catches were made by Chile and France in Subarea 48.3 and Division 58.5.1 respectively. The total catch was less than that declared in 1994/95 because there was no fishery for *C. gunnari*.

Table 4: National finfish catches (in tonnes) since 1987/88 based on STATLANT returns.

Country	Split-year*								
	1988	1989	1990	1991	1992	1993	1994	1995	1996
Argentina							9	867	107
Australia					4		2		
Bulgaria					114	220	70	177	
Chile					2917	2125	150	1894	3092
FRG	12								
France	488	587	579	1576	1589	826	4211	4173	3673
GDR	1198								
Japan									263
Republic of Korea							143	420	381
Poland	1659	12	523	41					
Russia			1453[1]		48589	281	265	11	102
Spain				35					
Ukraine		440[1]	3530[1]		11265	2346	942	5473	1003
UK	58	4	61	9	10		6		
USA	4								184
USSR**	84688	103813	46092	97240					
Total	88107	104856	52238	98901	64488	5798	5798	13015	8805

* and ** Refer to footnotes in Table 1.

[1] Recently submitted historical catch data has assigned a proportion of the former USSR catches to Ukraine and Russia.

Table 5: Total finfish catch (in tonnes) in 1995/96 by area and country. The catch for 1994/95 is indicated in brackets.

Subarea/ Division	Argentina		Bulgaria		Chile		France		Japan		Republic of Korea	
48.3	107	(867)	0	(177)	3092	(1894)					381	(420)
58.5.1							3670	(4058)	263	(0)		
58.6							3	(115)				
Total	107	(867)	0	(177)	3092	(1894)	3673	(4173)	263	(0)	381	(420)

Subarea/ Division	Russia		Ukraine		USA		Total	
48.3	102	(11)			184	(0)	3866	(3369)
58.5.1			1003	(5473)			4936	(9531)
58.6							3	(115)
Total	102	(11)	1003	(5473)	184	(0)	8805	(13015)

2.9 There appears to be a rapid expansion in the Convention Area of longline fisheries for *D. eleginoides* taking place in the southwest of the Indian Ocean sector of the Southern Ocean. During 1995/96 a high level of fishing took place in previously unfished Subareas 58.6 and 58.7. The unreported catches in these divisions may have been as large as, or even larger than the total catch declared to CCAMLR. The Scientific Committee is extremely concerned about this problem and has informed the Commission's Standing Committee on Observation and Inspection (SCOI) accordingly.

2.10 Eight Members reported catches of *D. eleginoides*. This shows the great deal of interest taken in this species, but it was noted that no catches had been reported for the four finfish fisheries for other species for which conservation measures were in force.

2.11 Trends for future finfish harvesting principally involve *D. eleginoides*, as is highlighted by the number of notifications of new fisheries for this species, especially in the Indian Ocean sector of the Southern Ocean. Table 6 summarises Members' plans for the 1996/97 season, including plans for surveys of finfish resources.

Table 6: Members' plans for finfish fisheries and surveys of fish resources for the 1996/97 season.

Member	Target species	Area	Survey	Harvesting	Harvested Compared to 1995/96
Argentina	*D. eleginoides*	48.3	no	yes	=
	All species	48.3	yes*	no	
Australia	*D. eleginoides*, *C. gunnari*	58.5.2	no	planned*	
	D. eleginoides	58.4.3	no	planned*	
Chile	*D. eleginoides*	48.3	no	yes	=
France	*D. eleginoides*	58.5.1	no	yes*	=
	C. gunnari	58.5.1	yes*	no	
	D. eleginoides	58.6	yes	no	
Germany	All species	48.1	yes*	no	
Japan	*D. eleginoides*	58.6	yes	no	
Republic of Korea	*D. eleginoides*	48.3	no	yes	=
New Zealand	*D. eleginoides*	88.1	no	planned	
	D. eleginoides	88.2	no	planned	
Norway	*D. eleginoides*	48.6	no	planned	
South Africa	*D. eleginoides*	58.4.3	no	planned	
	D. eleginoides	58.4.4	no	planned	
	D. eleginoides	48.6	no	planned	
	D. eleginoides	58.6	no	planned	
	D. eleginoides	58.7	no	planned	
Russia	*D. eleginoides*	48.3	no	yes	
United Kingdom	All species	48.3	yes*	no	
Ukraine	*D. eleginoides*	58.5.1	no	yes	=
	L. squamifrons, *D. eleginoides*	58.4.4	yes*	yes*	

* trawling operations (NB: all other fishing operations are carried out by longline)
= same fishing effort as in the previous season

2.12 Dr Balguerías informed the Scientific Committee that Spanish companies had expressed an interest in fishing for *D. eleginoides* in Area 48. Dr Holt advised that US companies were interested in fishing in the Convention Area, although no actual plans have been submitted as yet. Uruguayan fishing companies had also expressed interest in fishing for *D. eleginoides* in Subarea 48.3.

2.13 Dr T. Øritsland (Norway) stated that no fishing permits had yet been granted to Norwegian companies and that he was particularly concerned about the rapid expansion of the fishery. Dr D. Robertson (New Zealand) advised that three New Zealand companies had expressed interest in longlining for *Dissostichus* spp. in the area to the south of New Zealand both inside and outside the Convention Area, and that one company has applied for permission for two vessels to fish in Subareas 88.1 and 88.2 in the Convention Area (see CCAMLR-XV/8 Rev. 1).

2.14 Further discussions on fishing plans submitted under Conservation Measure 31/X by Australia, New Zealand, Norway and South Africa are reflected in section 8.

2.15 Dr Kock stated that *D. mawsoni* is mentioned as a future target species for these fisheries, and that this would mean that finfish harvesting would extend to the southernmost areas. In addition, Dr de la Mare pointed out that catches of *D. eleginoides* are taken both inside and outside the Convention Area, including areas adjacent to the Convention Area in the Indian Ocean and in the Australian EEZ around Macquarie Island.

Crabs

2.16 In 1995/96, reported catches of crabs taken in the experimental fishery for *Paralomis spinosissima* in Subarea 48.3 totalled 497 tonnes. The US company involved in this exploratory fishery does not intend to continue its operations in 1996/97.

2.17 Prof. Beddington stated that companies in the UK had expressed some interest in the fishery for this species but no concrete proposals had been received. Dr Holt advised that US companies were interested in fishing for crabs in the Convention Area, although no actual plans have been submitted as yet.

2.18 None of the Members expressed any knowledge of commercial interest in a fishery for *P. aculeata*, a species which is present in Division 58.4.4 (WG-FSA-96/15).

Squid

2.19 CCAMLR-XV/MA/10 reports that an experimental catch of 52 tonnes of *Martialia hyadesi* was taken by a Korean vessel in Subarea 48.3 during seven days of fishing. This is the first time a noticeable catch of squid in the Convention Area has been reported.

2.20 Notification of a new fishery for *M. hyadesi* in Subarea 48.3 has been submitted jointly to CCAMLR for the 1996/97 season by the Republic of Korea and the UK.

2.21 It is possible that a potential fishery for *Moroteuthis ingens*, which seems to be abundant in Division 58.4.4 (WG-FSA-96/15), may not commence because of the high ammonium content of this species.

DEPENDENT SPECIES

Species Monitored in the CCAMLR Ecosystem Monitoring Program (CEMP)

Dependent Species

Report of WG-EMM

3.1 Dr Everson introduced those sections of the WG-EMM report dealing with dependent species and with species specifically studied under the CCAMLR Ecosystem Monitoring Program (CEMP).

3.2 Activities at current CEMP sites and proposed activities are described in Annex 4, paragraphs 4.1 to 4. 10.

3.3 No proposals had been received suggesting incorporation of new species into the CEMP monitoring program.

3.4 The Subgroup on Monitoring Methods had met in Bergen, Norway, under the Convenership of Dr Kerry, immediately prior to the meeting of WG-EMM. The full report of the subgroup is contained in Annex 4, Appendix I.

3.5 The Scientific Committee noted that WG-EMM approved the following new methods (Annex 4, paragraph 4.26):

(i) attachment of instruments;

(ii) data collection using TDRs; and

(iii) monitoring methods for petrels which include methods for the collection and analysis of chick diet in cape and Antarctic petrels and monitoring population size, breeding success, recruitment and adult survival rate in Antarctic petrels.

These are now recommended by the Scientific Committee for publication in the *CEMP Standard Methods*.

3.6 The Scientific Committee also noted that WG-EMM approved the following initiatives which were the subject of advice from the Subgroup on Monitoring Methods (Annex 4, paragraph 4.54):

(i) develop additional new methods for Antarctic and Cape petrels, especially those for breeding chronology;

(ii) request a study of the effects on birds of using warm or fresh water for stomach lavage;

(iii) request the Subgroup on Statistics to consider analysis of predator foraging performance data based on studies of at-sea behaviour;

(iv) maintain close links with APIS; and

(v) add advice on appropriate methods for the collection of samples for toxicological and pathological analysis as an appendix to the *CEMP Standard Methods*.

3.7 The Scientific Committee thanked Dr Kerry and the subgroup for their work. It noted that with a new edition of the *CEMP Standard Methods* in preparation, the Subgroup on Monitoring Methods will not need to meet next year. Until further notice, proposals for new methods should be submitted directly to WG-EMM.

3.8 At its 1995 meeting, WG-EMM highlighted several areas in which the analysis and presentation of data from CEMP could be improved and extended. These include:

(i) the calculation of indices of dependent species parameters and, in particular, the need for an improved method to identify anomalous years; and

(ii) extension of indices to cover harvested species and environmental parameters; and

(iii) improve the way in which the data are presented.

3.9 These issues were referred to the Subgroup on Statistics for consideration during the intersessional period. That subgroup had met, under the convenership of Dr Agnew, in Cambridge, UK, from 7 to 9 May 1996 and the report is included as Appendix H to Annex 4.

3.10 The subgroup is currently developing a new method to identify anomalous years in time series of indices of dependent species parameters (Annex 4, paragraph 4.57). Although this is a considerable improvement on previous methods, this method still fails to identify anomalies for all years where these would have been expected (Annex 4, paragraph 4.60).

3.11 WG-EMM recommended that anomalies should be interpreted with caution at this stage (Annex 4, paragraph 4.68) and recommended that questions relating to the statistical definitions of anomalies in parameters should receive further attention (Annex 4, paragraph 4.76).

3.12 Summary presentations of CEMP indices and data held in the Secretariat database were presented in WG-EMM-96/4. There was considerable discussion on the content, presentation and interpretation of data leading to a revised form of presentation given in Annex 4, Table 4.

3.13 Table 4 in Annex 4 is a presentation of normal deviates of the indices (derived through statistical analysis of the CEMP data), so that it is halfway between the previous qualitative, and somewhat subjective, presentation of data in last year's report (SC-CAMLR-XIV, Annex 4, Table 3) and a future quantitative presentation of anomalies.

3.14 The Scientific Committee noted with satisfaction this significant development in the analysis and presentation of the CEMP indices.

3.15 Dr Croxall suggested that Members should be encouraged to update CEMP Tables 1 to 3 (SC-CAMLR-XV/BG/2 Rev. 1) on an annual basis, since these tables provide a very useful conspectus of which data are actually in the database and also provide the most convenient way for the Scientific Committee to understand the status of data collection and submission in respect of the monitoring indices. The Scientific Committee endorsed this suggestion.

3.16 The Scientific Committee expressed its appreciation to Members for the very substantial effort that had been put into the submission of data and to Dr Agnew for the compilation of data in the CEMP database. It also thanked Dr Agnew for organising the Subgroup on Statistics and leading a very stimulating and profitable discussion.

3.17 Directed research studies on diet, foraging activities and population dynamics of dependent species were discussed in Annex 4, paragraphs 4.80 to 4.93.

Proposals for Extension of the Scope of CEMP

3.18 There were no proposals to extend the scope of CEMP.

Proposals for CEMP Site Protection

3.19 No specific proposals for CEMP site protection were made at the meeting.

3.20 The Scientific Committee noted that Norway will be establishing a CEMP monitoring site at Bouvet Island during the forthcoming season.

Data Requirements

3.21 There is a continuing request (Annex 4, paragraph 7.58(xii)) for all appropriate data on CEMP indicator species currently held by Members and which have not yet been submitted, including historical datasets, to be compiled and submitted in CCAMLR formats.

Assessment of Incidental Mortality

Incidental Mortality in Longline Fisheries

Intersessional Work

3.22 The Scientific Committee noted with appreciation the substantial intersessional work coordinated and undertaken by the Secretariat in conjunction with ad hoc WG-IMALF (WG-FSA-96/32). The following actions, and matters arising therefrom, were specifically noted:

(i) Members are requested to suggest appropriate changes to the membership of ad hoc WG-IMALF; the additions specified in Annex 5, paragraph 7.2 were endorsed;

(ii) thanks to all involved in the production of the book *Fish the Sea Not the Sky* and especially to Australia for the generous additional funds permitting translation into all four languages of the Commission (Annex 5, paragraph 7.5);

(iii) the Commission is requested to distribute this book to priority recipients (Annex 5, paragraph 7.6) and to undertake appropriate further distribution and evaluation (Annex 5, paragraphs 7.7 to 7.10). Further development and dissemination of the message contained in this book should be investigated (Annex 5, paragraph 7.8);

(iv) the costed proposal from New Zealand for a seabird identification manual (CCAMLR-XV/13), prepared in response to requests in previous CCAMLR reports (CCAMLR-XIV, paragraph 5.29(xi); SC-CAMLR-XIV, paragraph 3.28(iii)); the Scientific Committee endorsed the support by WG-FSA as set out in Annex 5, paragraph 7.13;

(v) the response from SCAR to requests for information on means of determining the origin of birds caught in longlines (Annex 5, paragraph 7.14);

(vi) responses to a request for information on existing and proposed monitoring of albatross, giant petrel and white-chinned petrel populations from Australia, UK, New Zealand and South Africa; similar information is awaited from France (Annex 5, paragraphs 7.15 to 7.18); and

(vii) production and circulation of the Scientific Observer Logbook (Annex 5, paragraphs 7.19).

3.23 Detailed responses were received from New Zealand (Annex 5, paragraph 7.23) and Norway (Annex 5, paragraph 7.24) in respect of the request for information on work to develop and test systems for releasing baited longlines underwater.

3.24 Based on the Norwegian experiences in the North Atlantic and observations by Chilean scientists in the South Atlantic (reported by Prof. C. Moreno), it was clear that the existing Mustad design needs substantial modification (e.g. increases to the length of the setting funnel and/or more weight on the line) to prevent the line surfacing after setting.

3.25 The Scientific Committee reaffirmed the importance of further work on underwater setting techniques and encouraged all Members with relevant information to make this widely available in order to assist in the development of more effective devices, especially those for use with the Spanish method of longlining.

3.26 The Scientific Committee noted that further analysis of the 1995 data from the Scientific Observer Program had been postponed due to lack of time and resources in the Secretariat during the intersessional period.

Data from 1996 Scientific Observer Program: Subarea 48.3

3.27 Because data from observers were generally submitted late and often in formats different from those specified by CCAMLR (Annex 5, paragraphs 7.27 to 7.30), analysis of data provided by observers had so far been possible for only three vessels.

3.28 Several Members noted that they had only received CCAMLR logbooks after their observers departed to sea in March and that this had greatly complicated and delayed the submission of data to CCAMLR. It was stressed that the revised logbook, to be available in all languages of the Commission, needed to be provided directly and promptly to those who needed to use them. This and other issues relating to the efficient conduct of the International Scheme of Scientific Observation, and especially to the collection and submission of data, are summarised in paragraphs 9.7 to 9.11.

3.29 Data collected by the three scientific observers, supplemented by their reports, indicated that a total of about 150 birds were observed killed (and another 66 released alive) with catch rates ranging from 0.02 to 0.72 birds/1 000 hooks. Most birds, and especially albatrosses, were caught during daytime (39% of all sets); white-chinned petrel was the main species caught at night.

3.30 When these catch rates are extrapolated to all longline sets of all 16 vessels in the fishery in Subarea 48.3, the resulting estimate is that about 2 300 seabirds (65% albatrosses, mainly black-browed albatrosses) were caught, of which 1 618 were killed (Annex 5, paragraph 7.40). The C2 forms submitted by nine vessels give a total of 709 birds killed, which would extrapolate to a total mortality of about 1 260 birds.

3.31 Concern was expressed that these estimates assume that data for three vessels are representative of the whole fishery. More accurate data, however, will only be available once analysis of the full dataset is completed intersessionally.

3.32 Dr A. Baker (New Zealand) noted that a substantial proportion of albatrosses (20%) and shearwaters and petrels (52%) had not been identified to species by the observers, indicating a clear need for the proposed identification manual (see paragraph 3.22(iv)). Members agreed that there was a need to develop the skill and knowledge of observers to enable accurate identification of the seabirds killed in order to improve the quality of data on by-catch provided to the Commission and thus support its conservation measures relating to incidental mortality.

3.33 The Scientific Committee endorsed the main conclusions of WG-FSA (Annex 5, paragraphs 7.51 and 7.84) in respect of the analyses of the 1996 observer data undertaken so far, i.e.:

(i) the number of seabirds, especially black-browed albatrosses, being caught is a matter of serious concern;

(ii) daytime setting is the major contributor to these high catch rates, especially of albatrosses; discharge of offal on the same side of the vessel as the haul is also contributing. Both practices increase interactions with birds and result in decreased fishing efficiency; and

(iii) the Commission should request Members to take all appropriate steps to ensure compliance with all aspects of Conservation Measure 29/XIV, thereby achieving a substantial reduction in seabird by-catch and more cost-effective fishing.

3.34 Several Members raised concerns that information from logbook data and/or reports from scientific observers were being transmitted to SCOI as evidence of infractions of conservation measures. It was agreed that the greatest care should be taken to keep separate the roles of scientific observer and CCAMLR inspector.

Seabird By-catch Data from Division 58.5.1

3.35 The Scientific Committee noted the results of an experimental study by France testing the effectiveness of mitigating measures to reduce seabird by-catch (Annex 5, paragraphs 7.53 and 7.54). The CCAMLR specification of streamer line was less effective than expected, possibly due to sea conditions, and further study is needed. Nevertheless, relatively few albatrosses were caught, 86% of the 529 birds reported being white-chinned petrels. Although offal discharge did produce significantly lower by-catch rates, the continuation of this practice is not recommended because it attracts more birds to the vicinity of the vessel.

Data from Outside the Convention Area

3.36 The Scientific Committee thanked New Zealand, UK, Australia and France for providing information on seabird by-catch and the use of mitigating measures in areas adjacent to the Convention Area. The Scientific Committee endorsed the conclusions of WG-FSA (Annex 5, paragraph 7.63) that these reports:

(i) show that by-catch of albatrosses breeding in the Convention Area is prevalent in waters outside the Convention Area;

(ii) indicate that streamer lines of CCAMLR specification are effective in reducing by-catch; and

(iii) contain methods of analysis of by-catch data of relevance to CCAMLR.

The Scientific Committee also noted with approval that the use of mitigating measures similar to those required by CCAMLR is now mandatory in two areas adjacent to the Convention Area (Falkland/Malvinas Islands and Australian Fishing Zone south of 30°S).

3.37 The Scientific Committee welcomed the establishment by CCSBT of a Working Group on Ecologically Related Species (ERS) which had considered issues of fishery-seabird interactions; it endorsed WG-FSA's comments on the following matters:

(i) the suggestion relating to closer liaison between CCAMLR and CCSBT-ERS (Annex 5, paragraph 7.67(iv) to (vi));

(ii) the encouragement to CCSBT to implement provisions to reduce by-catch of seabirds in regions adjacent to the Convention Area (Annex 5, paragraph 7.67(iii); and

(iii) the hope that other conventions regulating longline fisheries would establish groups to tackle the problems of seabird-longline fishery interactions (Annex 5, paragraph 7.68).

3.38 Mr H. Moronuki (Japan) expressed concern that:

(i) while acknowledging the content of Annex 5, paragraph 7.67, CCAMLR should not prejudge the work of the CCSBT-ERS Working Group; and

(ii) it was necessary for CCAMLR to concentrate primarily on problems in the Convention Area rather than on seabird-fishery interactions outside the Convention Area, especially given the potential start of many new longline fisheries within the Convention Area.

3.39 Many Members noted that, for albatross species and white-chinned petrels breeding in the Convention Area, interactions with fisheries during their breeding season mainly occur within the Convention Area (except for wandering albatrosses), whereas throughout the rest of the year most interactions occur with fisheries outside the Convention Area. (This has been a concern expressed by CCAMLR over the last several years and is further supported by data presented at the present meeting, e.g. WG-FSA-96/8 (Annex 5, paragraph 7.70), WG-FSA-96/9 (Annex 5, paragraph 7.65) and WG-FSA-96/62, 96/63, 96/64 and 96/65 (Annex 5, paragraphs 7.59 to 7.61)). Furthermore, CCAMLR has introduced and implemented strict conservation measures (Conservation Measure 29/XIV) designed to reduce incidental mortality; all Members proposing new longline fisheries in the Convention Area have indicated that they will abide by these provisions. Therefore it is only natural that CCAMLR should express particular concern about the potential impact on birds from the Convention Area of fisheries adjacent to the Convention Area where the use of mitigating measures is not a requirement.

3.40 It was further noted that:

(i) much of the original work to develop appropriate mitigating measures had been initiated by Japanese fishermen (and subsequently developed in conjunction with Australian scientists) and that this had provided the basis for CCAMLR's provisions; and

(ii) CCAMLR not only wished to encourage Japan which now contributes only about 44% of the estimated tuna longline effort south of 30°S (WG-FSA-96/65) to continue to use and develop improved mitigating measures, but also to encourage other fishing nations to use measures to reduce seabird by-catch in as widespread a manner as they were understood to be used within the Japanese fishery.

Issues Relevant to Fishery Management

3.41 The Scientific Committee noted the new data concerning the overlap between the foraging ranges of albatrosses breeding on South Georgia and the locations of longline fishing operations in Subarea 48.3 (Annex 5, paragraphs 7.69 and 7.70) and endorsed the conclusions of WG-FSA that substantial reductions in incidental mortality of albatrosses would be achieved by delaying the start of longline fishing in Subarea 48.3 until 1 May (Annex 5, paragraph 7.71).

3.42 However, the Scientific Committee also noted that although no Member had explicitly provided any information on the consequences of delaying fishing in Subarea 48.3 until 1 May (as requested by the Scientific Committee last year), several concerns had been expressed at the meeting relating to fishing efficiency and the consequences of increasing fishing effort during the *D. eleginoides* spawning season. Other concerns raised included the consequences for stock assessment work of changing the timing of the fishery.

3.43 There were diverse opinions on the likely significance of any problems that would be caused by the fishery being conducted from May to September, but there was agreement that this should be investigated by WG-FSA as a matter of priority.

3.44 Aspects to be investigated intersessionally, once all current observer data are available, are the consequences of changing the season of the longline fishery for *D. eleginoides* in Subarea 48.3 to May through September for:

(i) recruitment to the stock;
(ii) fishing efficiency (including analysis of CPUE data when available); and
(iii) the ability to undertake appropriate and timely stock assessment, especially including the use of the generalised linear model (GLM).

3.45 It was recognised, however, that, compared with last year, there is now more information on the potential benefits, in terms of reducing albatross by-catch, to be gained by delaying longline fishing in Subarea 48.3 until 1 May. It was therefore essential to undertake critical evaluation, on the basis of the best data currently available, of the implications of changes to the fishing season before the next meeting of the Scientific Committee.

3.46 For the time being therefore, it was agreed that the Scientific Committee could only reiterate to the Commission its advice of last year, viz. that on the understanding that there would be full compliance with Conservation Measure 29/XIV, it recommended the retention of the fishing season of 1 March to 31 August for 1996/97.

3.47 The Scientific Committee endorsed other recommendations of WG-FSA concerning:

(i) the value of the International Scheme of Scientific Observation, suggested improvements to this scheme and the need to continue 100% observer coverage within all longline fisheries (Annex 5, paragraphs 7.80 to 7.82);

(ii) the high priority of continuing the work of the Scientific Observer Data Analyst, particularly given the volume of observer data that remains to be analysed intersessionally and that envisaged to be provided under the projected new fisheries (Annex 5, paragraph 7.89); and

(iii) the retention of Conservation Measure 29/XIV in its present form, subject to a minor revision to define precisely the meanings of the terms 'nautical twilight' and 'dawn'.

3.48 The need for this revision was indicated by Dr Miller, who drew the Scientific Committee's attention to potential difficulties that may arise from different interpretations of the definition of time contained in paragraph 2 and footnote 4 of Conservation Measure 29/XIV.

3.49 The Scientific Committee agreed that, as a practical guide, 'nautical twilight' ends or begins when it is too dark to see the horizon clearly. 'Nautical twilight' is defined as the instant where the centre of the sun is at a depression angle of twelve degrees (12°) below an ideal horizon. These times are obtainable from Nautical Almanac tables for the relevant latitude, local time and date.

3.50 All times, whether for ship operations or observer reporting, must be recorded with reference to GMT. For example, a vessel keeping its own time must ensure that the times set by the Nautical Almanac (as per paragraph 3.49 above) are referenced to the GMT time-zone in which the vessel is operating.

3.51 The Scientific Committee agreed that footnote 4 should remain with the term 'dawn' being replaced by 'sunrise'.

3.52 To assist vessels to implement this element of Conservation Measure 29/XIV, the Scientific Committee requested the Secretariat to provide a table indicating approximate times of nautical twilight for the appropriate parts of the Convention Area on a basis to be determined by the Scientific Observer Data Analyst in conjunction with interested Members.

3.53 The Scientific Committee noted that the details of future work on IMALF issues would be summarised within a proposal for a program of intersessional work, as done last year (Annex 5, paragraph 7.1). This would include the requirement that next year the IMALF subgroup should commence work at the start of the meeting of WG-FSA.

3.54 The Scientific Committee also noted:

(i) the draft report of the Workshop (held in Hobart in September 1995) on Incidental Mortality of Albatrosses Associated with Longline Fishing (SC-CAMLR-XV/BG/20). This report was tabled to give Members an opportunity to comment (in writing to the editors) on any matters of interest or concern before the text is finalised in late 1996 for circulation to workshop participants for final approval;

(ii) the text of the draft resolution to the General Assembly of IUCN (meeting in Montreal, Canada in October 1996) on seabird by-catch in longline fisheries (CCAMLR-XV/BG/10) which included commendation of the recent initiatives by CCAMLR to reduce seabird by-catch;

(iii) the report by Chilean observers of the death of one Weddell seal and one Antarctic fur seal due to entanglement during longline fishing for *D. eleginoides* in Subarea 48.3 in 1996 (Annex 5, paragraph 8.3); and

(iv) data from 1996 on the impact of marine mammals on longline fisheries for *D. eleginoides*, indicating considerable loss of fish to Antarctic fur seals in Division 58.5.1 and to killer whales (orca) in Subarea 48.3 (Annex 5, paragraphs 5.18 to 5.23).

Incidental Mortality in Trawl Fisheries

3.55 Prof. Duhamel noted that practically no incidental mortality has been observed in the trawl fishery in Division 58.5.1 since the ban on the use of netsonde cables came into effect (Annex 5, paragraph 8.2). Recognising that the French trawl fishery catch currently accounts for 40% of the total reported catches of *D. eleginoides* in Division 58.5.1, this ban makes a major contribution to reducing the incidental mortality of birds in this fishery as compared to the longline fishery. This should be taken into account in management advice to the Commission.

Marine Debris

3.56 In respect of the entanglement of Antarctic fur seals in marine debris at South Georgia, Dr Croxall introduced SC-CAMLR-XV/BG/3, summarising all data reported by the UK to CCAMLR from 1989 to 1994, and SC-CAMLR-XV/BG/5, reporting the results of the most recent surveys at Bird Island, South Georgia in winter 1995 and summer 1996. These latter data indicate that the latest entanglement rates in the study population were the highest since 1993, with eight fur seals entangled in the 1995 winter and 34 in the 1996 summer. Of additional concern were the first records of seals entangled in packaging bands in winter since 1993 and the increased proportion of entanglements in summer in fishing nets and packaging bands (despite the use of the latter on fishing vessels being prohibited in the Convention Area since the start of the 1995/96 summer under Conservation Measure 63/XII). It is not unlikely that these increases reflect the increased levels of fishing activity in Subarea 48.3 and particularly by vessels not operating under the auspices of CCAMLR and therefore unlikely to be complying with Conservation Measure 63/XII.

3.57 In response to a question from Prof. Moreno, Dr Croxall noted that, although the number of seals observed entangled at Bird Island nowadays was only about one-sixth of the values in 1989, because the South Georgia fur seal population had doubled since then, the number of seals entangled annually in the whole population was probably at least in the order of 2 000 animals.

3.58 In CCAMLR-XV/BG/6 the UK also reported the entanglement of a southern elephant seal in a packaging band and seven Antarctic fur seals in fishing nets and longline material at Bird Island, South Georgia in 1996. SC-CAMLR-XV/BG/4 notes that a gentoo penguin chick was released from entanglement in a (cut) packaging band at Bird Island in 1996.

3.59 In CCAMLR-XV/BG/26 the USA reported one Antarctic fur seal entangled in synthetic cord, part of an Antarctic fur seal pup entangled in a packaging band at Seal Island, South Shetland Islands, and a southern giant petrel with a longline hook embedded in its throat near Palmer Station, Antarctic Peninsula in 1996.

3.60 Prof. D. Torres (Chile) introduced SC-CAMLR-XV/BG/27 which reports observations of four Antarctic fur seals (two juveniles and two pups) entangled in fishing net and packaging bands at Cape Shirreff, South Shetland Islands in 1996. Although the packaging band had originally been cut, it had subsequently been tied into a loop before disposal. Chilean scientists have been able to publicise these data to national and international audiences, thereby increasing awareness of CCAMLR's work in this field and of the need to continue to improve practices relating to the disposal of waste from fishing vessels at sea in the Southern Ocean, as indicated in SC-CAMLR-XV/BG/27.

3.61 Mr Moronuki advised that all Japanese krill fishing vessels are equipped with incinerators for burning waste material such as plastics and net gear and that there were no reports of fishing gear lost from Japanese vessels in 1996.

3.62 Dr Croxall summarised SC-CAMLR-XV/BG/4, which reports three observations of oiled seabirds (wandering albatross, snow petrel) at Bird Island, South Georgia and presents the results of the third (1996) standardised survey of man-made debris associated with breeding seabirds. The incidence of marine debris, especially fishing gear, associated with breeding albatrosses had returned to the high levels of 1994. The fishing gear included a squid jig decoy associated with a grey-headed albatross nest. Given the known foraging range of breeding grey-headed albatrosses it is highly likely that the jig was acquired within the Convention Area, suggesting that squid fishing might have occurred between October 1995 and March 1996 in, or very near, the Convention Area. Many fishing hooks, all identical to those used in the *D. eleginoides* longline fishery, were recorded from pellets regurgitated by wandering albatrosses; four adult and two chick wandering albatrosses and one adult black-browed albatross were observed with ingested or impaled hooks with fishing line attached.

3.63 There was general concern over the problems posed by loss of fishing gear, especially hooks. It was noted that WG-FSA-96/57 had estimated that about 100 000 hooks are lost annually by the *D. eleginoides* fishery in Subarea 48.3 and that the loss of sections of line and hooks remaining in fish heads thrown overboard poses threats to marine life, especially seabirds (Annex 5, paragraphs 8.5 and 8.6).

3.64 The attention of the Commission was drawn to the concerns over increases in the amount of marine debris in 1996, especially that originating from fishing vessels in the Convention Area.

Advice to the Commission

3.65 The Scientific Committee recommended that the Commission:

(i) distribute the book *Fish the Sea Not the Sky* as widely and appropriately as possible (paragraph 3.22(iii));

(ii) encourage further work to develop effective devices for underwater setting of longlines (paragraph 3.25);

(iii) provide the revised edition of the Scientific Observer Logbook, in all languages of the Commission, as quickly as possible to those who need to use it (paragraph 3.28);

(iv) note the conclusions of the Scientific Committee based on the analysis of the available data on seabird by-catch in the *D. eleginoides* longline fishery in Subarea 48.3 in 1996 (paragraph 3.33);

(v) note the conclusions of the Scientific Committee concerning seabird by-catch and mitigating measures outside the Convention Area (paragraph 3.36);

(vi) note the recommendations of the Scientific Committee concerning the development of closer links between CCSBT and CCAMLR, and other matters relating to the Commissions which regulate longline fishing in regions adjacent to the Convention Area (paragraph 3.37);

(vii) note the recommendations of the Scientific Committee concerning changes to the timing of the *D. eleginoides* fishery in Subarea 48.3 to reduce incidental mortality of seabirds (paragraph 3.41), the further discussion on this topic (paragraphs 3.42 to 3.45) and the advice to the Commission for the 1996/97 season (paragraph 3.46);

(viii) note the recommendations concerning the retention of Conservation Measure 29/XIV, subject to a minor revision to clarify the meanings of 'nautical twilight' and 'dawn' (paragraph 3.49 to 3.52);

(ix) note the positive effect of the ban on the use of netsonde cables in reducing incidental mortality of seabirds in the trawl fishery in Division 58.5.1 (paragraph 3.55); and

(x) note the concerns of the Scientific Committee over evidence of recent increases in the problems caused by marine debris (originating from fishing vessels) to marine mammals and seabirds (paragraph 3.64).

Marine Mammal and Bird Populations

Status of Marine Mammal Populations

Whales

3.66 The Scientific Committee had asked the Chairman to write to the Scientific Committee of IWC (SC-IWC) to request reports on the status of Antarctic whales for review at the 1996 meeting (SC-CAMLR-XIV, paragraph 3.70). The Secretary of the IWC had responded (SC-CAMLR--XV/BG/9) that following discussions in the past, IWC had decided that because of the considerable scientific uncertainty over the number of whales it would be better not to give whale population figures except for those species/stocks which have been assessed in detail. In the case of whales of the Southern Ocean, this would include minke and blue whales only, although there is some less comprehensive and reliable information for other species, notably humpback whales.

3.67 The best estimates of abundance of minke whales, published in 1993, add up to more than 700 000 animals (SC-CAMLR-XV/BG/24, Table 1 as reported by SC-IWC-1993; Annex E, Appendix 6). Estimates of abundance of other species of whales are provided in SC-CAMLR-XV/BG/24, Table 2. Population estimates of blue whales remained low relative to previous estimates, while estimates of humpback whales had increased substantially.

3.68 The Scientific Committee expressed its appreciation to IWC for providing the information requested and noted this was another example of the close working relationship of CCAMLR and IWC members.

Antarctic Seals

3.69 Last year, the Chairman was asked to write to the Convener of the SCAR Group of Specialists on Seals (SCAR-GSS) requesting the group to consider the collection and analysis of data relevant to the aims of CCAMLR and the CEMP program in particular. No response having been received, the Scientific Committee deferred its consideration of this item until its next meeting.

Status of Marine Bird Populations

3.70 As has been done in the past, the Chairman was requested to write to the Chairman of the SCAR Bird Biology Subcommittee (SCAR-BBS) and ask for reports on the status of Antarctic birds (SC-CAMLR-XIV, paragraph 3.70). The SCAR Subcommittee provided a comprehensive review of the status and trends of Antarctic and sub-Antarctic seabirds (SC-CAMLR-XIV/BG/29). The review, provided for CCAMLR, was the third such undertaking by SCAR, with previous reviews completed in 1988 and 1992.

3.71 The current review provides a detailed summary of published and unpublished data on the distribution and abundance of penguins which updates the comprehensive review published by SCAR in 1993 (SC-CAMLR-XIV/BG/29, Appendix 2), information on the population status and trends of Antarctic and sub-Antarctic penguins as considered at the International Workshop on the Conservation and Management Plan for Penguins held in September 1996 (Appendix 3), and summaries of information on the distribution and abundance of several other species of Antarctic seabirds currently under detailed review by SCAR (Appendix 4).

3.72 SCAR-BBS also produced a summary of the status of all Antarctic seabird species (or species groups), drawing on the sources indicated above and the 1996 review of the status, trends and threats to populations of all albatross species (SC-CAMLR-XV/BG/21).

3.73 SCAR-BBS also provided a brief executive summary from which paragraphs 3.74 to 3.79 below are taken.

3.74 Populations of king penguins are increasing in numbers; however, except for emperor and gentoo penguins, all the other Antarctic and sub-Antarctic penguin species (including Adélie and chinstrap penguins) are currently showing an overall decrease in populations compared with those of a decade ago. The situation is potentially most serious for macaroni penguins and especially for rockhopper penguins, the latter being recommended for Globally Threatened status in the next IUCN Red Data Book.

3.75 For all sub-Antarctic albatross species breeding in the Convention Area, there is evidence of decreases from at least one site (and usually most, if not all, sites). Incidental mortality associated with longline fisheries is recognised as the main known or potential cause of these changes. Most species (including wandering, grey-headed and sooty albatrosses) are being recommended for Globally Threatened status; even the black-browed albatross is now regarded as deserving Near Threatened status.

3.76 Evidence of general decreases in giant petrel populations is less clear than in 1992, with new data indicating increases at some sites and decreases at others. More monitoring studies are needed.

3.77 Programs to eradicate introduced predators of seabirds (especially of burrowing species) at sub-Antarctic islands are proving successful. There is little, if any, evidence of change in populations due to human activities in the vicinity of breeding colonies.

3.78 There is still no evidence that any seabird population decreases reflect competition with commercial fisheries.

3.79 For some species and situations a better understanding is developing of interactions between the physical and biological environment in relation to prey availability and population processes in seabirds.

3.80 The Scientific Committee recognised the vast amount of work involved in preparing the review which it had requested and expressed its appreciation for the work of SCAR-BBS.

Krill

Methods for Estimating Distribution, Standing Stock, Recruitment and Production

4.1 The Scientific Committee noted that WG-EMM has continued its work on refining the methodology for acoustic estimation of krill biomass (Annex 4, paragraphs 3.1 to 3.10 and Appendices D and E) and, because of the level of expertise on this topic present in the Working Group, the Scientific Committee suggested that it might also examine the results of acoustic surveys for fish such as one reported by Russia and considered by WG-FSA (Annex 5, paragraphs 4.145 and 4.146).

4.2 The results of a large number of acoustic surveys for krill covering parts of Areas 48, 58 and 88 were reported to WG-EMM in 1996 (Annex 4, paragraphs 3.12 to 3.41). Particularly noteworthy were the results of a very successful Australian survey in Division 58.4.1 which covered an area of 873 000 km^2 and produced a biomass estimate of 6.67 million tonnes with a CV of 27% (Annex 4, paragraphs 3.31 to 3.36). The Scientific Committee recognised the significance of this survey which was the first acoustic survey of a CCAMLR statistical division designed to produce an estimate of B_0.

4.3 Whilst recognising the quality of the biomass estimate produced by the survey of Division 58.4.1, the Scientific Committee noted that it would be desirable to repeat the survey at some point in the future so that some assessment of the variability of krill abundance in this area could be made.

4.4 The Scientific Committee also received details of an Indian survey carried out in Division 58.4.4 during 1996 to study fisheries potential in this area and, jointly with Polish scientists, to examine processing technology (SC-CAMLR-XV/BG/15). The Scientific Committee welcomed India's research efforts and encouraged Indian scientists to participate in the work of WG-EMM. The Scientific Committee looked forward to receiving detailed results of this research for consideration at WG-EMM.

4.5 The Scientific Committee noted the extremely high priority given by WG-EMM to a new synoptic survey of krill in Area 48 and endorsed the plans put forward by the Working Group to form a steering group to move this proposal forward (Annex 4, paragraphs 3.72 to 3.75 and 7.58(v)). The Scientific Committee looked forward to receiving a detailed proposal for this survey, including a timetable and the resources required from Members to accomplish the task.

4.6 It was agreed that in the light of advances in technology and from experience gained in the conduct of recent large-scale acoustic surveys, a synoptic survey of Area 48 would require much less in the way of resources than had been envisioned in the past (Annex 4, paragraph 3.72). The Working Group estimated that approximately 60 ship-days sampling would be required and the Scientific Committee noted that with the current number of nations operating research vessels in the South Atlantic, such a figure would be attainable.

4.7 Given the feasibility of a survey of this magnitude, the Scientific Committee advised the Commission that it saw the conduct of a synoptic survey of krill in Area 48 as being a task of the highest priority.

4.8 Accordingly, the Scientific Committee requested that the Commission ask the Secretariat to send a circular to all Members informing them of the urgent need for a synoptic survey of Area 48, the status of planning arrangements and the timetable for implementation.

4.9 Members should be encouraged to bring to the next meeting of WG-EMM information on whether they could contribute to such a survey which would be scheduled to occur in the 1998/99 season. This would allow a suitable lead time for detailed planning and discussion of the survey before its implementation.

Catch per Unit Effort

4.10 Analyses of the CPUE data from the krill fishery in Subarea 48.1 indicated that there had been a declining trend from the mid-1980s to the 1989/90 season, but that the CPUE had remained relatively constant since the 1990/91 season. These changes were considered to be related to changes in the timing and intensity of the fishery in Subareas 48.1 and 48.3 (Annex 4, paragraphs 3.42 to 3.47). The Scientific Committee encouraged the submission of more of these data to future meetings of the Working Group.

4.11 Progress had been made in the estimation of effort and the Scientific Committee noted that an exercise in the collation of a time budget for fishing operations had been completed by a scientific observer which confirmed the feasibility of this technique which had been suggested by WG-EMM (Annex 4, paragraphs 2.10 and 2.11). Further collection of such data and their submission and analysis were encouraged.

4.12 The Scientific Committee endorsed the Working Group's call for further submission of haul-by-haul data from defined fishing locations and noted the utility of this information in interpreting the behaviour of the fishery (Annex 4, paragraphs 3.28 to 3.30).

Recruitment

4.13 The Working Group had examined the evidence of long-term changes in krill recruitment and abundance in the Elephant Island area and was unable to determine whether the results represented fluctuations about a median level or whether they were indicative of a longer-term trend in overall abundance (Annex 4, paragraphs 3.48, 3.59 and 7.4 to 7.13).

4.14 Because only one long-term dataset had been analysed – that from the Elephant Island area – the Working Group was unable to determine whether the results from a restricted area in Subarea 48.1 were indicative of changes that might have occurred throughout the whole of Subarea 48.1 or even over a wider area.

4.15 Members were urged to examine the datasets in their possession and to analyse them for any long-term trends in abundance and recruitment (Annex 4, paragraphs 3.58 and 3.59). In particular, the analysis of data from the fishery over wide areas was encouraged.

4.16 It is likely that there are sufficiently long time series of length-density data from the Indian Ocean sector and Japanese and Australian scientists were encouraged to collaborate in the analysis of these data and to submit their analyses to the next meeting of the Working Group (Annex 4, paragraph 3.59).

4.17 If the observed changes in recruitment and abundance are merely fluctuations about a median level, then such variability is incorporated into the krill yield model currently used to set precautionary limits. If, on the other hand, the changes are a result of long-term changes in abundance and recruitment, then the current krill yield model may have difficulty reflecting the actual level of variability and will need to be modified.

4.18 The Scientific Committee recognised that it was desirable to examine the outputs of the krill yield model to determine whether they conform to the observed level of recruitment variability determined from samples in the South Atlantic and recommended that this work proceed.

4.19 Because of the fundamental nature of the questions raised by the variation in the observed recruitment indices, the Scientific Committee endorsed the Working Group's plan for a workshop to examine these changes in recruitment and abundance in Area 48 (Annex 4, paragraph 6.93) (La Jolla, USA, June 1997).

Local Distribution

4.20 The Subgroup on Statistics and the Working Group had indicated that considerable research was required in the area of indices of local abundance and Members were requested to submit information to the Working Group of size composition, sex and maturity stage and energy content of krill (Annex 4, paragraphs 3.66 to 3.71 and Table 2). The Scientific Committee recognised these research priorities.

Future Work

4.21 The Scientific Committee endorsed the tasks identified by the Working Group as requiring further work (Annex 4, paragraph 7.58). These included the following items which directly relate to krill and which would be carried out informally by various members of WG-EMM:

(i) further coordination of research in the Antarctic Peninsula region;
(ii) further examination of uncertainty in acoustic surveys;
(iii) investigations into the use of multifrequency acoustic techniques in surveying; and
(iv) further work on the submodels within the overall ecosystem modelling framework.

General Advice Relating to Krill
(Annex 4, paragraph 8.3)

4.22 Given the difficulties experienced in surveying large statistical subareas and divisions, further consideration should be given to subdividing such areas into smaller management units (Annex 4, paragraph 3.41).

4.23 The updated *Scientific Observers Manual* should be published in 1997 as a matter of urgency.

4.24 The Subgroup on Statistics should meet in 1997 immediately prior to the meeting of WG-EMM. The terms of reference of the Subgroup on Statistics are provided in paragraph 5.38. The Convener will be Dr Watters.

4.25 A workshop is planned on the inter-relationship between the subareas in Area 48, including the study of changes in krill recruitment and abundance in subareas and the linkages between monitoring sites (see paragraph 4.19) (La Jolla, USA, June 1997).

4.26 The krill symposium identified in last year's Scientific Committee report is now to be held in 1998 or 1999. Dr M. Mangel of the University of California, Santa Cruz, USA, has offered to host this symposium and a full proposal will be put to the Scientific Committee in 1997 (Annex 4, paragraphs 9.1 to 9.4).

Management Advice
(Annex 4, paragraphs 8.1 and 8.2)

Area 58

4.27 The Scientific Committee endorsed the Working Group's calculation of a precautionary limit using the results from the krill biomass survey carried out in Division 58.4.1 (Annex 4, paragraphs 7.23 and 7.24) and recommended a precautionary catch limit of 775 000 tonnes per year for this division.

Area 48

4.28 The Scientific Committee recognised the urgent need for a synoptic survey in Area 48 and noted that it could not update its management advice for this area until such a survey had been conducted. Consequently, the Scientific Committee recommended that the existing management measures for Area 48 remain in force.

Fish Resources

Area 48

Antarctic Peninsula (Subarea 48.1)

4.29 The Scientific Committee noted that no new information on stocks in this subarea was available to WG-FSA. It also noted that a bottom trawl survey of Subarea 48.1 will be carried out by the German RV *Polarstern* in November and December 1996 (see Annex 5, paragraph 4.35).

Management Advice

4.30 In the absence of new information on stocks in this subarea, the Scientific Committee endorsed the advice of the Working Group that fisheries in Subarea 48.1 should remain closed in accordance with Conservation Measure 72/XII.

South Orkney Islands (Subarea 48.2)

Champsocephalus gunnari (Subarea 48.2)

4.31 The Scientific Committee noted that no new information was available to the Working Group on stocks in this subarea and that no new assessment had been undertaken at this year's meeting.

4.32 The Scientific Committee also noted the suggestion of Dr P. Gasiukov (Russia), made at the Working Group, that an experimental scientific fishery for *C. gunnari* should be permitted in this subarea following a similar approach to that adopted for *C. gunnari* in Subarea 48.3 for the 1995/96 season (Conservation Measure 97/XIV). Dr Gasiukov suggested a precautionary TAC of 1 500 tonnes, based on the approximate midpoint of the range of minimum (392 tonnes) and maximum (3 010 tonnes) MSY calculated for this stock by the Working Group in 1991 (SC-CAMLR-X, Annex 6, paragraphs 7.214 to 7.217). This proposal would depend on a research bottom trawl survey being carried out prior to the commercial fishery, and the presence of an international scientific observer on board each vessel fishing commercially.

4.33 The Scientific Committee recalled that the existing Conservation Measure (73/XII) requires a survey to be carried out, its results reported to and analysed by WG-FSA, and a decision made by the Commission, based on the advice of the Scientific Committee, before the finfish fishery can be reopened. This situation is analogous to that in Subarea 48.1.

Management Advice

4.34 In the absence of new information, the Scientific Committee was unable to provide advice on the reopening of the finfish fisheries in this subarea. The Scientific Committee therefore recommended that the finfish fisheries in Subarea 48.2 remain closed in accordance with Conservation Measure 73/XII.

South Georgia (Subarea 48.3)

Dissostichus eleginoides (Subarea 48.3)

4.35 The Scientific Committee noted the information provided by the Working Group on catch and effort data reported from this fishery in the 1995/96 season (Table 7). It had not been possible to make an estimate of the level of unreported catches at this year's meeting. However, the Scientific Committee noted that information provided intersessionally by the Chilean authorities indicated that there were no unreported catches by Chilean vessels in Subarea 48.3 during 1995/96.

Table 7: Estimated catches of *D. eleginoides* in Subarea 48.3 and adjacent Rhine and North Banks and TACs agreed by the Commission for Subarea 48.3 (tonnes).

Split-year	Fishing Season	TAC	Catch Reported to CCAMLR for the Fishing Season[1]	Catch Reported to CCAMLR for the Split-year	Estimate of Unreported Catch (split-year)	Best Estimate of Real Catches
1989/90				8156	345	8501
1990/91	2 November 1990 – 25 August 1991	2500	2200[2]	3639	565	4206
1991/92	2 November 1991 – 10 March 1992	3500	3150	3842	3470	7312[5]
1992/93	6 December 1992 – 5 February 1993	3350	2694	3089	2500	5589
1993/94	15 December 1993 – 15 September 1994	1300	537	460	6145	6605
1994/95	1 March – 10 May	2800	2635	3301	2870	6171
1995/96	1 March – 24 July 1996	4000	3871[3]	4362	?[4]	4362 + ?

[1] Form C2 except where indicated
[2] From Statlant reports
[3] From five-day catch reports
[4] No new quantitative information was available to the Working Group to estimate unreported catches during 1995/96.
[5] The best estimate of real catch for 1991/92 was erroneously given as 6 309.6 in Table 6 of last year's report (SC-CAMLR-XIV, Annex 5) due to an arithmetical mistake.

4.36 The Scientific Committee also noted information provided in Annex 5, paragraphs 4.48 to 4.59, regarding reports from CCAMLR observers, conversion factors, discards of *D. eleginoides*, baiting efficiency, non-reporting of zero catches, fish movements and environmental factors. In particular, the Scientific Committee endorsed the advice of the Working Group that:

(i) CCAMLR observers should collect further information on the values of conversion factors and methods of their estimation and application on board fishing vessels (Annex 5, paragraph 4.51);

(ii) the Scientific Observer Logbook be amended to include provision for the recording of discards of *D. eleginoides* (Annex 5, paragraph 4.52);

(iii) the estimation of loss rates of fish from hooks needs further investigation (Annex 5, paragraph 4.53);

(iv) consideration should be given to undertaking separate assessments for male and female fish in the future (Annex 5, paragraph 4.58); and

(v) the Secretariat be requested to investigate the possibility of obtaining meteorological information from Subarea 48.3 and other areas where there are fisheries for *D. eleginoides* (Annex 5, paragraph 4.59).

4.37 The Working Group had considered the use of catch-at-age analysis, applying such approaches as SPA (Sequential Population Analysis) or VPA (Virtual Population Analysis) as an alternative approach to estimating exploitation rates and spawning stock biomass of *D. eleginoides*. A background paper using this approach to study trends in the *D. eleginoides* stock between 1992 and 1996 was submitted to the Scientific Committee (SC-CAMLR-XV/BG/14) and had been reviewed by the Working Group. This analysis was undertaken using only data available in the CCAMLR database. The Scientific Committee noted the view of the Working Group that at this stage the analysis was preliminary in nature and that further developments could investigate the use of standardised CPUE data. The Scientific Committee encouraged further analyses using such models, because they have the potential to provide an independent assessment of the stock, which can be compared to the results of the generalised yield model.

4.38 The Scientific Committee recalled last year's recommendations for future work on the assessment of *D. eleginoides* in Subarea 48.3 (SC-CAMLR-XIV, paragraphs 4.48 and 4.51, Annex 5, paragraphs 5.72, 5.75 and 5.76 and Appendix E, paragraph 2.72) and noted the approach taken by the Working Group to address these recommendations. The work undertaken at this year's meeting of the Working Group focused on four main areas:

(i) revision of the length-density analysis undertaken at last year's meeting, using additional survey data;

(ii) consideration of the effects of varying the decision rule criteria applied in the generalised yield model;

(iii) revision of the stock simulations undertaken at last year's meeting, using the improved generalised yield model with various alternative input parameters, including revised parameters in the recruitment function; and

(iv) examination of methods of monitoring the status of the population, including analysis of trends in standardised CPUE and length samples taken from the fishery.

4.39 The details of the length-density analysis are provided in paragraphs 4.66 to 4.73 of the Working Group report (Annex 5). The Scientific Committee endorsed the view of the Working Group that the resulting recruitment function was the best information currently available on the recruitment of *D. eleginoides* for use in the generalised yield model for Subarea 48.3.

4.40 The Scientific Committee welcomed the refinements made to the generalised yield model since last year's meeting. A detailed description and explanation of the current method is provided in Constable and de la Mare (1996) and in Annex 5, paragraphs 3.65 to 3.69.

4.41 At last year's meeting, the Scientific Committee noted that the probability level (10%) in the γ_1 decision rule was not purely a scientific question and that the Commission may wish to consider this matter further. However, before this could be done, the Commission would require more information and advice from the Scientific Committee. To this end, the Scientific Committee tasked the Working Group with giving this issue detailed consideration at this year's meeting.

4.42 The Working Group undertook a series of test runs of the generalised yield model to explore the implications of variations in the decision rule criteria. The results of these runs are illustrated in Figures 2(a) and 2(b) and explained in paragraphs 4.77 to 4.80 of the Working Group's report (Annex 5). The Scientific Committee noted the advice regarding the relative effects on catch levels of departing from the γ_1 decision rule (i.e. that the probability during the projection period of the spawning stock biomass falling below 20% of its initial level should not exceed 10% – Annex 5, paragraphs 4.75 to 4.80 and Figures 2(a) and 2(b)). The Scientific Committee also noted that no specific decision rule criteria, other than γ_1 and γ_2 (the median status of the spawning stock biomass at the end of the projection period should not fall below 50% of the median pre-exploitation level), were considered at this year's meeting. However, the Scientific Committee endorsed the suggestion of the Working Group that more detailed consideration should be given to the critical level of spawning stock biomass in the γ_1 decision rule at its next meeting. If the Commission wishes to change the probability level or the ratio of median spawning stock biomass, the graphs in Figure 2(a) of Annex 5 should be used.

4.43 The Scientific Committee also noted results of a series of runs testing for the sensitivity of the results to changes in various input parameters, including the catch history, the size of fish selected in the fishery, von Bertalanffy growth parameters and natural mortality (M). The results of these sensitivity tests are presented in Table 13 and paragraphs 4.88 to 4.95 (Annex 5).

4.44 Following a request from Prof. Beddington for clarification of the way in which uncertainty in M had been represented, Dr de la Mare explained that each individual trial of the projection randomly selected a value of M in the range 0.12 to 0.2, sampled from a uniform distribution.

4.45 The final run of the yield model determined that a catch level of 5 000 tonnes was consistent with the γ_1 decision rule using a 10% probability level (see paragraph 4.42). At this level of catch, the ratio of median spawning stock biomass to the pre-exploitation level was 53%. The Scientific Committee noted that this catch level was an increase of 25% compared to the result from last year's meeting and agreed that a change from last year's result was to be expected for three principal reasons: refinements in the formulation of the yield model, revision of the recruitment function and changes in other input parameters (see Annex 5, Table 14).

4.46 The Scientific Committee welcomed the refinements to the analysis using the generalised yield model made during the intersessional period and at this year's meeting of the Working Group.

4.47 The Scientific Committee endorsed the conclusion of the Working Group that the results of the yield model projection described in paragraph 4.45 provided a reasonable basis on which to set guidelines for the limits on total removals of *D. eleginoides* in Subarea 48.3 during the 1996/97 season.

4.48 The Scientific Committee endorsed the approach taken by the Working Group to standardise CPUE using a GLM (Annex 5, paragraphs 4.97 to 4.107). The aim of this analysis was to determine whether there were any annual trends in CPUE after accounting for the effects of any other factors/covariates that add to the variability in observed CPUE. Response variables considered were vessel type, month, area, depth and bait type. The GLM analyses followed the approach used at the 1995 meeting of the Working Group. Details of the methodology are provided in SC-CAMLR-XIV, Annex 5, Appendix G.

4.49 The Scientific Committee endorsed the conclusion of the Working Group that the GLM analyses indicated that there has not been an appreciable decline in standardised CPUE during the period 1992 to 1996. However, concern was expressed at the difficulties experienced by the Working Group during the analysis of the catch and effort data in the CCAMLR database. The data were checked for errors before the analysis was conducted in order to exclude records that were spurious or incomplete. The raw dataset contained 5 163 records, but the final dataset contained only 2 740 records, 2 423 records being excluded from the analysis, principally due to missing data.

4.50 Prof. Beddington pointed out that the plot of unstandardised catch rates in Figures 5 and 6 of the Working Group's report (Annex 5) should include all data points, not just those remaining following the error checking described in paragraph 4.49. Dr Watters explained that this was not in fact the case and only the final dataset had been used.

4.51 The Scientific Committee expressed concern that the difficulties encountered by the Working Group meant that this year it had not been possible to undertake as full an analysis of the CPUE data as would have been desirable. Members were encouraged to resubmit historical haul-by-haul data which will be specifically requested by the Secretariat following a data audit.

4.52 The Scientific Committee noted the preliminary analysis of length frequency data described in Annex 5, paragraphs 4.109 to 4.113, and endorsed the proposal of the Working Group that the analysis of the length distribution of the catches should be pursued in the intersessional period, including completion and validation of the available dataset by the Secretariat.

Future Work

4.53 The Scientific Committee endorsed the areas of future work identified by the Working Group in Annex 5, paragraph 4.115.

Management Advice

4.54 The Scientific Committee noted that in spite of information in the Working Group's report from which it might be inferred that the level of unreported catches had probably fallen in 1995/96 (see paragraph 4.35), unreported catches continue to be a cause for concern and solving the problem of illegal catches remains a high priority.

4.55 The Scientific Committee recommended the continuation of the current provisions for reporting haul-by-haul and biological information from the fishery. In view of the problems experienced by the Working Group in the analysis of CPUE data, the Scientific Committee also strongly encouraged the reporting of existing haul-by-haul data from the longline fishery prior to 1992, and of information missing from the database for haul-by-haul data from 1992 to the present (paragraph 4.49). The Scientific Committee also recognised the continued importance to the assessment work of the biological data and information collected by scientific observers, and recommended that the 100% observer coverage applied to this fishery over the past three seasons be maintained. The Scientific Committee also stressed the importance of timely submission to the Secretariat of data from observer trips, in the appropriate formats, to enable them to be made available for consideration by the Working Group (Annex 5, paragraph 3.16).

4.56 The Scientific Committee noted that, as at last year's meeting, the assessment of yield was based on the expectation that future catches will be taken only by longline vessels and recommended that the directed fishery for *D. eleginoides* in Subarea 48.3 should be restricted to longliners during the 1996/97 season.

4.57 The results of the projections using the generalised yield model indicated that an annual catch of 5 000 tonnes applied over a period of 35 years was consistent with the γ_1 decision rule. At this level of catch, the ratio of median spawning stock biomass at the end of the projection period to the pre-exploitation level was 53%. The Scientific Committee recommended that this should be the basis for setting the catch limit for *D. eleginoides* in Subarea 48.3 during the 1996/97 season.

4.58 Additional advice on the period of the fishing season is given in paragraph 3.46.

Champsocephalus gunnari (Subarea 48.3)

4.59 Despite a 1 000-tonne TAC for *C. gunnari* in Subarea 48.3 for the1995/96 season (Conservation Measure 97/XIV), there was no reported commercial catch of *C. gunnari*. There has now been no substantial reported commercial catch in Subarea 48.3 since March 1990.

4.60 Two research surveys were conducted in Subarea 48.3 during 1995/96: an acoustic survey by Russia in February 1996, using the RV *Atlantida*, and a bottom trawl survey by Argentina in March/April 1996, using the RV *Dr Eduardo L. Holmberg* (third in the series). The results of these surveys were reviewed by the Working Group (Annex 5, paragraphs 4.125 to 4.135). The Scientific Committee noted that this was the first time that standing stock estimates had been made for Channichthyidae using acoustic survey methodology.

4.61 The Scientific Committee endorsed the view of the Working Group that, due to the short nature of the time series of relative abundance from the Argentinian trawl survey, the questions surrounding the single estimate of abundance from the Russian acoustic survey which could not be resolved at the meeting, and the clearly identified need to develop a long-term management strategy, an assessment at this time was inappropriate.

4.62 Provision of this information in the specified form aids in the consideration of the results of surveys by the Working Groups. The Scientific Committee noted that considerable technical expertise on acoustic survey methodology was available in WG-EMM and recommended that the methods applied in acoustic surveys should be submitted to that Working Group, where they could be reviewed in more detail than would be possible at WG-FSA. The Scientific Committee recalled its advice on the information required from resource surveys, developed during the CCAMLR Workshop on the Design of Bottom Trawls held in 1992 (Draft Manual for Bottom Trawl Surveys in the Convention Area – SC-CAMLR-XI, Annex 5, Appendix H, Attachment E, section 7) and at the 1990 meeting of WG-Krill (SC-CAMLR-IX, paragraph 102).

4.63 The Scientific Committee considered management advice for *C. gunnari* in Subarea 48.3 in the 1996/97 season before returning to the issue of a long-term management strategy for this species in this area.

Management Advice

4.64 The Scientific Committee noted that WG-FSA had not attempted a full assessment of *C. gunnari* at this year's meeting (see paragraph 4.61).

4.65 The Scientific Committee agreed that the development of a long-term management strategy for this fishery remains a high priority (see paragraphs 4.71 to 4.75).

4.66 The Scientific Committee noted that at last year's meeting the Commission stated that (CCAMLR-XIV, paragraph 8.26):

> 'should a similar situation to the current one prevail at the next meeting of the Commission, the fishery should be closed until the Scientific Committee has:
>
> (i) provided advice on a long-term management strategy for the stock; and
>
> (ii) provided advice on the reopening of closed fisheries;
>
> or has provided unanimous advice on an appropriate TAC for *C. gunnari* in Subarea 48.3.'

4.67 The Scientific Committee noted two different views expressed in the Working Group.

4.68 Drs P. Gasiukov (Russia), V. Gerasimchuk and E. Gubanov (Ukraine) considered that the two surveys undertaken in 1995/96 and surveys undertaken previously provided sufficient information on which to base recommendations for a TAC for *C. gunnari* in Subarea 48.3 during the 1996/97 season (Annex 5, paragraphs 4.159 to 4.163). Specifically, taking into account:

(i) the results of a comparison of biomass estimates and corresponding catches in the same year;

(ii) the successive increase in relative abundance from results of recent Argentinian surveys; and

(iii) the estimate of total biomass of around 43 000 tonnes by the Russian acoustic survey;

these members recommended that, bearing in mind the precautionary approach, the fishery for *C. gunnari* should be opened with a TAC of 13 000 tonnes. This value is the lower 95% confidence interval of the 1994 UK survey trawl survey biomass estimate.

4.69 The rest of the members of the Working Group considered that they were unable to provide advice on an appropriate long-term management strategy or TAC at the present time and that the situation regarding the assessment of *C. gunnari* remained substantially the same as at last year's meeting.

4.70 Advice on the reopening of closed fisheries in general is provided in paragraphs 6.1 to 6.12.

Development of Long-term Management Strategy for *C. gunnari* in Subarea 48.3

4.71 The Scientific Committee noted that the Working Group had identified a number of issues which need to be considered and tasks to be carried out before a long-term management strategy could be developed. These issues are discussed in Annex 5, paragraphs 4.137 to 4.154.

4.72 The Scientific Committee raised some concerns over paragraph 4.151 in the Working Group report (Annex 5), in which the Working Group expressed the need to understand the ecosystem processes occurring. Prof. Beddington pointed out that the ability to predict long-term krill availability in the area was likely to remain poor, although the prospects for making short-term predictions were better.

4.73 Dr de la Mare explained that it was not the intention of the Working Group to suggest that all of the issues listed in paragraph 4.151 (Annex 5) had to be resolved before the long-term management strategy could be developed. The intention was rather to highlight areas where information would be needed for providing a basis for the structure of the ecosystem model and plausible bounds on input parameters.

4.74 The Scientific Committee agreed that this highlighted the need for the development of a feedback style of fishery management, based on real-time monitoring of the fishery and the links between *C. gunnari* and krill abundance.

4.75 The Scientific Committee agreed that it would require substantial resources to develop a long-term management strategy for this fishery and endorsed the conclusion of the Working Group that, for the reasons summarised in Annex 5, paragraph 4.155, the development of the strategy should nevertheless be given a high priority.

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

4.76 Estimates of biomass and size composition for these species were available from the surveys by Argentina and Russia, but for similar reasons to those outlined for *C. gunnari* no assessment of these stocks was attempted by the Working Group.

Management Advice

4.77 The Scientific Committee endorsed the recommendation of the Working Group that, in the absence of a new assessment of these species, Conservation Measures 2/III, 3/IV and 95/XIV remain in force and that Conservation Measure 76/XIII be extended to the 1996/97 season.

Electrona carlsbergi (Subarea 48.3)

4.78 The Scientific Committee endorsed the recommendation of the Working Group that, in the absence of any new information on this species, Conservation Measure 96/XIV should be carried forward for the 1996/97 season.

South Sandwich Islands (Subarea 48.4)

Dissostichus eleginoides (Subarea 48.4)

4.79 The Scientific Committee endorsed the recommendation of the Working Group that, in the absence of any new information on this species, Conservation Measure 92/XIV should be carried forward for the 1996/97 season.

Bouvet Island (Subarea 48.6)

Dissostichus eleginoides (Subarea 48.6)

4.80 The Scientific Committee noted that notifications of the intention to conduct new fisheries for *D. eleginoides* in Subarea 48.6 for the 1996/97 season had been lodged by Norway and South Africa during the intersessional period. Management advice is given in section 8.

Statistical Area 58

4.81 Catches in Area 58 during the 1995/96 season consisted of 4 911 tonnes of *D. eleginoides*, 15 tonnes of *L. squamifrons* and 5 tonnes of *C. gunnari*, all taken in Division 58.5.1, and 3 tonnes of *D. eleginoides* taken in Subarea 58.6 (Annex 5, Table 21).

Ob and Lena Banks (Division 58.4.4)

4.82 Conservation Measure 87/XIII, allowing a catch of 1 150 tonnes of *L. squamifrons* on the two banks, lapsed at the end of the 1995/96 season. Subject to the Commission's conditions associated with this particular conservation measure (CCAMLR-XIII, paragraphs 8.52 and 8.53), Ukraine indicated its desire to undertake a research survey in the 1994/95 season on

L. squamifrons at Ob and Lena Banks following the plan endorsed by WG-FSA and the Scientific Committee (SC-CAMLR-XIII, paragraph 2.77). The Scientific Committee noted that no notification had been received from Ukraine for such a survey in accordance with Conservation Measure 64/XII. The Scientific Committee also noted that Ukraine has expressed an interest in undertaking a biomass survey in the area during the 1996/97 season.

Management Advice

4.83 The Scientific Committee recommended that Conservation Measure 87/XIII be extended to cover the 1996/97 season provided that a biomass survey is undertaken and that this survey is of the design approved by the Scientific Committee in 1994 (CCAMLR-XIII, paragraphs 8.52 and 8.53).

Kerguelen Islands (Division 58.5.1)

Dissostichus eleginoides (Division 58.5.1)

4.84 The 1995/96 commercial fishery consisted of a French trawl fishery in the northern and eastern sectors, which took 2 574 tonnes and 1 029 tonnes respectively, and a Ukrainian longline fishery in the western sector, which took 1 003 tonnes. There was also a joint French/Japanese exploratory deep-sea longline cruise, which took 263 tonnes. None of these catches exceeded the catch limits imposed by French authorities (Annex 5, paragraphs 4.199 to 4.202).

4.85 A GLM was used to standardise CPUE data from the French and Ukrainian trawl fisheries (Annex 5, paragraphs 4.203 to 4.211). This analysis identified vessel, year and month as significant sources of variation in the data, but it supported the view that there had not been a decline in trawl catch rates.

4.86 The results of the GLM analysis in Annex 5, Figure 7, indicated a rise in CPUE between 1992 and 1993 seasons, and a maintenance of that approximate level since then. Although not analysed by the Working Group, there is no indication of an increase in fish recruitment to explain this. WG-FSA was requested to analyse length composition of the catch to investigate this question. Prof. Duhamel suggested that CPUE is indicating increased fishing efficiency rather than the status of the stock abundance.

4.87 As trawl fisheries target a limited age range of fish, CPUE does not give comprehensive information on the state of the spawning stock biomass. Recommendations are sought from WG-FSA on methods to improve the monitoring of the stock in this division as well as other areas.

4.88 One such method would be to use recruitment estimates based on trawl surveys for this area, as used for Subarea 48.3 and Division 58.5.2. At the moment, no such survey data exist for Division 58.5.1.

Management Advice

4.89 The French authorities have allocated TACs to the two trawling sectors for the 1996/97 season of 2 500 tonnes for the northern sector and 1 000 tonnes for the eastern sector. A catch limit of 500 tonnes has already been established for longlining in the western sector for the period October to December 1996, and the number of vessels limited to two. The level of catch by longlining in the first six months of 1997 is not expected to increase, and will be in line with the 1993 recommendations of WG-FSA.

4.90 For the western sector longline fishery, no further analysis of *D. eleginoides* has been undertaken. There has been no decline in the trend of CPUE in recent years (WG-FSA-93/15 and subsequent data), so the Scientific Committee recommended that the estimate of long-term sustainable yield, established during the 1994 meeting at 1 400 tonnes per split-year, be retained.

4.91 For the northern sector trawl fishery, the GLM analysis has not detected a significant decline in CPUE in recent years. The Scientific Committee therefore recommended that the TAC of 2 500 tonnes set by the French authorities be endorsed. This is a slight decrease from the 2 800 tonnes set in the previous year.

4.92 Given the uncertainty over the applicability of using CPUE analysis to monitor the stock when only a small part of it is susceptible to the fishery, the Scientific Committee recommended that WG-FSA should consider other ways of assessing fisheries such as this. In particular, it encouraged the collection of trawl survey data on *D. eleginoides* in this division so that an estimate of recruitment can be made.

4.93 For the eastern sector, for which 1995/96 was the second year of fishing, the limit of 1 000 tonnes set in 1995/96 by the French authorities was considered an appropriate precautionary catch limit for 1996/97.

4.94 The Scientific Committee felt that the GLM analysis of factors affecting CPUE in trawl fisheries is a useful technique, and recommended the continued reporting of catch and effort data on a haul-by-haul basis. In addition, efforts should be made to acquire haul-by-haul data from the Ukrainian authorities concerning their longline vessels in the division.

Champsocephalus gunnari (Division 58.5.1)

4.95 There was no commercial fishing for this species in the 1995/96 season, although a small number of trawls were made by a commercial vessel to gain information about the new cohorts entering the population (Annex 5, paragraphs 4.218 to 4.220). The 1994 year class appears abundant, but at present is below the legal size of 25 cm total length under French regulations and will remain so during a large part of the 1996/97 season, so no fishery is expected to occur. A survey will be carried out in 1996/97 to assess pre-recruit biomass (1994 year class).

Management Advice

4.96 The Scientific Committee reiterates its advice from last year (SC-CAMLR-XIV, paragraph 4.83) that the Kerguelen shelf fishery for *C. gunnari* in Division 58.5.1 be closed until at least the 1997/98 season, when the cohort born in 1994 will have had an opportunity to spawn. The Scientific Committee recommends that before this cohort is fished, a pre-recruit biomass survey be conducted in the 1996/97 season to evaluate the strength of the cohort at age 2+. These data should be evaluated at the 1997 meeting of WG-FSA, and an appropriate level of catch recommended.

Notothenia rossii (Division 58.5.1) – Management Advice

4.97 No new data on this species are available. The Scientific Committee therefore reiterated its advice that the fishery for *N. rossii* remain closed until a biomass survey demonstrates that the stock has recovered to a level that will support a fishery (SC-CAMLR-XIV, paragraph 4.78).

Lepidonotothen squamifrons (Division 58.5.1)

4.98 Exploratory fishing was carried out in the traditional fishing areas for this species by French trawlers, and length frequency and CPUE data were collected. The distribution of *L. squamifrons* concentrations was found to be unchanged, but results are very dependent on the time at which the survey is undertaken. A specific survey will be necessary to estimate the biomass and potential yield (Annex 5, paragraphs 4.224 to 4.226).

Management Advice

4.99 In the absence of a new assessment, the Scientific Committee recommended that the Kerguelen Shelf fishery for *L. squamifrons* should remain closed.

Heard Island and McDonald Islands (Division 58.5.2)

Dissostichus eleginoides (Division 58.5.2)

4.100 In 1994 and 1995, WG-FSA had assessed the potential yield of *D. eleginoides* in Division 58.5.2 in a manner similar to assessments of krill yield. This was because the only information available was two estimates of biomass from trawl surveys in previous years. These assessments determined the proportion of the estimated biomass that satisfies the two decision rules used by the Commission (see SC-CAMLR-XIII, paragraphs 5.18 to 5.26, for a discussion on the application of these two rules). The resulting recommended TAC in both assessments was 297 tonnes, and Conservation Measure 78/XIV specifies this figure as the TAC for *D. eleginoides* in Division 58.5.2.

4.101 This year, WG-FSA reassessed this stock using improved techniques developed in 1995. This involved applying the generalised yield model described in Annex 5, paragraphs 3.65 to 3.69, to estimates of recruitment derived from two trawl surveys described in WG-FSA-96/38. This was essentially the same method employed for *D. eleginoides* in Subarea 48.3 (Annex 5, paragraphs 4.67 and 4.68), although different input parameters, principally the age-specific selectivity function, were used to take account of the fact that the catches will be taken by trawling. The catch limit that satisfies the decision rules is 3 800 tonnes. Full details of the analysis are given in Annex 5, paragraphs 4.228 to 4.234.

4.102 The Scientific Committee welcomed the refinements to the analysis using the generalised yield model.

4.103 The reason for the increase in the catch limit over the previous estimate of sustainable yield of 297 tonnes involves two factors: the refinement to the generalised yield model and the use of the new estimate of recruitment, rather than total biomass, in the calculations. The explanation of this difference lies in the assessment of recruitment, which revealed that the biomass estimates used in the previous assessments were underestimates of the stock biomass because the trawl surveys had sampled mostly the younger age classes.

4.104 The Scientific Committee noted that the Commission has previously decided that this fishery does not constitute a new or exploratory fishery (see CCAMLR-XIII, paragraph 6.1 and Conservation Measure 78/XIII). The Scientific Committee reaffirmed that the available information was sufficient to determine, in accordance with paragraph 1 of both Conservation Measures 31/X and 65/XII, that this fishery should not be classified as either a new or exploratory fishery.

4.105 Dr Croxall noted that consideration of the potential impact on dependent and related species of fisheries for *D. eleginoides* in other areas had not been able to incorporate data on the occurrence of *D. eleginoides* in predators' diets. In the Heard Island area, however, there is some evidence that *D. eleginoides* occurs in the diet of elephant seals; they could consume quite substantial quantities of fish even if these formed a small proportion of their diet.

4.106 Dr de la Mare informed the Scientific Committee that there are some as yet unpublished data on the frequency of occurrence of *D. eleginoides* in elephant seal stomachs, amounting to 21 otoliths among about 1 500 squid beaks. Seals take relatively small *D. eleginoides*, so that the overlap with the fishery is incomplete. The abundance of small fish would not be reduced by a fishery unless the spawning stock biomass was dramatically reduced, and the Commission's decision rules are designed explicitly to prevent this.

Management Advice

4.107 The results of the projections using the generalised yield model applied to assessments of recruitment indicated that an annual catch of 3 800 tonnes was consistent with the two decision rules used by the Commission. The Scientific Committee recommended that this should be the basis for setting the catch limit for *D. eleginoides* in Division 58.5.2.

4.108 The Scientific Committee noted that the assessment of yield was based on the expectation that future catches will be taken only by trawling and recommended that the directed fishery for *D. eleginoides* in Division 58.5.2 should be restricted to trawling during the 1996/97 season. Use of other types of fishing gear such as longlines would change the age structure of the catch. It was recognised that the catch level applied for longlining is likely to be greater than that for a trawl fishery but the Scientific Committee did not consider such catch levels. Should there be an interest in longlining in Division 58.5.2 in the future, then the assessment using the generalised yield model can be adjusted to take this into account.

4.109 The Scientific Committee recommended that because the locations of fishable aggregations are not yet known, it would be appropriate to apply some effort limitations during the expansion of the fishery.

4.110 The Scientific Committee recognised the importance to the assessment work of biological data and other information collected from Division 58.5.2. The information can be collected both by scientific surveys and through a scientific observer program. In view of the need for information, the Scientific Committee recommended that at least one observer be on board each vessel.

Champsocephalus gunnari (Division 58.5.2) – Management Advice

4.111 Conservation Measure 78/XIV established a TAC of 311 tonnes for *C. gunnari* in Division 58.5.2 on the basis of results from Australian biomass surveys. There is no new information available to suggest any change to this figure. In the light of experience with the fishery for this species in Division 58.5.1 (SC-CAMLR-XIV, Annex 5, paragraphs 5.146 to 5.152), the Scientific Committee recommended that the fishery for *C. gunnari* in Division 58.5.2 should also avoid taking fish smaller than the size at first spawning (about 28 cm total length).

General

The Definition of 'Fishing Ground'

4.112 The Scientific Committee considered the response of WG-FSA to the Commission's request (CCAMLR-XIV, paragraph 8.5) in relation to the definition of fishing grounds given in the WG-FSA report (Annex 5, paragraphs 4.1 to 4.4).

4.113 The Scientific Committee agreed that the term 'fishing ground' is confusing and should not be used but replaced with a specific geographical definition.

4.114 The Working Group noted that, in their present form, the conservation measures which aim to control by-catch could give rise to practical problems in demanding that a fishing ground be abandoned when the by-catch is greater than a given percentage of the total catch, even though the catch itself may be very small.

4.115 The Scientific Committee deemed this to be a problem within the scope of SCOI. The problem is the need to establish additional criteria in the monitoring of the by-catch which are easily applied by fishermen and where compliance can be ascertained.

Future Work

4.116 When considering the future work for WG-FSA, the Scientific Committee noted the substantial increase in the workload to be performed by the Working Group in forthcoming years, and the consequent increased workload for the Secretariat.

4.117 The Scientific Committee endorsed the details of the future work required by WG-FSA, presented in Annex 5, paragraphs 9.2 to 9.7.

Crab Resources

4.118 The Scientific Committee noted that a single US fishing vessel, *American Champion*, had fished for crabs in Subarea 48.3 during the 1995/96 fishing season. The vessel targeted *P. spinosissima* with *P. formosa* being returned to the sea.

4.119 The *American Champion* acted in accordance with the experimental harvest regime set forth in Conservation Measure 90/XIV. The vessel initiated Phase 2 of the experimental harvest regime on 4 November 1995 (the provisions of Phase 2 require vessels to concentrate fishing effort in three squares each measuring approximately 26 n miles^2). The *American Champion* completed Phase 2 of the experimental harvest regime on 20 November 1995 and continued standard commercial operations until 29 January 1996, when it stopped participating in the fishery.

4.120 The *American Champion* has surrendered its US-issued permit to fish for crabs in Subarea 48.3. American Seafoods South America (the company which manages *American Champion*) does not currently consider this fishery to be economically viable.

4.121 In accordance with the Ten-day Catch and Effort Reporting System set forth in Conservation Measure 61/XII, catch and effort data for both the 1994/95 and 1995/96 crab fishing seasons have been submitted to the Secretariat (Annex 5, Table 19). A total catch of 479 tonnes was taken during these two seasons.

4.122 Data on the by-catch of *D. eleginoides* during the 1994/95 and 1995/96 fishing seasons were also provided to the Secretariat (Annex 5, Table 20), and the Scientific Committee noted that the by-catch in the 1995/96 season was lower than that in the 1994/95 season.

4.123 The decreased by-catch during the 1995/96 season probably resulted from changes in the availability of *D. eleginoides* to the crab fishing gear and not from physical changes in the design of the gear itself.

4.124 The Scientific Committee noted that several analyses of data collected during the experimental harvest regime had been presented to WG-FSA, including a review of the current minimum size limit for *P. formosa*. WG-FSA reviewed these analyses (see Annex 5, paragraphs 4.174 to 4.179) and came to three conclusions:

(i) data collected during Phase 1 of the experimental harvest regime indicate that estimates of local crab abundance should not be extrapolated to the whole of Subarea 48.3 solely on the basis of depth-specific seabed area (extrapolations must consider area-specific differences in crab density);

(ii) results from Phase 2 of the experimental harvest regime suggest that there is not much scope for using depletion estimators to estimate local abundances of *P. spinosissima*; and

(iii) there is not a sufficiently strong biological reason to revise the current size limit on *P. formosa* (90 mm carapace width) set forth in Conservation Measure 91/XIV.

4.125 The Scientific Committee agreed that the experimental harvest regime set forth in Conservation Measure 90/XIV had provided valuable information and endorsed the views of WG-FSA in this regard (Annex 5, paragraphs 4.181 to 4.184). In particular, the Scientific Committee agreed with the following points:

(i) the wide geographic distribution of fishing effort required by Phase 1 was useful for learning about the distribution of *P. spinosissima*, determining where the areas of high crab abundance are located, and providing information about whether the crab fishery was likely to be economically viable;

(ii) the implementation of Phase 2 had successfully shown that local depletion estimators cannot be used for estimating the abundance of *P. spinosissima* and that Phase 2 of the experimental harvest regime should be redrafted so that vessels are not required to conduct depletion experiments during this phase; and

(iii) the experimental harvest regime has, to date, been successful at controlling development of the crab fishery.

4.126 Noting that data collected from the experimental crab fishery did not provide a basis for estimating crab abundance and also that the crab fishery does not currently appear to be economically viable, the Scientific Committee endorsed WG-FSA's opinion that it was not necessary to make an assessment of the crab stocks in Subarea 48.3.

4.127 Dr Holt concluded the discussion on crab resources by thanking the Scientific Committee and WG-FSA for assistance in developing the experimental harvest regime and helping to ensure that the crab fishery developed in a controlled fashion.

Management Advice

4.128 Since the crab stock was not assessed and since the US and the UK have indicated that some fishing companies may still be interested in participating in the crab fishery (paragraph 2.17), the Scientific Committee recognised that a conservative management scheme is still appropriate for this fishery. In particular, the Scientific Committee noted that the fishery should continue to be controlled by direct limitations on catch and effort, as well as by limitation on the size and sex of individual crabs which may be retained in the catch. In this regard, the Scientific Committee noted that Conservation Measure 91/XIV contains such limitations and endorsed WG-FSA's recommendation that this measure should continue to be applied to the crab fishery in Subarea 48.3.

4.129 In light of the conclusions presented in paragraphs 4.125(i) and (ii), the Scientific Committee agreed that the experimental harvest regime set forth in Conservation Measure 90/XIV should be revised in accordance with the following specific recommendations:

(i) Phase 1 of the experimental harvest regime should remain in force;

(ii) Phases 2 and 3 of the experimental harvest regime should not remain in force in their present form, but the regime should include provisions for requiring approximately one month of experimental fishing effort during the second season of a vessel's participation in the fishery. The details of appropriate revisions to Phases 2 and 3 should be considered by WG-FSA if any new vessels initiate participation in the crab fishery; and

(iii) the experimental harvest regime should include provisions for the placement of scientific observers on the fishing vessels.

Squid Resources

4.130 Results from a research cruise conducted in Subarea 48.3 in June 1996 using a Korean squid jigging vessel had been discussed by WG-FSA (Annex 5, paragraph 3.56) (paragraph 2.19).

4.131 The Scientific Committee noted that notification to initiate a new fishery for *M. hyadesi* in Subarea 48.3 had been received from the Republic of Korea and the UK (paragraph 2.20). This was considered under Agenda Item 8 (see paragraphs 8.2 and 8.3). Arising from this, the Scientific Committee noted that an assessment based on predator food consumption had been considered by WG-FSA. The Scientific Committee agreed that this approach should be reviewed at WG-EMM.

ECOSYSTEM MONITORING AND MANAGEMENT

Report of WG-EMM

5.1 In its discussions leading to an ecosystem assessment, WG-EMM considered trends in harvested species, dependent species and the environment and interactions between them. Trends in harvested species were discussed under Agenda Item 4, and trends in dependent species under Agenda Item 3.

Environment

5.2 The Scientific Committee noted that, in order to obtain a better understanding of krill flux, a practical index of current flow is required (Annex 4, paragraph 5.2).

5.3 Sea-surface temperature (SST) is widely seen as being an important environmental variable. SST data have been included on the CCAMLR database and a preliminary index of SST has been developed by WG-EMM. The Scientific Committee noted that further consideration of an SST index would be possible only after interactions in the ecosystem had been studied (Annex 4, paragraph 5.6). Data on bathymetry are also considered important for an understanding of both ecological and fishery interactions (Annex 4, paragraphs 5.11 to 5.13).

5.4 The Scientific Committee noted that some progress had been made on incorporation of sea-ice information into assessments, but further consideration of this topic is needed (Annex 5, paragraphs 5.7 and 5.14 to 5.22). Consideration has also been given to water circulation with respect to SST, bathymetry, and sea-ice (Annex 4, paragraphs 5.23 to 5.27).

5.5 Information had been provided to WG-EMM which indicated that an increase in mean temperature has been taking place over the past decade and the implications of this for krill were discussed (Annex 4, paragraphs 5.28 to 5.31). The Scientific Committee noted the view of WG-EMM that a better understanding of interactions within the system would be obtained by encouraging a more active participation by physical oceanographers who have a particular interest in helping to solve biological problems.

By-catch of Fish in the Krill Fishery

5.6 WG-EMM has reviewed new data and analyses by Japanese scientists of by-catches of fish in the krill fishery (Annex 4, paragraphs 6.1 to 6.3). It recommended that these data, augmented by length composition data for the most abundant species, should be incorporated into the comprehensive review of fish by-catches being undertaken by a correspondence group under the coordination of the Science Officer, Dr E. Sabourenkov. It has also requested that by-catch studies be extended to cover seasons other than the austral summer.

5.7 The Scientific Committee welcomed the provision of the new data and analyses, noting with gratitude that further data, including historical Russian data from krill surveys, have also been provided to WG-FSA (Annex 4, paragraphs 5.8 to 5.12). It endorsed the recommendations of WG-

EMM on fish by-catch studies and looked forward to receiving the final report of the correspondence group.

Interactions between Harvested Species and the Environment

5.8 When attempting to relate krill distribution and recruitment to environmental variables, WG-EMM had identified a need to establish the degree of linkage between major concentrations of krill, to determine the size of areas in which similar variation takes place, and to establish to what extent observed variation could be explained by changes in krill production within an area, as opposed to movement of krill from area to area (Annex 4, paragraph 6.9). The Scientific Committee endorsed WG-EMM's conclusion that the implications of these points with respect to the size of management areas used by CCAMLR should be considered.

5.9 The Scientific Committee noted WG-EMM's discussion of the extent of variation in krill recruitment and its underlying causes. It endorsed the conclusion that the next step should be to derive an absolute recruitment index. It noted that further work was needed on the interpretation of recruitment indices and their relationship with sea-ice and other environmental variables (Annex 4, paragraphs 6.10 to 6.21).

5.10 The present krill yield model is based on the assumption that there is no temporal trend in krill recruitment. Evidence has been provided to WG-EMM which indicates that there may have been a decline in krill recruitment and abundance in Subarea 48.1 and possibly other subareas, arising from environmental changes. In the event that significant real trends are demonstrated, the Scientific Committee recognised that further development of the krill yield model may be required. It also noted that refinements of the krill yield model to account for environmental effects on krill growth and mortality need to be considered (Annex 4, paragraphs 6.22 to 6.24).

Interactions between Harvested Species and the Krill Fishery

5.11 The Scientific Committee noted that analysis of haul-by-haul data from the krill fishery indicated that in Areas 48 and 58, the fishery was concentrated at locations which appear to be associated with environmental features, such as topographically induced eddies. The Scientific Committee endorsed the conclusion of WG-EMM that the provision of haul-by-haul data will improve our understanding of factors responsible for the local aggregation of krill (Annex 4, paragraph 6.25).

Interactions between Dependent Species and the Environment

5.12 The Scientific Committee noted WG-EMM's discussions on the relationship between penguin breeding success and local environmental variables, such as sea-ice distribution. It endorsed the request for Members to prepare formats for data submission and to suggest how appropriate indices might be calculated (Annex 4, paragraphs 6.30 to 6.36).

Interactions between Dependent Species and Harvested Species

5.13 The Scientific Committee noted new developments in studies on diet, energy budgets and foraging ranges of birds and marine mammals in the Convention Area (Annex 4, paragraphs 6.38 to 6.42). It endorsed the standing request to Members to monitor and update annually data on these aspects (Annex 4, paragraph 6.37). It also noted that studies on interactions between dependent species and their prey had highlighted the need for precise information on diet, feeding activity and diving behaviour in relation to the types of prey available (Annex 4, paragraphs 6.43 to 6.46).

5.14 Two approaches to modelling the relations between dependent species and prey were discussed by WG-EMM. The first of these investigated the effects of fisheries on krill predators, considering processes at the level of a foraging trip, rather than at the level of population effects. The Scientific Committee noted that this approach would be of particular relevance to ecosystem assessment (Annex 4, paragraphs 6.47 to 6.55). The second approach involved modelling functional relationships between predators and prey. Initial models have been developed for fur seal, black-browed albatross and Adélie penguin. The Scientific Committee endorsed the plans for further development of these models developed by WG-EMM (Annex 4, paragraphs 6.56 to 6.61 and Appendix F).

5.15 Prof. Moreno welcomed the progress that had been made in understanding the interactions between dependent and harvested species, but queried the apparent absence of studies in which krill-eating fish are treated as dependent species.

5.16 Dr Everson noted that one example of such a study involving *C. gunnari* has been discussed by WG-FSA (Annex 5, paragraphs 4.149 to 4.153). As this work progresses, it may be appropriate for it also to be discussed by WG-EMM.

Overlap between Fisheries and Dependent Species

5.17 For a number of years, the Secretariat has been calculating the critical period-distance (CPD) index. Last year, it was agreed that the derivation and use of this index should be reviewed. This issue had been considered by WG-EMM's Subgroup on Statistics. Four levels at which the analysis of niche overlap may be considered were identified (Annex 4, paragraph 6.63 and Appendix H). The current CPD index is based on a potential overlap model. An alternative approach, which calculates a realised overlap index, is provided by the Agnew and Phegan (1995) model, however, WG-EMM noted that neither the model, nor its parameter values, had been evaluated by the Scientific Committee or its working groups (Annex 4, paragraph 6.72).

5.18 The Scientific Committee noted that this was a particularly complex subject on which considerable further work was needed (Annex 4, paragraphs 6.65 to 6.79). It endorsed the suggestion by WG-EMM that progress could be made intersessionally on the realised overlap index if the Agnew and Phegan model were evaluated critically in terms of its assumptions and the values of parameters used. It agreed that this task should be initiated through the WG-EMM Subgroup on Statistics and also by inviting submissions to the subgroup of additional or alternative values of parameters, including those suitable for extending the generality of the model beyond the Seal Island area (Annex 4, paragraph 6.80).

5.19 In relation to the additional data and analyses that would be needed by the subgroup for the review, the Scientific Committee agreed with the proposal from WG-EMM that the Secretariat should be asked to request data or analyses describing, for all relevant sites and species, (i) monthly estimates of typical diet composition, maximum and modal foraging range and direction, (ii) finer-scale foraging data where possible, and (iii) estimates of the above derived from close and/or similar sites if the information is not available for the specific CEMP site.

5.20 The Scientific Committee noted the expectation of WG-EMM that this process would lead to the development of one or more versions of the realised overlap model. The indices of overlap provided by this approach would be expected ultimately to replace those currently calculated using the potential overlap model. However, the current indices would continue to be calculated for the time being, particularly until implications relating to krill flux are better understood (Annex 4, paragraph 6.82).

5.21 Mr Ichii emphasised his view that the current potential overlap index was inappropriate and should be replaced by one based on realised overlap. He noted, however, that a commonsense approach should be taken when identifying realised overlap. In Subarea 48.1, for example, the foraging range of fur seals depends on the distribution of available myctophids, as well as krill. Also, the relative food consumption of the different predators should be taken into account.

5.22 Dr Croxall noted that:

(i) this was not the consensus view either of the Subgroup on Statistics (see Annex 4, paragraph 6.65) or of WG-EMM (see e.g. Annex 4, paragraph 6.75);

(ii) the existing formulation of the realised overlap model was, at best, applicable only to penguins in the vicinity of Seal Island and WG-EMM had agreed that it was essential to critically evaluate this model in terms of its assumptions and the parameter values used (Annex 4, paragraph 6.80); and

(iii) WG-EMM had agreed to try to develop realised overlap models for appropriate combinations of species, sites and areas (Annex 4, paragraph 6.81) but they would need to be based on empirical data on diet and distribution of predators rather than on assertions concerning these.

5.23 The Scientific Committee agreed that ultimately overlap indices would probably be calculated on a site-by-site basis.

Analysis of Data from CEMP Indices

5.24 The Scientific Committee noted that integrated analyses have shown that some CEMP indices may show rather different and more complex responses than those which were previously assumed (Annex 4, paragraphs 6.85 to 6.88). Arising from discussion on an initial multivariate analysis using data on chinstrap penguin breeding success, krill density and sea-ice extent, a regression model linking breeding success to sea-ice extent was constructed (Annex 4, paragraph 6.90). The Scientific Committee welcomed this approach to the analysis of CEMP data.

5.25 The Scientific Committee agreed that a workshop should be held intersessionally to address uncertainties regarding the relationship between indices of harvested and dependent species at specific sites and also between subareas in Area 48. The main focus would be on examining long time series of data in the area. The terms of reference for the meeting would be:

(i) identify the extent of between 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 by the 1997 meeting of WG-EMM.

The meeting will be held in the USA (local organiser, Dr Holt).

Ecosystem Assessment

5.26 The Scientific Committee welcomed the considerable progress that has been made this year in the analysis of the CEMP indices, particularly the identification of anomalies and trends. It noted, however, that some further work is required, particularly on the treatment of indices which are not normally distributed. It further noted that, because of this, it was not yet possible for WG-EMM to present a table of statistically reliable anomalies. In its place, WG-EMM had developed a table presenting the information as standardised normal deviates for all years. These are set out in Annex 4, Table 4. The Scientific Committee noted that this table is halfway between the previous qualitative subjective presentation of data in last year's report and a future quantitative presentation of anomalies, which is one of the goals of WG-EMM.

5.27 The Scientific Committee joined WG-EMM in congratulating the Secretariat on the new analysis that had been conducted and endorsed the Working Group's recommendation that similar presentations be made in future years. It also agreed that further development should be undertaken by individual research communities with specific experience of individual CEMP sites. It noted that the full set of raw CEMP data and a table of the indices calculated by the Secretariat, are now available for Members to use in such investigations, in accordance with the rules of access to CCAMLR data.

5.28 Using the information in Annex 4, Table 4 and other indicators contained in papers presented to the meeting, WG-EMM derived an ecosystem assessment for 1995/96. This is given in Annex 4, paragraph 7.2 and is summarised below.

5.29 For Subarea 48.1, there is evidence for a strong 1994/95 krill year class, and predator breeding success was also high. For Subarea 48.2, there are no time series data on prey abundance, but predators experienced a good breeding year. In Subarea 48.3, krill were more abundant than in previous seasons and predators experienced a better-than-average breeding season. Overall in Area 48, there is some coherence between events throughout, with 1995/96 being a cold year with better-than-average krill abundance and predator performance.

5.30 In Division 58.4.2, following the total failure of breeding Adélie penguins at Béchervaise Island, which occurred as a result of a local krill shortage, most breeders returned in 1996 although breeding success was a little lower than normal. No information on prey abundance was available. In Division 58.4.1, a krill survey discovered higher krill abundance in the western portion of the subarea than in the eastern portion, although no other historical surveys were available to enable an assessment to be made of the relative abundance of krill in the 1996 season.

5.31 In Subarea 88.1, predator performance in the Ross Sea was at an average level in 1996.

Strategic Modelling

5.32 The Scientific Committee noted that WG-EMM had further considered the conceptual framework developed last year (Annex 4, paragraphs 7.34 to 7.42). At present, most effort by WG-EMM is devoted to improving the understanding of the processes and linkages between harvested species, dependent species, the environment and the fishery. It endorsed WG-EMM's view that its ultimate aim should be to develop effective mechanisms for management of the ecosystem, as envisaged in the CCAMLR Convention.

5.33 In light of discussions concerning Annex 4, paragraphs 7.24 to 7.30, Dr K. Shust (Russia) noted that the large figure given in WG-EMM-96/66 for krill consumption by fur seals and penguins in Subarea 48.3 indicates that all previous calculations produced significant underestimates of krill biomass in the subarea, and that the fishery removed an infinitesimal part of the total stock. On the other hand, if the figures for potential krill consumption by South Georgia fur seals are correct, then the increase in abundance of this predator over the last few years in Subarea 48.3 and the possible impact of this on other krill consumers are cause for concern.

5.34 In this regard, Dr Shust proposed that the abundance dynamics of South Georgia fur seals be studied thoroughly and, if the population is indeed increasing very rapidly, that the possibility of controlling the numbers of this predator be discussed together with specialists from SCAR and specialists on Antarctic fur seals.

5.35 Dr M. Naganobu (Japan) agreed that further study of this issue was needed and proposed that it should be discussed at the next WG-EMM meeting.

Ecosystem Implications of Proposals for New Fisheries

5.36 Consideration by WG-EMM of the ecosystem implications of proposals for new fisheries is discussed under Agenda Item 8. The Scientific Committee agreed, however, that WG-EMM should further consider the ecosystem components related to squid at its next meeting (Annex 4, paragraph 7.54).

Future Work

5.37 The Scientific Committee was pleased to note that a number of tasks identified at previous meetings of WG-EMM had been completed (Annex 4, paragraph 7.57). It noted that further work was needed on other tasks previously identified, as listed in Annex 4, paragraph 7.58, and it also noted the additional tasks identified during the most recent meeting of WG-EMM (Annex 4, paragraph 7.59).

5.38 The Scientific Committee recommended that the Subgroup on Statistics should meet during the intersessional period with the following terms of reference:

(i) development of indices of at-sea behaviour and methods of deriving them via analysis of sample datasets;

(ii) further review of identification of anomalies in CEMP indices;

(iii) methods for dealing with missing values in multiple datasets; and

(iv) critical evaluation of the assumptions and parameter values of the Agnew and Phegan (1995) model of realised overlap.

5.39 The Scientific Committee endorsed the appreciation shown by WG-EMM to Dr Agnew for his major contribution to the work of WG-EMM. It also joined WG-EMM in thanking Norway for hosting the meeting.

Data Requirements

5.40 The Scientific Committee endorsed the following conclusions of WG-EMM in relation to data requirements:

(i) the continued collection and analysis of time budget data from the krill fishery is encouraged (Annex 4, paragraph 2.11);

(ii) because of their utility, the submission of haul-by-haul data from the krill fishery should continue to be encouraged (Annex 4, paragraphs 3.28 and 3.29); and

(iii) studies on the occurrence of fish in krill catches should continue in accordance with the recommended methods (Annex 4, paragraph 6.1).

Advice to the Commission

5.41 Advice to the Commission in relation to precautionary catch limits for krill is given in paragraph 4.27.

MANAGEMENT UNDER CONDITIONS OF UNCERTAINTY ABOUT STOCK SIZE AND SUSTAINABLE YIELD

Resumption of Fishing

6.1 At last year's meeting, the Commission recognised that no clear policies or measures exist to manage fisheries which have been closed but are under consideration for reopening (CCAMLR-XIV, paragraph 8.26). The Commission requested the Scientific Committee to provide advice on this matter. Dr Holt introduced SC-CAMLR-XV/BG/11 which outlined some suggested procedures to apply to the resumption of a closed fishery.

6.2 WG-FSA advised the Scientific Committee of its deliberations on the matters raised in SC-CAMLR-XV/BG/11, over the definition of a resumed fishery, under what conditions a fishery might be reopened, and whether the existing conservation measures for new (Conservation Measure 31/X) or exploratory (Conservation Measure 65/XII) fisheries could be used instead. WG-FSA recognised that fisheries may lapse for a variety of reasons (including both economic and sustainability factors), and resumption may therefore need to be considered case by case.

6.3 WG-FSA agreed that information and procedures similar to those required for the initiation of a new fishery (Conservation Measure 31/X) and/or for the execution of an exploratory fishery (Conservation Measure 65/XII) should be required during the resumption of a closed fishery. For example, guidelines for a Data Collection Plan and a Research and Fishery Operation Plan, which are required for new and exploratory fisheries, should be considered.

6.4 However, WG-FSA recognised that the requirement for a survey prior to the resumption of a fishery might also be best considered case by case. For example, the Commission requires a survey be completed before closed areas (Subareas 48.1 – Conservation Measure 72/XII and 48.2 – Conservation Measure 73/XII) are reopened for fishing and has required a survey be conducted before directed fishing on a depleted species is resumed (Conservation Measure 97/XIV). However, the Commission does not require a survey before the initiation of a new fishery and may not require a survey before reopening a fishery which had closed for reasons other than stock depletion.

6.5 In all cases, WG-FSA considered it highly desirable for prior notification of the intention to resume a fishery to be provided so that an assessment of the status of the stock can be made and management advice given to the Scientific Committee and Commission. To this end, WG-FSA recommended that the Commission maintain a register of lapsed fisheries.

6.6 The Scientific Committee recognised that one of the key issues in resuming a fishery which has not been exploited for some time is uncertainty over the current status of the stocks. There are two basic cases. The first is where a fishery has been closed as a result of the Commission adopting a specific conservation measure due to an assessment that the stock has been overfished (e.g. *N. rossii* in Subarea 48.3). The second basic case is where fishing activity has ceased for other reasons, for example due to lack of commercial viability. An example of such a case is the fishery for the myctophid *E. carlsbergi* in Subarea 48.3.

6.7 The Scientific Committee considered that reopening a fishery which has been closed by a conservation measure requires an up-to-date stock assessment by the Scientific Committee and its working groups to develop management advice on whether the stock has sufficiently recovered, and to recommend an appropriate TAC. In most cases, a reassessment will require recent information on stock abundance from a scientific survey. Scheduling a reassessment will require prior notice of intent to reopen a fishery so that the required scientific and assessment work can be done. The Scientific Committee noted that its current procedure of seeking information from Members about future fishing plans during its annual meeting has proved unreliable. Therefore the Scientific Committee considers that a formal notification procedure would be more reliable.

6.8 In the case where a fishery has lapsed rather than been closed by a conservation measure, the Commission's recent practice in the instance of the myctophid fishery was to adopt a precautionary TAC based on a method of assessment which takes uncertainty into account in such a way that the assessment remains applicable for an indefinite time. When fisheries appear to have lapsed, the Scientific Committee should, wherever possible, attempt to calculate precautionary catch limits which could then remain in force in case a fishery recommences. Once a fishery has recommenced, normal assessments can be resumed as further information on the status of the stocks is acquired. The Scientific Committee recognised that to ensure that new information becomes available to revise the assessments, it should develop data plans and improved assessment methods as required when it is notified that the fishery is to be resumed.

6.9 A special case is exemplified by *C. gunnari*, where a long-term management strategy is under development. In the case of this species, the status of the stock in Subarea 48.3 is uncertain, and the available information indicates that it can fluctuate in abundance over a large range in an apparently unpredictable manner. One possibility that may be considered in the long-term management strategy is that when it appears that the stock is increasing, a low TAC can be set based on information such as the low end of the range of previous TACs or stock sizes. Such an arrangement, in conjunction with an appropriate survey and other elements of an experimental fishery regime, could allow a fishery to proceed when strong year classes enter the stock. As in the first case, a notification of intent to resume exploitation is necessary so that survey and other data collection requirements can be coordinated and reviewed by the Scientific Committee and its working groups.

6.10 A further special case is where an early exploratory fishery lapsed and no assessment has ever been completed. An example of such a case is some exploratory fishing for *P. antarcticum* which was carried out in Division 58.4.2 during the 1970s. Resumption of such a fishery could be regulated as if it were either a new fishery or an exploratory fishery. Similarly, for the case of the recent exploratory fishery for crabs in Subarea 48.3, an assessment has not yet been undertaken and so some form of exploratory fisheries measure could be retained so as to be in force should there be an interest in resuming the fishery.

Stock Identity

6.11 An important factor which needs to be taken into account in the further development of management under uncertainty is uncertain stock identity in *D. eleginoides* over its wide area of distribution which probably continues across statistical boundaries inside and outside the Convention Area. A related problem is whether existing statistical boundaries might lead to *D. eleginoides* and

D. mawsoni being taken in a mixed species fishery. Thus, studies on stock identity, species overlap, fish movement and dispersal have a high priority, particularly in light of the increase in the geographical spread of fishing. If uncertainty in stock identity cannot be overcome by further direct research in the near future, the properties of the assessment methods with respect to uncertain stock identity will require further study.

Feedback Management for *Dissostichus eleginoides*

6.12 Another area requiring further development is the identification of suitable feedback methods to apply to the *D. eleginoides* fisheries. The current assessment method is based on estimating the absolute abundance of young fish by means of trawl surveys. However, the abundance of the total stock cannot be directly estimated in this way, and currently there is no reliable method available for monitoring trends in the total stock. WG-FSA is exploring the properties of methods which may be useful for this purpose, including standardised indices based on CPUE, monitoring changes in the length distribution of the catches and continuing direct monitoring of recruitment. The next step is to develop a strategic model which will allow the properties of these methods to be examined for their possible inclusion in a feedback management system. This work will have a substantial overlap with the strategic modelling approaches currently under development for managing krill fisheries and for the development of a long-term management strategy for *C. gunnari*. Uncertainty over stock identity can be incorporated into the population components of the strategic models.

SCIENTIFIC RESEARCH EXEMPTION

7.1 In 1994, the Commission requested the Scientific Committee to consider the appropriateness of the 50-tonne catch limit for krill in respect of the scientific research exemption provisions of Conservation Measure 64/XIII (CCAMLR-XIII, paragraph 9.4). Since no information was available to the Scientific Committee last year, Members were requested to provide relevant information and the matter was referred to WG-EMM for consideration (SC-CAMLR-XIV, paragraph 7.2).

7.2 The Scientific Committee noted that WG-EMM had not provided specific advice on the above. However, it was agreed that current levels of catches of krill for scientific research are at levels which are unlikely to compromise the intent of the requirement set out in paragraph 3 of Conservation Measure 64/XII.

7.3 The Scientific Committee therefore advised the Commission that it will keep the 50-tonne catch limit for scientific research exemption for krill under review. Should the current situation change, the matter will be looked at again and advice developed accordingly.

NEW AND EXPLORATORY FISHERIES

8.1 Five notifications of intent to initiate new fisheries in 1996/97 under Conservation Measure 31/X were received by the Commission (Table 8).

Table 8: Summary of notifications of intent to initiate new fisheries under Conservation Measure 31/X in 1996/97.

Member	Fishery	Area	Document No.
Republic of Korea/UK	Squid	Subarea 48.3	CCAMLR-XV/7
Australia	*D eleginoides*, *D. mawsoni*, other species	Division 58.4.3	CCAMLR-XV/9
	Miscellaneous species	Division 58.5.2	
New Zealand	*D. eleginoides*	Subareas 88.2, 88.1	CCAMLR-XV/8 (Rev. 1)
Norway	*D. eleginoides*	Subarea 48.6	CCAMLR-XV/10 (Rev. 1)
South Africa	*D. eleginoides*	Subareas 48.6, 58.6, 58.7 Divisions 58.4.3, 58.4.4	CCAMLR-XV/11

New Fishery for *M. hyadesi* in Subarea 48.3

8.2 The Republic of Korea and the UK jointly submitted a notification for a new fishery for *M. hyadesi* in Subarea 48.3 (CCAMLR-XV/7). The proposal was for two vessels to harvest up to 2 500 tonnes of *M. hyadesi*. WG-FSA considered this proposal in depth (Annex 5, paragraphs 4.11 to 4.14).

8.3 The Scientific Committee noted the precautionary approach proposed for this fishery and endorsed WG-FSA's advice regarding data collection for this fishery.

New Fishery for *D. eleginoides* in Subarea 48.6

8.4 Norway submitted a notification (CCAMLR-XV/10 Rev. 1) for a new longline fishery for *D. eleginoides* in Subarea 48.6. WG-FSA was unable to comment on the proposal as there was no information on catch levels, the biology of proposed harvested species, dependent/associated species-effects or comparisons with similar fisheries.

8.5 Clarification by Norway indicated that the notification was preliminary and that no permit had been issued for fishing during 1996/97. Appropriate information for review will be provided in the future. It was noted that the intent was to distribute fishing activity widely within Subarea 48.6 in order to maximise fisheries data collection.

New Fishery for *D. eleginoides*, *D. mawsoni* and Mixed Species in Divisions 58.4.3 and 58.5.2

8.6 Australia submitted a notification (CCAMLR-XV/9) for a new bottom trawl fishery in Division 58.5.2 which was similar to that submitted last year (CCAMLR-XIV, paragraph 6.1). This fishery proposes to take up to 50 tonnes per species (other than *C. gunnari* and *D. eleginoides*, which are subject to TACs under Conservation Measure 78/XIV) and to allow a bottom trawl fishery in Division 58.4.3 with a catch limit of 200 tonnes for *D. eleginoides* and *D. mawsoni* combined.

New Fishery for *D. eleginoides* in Subareas 88.1 and 88.2

8.7 New Zealand submitted a notification of its intention to initiate a fishery for *D. eleginoides* in Subareas 88.1 and 88.2 (CCAMLR-XV/8 Rev. 1) which includes a plan of data collection and a fishery operation protocol. The notification proposes setting precautionary limits of 2 500 tonnes per statistical area with subarea limits between 200 and 1 500 tonnes being distributed by rectangles of 0.25° latitude by 0.25° longitude on the basis of catch limits established during limited periods of fishing. Catch rates are to be used to terminate fishing in specific rectangles and to provide criteria to be applied to the resumption of fishing.

8.8 A question was raised whether proposed plans included strict adherence to Conservation Measure 29/XIV for the avoidance of incidental mortality. New Zealand noted that if a permit were to be issued, full compliance with mitigation measures for the avoidance of incidental mortality would be required.

8.9 It was noted that the small size of the rectangles could be problematic; for example, taking 1 500 tonnes from such a small rectangle could be detrimental to the stock.

New Fishery for *D. eleginoides* in Subareas 48.6,
58.6, 58.7 and Divisions 58.4.3 and 58.4.4

8.10 South Africa submitted a proposal (CCAMLR-XV/11) for a longline fishery for *D. eleginoides* in a number of areas in the Indian Ocean which have never been fished (e.g., Subareas 48.6 and 58.7) or where South Africa has not fished (e.g., Divisions 58.4.3 and 58.4.4). It was noted that the management plan described a data collection plan and fishery operation protocol. It proposes setting precautionary catch limits by statistical area (a limit of 3 200 tonnes per area was chosen based on historic catches from Subarea 48.3) with local limits of between 200 and 800 tonnes being distributed by rectangles of 0.5° latitude by 1.0° longitude depending on the catch rates achieved during specific periods of fishing.

8.11 A question was raised as to whether Conservation Measure 87/XIII, regulating the fishery for *L. squamifrons* in Division 58.4.4 on the Ob and Lena Banks, applies to the proposed new fishery for *D. eleginoides*. This measure requires the by-catch of *D. eleginoides* to be reported monthly. It was also noted that this conservation measure, which specifically applies to trawl fishing, expires during the 1995/96 season.

8.12 South Africa noted that any current conservation measure in force would apply to the proposed fishery. With regard to Conservation Measure 87/XIII, the reported by-catch of *D. eleginoides* from the Ob and Lena Banks would be included in any TAC established for the new longline fishery.

8.13 Additionally, South Africa noted that Conservation Measure 29/XIV, designed to minimise incidental mortality of seabirds, would apply to the proposed fishery. The period of fishing was noted as a potential issue because it may be difficult to adhere to night-time setting of longlines as mandated in Conservation Measure 29/XIV if fishing is allowed for a 12-month period.

8.14 Clarification was requested from South Africa on item (3).(g) in its proposed fishery plan (CCAMLR-XV/11); this specifies that the by-catch of species other than *D. eleginoides* shall not exceed 50 tonnes. If this was exceeded, the fishable resource would become a new fishery and it would not commence until the notification procedure requirement under Conservation Measure 31/X was fulfilled. This plan was considered appropriate for the mixed species fishery.

8.15 The Scientific Committee was encouraged by the thoroughness of the South African plan for the collection of data, including environmental, catch and effort and biological data.

8.16 The Scientific Committee endorsed the observation of WG-FSA (Annex 5, paragraphs 4.19 and 4.20) that a number of general principles, particularly with reference to finfish, were common to all five notifications of new fisheries.

8.17 These principles for the new fisheries for *D. eleginoides* (which could be applied to other new fisheries to some degree) are as follows:

(i) CCAMLR should adopt a common and integrated approach to areas likely to be developed by new fisheries;

(ii) as part of such an integrated approach, the application of Conservation Measure 31/X should anticipate the requirements of Conservation Measure 65/XII by setting up scientifically-based data collection and fishery/research operation plans. This will facilitate the acquisition of data necessary to manage the development of new fisheries in accordance with CCAMLR's precautionary approach;

(iii) precautionary catch limits should be determined for statistical areas using available information (e.g. based on catches from similar fisheries elsewhere and/or on areas likely to be suitable for fishing). Limits for smaller areas (e.g. rectangles of 0.5° latitude by 1.0° longitude) should also be developed. These will serve to distribute catch and fishing effort while augmenting the collection of relevant information over a wide geographic area in a way that should reduce the risk of localised overfishing;

(iv) the collection of crucial fisheries and biological information mandates the deployment of scientific observers; and

(v) accurate positional information is essential, particularly if fine-scale rectangles are applied, if the fishery should follow stock across the Convention Area boundaries (as appears to be the case for *D. eleginoides* in Subarea 58.7 and on the banks adjacent to Subarea 48.3) or if the fishery should move between subareas within the Convention Area.

8.18 The Scientific Committee discussed at length the issue of fine-scale limits as described in paragraph 4.20(iii) of Annex 5. The Scientific Committee agreed with WG-FSA on the scientific rationale for catch limits for fine-scale areas and the proposed size of such fine-scale areas.

8.19 The observation was made that it would be extremely difficult to implement a system of catch limits in such fine-scale areas. The administration of fine-scale area limits requires near real-time catch reporting and positional information as well as near real-time dissemination of this data to those involved in the fishery.

8.20 However, in order to ensure that a new fishery will provide sufficient data required under Conservation Measure 65/XII, fishing effort must not be concentrated in too small an area.

8.21 The Scientific Committee also noted that the level of effort must be taken into account when setting fine-scale area limits. The level of effort in the finfish proposals was not addressed by WG-FSA, nor was advice provided by the Scientific Committee. It was recognised that this was an important topic for the Commission.

8.22 Based on discussions by WG-FSA (Annex 5, paragraphs 4.28 to 4.30) on the calculation of a precautionary limit for *D. eleginoides* in previously unfished statistical areas, the Scientific Committee recommended that a limit of 2 200 tonnes for *D. eleginoides* be applied to each subarea or division in the new fisheries proposals.

8.23 It was noted that the best data for the estimation of stock size and recruitment levels using current methods would be obtained from trawl surveys and that such estimations are not possible from commercial fishing data.

8.24 The applicability of the level of 2 200 tonnes to each subarea or division was of concern to some Members. The Scientific Committee noted that a better basis for adjusting areal limits would probably be to take into consideration the proportional seabed area for specific depth ranges. Such calculations were not possible for WG-FSA this year but have been given a high priority for next year's meeting of the Working Group.

8.25 It was noted that no commercial fishing had been allowed until now in the French EEZ surrounding Crozet Island due to conservation reasons, this island being a major breeding area for albatrosses and petrels. Such considerations may also be applicable to other areas for future new fisheries.

8.26 Detailed information on the distribution and abundance of albatrosses in the region is available in SC-CAMLR-XV/BG/21; similar data on petrels can be made available via ad hoc WG-IMALF as required.

8.27 It was noted that stocks regulated within the Convention Area may move outside the Convention Area, but that insufficient data exist for questions of stock identity to be addressed at this time. Due to the lack of knowledge on stock identity, it was recommended that biological samples, particularly of otoliths, be collected from catches in the new fishery.

8.28 The ASOC Observer expressed concern about the level of catch limits suggested by the Scientific Committee for statistical subareas for the new fisheries for *D. eleginoides*. ASOC stated that the suggested limits seemed to allow commercial-scale catches instead of a fishing level which would allow for adequate data collection; this is not in keeping with Conservation Measure 65/XII. ASOC expressed the opinion that a true precautionary approach would create a transition period from no fishery to full-scale commercial catches and urged CCAMLR to set catch limits for *D. eleginoides* in the new fisheries at an order of magnitude below the existing TACs in statistical subareas where commercial catches have been taken for several years.

8.29 The Scientific Committee noted that the timing and duration of new fisheries might have implications for incidental mortality due to variation in day length during the year and consequent differences in the likelihood of substantial by-catch of seabirds. The Scientific Committee noted that for the areas under consideration, it did not currently have sufficient data on seabird by-catch in new fishery areas to provide guidance. It was recommended that the topic should be readdressed in the future when more data are available (see paragraph 8.32).

Future Work

New Fishery for *M. hyadesi* in Subarea 48.3

8.30 The Scientific Committee requested that the Secretariat compare the proposed data elements in WG-FSA-96/21 with those of CCAMLR's standard fine-scale catch and effort data form for a squid jig fishery (Form C3 Version 1) to ensure that critical data are collected. Revised data forms should be developed in consultation with Dr P. Rodhouse (British Antarctic Survey).

New Fishery for *D. eleginoides*, *D. mawsoni* and Mixed Species in Subareas 48.6, 58.6, 58.7 and Divisions 58.4.3 and 58.4.4

8.31 The Secretariat was requested to undertake calculations of seabed area for specific depth ranges in previously unfished areas and to compare the results with those for fished areas.

8.32 The ad hoc WG-IMALF subgroup was requested to summarise available data on seabird by-catch within the subareas and divisions of proposed new fisheries.

Management Advice

All New Fisheries

8.33 The Scientific Committee agreed that information collected by scientific observers would be critical for evaluating the potential of new fisheries and recommended that each vessel participating in any of the new fisheries have at least one scientific observer onboard throughout all fishing activities. These observers should record and submit their data in the most recent version of the Scientific Observer Logbook (paragraphs 9.8 to 9.11).

Squid

8.34 The Scientific Committee recommended a catch limit of 2 500 tonnes for this fishery.

8.35 The Scientific Committee recommended that the fishery collect data in accordance with the revised fine-scale catch and effort data form for a squid jig fishery (paragraph 8.30).

D. eleginoides / *D. mawsoni* / Mixed Species

8.36 The Scientific Committee recalled the Commission's concern that new finfish fisheries have started in the Convention Area without adequate information being available to evaluate either the fishery potential or the possible impacts on target stocks or species dependent on them (Conservation Measure 31/X). The Scientific Committee recommended that the new finfish fisheries proposed for the 1996/97 fishing season should proceed under the data reporting and submission provisions of Conservation Measures 51/XII (Five-day Catch and Effort Reporting System) and 94/XIV (monthly submission of haul-by-haul data). The Scientific Committee further recommended that Conservation Measure 94/XIV be generalised to accommodate data collection and submission from longline and trawl fisheries in all parts of the Convention Area.

8.37 The Scientific Committee agreed that it would be difficult to evaluate the potential of the new finfish fisheries if the catches were taken in short periods of time or over very small areas. In this regard, the Scientific Committee made three specific recommendations:

(i) provisions should be made to distribute fishing effort over as wide a geographic area as possible (this might be accomplished by permitting a nominal level of exploitation in a number of fine-scale rectangles measuring 0.5° latitude by 1.0° longitude);

(ii) the Commission should consider methods for limiting effort in each new finfish fishery; and

(iii) provisions should be made to obtain accurate positional information from each vessel participating in a new finfish fishery.

8.38 The Scientific Committee agreed that each new finfish fishery should be limited by an overall catch limit applied to each statistical subarea or division in which a new fishery will occur. In this regard, the Scientific Committee recommended 2 200 tonnes as an appropriate subarea or division catch limit. The Scientific Committee reiterated WG-FSA's warning that the 2 200-tonne limits do not indicate that such quantities of fish would be available in each statistical subarea or division, or that this limit represents a conservative assessment of the potential yield in each of these statistical subareas or divisions (Annex 5, paragraph 4.30).

8.39 The Scientific Committee also recommended that the Commission consider arrangements for the inclusion of any by-catch of *D. eleginoides* taken in the trawl fishery for *L. squamifrons* on Ob and Lena Banks in the TAC of the new longline fishery in Division 58.4.4.

CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

9.1 During the 1995/96 season and in accordance with the Scheme of International Scientific Observation, observers had conducted observations on 16 longline vessels fishing for *D. eleginoides* in Subarea 48.3 (Annex 5, Tables 26 and 27).

9.2 All data were submitted to the Secretariat. Observations reported by scientific observers were considered by WG-FSA (Annex 5, paragraphs 7.27 to 7.51) and also by WG-EMM (Annex 4, paragraphs 2.10 and 2.11). Discussions of the Scientific Committee on this subject are given in paragraphs 3.27 to 3.34 of this report.

9.3 One major development in the implementation of the scheme this season was that all observers on longline vessels were required to record data using Scientific Observer Logbooks prepared by the Secretariat and distributed to Members in January 1996. Only four completed logbooks have so far been received by the Secretariat. Other reports used different formats for recording observations. WG-FSA recommended ways of improving data recording and submission procedures (Annex 4, paragraphs 3.7 to 3.19, 7.81 and 7.82). This is considered below in paragraphs 9.8 to 9.10.

9.4 Following the request of the 1995 meeting of WG-FSA, the Secretariat drafted forms for the Scientific Observer Logbook for recording observations in trawl fisheries. Several changes to longline logbooks were also suggested by scientific observers and considered by WG-FSA (Annex 5, paragraphs 3.10 to 3.13). The revised logbook data submission forms for longline and trawl fisheries have been submitted to the Scientific Committee (SC-CAMLR-XV/BG/26) for information.

9.5 The Scientific Committee recalled its advice to this year's meeting of SCOI. The advice covered two major topics:

(i) the scope of the scheme's application; and
(ii) the need to obtain accurate positional information from fishing vessels.

9.6 With regard to accurate positional information from fishing vessels, the Scientific Committee emphasised that this information is essential if fishing effort expands over a wide geographical area or the fishery follows stock(s) across statistical areas or subareas.

9.7 The Scientific Committee considered and approved all the suggestions proposed by WG-EMM and WG-FSA (for reference see paragraph 9.2 above) on the improvement of data submission, in particular, and the work of the scheme, in general.

9.8 In particular, the Scientific Committee approved the suggestion that each Member should designate a technical coordinator who will be responsible for:

(i) receipt and distribution of observer logbooks;

(ii) advance notification to the Secretariat of all observers designated and the duration of their programs;

(iii) timeliness of the submission of reports on observations; and

(iv) answering data queries received from the Secretariat.

9.9 With regard to the deadline for submission of observers' reports, the Scientific Committee agreed that the reports should be submitted by Members not later than one month after the completion of the observer cruise.

9.10 The Scientific Committee recommended that the Commission approve the necessary funds for the publication in 1997 of the *Scientific Observer Manual* with data recording forms, instructions for their completion and examples of completed forms (Annex 5, paragraph 3.16). The publication should be in a loose-leaf format in order to enable Members to compile and copy Scientific Observer Logbooks in a number sufficient for their observers and the duration of their programs. The Commission is also requested to give priority to the publication of the *Scientific Observer Manual* in all four official CCAMLR languages.

9.11 Members were requested to ensure that all observers, both national and those designated by the Scheme of International Scientific Observation, provide data to the Secretariat in the format prescribed by the Scientific Observer Logbooks. The Secretariat would not be able in the future to process any data which are not submitted in formats other than CCAMLR's.

9.12 The Scientific Committee recommended that the Secretariat be requested to investigate the potential for developing a CCAMLR database data entry system for use by observers. This would possibly reduce the data entry burden on the Secretariat.

CCAMLR DATA MANAGEMENT

10.1 The Scientific Committee reviewed matters relating to data management included in the reports of WG-EMM and WG-FSA.

10.2 It was noted that the Working Groups identified three different types of problems with the CCAMLR database:

(i) a number of errors and omissions due to problems with the validation of the data before and/or after they have been entered into the database;

(ii) access difficulties due to a lack of understanding of the structure of the database and absence of guidelines for using it; and

(iii) lack of data essential to the analyses.

10.3 The Scientific Committee acknowledged the importance of these problems and the high priority which needed to be given to their solution. To this end, it recommended that the database be reviewed in order to identify and correct possible errors and also to determine which datasets were incomplete and which data were missing.

10.4 To facilitate the understanding and operation of the database, the development of an inventory of the information contained in the database and a user's guide was considered important. Therefore, the Scientific Committee recommended that the new Data Manager undertake this task as a matter of priority.

10.5 The Scientific Committee also noted that, as anticipated at the 1995 meeting (SC-CAMLR-XIV, paragraph 10.7), data requirements and analyses requested by the Working Groups had grown considerably, and consequently increased the workload of the data management section. These tasks could not be handled by the Secretariat under current circumstances, primarily because the position of Data Manager was vacant and would take some time to be filled.

10.6 In consequence, the Scientific Committee endorsed all data requirements from WG-EMM and WG-FSA, but recommended that tasks be prioritised so that in the next intersessional period, those of high priority are undertaken first.

10.7 In addition to the processing of information routinely submitted to the Secretariat, data management tasks identified as having high priority include:

(i) complete entry and validation of haul-by-haul data for the *D. eleginoides* fishery in Subarea 48.3, particularly with respect to positional information and other items specified in Annex 5, Table 16;

(ii) develop and apply methods for validation of data entered into the database;

(iii) prepare data files for length-density analyses of *D. eleginoides* from trawl surveys;

(iv) complete and validate entry of data from the 1995/96 observer programs contained in the database;

(v) obtain comprehensive bathymetric data;

(vi) produce tables of areas of seabed within depth strata for Subareas 48.6, 58.6, 58.7, 88.1 and 88.2 and Divisions 58.4.2 and 58.4.3 similar to those produced by Everson and Campbell (1990);

(vii) revise catch and effort and biological data forms for the reporting of data from the new fishery for *M. hyadesi* in Subarea 48.3;

(viii) enter and validate data in the database pertaining to CEMP parameters for dependent species and calculate CEMP indices for the current season;

(ix) continue the analysis of the link between overall krill abundance and actual krill availability to predators within CPDs; and

(x) support the Subgroup on Statistics in its analyses as described in Annex 4, paragraph 7.59;

10.8 In addition, there were a number of requests to be made for data and information to be submitted by Members to the Secretariat which were of high priority. These are:

(i) haul-by-haul length frequency data for *D. eleginoides* from earlier bottom trawl surveys carried out in Subarea 48.3;

(ii) catch data from *D. eleginoides* fisheries from areas adjacent to the Convention Area;

(iii) haul-by-haul, catch and age data from earlier commercial fisheries of *C. gunnari* in Subarea 48.3;

(iv) haul-by-haul data from the Ukrainian fishery of *D. eleginoides* in Division 58.5.1;

(v) information on *D. eleginoides* fishing activities conducted in the Convention Area by non-Members States;

(vi) all appropriate data in CCAMLR formats on CEMP indicator species currently held by Members; and

(vii) continued submission of haul-by-haul data from the krill fishery.

10.9 Lower-priority tasks which could be performed when time becomes available include:

(i) collection and analysis of time budget data from the krill fishery; and

(ii) studies on the occurrence of fish in krill catches in accordance with the recommended methods set forth in SC-CAMLR-XIV, paragraphs 3.28 and 3.29.

10.10 The Scientific Committee recognised that continuous updating and validation of the information contained in the database is vital to maintaining the quality of the analyses performed by WG-EMM and WG-FSA and for developing the Scientific Committee's advice to the Commission. The Scientific Committee reiterated its concern over the difficulties described in paragraphs 10.2 and 10.5, and these may become worse in the near future due to the expansion of the new fisheries.

COOPERATION WITH OTHER ORGANISATIONS

SCAR

11.1 The report of the CCAMLR Observer to XXIV SCAR (Dr Croxall) was based principally on matters discussed at the SCAR Working Group on Biology. The report:

(i) drew to the attention of CCAMLR forthcoming SCAR meetings of potential interest, viz.:

(a) the Seventh Symposium on Antarctic Biology on 'Antarctic Ecosystems: Models for Wider Understanding' (1 to 5 September 1998, New Zealand);

(b) 'Environmental Research in the Antarctic' (December 1996, Japan); and

(c) 'Marine Biological Research in the Magellanic Region Related to the Antarctic' (April 1997, Chile);

(ii) noted the commencement of the new SCAR marine research program, EASIZ, (Ecology of the Antarctic Sea-Ice Zone) with the RV *Polarstern* cruise in the Weddell Sea last year and the production of the program newsletter via the SCAR Global Change Project Office in Hobart, Australia;

(iii) noted that SCAR has decided not to continue to coordinate current, and plan for future, collaborative marine research through the SCAR/SCOR Group of Specialists on Southern Ocean Ecology (GOSSOE);

(iv) raised relevant matters arising from GOSEAC (Group of Specialists on Environmental Affairs and Conservation) initiatives, including:

(a) the Italian project to collect, certify and archive krill material and ocean water as a baseline for future analyses (e.g. of metals, organochlorines, etc.);

(b) the forthcoming production of a SCAR/COMNAP working paper as a follow-up to workshops monitoring environmental impacts from scientific and other operations in Antarctica (see SC-CAMLR-XV/BG/8); and

(c) the SCAR agreement to consult organisations, including CCAMLR, on the preparation of the state of the environment report for Antarctica as required by the Committee for Environmental Protection (CEP) (when established) and with potential relevance to the UNEP Global Environment review as required following the Agenda 21 meeting in Rio de Janeiro. The draft SCAR proposals indicate that substantial input would be required from CCAMLR and from scientists associated with its work.

(v) informed CCAMLR of the formation and terms of reference of a subcommittee on the Evolutionary Biology of Antarctic Organisms. This subcommittee will consider a request from CCAMLR relating to genetic studies to determine the provenance of seabirds killed in longline fisheries;

(vi) noted that SCAR-BBS had prepared a detailed report on status and trends of Antarctic and sub-Antarctic seabirds (see paragraphs 3.70 to 3.73), but regretted that the SCAR-GSS had been unable to make a timely response to CCAMLR on the important topic of status and trends of Antarctic and sub-Antarctic seals;

(vii) requested support from CCAMLR for the next review of the status and trends of Antarctic and sub-Antarctic seabirds. A workshop to prepare for this review would be held in 1998 or 1999;

(viii) noted plans to arrange a workshop to consider a coordinated collaborative research program on predator-prey-environment interactions associated with the Antarctic Polar Frontal Zone;

(ix) drew Members attention to new developments in quantitative studies of the distribution and abundance of seabirds at sea;

(x) drew the attention of Members, particularly those undertaking or planning CEMP studies, to the care needed to be taken with flipper banding studies of penguins; and

(xi) noted the formal request to CCAMLR for reporting (via e-mail) to SCAR information on planned research cruises relating to harvested commercial species.

11.2 At the XXIV SCAR Delegates' meeting a formal resolution concerning incidental mortality of Antarctic seabirds was adopted. The text is as follows:

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Noting the serious and ongoing threats to seabirds of the Southern Ocean, especially albatrosses, many of which are now classified as threatened under IUCN criteria, due to kills on longlines set for tuna and Patagonian toothfish, and to support the efforts being made by CCAMLR to reduce the incidental mortality of seabirds by regulating fishing procedures, the Working Group on Biology recommends that:

SCAR National Committees be requested to support relevant research on southern seabird populations at risk from longlining fisheries, in waters within and outside the SCAR area of interest.'

11.3 In a supplementary report the CCAMLR liaison officer with GOSEAC (Dr E. Fanta, Brazil) noted:

(i) that GOSEAC has developed a checklist of activities in near-shore and shallow waters to be used in environmental impact evaluation; this might be of interest to CCAMLR given that these areas are breeding and/or feeding grounds of fish, birds and mammals;

(ii) the interest expressed by SCAR in collaboration with CCAMLR concerning issues relating to marine debris and avoidance of incidental mortality;

(iii) that the draft SCAR management plan handbook for Antarctic Specially Protected Areas (ASPAs) had been revised by GOSEAC and the items requested by CCAMLR when considering the Admiralty Bay Antarctic Specially Managed Area (ASMA) (SC-CAMLR-XIII, paragraph 61) were included. (This includes the location of CEMP sites and breeding sites of seabirds and seals, entry and departure points and foraging grounds of seals and birds and the need for good quality and detailed maps). GOSEAC is aware that if prohibitions or restrictions of activities are necessary in a specific marine area to be protected, a conservation measure under CCAMLR has to be approved;

(iv) GOSEAC's interest in developing closer contact with the WG-EMM Subgroup on Monitoring Methods;

(v) that CCAMLR was requested by GOSEAC to contribute to the assembly of all available information on emissions and fuels in Antarctica by providing information on:

(a) the fuel used by fishing vessels;
(b) the type of engines that use this fuel; and
(c) the number of vessels likely to be operating in the Convention Area next year.

11.4 The CCAMLR Observer to CS-EASIZ, Dr Fukuchi, reported that:

(i) the second meeting of the CS-EASIZ Steering Committee was held at British Antarctic Survey (BAS), 1 and 2 August 1996, Cambridge, UK;

(ii) the EASIZ field program commenced in the 1995/96 austral summer, with measurements at several shore stations, and the EASIZ cruise to the Weddell Sea on the RV *Polarstern*;

(iii) the first EASIZ workshop on 'In-situ Imaging Methods in the Antarctic Ecology' was held at the Alfred Wegener Institute for Polar and Marine Research, 12 to 15 August 1996, Bremerhaven, Germany.

11.5 Dr Miller, referring to paragraph 11.1(iii) above, emphasised that disbanding the SCAR/SCOR GOSSOE will reduce SCAR's capability to undertake integrated marine research. This will almost certainly affect the Scientific Committee's relationship with the SCAR marine research community and may substantially reduce the collaborative research opportunities for many scientists currently able to contribute to the research underpinning much work within WG-EMM.

11.6 The Scientific Committee noted the above situation with concern and encouraged SCAR to ensure that it maintains an effective mechanism for developing and coordinating new collaborative research programs in marine sciences.

11.7 In respect of paragraph 11.1(iv)(c) above, the Scientific Committee agreed that the compilation of a report on the status of the Antarctic environment is likely to be a major task. It requested the Commission to consult with the Scientific Committee before any CCAMLR involvement in the compilation of such a report is agreed.

SCOR

11.8 SC-CAMLR-XV/BG/30 reported on the 32nd Executive Meeting of SCOR held in Cape Town, South Africa, from 14 to 16 November 1995.

11.9 The UK introduced the report (SC-CAMLR-XV/BG/18) of the CCAMLR Observer (Dr Priddle) to the 23rd General Meeting of SCOR. With respect to items of special relevance to CCAMLR, it was noted that:

(i) the work of WG-105 (the Impact of World Fisheries Harvests on the Stability and Diversity of Marine Ecosystems) could have relevance to WG-FSA;

(ii) implementation of SO-GLOBEC programs has been delayed, but the steering committee (now chaired by Dr E. Hofmann (USA)) has been reorganised; field work is expected to start in 1999;

(iii) the Global Ocean Observation System (GOOS) is developing a Living Marine Resources Module (LMR) and held a planning meeting in March 1996;

(iv) an ICES meeting entitled 'Role of Physical and Biological Processes in the Recruitment Dynamics of Marine Populations' will be held in Baltimore, USA, in September 1997; and

(v) only an abstract of the CCAMLR report had been available in the SCOR meeting papers; it was suggested that CCAMLR should submit more detailed information, especially on its ecosystem monitoring and modelling activities.

11.10 The Scientific Committee acknowledged this report with thanks. It requested the Secretariat to contact SCOR to acquire further information on paragraphs 11.9(i) to (iv) above and to ensure that SCOR receives appropriate information on activities of CCAMLR relevant to SCOR initiatives for all meetings of SCOR, its relevant working groups and related bodies. Surprise was expressed that despite the GOOS LMR planning meeting noting that the CEMP is a commendable model for planning and implementing the LMR module (CCAMLR-XV/BG/21; see also paragraph 11.17), SCOR had apparently not contacted CCAMLR before or after this meeting.

IWC

11.11 The observer from SC-IWC, Mr Ichii, noted the establishment of a new subcommittee under the SC-IWC on the influence of environmental factors on cetaceans. The subcommittee is expected to seek close cooperation with SC-CAMLR and WG-EMM.

11.12 Mr Ichii pointed out that in IWC, cetacean studies have mostly been conducted independently of prey availability and environmental parameters. In CCAMLR, on the other hand, cetaceans are excluded from the ecosystem assessment. Therefore collaboration between CCAMLR and IWC can be expected to be beneficial.

11.13 The report of the IWC Workshop on Climate Change and Cetaceans (SC-CAMLR-XV/BG/13) recommended the establishment of a joint CCAMLR/IWC working group to consider collaborative work in the Southern Ocean.

11.14 The Scientific Committee felt that establishing a working group was premature. It would prefer first to involve an expert from IWC in the work of WG-EMM and then to discuss potential collaboration. Accordingly, it was proposed to invite IWC to send an appropriate representative to the next meeting of WG-EMM (paragraphs 11.27 to 11.30).

11.15 The report of the CCAMLR Observer to IWC (SC-CAMLR-XV/BG/16) noted that in respect of queries about the minimum effort required to carry out statistically reliable whale observations on 'platforms of opportunity', SC-IWC was unable to provide general advice due to differences in the design of surveys and the species targeted. Therefore, if CCAMLR Members wish to include systematic whale sightings in their surveys, they should seek advice directly from the IWC secretariat.

CCSBT

11.16 Dr Hermes was the CCAMLR Observer present at the CCSBT-ERS Working Group. Information from this working group on tuna-seabird interactions was made available for use by WG-FSA (Annex 5, paragraphs 7.66 and 7.67).

IOC

11.17 Dr Kock (CCAMLR Observer) reported on the First Meeting of the Southern Ocean Forum of the IOC held in Bremerhaven, Germany, from 9 to 11 September 1996. In his presentation on

CCAMLR activities at the meeting, he emphasised the importance of incorporating environmental features (sea-ice etc.) into CCAMLR ecosystem assessments. Routine monitoring of sea-ice conditions and SST has provided CCAMLR with very useful information on environmental variability on scales of integrated study regions (ISRs) and statistical subareas. However, he also pointed at the mismatch of scales which is often apparent between CCAMLR-related biological programs, mostly addressing events operating on micro- and meso-scales, and oceanographic programs, often related to physical processes operating on large or ocean basin scales.

11.18 He noted that in Recommendation IOCSOC-VI.5 of the Sixth Session of the IOC Regional Committee for the Southern Ocean, CEMP is especially commended as a model for planning and implementation of the developing LMR module of GOOS (see paragraph 11.9(iii)). He concluded that in order to address problems of particular relevance to CCAMLR, such as krill flux, it appears to be more beneficial for the Scientific Committee at present to design its own specific joint oceanographic/biological programs with the assistance of oceanographers, instead of trying to accommodate some of these questions into large programs primarily designed to study oceanographic processes on various scales.

11.19 The Scientific Committee shared the concerns raised by Dr Kock. It noted that CCAMLR-XV/BG/21 suggests that IOC, in reconstituting its Regional Committee for the Southern Ocean (IOCSOC), appeared to be trying to create an umbrella organisation seeking to coordinate an enormous range and diversity of activities in the Southern Ocean, many of which already have well-developed coordination and interaction. A number of Recommendations of IOCSOC (e.g. Southern Ocean Ecosystems and their Living Resources, Pollution and Monitoring in the Southern Ocean, International Cooperation in the Southern Ocean) relate to fundamental aspects of CCAMLR's work. However it appears that few invitations were issued by IOC to scientists responsible for coordinating CCAMLR's work in these fields. Furthermore, the International Advisory Group to the Chairman of IOCSOC (Dr M. Tilzer, Germany) contains no-one with connections to CCAMLR. The Scientific Committee drew its concerns on these matters to the attention of the Commission.

ICCAT

11.20 Mr L. López Abellán (Spain) introduced document SC-CAMLR-XV/BG/19 which reports on the ICCAT symposium held in the Azores, Portugal, in June 1996. He pointed out as interesting future work of the organisation the clarification of 'the precautionary approach' and its application in tuna fisheries as well as a future symposium on tuna fisheries worldwide.

Reports from CCAMLR Observers to Other Meetings

11.21 Dr de la Mare reported on behalf of Dr Kerry from the Third International Penguin Symposium which was held in Cape Town, South Africa, 2 to 6 September 1996. It was convened by Dr J. Cooper. Approximately 50 oral and 40 poster papers were presented on a wide variety of topics. Papers will be published in a special issue of *Journal of Marine Ornithology*. Of interest to CCAMLR were a number of papers on the foraging ecology of king, emperor, and Adélie penguins. Other papers, covering a variety of penguin species, included breeding biology, diseases, treatment of oiled penguins, population biology, conservation and the maintenance of captive birds.

11.22 SC-CAMLR-XV/BG/6 reported on the workshop 'Harvesting krill: ecological impact, assessment, products and markets' held in Vancouver, Canada, from 14 to 16 November 1995.

11.23 The Scientific Committee noted that the workshop had provided a highly appropriate forum for publicising CCAMLR's work, and as a result the CCAMLR approach is likely to be used as a model for other developing euphausiid fisheries.

11.24 The workshop produced a report in the Fisheries Centre Report Series of the University of British Columbia (UBC). A multi-author book (edited by Prof. A. Pitcher of UBC, and Dr Everson, WG-EMM's Convener) is planned for publication in 1998. A number of scientists involved with CCAMLR will contribute to this book, which again reflects well on CCAMLR's experience and approach to management.

11.25 Finally, of potential interest to CCAMLR is that the workshop indicated that North American aquaculture feed markets have the potential to absorb tens or hundreds of thousands of tonnes of krill. Should local fisheries be unable to meet these needs, krill harvesting in CCAMLR waters could become more important.

Future Cooperation

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

- Seventeenth Session of the CWP on Fishery Statistics, March 1997, Hobart, Australia – the Secretariat;
- ICES Annual Science Conference, September 1997, Baltimore, Maryland, USA – Ms I. Lutchman (UK);

- IWC Scientific Committee, September–October 1997, Bournemouth, UK – Mr Ichii;
- ICES Symposium – Seabirds in the Marine Environment, November 1996, Glasgow, UK – Dr Croxall;
- Symposium on the Antarctic and Global Change, July 1997, Hobart, Australia – Australia;
- International Symposium on Environmental Research in the Antarctic, December 1996, Tokyo, Japan – Dr Fukuchi;
- 9th meeting of SCAR-GOSEAC, July 1997, Bremerhaven, Germany – Dr Fanta; and
- SCAR Workshop on Evolutionary Biology of Antarctic Organisms, September 1997, Curitiba, Brazil – Dr Fanta.

Observers at Scientific Committee Working Group Meetings

11.27 In 1995, the Scientific Committee decided that it will consider the invitation of observers from international organisations to the next meeting of the Scientific Committee and to its working groups during the 1996/97 intersessional period.

11.28 CCAMLR has received an application from IUCN (intergovernmental and non-governmental) and IWC (governmental) to send observers to meetings of WG-EMM. Article XXIII, paragraph 3 of the CCAMLR Convention directs the Scientific Committee to seek to develop cooperative working relationships with intergovernmental and non-governmental organisations which can contribute to its work. Rule 19(e) of the Scientific Committee's Rules of Procedure provides that the Committee may invite observers to attend meetings of its subsidiary bodies, unless a Member of the Committee objects.

11.29 The Scientific Committee recognised that both IWC and IUCN have strong interests related to ecosystem monitoring and management. The Scientific Committee also recognised that observers from these organisations could contribute to the work of WG-EMM.

11.30 The Scientific Committee agreed that IWC and IUCN should be invited to send observers with expertise in the substance of WG-EMM's work to the next meeting of WG-EMM. The Scientific Committee requested that the Chairman consult with these organisations to determine the names of their nominees and to convey this information to the Members in advance of the meeting in accordance with Rule 19(e).

PUBLICATIONS

CCAMLR Science

12.1 The third volume of *CCAMLR Science* was published just prior to CCAMLR-XV. This was the third year of the three-year trial period during which the Secretariat was requested to obtain an independent review of the quality of the publication and to report annually to the Commission on the journal's production cost, subscriber interest and progress towards cost recovery. The report of the Secretariat was available as CCAMLR-XV/15.

12.2 In presenting the document, the Science Officer, in his capacity as the Editor of *CCAMLR Science*, concluded that taking into account the results achieved by the publication of *CCAMLR Science* in the first three years, it would be advisable for the Commission to consider extending the journal trial period for another three years. An extension of the trial period would allow more time for *CCAMLR Science* to establish itself firmly among the world's scientific community and would present an opportunity to evaluate reliably the subscription interest and potential for recovery of publication costs.

12.3 The first three-year trial period of *CCAMLR Science* has shown that the Secretariat has gained the level of skills required for the long-term production of a high-quality publication within the limits of the budget allocated for this purpose by the Commission.

12.4 The Scientific Committee commended the Science Officer for his excellent work in producing a journal of such high quality. It also stressed that it would not have been possible to achieve this without the assistance of the entire Secretariat's publication team and especially of the Publications Administrator, Ms G. Naylor.

12.5 The Scientific Committee recommended that the Commission extend the journal trial period for another three years.

12.6 The Scientific Committee also noted that now that the first three-year trial period has concluded, some aspects of the publication policy and its application during the paper selection process might need to be clarified. In particular, attention was drawn to the recommendation of WG-FSA with regard to the identification of experts from each of the working groups whose advice would be sought by the Editorial Board in selecting papers for publication (Annex 5, paragraphs 10.3 to 10.5).

12.7 The Scientific Committee took note that the meeting of the Editorial Board was to be held later during CCAMLR-XV. The Board was advised that in considering editorial policy it should take into account difficulties faced by authors whose first language is not English and also that the journal is aiming for the highest possible quality.

CCAMLR Scientific Abstracts

12.8 At last year's meeting of the Commission, it was decided that there were insufficient funds to permit publication of *CCAMLR Scientific Abstracts* in 1996. The objective of this publication is to provide a complete record of and facilitate access to scientific documents that have been used in discussions leading to management decisions (SC-CAMLR-XI, paragraph 11.1). The Scientific Committee recommended that the Commission allocate funds for its continued publication. It was also noted that in 1997 a double volume should be published in order to include abstracts of scientific papers submitted in 1995 as well as in 1996.

Other Publications

12.9 Other publications of the Scientific Committee were also considered. The Scientific Committee recommended publication of the revised edition of the *Statistical Bulletin*, the *Scientific Observers Manual* and the new edition of *CEMP Standard Methods*.

12.10 The Chairman informed the Scientific Committee that work on the *Guide to Understanding CCAMLR's Approach to Management* (CCAMLR-XIV, paragraph 4.13) would be continued during the intersessional period. He plans to submit the final version of the guide to the 1997 meeting of WG-EMM.

12.11 The Scientific Committee also agreed that the glossary of acronyms and abbreviations used in the work of the Scientific Committee which had been appended to the WG-EMM report should be regularly updated and published in the report of the Scientific Committee.

ACTIVITIES OF THE SCIENTIFIC COMMITTEE DURING THE 1996/97 INTERSESSIONAL PERIOD

13.1 An offer was made by the USA to host WG-EMM in 1997. This was gratefully received by the Scientific Committee.

13.2 A WG-EMM workshop to examine changes in krill recruitment and abundance in Area 48 will be held in La Jolla, USA, in June 1997.

13.3 WG-EMM will also meet in La Jolla in late July 1997 and will be convened by Dr Everson.

13.4 The Subgroup on Statistics will meet immediately prior to the meeting of WG-EMM and will be convened by Dr Watters.

13.5 Dr Kim advised the Scientific Committee that a second joint research program in the Peninsula area will take place from December 1996 to February 1997. The main aims of this international cooperation are to detect interannual and interseasonal changes in the Antarctic marine ecosystem and to investigate the processes and relationships between the environment and life forms. Brazil, Germany, Republic of Korea and USA plan to conduct cruises in the area, and the study area will be covered six times with standard methodologies during the forthcoming austral summer. Details of these activities are given in SC-CAMLR-XV/BG/25.

13.6 A second workshop to analyse the results from the research cruises referred to in paragraph 13.5 above will be held prior to the WG-EMM meeting in La Jolla in July 1997.

13.7 Dr Kock congratulated Dr Kim for his ongoing effort with this international collaboration.

13.8 Dr Nicol suggested that, in the light of the success of Dr Kim's efforts in coordinating research in the South Atlantic, there might be merit in attempting similar coordination efforts in the Southern Indian Ocean. In this regard, he agreed to initiate correspondence with Members operating in Subareas 48.4 and 88.1 and Divisions 58.4.1 and 58.4.2 and report back to the next meeting of WG-EMM.

13.9 WG-FSA will meet in Hobart, Australia from 13 to 22 October 1997.

BUDGET FOR 1997 AND FORECAST BUDGET FOR 1998

14.1 The budget of the Scientific Committee for 1997 and the budget forecast for 1998 only include costs directly related to meetings of the Scientific Committee or to meetings which are of immediate relevance to the work of the Scientific Committee, for example international data meetings, or the planned international krill symposium.

14.2 The budget of the Scientific Committee does not include costs for data management. It is the understanding of the Scientific Committee that costs for data management relate directly to the management of fisheries in the Convention Area. These data are not collected to support scientific work on Antarctic marine living resources but to undertake scientific analyses as requested by the Commission (on the advice of the Scientific Committee) to fulfil the management objectives of the Commission.

14.3 Although data management is not a matter to be addressed in the Scientific Committee's budget, the Scientific Committee wants to draw the attention of the Commission to the likelihood that the workload of the Data Management section of the Secretariat will increase substantially in the very near future due to the considerable amount of additional data which the Scientific Committee has recommended should be collected from the new fisheries. This bears considerable financial implications and will necessitate the allocation of additional financial resources to the Secretariat to meet these new requirements.

14.4 Table 9 provides an overview of the budget of the Scientific Committee for 1997. The increase in meeting and costs of travel to the meetings by A$3 900 falls within the limits of the annual inflation rate.

14.5 The forecast of the Scientific Committee's budget for 1998 (Table 9) envisages an increase of A$16 000. The projected increase is mainly due to costs for holding a meeting of the Subgroup on Monitoring Methods if necessary and support for an international krill meeting to be held in the USA. Financial support for the krill meeting was endorsed by the Commission in 1995.

14.6 In order to better understand the different budgetary items, the Scientific Committee requested that the Executive Secretary and the Finance Officer be present when the Scientific Committee discusses budgetary matters at its 1997 meeting.

Table 9: Scientific Committee budget.

1996 Budget	1996 Projected*		1997	1998 (forecast only)
		Working Group on Fish Stock Assessment		
		Meeting		
12 300	15 400	Preparation and Secretariat support	13 000	13 400
20 300	17 200	Report completion and translation	21 000	21 700
32 600	32 600		34 000	35 100
		Working Group on Ecosystem Monitoring and Management		
		Meeting		
18 400	17 200	Preparation and Secretariat support	19 000	19 600
22 500	23 600	Report completion and translation	24 000	24 700
40 900	40 800		43 000	44 300
1 000	1 000	Guide to Understanding CCAMLR's Approach to Management	1 000	2 000
0	0	Support of International Krill Symposium	0	7 000
		Travel for Scientific Committee Program		
32 400	36 600	WG-EMM meeting (freight, flights and subsistence)	39 500	40 700
5 400	6 100	Subgroup on Statistics (including Secretariat support)	8 500	7 000
4 500	4 500	Subgroup on Monitoring Methods	0	5 000
5 900	5 900	International Data Meetings	4 400	5 200
700	0	**Contingency**	1 000	1 100
A$123 400	A$127 500	Total	A$131 400	A$147 400

* Note: the excess of expenditure on travel of the Secretariat in supporting WG-EMM was anticipated at the 1995 meeting of the Commission, and it was agreed that this excess would be met out of the Secretariat Costs budget item. This will not, therefore, lead to the total Scientific Committee budget being over-expended.

ADVICE TO SCOI AND SCAF

15.1 Advice to SCOI and SCAF is given under Agenda Items 9 and 14.

ELECTION OF CHAIRMAN OF THE SCIENTIFIC COMMITTEE

16.1 The Chairman informed the Scientific Committee that this would be his last year in the Chair.

16.2 Dr Miller was unanimously elected Chairman of the Scientific Committee, having been nominated by Dr Kim and seconded by Dr Holt. Dr Miller has been active in the work of the Scientific Committee for many years, being Convener of WG-Krill from 1989 to 1994.

NEXT MEETING

17.1 The next meeting of the Scientific Committee will take place in Hobart, Australia from 27 October to 7 November 1997.

OTHER BUSINESS

18.1 There was no other business.

ADOPTION OF THE REPORT

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

CLOSE OF THE MEETING

20.1 On behalf of the Scientific Committee, Prof. Moreno thanked Dr Kock for his hard work as Chairman of the Scientific Committee during the past four years. Thanks to his abilities and interest, Dr Kock had guided the Scientific Committee through a period of rapid development characterised by many changes.

20.2 In saying farewell as Chairman, Dr Kock stated that the past four years had been a stimulating, often rewarding although sometimes frustrating experience. He thanked all members of the Scientific Committee for their dedication and support. He also thanked the sound technicians and interpreters, some of whom had attended many CCAMLR meetings. Dr Kock expressed his sincere gratitude to the Secretariat for its outstanding support and dedication during his period as Chairman.

20.3 Finally, Dr Kock extended his best wishes to the incoming Chairman of the Scientific Committee, Dr Miller.

20.4 The Chairman then closed the meeting.

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ANNEX 1

LIST OF PARTICIPANTS

LIST OF PARTICIPANTS

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GREECE	His Excellency Mr George Constantis Ambassador of Greece Canberra

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IWC	Mr Taro Ichii National Research Institute of Far Seas Fisheries Shimizu

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ADMINISTRATION/FINANCE OFFICER	Jim Rossiter
PERSONAL ASSISTANT TO THE EXECUTIVE SECRETARY	Geraldine Mackriell
REPORT SECRETARY	Genevieve Naylor
MEETING DOCUMENTS OFFICER	Rosalie Marazas
RECEPTIONIST	Kim Butler
DOCUMENT PRODUCTION AND DISTRIBUTION	Leanne Bleathman Philippa McCulloch
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COMPUTER NETWORK ADMINISTRATOR	Fernando Cariaga
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ANNEX 2

LIST OF DOCUMENTS

LIST OF DOCUMENTS

SC-CAMLR-XV/1	PROVISIONAL AGENDA FOR THE FIFTEENTH MEETING OF THE SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES
SC-CAMLR-XV/2	ANNOTATED PROVISIONAL AGENDA FOR THE FIFTEENTH MEETING OF THE SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES
SC-CAMLR-XV/3	REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT (Bergen, Norway, 12 to 22 August 1996)
SC-CAMLR-XV/4	REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT (Hobart, Australia, 7 to 16 October 1996)

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SC-CAMLR-XV/BG/1 Rev. 2	CATCHES IN THE CONVENTION AREA 1995/96 Secretariat
SC-CAMLR-XV/BG/2 Rev. 1	CEMP TABLES 1 TO 3 Secretariat
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AGENDA FOR THE FIFTEENTH MEETING OF THE SCIENTIFIC COMMITTEE

AGENDA FOR THE FIFTEENTH MEETING OF THE SCIENTIFIC COMMITTEE

1. Opening of the Meeting
   (i) Adoption of the Agenda
   (ii) Report of the Chairman

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

3. Dependent Species
   (i) Species Monitored in the CCAMLR Ecosystem Monitoring Program (CEMP)
      (a) Report of WG-EMM
      (b) Proposals for Extension of CEMP Activities
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   (ii) Assessment of Incidental Mortality
      (a) Incidental Mortality in Longline Fisheries
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   (iii) Marine Mammal and Bird Populations
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4. Harvested Species
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(ii) Fish Resources
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(iii) Crab Resources
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(iv) Squid Resources
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5. Ecosystem Monitoring and Management
  (i) Report of WG-EMM
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6. Management under Conditions of Uncertainty about Stock Size and Sustainable Yield

7. Scientific Research Exemption

8. New and Exploratory Fisheries
  (i) New Fisheries
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9. CCAMLR Scheme of International Scientific Observation
  (i) Scientific Observations Conducted in the 1995/96 Fishing Season
  (ii) Publication of the *Scientific Observers Manual*
  (iii) Advice to the Commission

10. CCAMLR Data Management

11. Cooperation with Other Organisations
  (i) Reports of Observers from International Organisations
  (ii) Reports of SC-CAMLR Representatives at Meetings of Other International Organisations
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12. Publications

13. Activities of the Scientific Committee during the 1996/97 Intersessional Period

14. Budget for 1997 and Forecast Budget for 1998

15. Advice to SCOI and SCAF

16. Election of Chairman of the Scientific Committee

17. Next Meeting

18. Other Business

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

20. Close of the Meeting.

REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT

(Bergen, Norway, 12 to 22 August 1996)

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REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT

(Bergen, Norway, 12 to 22 August 1996)

INTRODUCTION

Opening of the Meeting

1.1 The second meeting of WG-EMM was held at the Directorate of Fisheries, Bergen, Norway, from 12 to 22 August 1996.

1.2 Dr P. Gullestad, Deputy Director of the Directorate of Fisheries, welcomed participants to Bergen, and an outline of the Norwegian Antarctic Program was presented by Dr F. Mehlum from the Norwegian Polar Institute. Ambassador J. Bech, Special Adviser on Polar Affairs from the Ministry of Foreign Affairs, opened the meeting and spoke of CCAMLR's challenges and achievements.

1.3 On behalf of the Working Group, the Convener, Dr I. Everson (UK), thanked the Norwegian Government for the invitation to hold the meeting in Bergen, and expressed appreciation to Dr T. Øritsland from the Institute of Marine Research for his substantial work in preparation for the meeting.

Adoption of the Agenda and Organisation of the Meeting

1.4 A revised Provisional Agenda was introduced and discussed. A number of changes were made to Items 4 and 6 which included Item 6 being renamed 'Ecosystem Analysis'. A new Item 7 'Ecosystem Assessment' was added. The Agenda, as amended, 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 I. Boyd (UK), D. Butterworth (South Africa), J. Croxall (UK), W. de la Mare (Australia), D. Demer (USA), G. Kirkwood (UK), K.-H. Kock (Chairman, Scientific Committee) and S. Nicol (Australia), Mr T. Ichii (Japan), Drs E. Murphy (UK), D. Miller (South Africa), W. Trivelpiece (USA), J. Watkins (UK) and the Secretariat.

DATA

2.1 In considering this agenda item, it was decided that data from surveys on harvested species (subitem (ii)), dependent species (iii) and environment (iv) would best be considered under specialised agenda items together with results of survey analyses, i.e. Item 3 'Harvested Species' or Item 4 'Dependent Species'. Discussions under subitem (v) should be focused mainly on any unusual events in the Antarctic marine ecosystem observed in the past season and which are of particular relevance to fisheries management and CEMP. The Working Group agreed that this arrangement should also be followed at future meetings of WG-EMM.

Fisheries

2.2 A summary of fine-scale data from krill fisheries conducted in the 1994/95 season was presented by the Secretariat in WG-EMM-96/25. In general, this season was characterised by the same distribution patterns of krill catches as has been observed over recent years.

2.3 In the 1995/96 season, krill catches were reported by three members: Japan (60 559 tonnes), Poland (20 619 tonnes) and Ukraine (13 338 tonnes). The total reported catch was 94 516 tonnes. This was slightly less that the total catch in the 1994/95 season (118 714 tonnes).

2.4 Most catches were taken in Subareas 48.1 and 48.3, with very little being taken from Subarea 48.2 (Poland and Ukraine only) and no catches from the Indian Ocean sector. The bulk of Japanese catches were taken in Subarea 48.1 in December–June (about 50 000 tonnes) and the remainder taken during winter months in Subarea 48.3.

2.5 During the 1996/97 season, Japan plans to continue fishing for krill at the same level of about 60 000 tonnes (four vessels). The extension of the fishing season in Subarea 48.1 into winter months over the last few years, made possible by less severe ice conditions, serves the dual purpose of avoiding catching early season 'green' krill, thereby increasing the catch of colourless krill which are available later in the season in Subarea 48.1 and which the Japanese market has been demanding recently, and evenly distributing krill shipments to storage plants in Japan over the year.

2.6 Chile and Russia reported that they do not have plans to conduct krill fishing in the 1996/97 season. No information was available from Poland and Ukraine about plans for 1996/97. Since Poland has increased its catch in 1995/96, and also because scientists from Poland have not attended the past two meetings of WG-EMM, the Secretariat was asked to write to Poland and request information about its plans with regard to krill fishing.

2.7 In the past Australia has indicated that an Australian company intends to start fishing for krill. The Working Group was advised that no decisions had yet been taken in Australia in this regard.

2.8 Dr Nicol reported that information presented to the Workshop on Krill Fisheries (Vancouver, Canada, November 1995) indicated that some Canadian companies were experiencing an increased demand for northern euphausiids as food stock for the fish farming industry and that the potential for catches to increase in the Northern Hemisphere was limited. Therefore, Canadian fishing companies may be considering krill fishing in the Convention Area.

2.9 No information was available on krill catches in the CCAMLR Convention Area by any non-Member States.

Observer Scheme

2.10 In 1993, WG-Krill suggested that recording a krill fishing vessel's activity at random time intervals would provide an estimate of searching and towing times as required for the estimation of effort in catch per unit effort (CPUE) indices (SC-CAMLR-XII, Annex 4, paragraphs 5.31 and 5.32). It was agreed that this could only be achieved by the placement of scientific observers aboard fishing vessels. The guidelines for recording fishing vessel activity (time budget) were subsequently developed for inclusion in the *Scientific Observers Manual*, a draft of which was submitted to CCAMLR-XIV (SC-CAMLR-XIV/6).

2.11 The first set of records of a vessel's time budget was collected and submitted to CCAMLR by the Ukrainian scientific observer on board the krill fishing vessel *General Petrov* (WG-EMM-96/26). These data indicated that about 70% of the vessel's time was spent setting, hauling or trawling. It was noted that very little time was spent searching, and the vessel rarely had to pause its fishing activities in order to complete processing. The Working Group welcomed this dataset, which demonstrated that the methodology was practical, and encouraged further use of the system.

2.12 Logbooks for krill and finfish trawl fisheries are in preparation and will include time-budget forms. It was recommended that the logbooks and *Scientific Observers Manual* should be published in 1997 as a matter of urgency.

Coordination of Research in Subarea 48.1

2.13 Dr S. Kim (Republic of Korea) convened the ad hoc Subgroup on the Coordination of Research in the Antarctic Peninsula, and some Members (Brazil, Germany, Japan, Korea, UK and USA) discussed the progress of the second oceanographic cruise planned for the coming season. It was agreed that some elaboration of the purposes and methodologies would be needed in time for the 1996 Scientific Committee meeting and that a workshop on the survey results should be held before the next WG-EMM meeting, wherever possible.

HARVESTED SPECIES

Methods for Estimating Distribution, Standing Stock, Recruitment and Production of Harvested Species

3.1 WG-EMM-96/34 presented comparisons of the length frequencies of krill caught in a research trawl (IKMT) and a commercial trawl (PT 72/308) which targeted the same aggregation. The length distributions of krill in the IKMT varied considerably between hauls because each haul sampled a small portion of the heterogeneous aggregation. Conversely, the commercial trawl sampled a much larger portion of the aggregation and the resulting krill length distributions were much more consistent. The difference in mean lengths of krill was as much as 6 mm larger in the commercial trawl than in the research trawl. The length difference translated to a target strength (TS) difference of 2.1 dB or a factor of 1.6 (or 0.6) when calculating animal numerical density. It was concluded that:

(i) commercial trawls may under-sample small krill while research trawls may under-sample large krill; and

(ii) trawl selectivity should be taken into account when estimating animal densities from hydroacoustic surveys.

3.2 If a bias did exist, its effect would be less severe for estimates of biomass than for estimates of numerical density (e.g. those required for comparisons of predator consumption). The Working Group noted that the TS values reported in WG-EMM-96/34 were calculated from the mean lengths of animals in the samples, leading to a positive bias in mean TS estimation. The mean TS should be calculated as the density-weighted mean of the target strengths (i.e. in the linear domain) for each length class[1].

3.3 Potential research trawl (RMT-8) biases were discussed in WG-EMM-96/8 (e.g. day-night differences, swarm density effects, size-specific mobility, observer bias). Recognising these potential biases and that no objective method exists to characterise the local krill population, the authors concluded that the catches could still be used to estimate the prey population available to foraging macaroni penguins.

3.4 WG-EMM-94/42 reported a krill biomass survey conducted while transiting between randomly selected bottom trawl locations (bathymetrically stratified). Although the directions and lengths of these transects were random, the design could not be considered a true random stratified survey. Nevertheless, opportunistic surveys may warrant the use of non-optimal survey designs, and the development of methods for characterising the variance of such surveys is encouraged. The importance of using calibrated echosounders and, where possible, multiple frequencies for target classification was emphasised.

3.5 WG-EMM-96/8 reported a krill biomass survey where acoustic data were collected by a vessel following an icebreaker through the pack-ice in the Ross Sea. Potential problems associated with ice noise, vessel noise, and behaviour of targets relative to the lead vessel which could cause an underestimate of the biomass were noted.

3.6 WG-EMM-96/40 presented the latest in a series of experiments investigating the uncertainty of echosounder calibrations at 120 kHz. Results indicated that:

(i) TS measurements derived from integrated echo intensity were in closer agreement with theory than those derived from peak amplitude measurements;

(ii) TS measurements with a Simrad EK500 echosounder varied up to 1.4 dB over a 15-hour period for a stationary standard sphere; and

(iii) transducer efficiency decreased with water temperature.

The TS measurements of standard spheres, made with a hydrophone, 10 W transmitted power, a 0.3 ms pulse length, and a 290 kHz receiver bandwidth, differed from theoretical predictions by an

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1 Specifically because TS is modelled as a function of the logarithm of length (L), the average value of TS, E{TS(L)}, is less than the target strength of the average length, D TS{E(L)}. This is generally known as Jensen's inequality (De Groot, 1970).

average of 0.2 dB (mean SD = 0.2 dB). More substantial calibration uncertainty (>1 dB) may result from:

(i) variations in transducer performance related to changes in water temperature over the survey area; and

(ii) instabilities in the echosounder.

3.7 WG-EMM-96/46 reported the effect of single missing modes of vibration on the TS of a calibration sphere, possibly resulting from the method used for suspension. The paper concluded that missing a single mode of vibration could not account for the uncertainty in echosounder calibration that was reported in WG-EMM-95/70. Since different means of sphere suspension were used for the Cu (monofilament tether glued into a single bore) versus WC spheres (monofilament net bag), members questioned the plausibility of a single missing mode, and the premise that each of the four spheres in the study must necessarily omit the same modal component. Also discussed was the plausible solution of partial modal suppression of one or more high-order modes rather than complete modal omission. The paper (WG-EMM-96/46) will be revised before submission to ICES.

3.8 WG-EMM-96/28 reported calibration variability of 1.0 dB over a sea temperature range of 11.8°C for a Simrad EK500 echosounder configured with a 120 kHz transducer. Other members reported similar experiences. Considering these observations and the results of WG-EMM-96/40, it was concluded that echosounder calibration methods should take into account the range of water temperatures encountered in a survey area. Relevant sections of the CCAMLR recommended calibration procedures (SC-CAMLR-XI, Annex 4, Appendix H, points 2 and 3) were updated (Appendix D).

3.9 WG-EMM-96/41 reported on a feasibility study of the use of an Acoustic Doppler Current Profiler (ADCP) to determine animal velocities relative to ship and water movements. It was concluded that the proposed method could be applied to studies of krill behaviour such as vertical and horizontal migration, avoidance reaction, and flux. Caution was expressed regarding the possible use of an ADCP instrument for biomass estimation.

3.10 WG-EMM-96/71 summarised the ICES FAST Working Group meeting in Woods Hole, USA, during April 1996. Highlighted were shoal and swarm description techniques, use of multifrequency systems for target identification, and a draft proposal for a standard acoustic data format. A description of the data model developed for the acoustic data management and analysis software, ECHO, developed by the Australian Antarctic Division and CSIRO will be forwarded to Dr Y. Simard (Canada) for consideration.

Analysis and Results of Studies on Distribution and Standing Stock

3.11 A number of papers describing the results of krill biomass surveys were presented (Table 1). The Working Group noted that differences in the amount of detailed descriptions of methods made it very difficult to assess the comparability of echo classification used in these papers. A subgroup to investigate these methods was formed and the report is given in Appendix E.

Area 48

3.12 WG-EMM-96/5 described the distribution of krill in the Atlantic sector and adjacent waters with an emphasis on localities outside the current fishing grounds of the Scotia Sea. In a number of localities on the periphery of the Weddell Gyre, as well as in the coastal waters of the Antarctic continent, the location at which krill aggregations are formed is variable. In general, the biomass values within each of these localities are comparable with that associated with the fishing grounds in the Scotia Sea.

3.13 WG-EMM-96/56 also drew attention to the importance of the 'background' level of krill and of oceanic krill which is not targeted by the fishery. These may form a significant portion of the krill population and hence need to be taken into account in the estimation of standing stock within subareas.

3.14 In contrast, WG-EMM-96/28 presented the distribution of average mean area backscattering coefficient (S_a) values from an acoustic survey in Division 58.4.1. The conclusion presented was that the overall biomass estimate was not sensitive to contributions from weak scatters, i.e. the biomass estimate is dominated by acoustic backscatter from larger, generally monospecific, aggregations of krill.

Subarea 48.1

Scientific Surveys

3.15 Mean krill densities from two surveys conducted in the Elephant Island area during January and in February–March 1996 were high relative to those found in previous years (WG-EMM-96/23). Highest krill densities were found in wide bands to the north of King George and Elephant Islands.

3.16 One-year-old juvenile krill (modal length 28 mm) dominated during the first survey, whereas mature adult krill (modal length 48 mm) dominated during the second survey. Salp abundance was low.

3.17 WG-EMM-96/49 highlighted contrasts in the distribution of krill and myctophids between the slope/offshore and inshore regions around Seal Island as follows:

(i) krill showed more uniform distribution in the slope/offshore region in contrast to its very patchy inshore distribution;

(ii) krill showed no diel vertical migration in the slope/offshore region;

(iii) krill tended to be larger in body size and at a more advanced maturity stage in the slope/offshore region than in the inshore region. This segregation tends to break down in the post-spawning phase; juveniles are rarely sampled, adults appear to migrate onshore and superswarms may form at this time; and

(iv) myctophid fish occurred near surface at night in the slope/offshore region.

Subarea 48.2

Scientific Surveys

3.18 Results of a biomass survey for krill north of the South Orkneys in February/March 1996 were presented in WG-EMM-96/36. The survey consisted of thirteen parallel transects which were subsequently stratified on the basis of mean volume backscattering strength (MVBS).

3.19 This paper combined the results of the 1996 survey with those of a 1992 survey for the area to the south of the South Orkneys to give a total biomass estimate for the whole area of 2.6 million tonnes (the FIBEX estimate for this area was 6.9 million tonnes).

3.20 The density of krill in this area tended to increase inshore. The lowest densities were found in the deep oceanic waters of the Antarctic Circumpolar Current (ACC).

3.21 A significant diurnal vertical migration of krill was detected and a proportion of the krill population was found to be above the echosounder transducer at night and so was not sampled. To allow for this, a correction factor of 1.54 was applied to the night-time density estimates (Demer and Hewitt, 1995). It was suggested that the night-time and daytime data be analysed separately. This would allow tasks to be undertaken to determine whether the correction factor applied was appropriate for the region.

Subarea 48.3

Scientific Surveys

3.22 Results from the first year of a five-year study into the interannual variability of the distribution and abundance of krill in two areas in the vicinity of South Georgia were presented in WG-EMM-96/42. The location of the two survey boxes was chosen because of the high concentrations of krill found there in the past, the fishery activity in the region, the past whaling records and because of land-based field activities of the British Antarctic Survey on Bird Island.

3.23 The acoustic surveys consisted of 10 randomly-spaced parallel transects, 80 km in length, running approximately perpendicular to the shelf break in each survey box. The transects were sampled during daylight hours to avoid problems caused by vertical migration. Net hauls for target identification were carried out at night.

3.24 The density estimates for the two boxes were 40.57 g m^{-2} for box 1 (on the shelf break northeast of South Georgia) and 26.48 g m^{-2} for box 2 (on the shelf break north west of South Georgia). These values were much higher than those obtained in 1994 (box 1 –1.87 g m^{-2}, box 2 – 7.43 g m^{-2}) and are reflected in the improved breeding success of predators at Bird Island (see section 7).

3.25 Krill were estimated to comprise 60% of the acoustic biomass in both boxes. The population size distribution of krill was essentially unimodal in both boxes (24 to 35 mm) although there was a small number of larger krill caught in box 2.

3.26 A further estimate of krill biomass on the South Georgia shelf was provided as a by-product of a finfish survey of the region in 1992 and was reported in WG-EMM-96/42. This survey utilised acoustic transects between trawl stations to arrive at a biomass estimate.

3.27 The Working Group considered the approach used in WG-EMM-96/42 to be useful in providing additional information on krill biomass. Attention should be paid to the analytical treatment of the results of such surveys, particularly regarding the coverage probabilities associated with the effect of design on the estimate of the mean densities. The Working Group encouraged the examination of these approaches. This survey resulted in a density estimate of 95 g m^{-2}, compared with earlier values for the same region of between 1.87 and 76 g m^{-2}.

Fisheries Data

3.28 Additional information on krill distribution is available from haul-by-haul data which have been recorded in the South Georgia area over the last three winter fishing seasons (WG-EMM-96/64). Analyses of these data show marked internal variability and indications of a seasonal pattern. The fishery was closely associated with bottom topographic features such as shelf edge and submarine bank and canyons. The authors discussed the results in relation to the ecology of krill and the interaction of the fishery with the local predator colonies.

3.29 The Working Group noted the utility of these results and recalled that it had in the past called for the submission of haul-by-haul data from the fishery. Further submission of such data was encouraged.

3.30 The density and biomass of krill aggregations as well as their shape and distribution patterns in the fishing grounds of Subarea 48.3, based on data collected by Ukrainian commercial trawlers during June and August 1995, were briefly reported (WG-EMM-96/70). The total biomass of krill on fishing grounds with an area of 180 km^2 was evaluated to be 300 000 tonnes.

Division 58.4.1

Scientific Surveys

3.31 WG-EMM-96/28 and 96/29 described the results of a survey in Division 58.4.1 based on an approved design (WG-Krill-94/18 and WG-EMM-95/43). This survey was specifically designed with the aim of estimating B_0 and was carried out from January to March 1996.

3.32 A range of additional measurements was also made during the course of this survey, including oceanographic sampling on eight of the 18 transects and a detailed suite of biological measurements ranging from primary productivity to whale observations.

3.33 The biomass of krill in the surveyed area (873 000 km^2) was estimated to be 6.67 million tonnes with a coefficient of variation (CV) of 27%. The survey covered most of the area that has been commercially fished in Division 58.4.1.

3.34 Krill were far more abundant in the west of the region (80 to 120°E) than in the east (120 to 150°E), which appeared to be related to the large-scale oceanographic conditions of the region, where a southward intrusion of warmer water (containing salps) approached the shelf/slope area.

3.35 Experience from the Japanese fishery indicated that the southeast Indian Ocean sector was an area which was subject to considerable diurnal fluctuations in the amount of krill in aggregations, particularly late in the season. During the reported survey, however, the majority of the krill was found in the top 80 m of the water column and aggregations, which rarely extended to the sea surface, were present during both day and night.

3.36 This survey was recognised as a significant contribution to the work of the Working Group and served to demonstrate that it was possible to carry out large synoptic surveys without many of the technical and organisational problems of the past.

Subarea 88.1

Scientific Surveys

3.37 The biomass of krill in the Ross Sea (Subarea 88.1) was reported from two surveys (WG-EMM-96/63) carried out during the Tenth Italian Expedition in November to December 1994. The survey included a marine mammal and bird census. The conduct of such multidisciplinary cruises was encouraged by the Working Group.

3.38 Two biomass estimates were reported; one, for 9 November to 15 December, provided a biomass estimate of 5.14 million tonnes for an area of 49 800 n miles^2, and the other, carried out between 17 and 28 December, provided a krill biomass estimate of 3.37 million tonnes for an area of 45 600 n miles^2.

3.39 The earlier survey encountered a 'superswarm' which was estimated to contain over 1.5 million tonnes of krill.

3.40 The results of these surveys showed a similar krill distribution pattern to other Antarctic waters, with *Euphausia crystallorophias* occurring inshore and *E. superba* being found over the shelf/slope region. This study highlighted that substantial quantities of Antarctic krill may occur in waters normally covered by ice.

3.41 The difficulties of surveying such large areas as Division 58.4.1 and Subarea 88.1 were pointed out, and it was suggested that further consideration should be given to the subdivision of these large statistical areas so that more appropriately sized management areas could be defined.

Indices of Harvested Species Abundance, Distribution and Standing Stock

CPUE

Subarea 48.1

3.42 Seasonal variations in CPUE indices (catch/tow and catch/towing time) of the Japanese fishery in Subarea 48.1 were reported for the 1994 season (WG-EMM-96/47). The main fishing grounds were mostly to the north of Livingston Island, and shifted to the Elephant Island area later in the season. CPUE values to the north of Livingston Island were relatively stable throughout the season, while those around Elephant Island were higher but very variable. Krill size was much larger (a modal length of 48 to 50 mm) than in the previous season.

3.43 Long-term variations in the CPUE of the Japanese fishery in Subarea 48.1 were reported for the period 1980/81 to 1994/95 (WG-EMM-96/50). There was a declining trend in CPUE both in the Livingston and Elephant Island areas from the mid-80s to the 1989/90 season. This trend reflects a number of factors, including an increasing demand for good quality krill (non-green) rather than high catch rates. From 1990/91, CPUE remained relatively constant in the Livingston Island area, whereas that in the Elephant Island area it increased to the earlier levels. The recent shift of the fishing period in the Elephant Island area to later in the season, when the phytoplankton bloom is over and krill are no longer green, may allow fishing vessels to operate at high efficiency and to return to high CPUEs.

3.44 The Working Group welcomed the detailed analyses of the long-term trends of CPUE in Subarea 48.1.

Subarea 48.3

3.45 Interannual variation in the CPUE of the Japanese fishery in Subarea 48.3 was reported for the winters of 1990 to 1994 (WG-EMM-96/51). It was noted that CPUE in winter appeared to correlate to the availability of krill as assessed by the performance of predators at Bird Island in the preceding, rather than the following summer season. For example, the poor krill summers of 1990/91 and 1993/94 were followed by low CPUE in the winters of 1991 and 1994 respectively, and the good krill summer of 1992/93 was followed by high CPUE in the winter of 1993. The low CPUE in the winters of 1991 and 1994 in Subarea 48.3 was comparable with low CPUE values in Subarea 48.1 in the preceding 1990/91 and 1993/94 summers.

3.46 Commercial catch data on the depth of fishing indicate that krill distribution in winter might be deeper than in summer (e.g. Kalinowski and Witek, 1983). WG-EMM-96/51 indicated that there was also an interannual variation in length frequency in Subarea 48.3, implying the existence of krill flux from the Peninsula area and the Weddell Sea.

3.47 Based on tow data in the above paper, Dr R. Hewitt (USA) pointed out a possible relationship between interannual variations in modal krill length and the range of tow depths. That is, it would appear from the data that larger krill undergo greater vertical migrations which means that the net must be towed deeper. Dr Murphy suggested that, based on WG-EMM-96/64, shallower net towing depth may also be associated with shallower bottom depths of fishing grounds.

Analysis and Results of Studies on Recruitment and Production of Harvested Species

3.48 Length composition data from the Japanese commercial catch for the period 1980/81 to 1994/95 were analysed to examine variation of the recruitment indices (R_2) in the Livingston Island area (WG-EMM-96/50).

3.49 Year-by-year recruitment indices from fishery data generally agreed with R_1 and R_2 of Siegel and Loeb (1995) that had been observed in the Elephant Island area. However, some differences were noted, resulting from distinct differences in length composition between krill from the Livingston and Elephant Island areas.

3.50 The Working Group noted that the calculation of a recruitment index from the commercial fishery data was a useful development which could provide valuable additional information. However, because the fishery data do not provide an unbiased estimate for the population, they cannot be directly compared to those derived from scientific surveys.

3.51 As requested in SC-CAMLR-XIV (Annex 4, Appendix D), a re-analysis of the long-term recruitment and density data from scientific surveys carried out in the Elephant Island area was presented in WG-EMM-96/45. The re-analysis confirmed the statistical significance of the observed fluctuations in krill density and recruitment.

3.52 Mr Ichii pointed out that recruitment of krill in the Elephant Island area is not necessarily representative of the wider spatial scale of the Peninsula region. From fisheries catch data over a 15-year period, it is apparent that in some years, there are occasional occurrences of distinct differences in length composition between krill from the Elephant Island and Livingston Island areas; differences which cannot be explained by fishing selectivity.

3.53 However, a comparison between the Elephant Island survey and large-scale Antarctic Peninsula surveys, concluded in four separate seasons, demonstrated that the differences between these areas in the proportion of recruits were less than 5% (WG-EMM-96/45).

3.54 In general, the acoustic data from the Peninsula region have tracked the density estimates obtained by nets but the time series of reliable acoustic data is much shorter.

3.55 The density estimated from net haul surveys is such that only highly significant changes can be detected. There may have been less substantial changes in the density index which have escaped detection because of the low statistical power obtained using data from net surveys.

3.56 The mean krill density was higher at the beginning of the time series (late 1970s, early 1980s). However, it was not clear whether this was a reflection of a persistent trend or of a serially correlated natural variability in density. It must also be borne in mind that density changes do not necessarily arise from recruitment variation alone, but can also be the result of changes in natural mortality or distribution patterns.

3.57 Further work to examine the consequences of the estimates of proportions of recruits and variations in krill density reported in WG-EMM-96/45 for the krill yield model is described in paragraphs 7.6 to 7.13.

3.58 Although data from scientific surveys are required to estimate proportional recruitment for the krill yield model, it would be useful to obtain fisheries-derived data for comparative purposes. The Working Group encouraged the submission of other time series of krill data for the estimation of recruitment variability from both scientific and fisheries sources.

3.59 It is likely that there is a sufficiently long time series of length-density data from Japanese, Australian and other scientific cruises in the Indian Ocean sector that could be used to examine changes in proportional recruitment. The Working Group encouraged the analysis of this dataset and the submission of the result.

Future Work

Indices of Local Prey Abundance

3.60 As indicated by the Subgroup on Statistics (Appendix H, Table 4), the development of indices of local distribution of harvested species 'needs considerable research'. Such research should involve and seek to integrate two main approaches:

(a) predator-based (top-down)
(b) prey pattern-based (bottom-up).

Predator-based Approach (top-down)

3.61 An index of local prey distribution is relevant if it is related to predator behavioural regimes and/or ecological requirements, particularly at the spatial and temporal scales over which the predator's foraging behaviour is integrated.

3.62 The scales at which data on predator performance are currently collected via existing standard methods range from temporal scales of days (foraging trip) to weeks (incubation shift) and months (breeding success, chick mass at fledging, adult mass at arrival) and years (survival); the spatial scales vary from tens to thousands of kilometres.

3.63 For most purposes relating to potential indices of local prey abundance, it is principally the shorter time and space scales (days/weeks and 10–100 km) that are of relevance.

3.64 Many aspects of predator performance, however, are closely linked to the dispersion and/or density of prey and are manifested through changes in foraging behaviour on scales of minutes to hours. Existing approaches to analysis of foraging behaviour data have chiefly been to attempt to identify structure within foraging trips (e.g. foraging bouts and their constituent elements; see Boyd et al., 1994; Boyd, 1996).

3.65 Some of the more relevant spatial and temporal scales are summarised in Table 2 which shows that black-browed albatrosses and penguins/fur seals tend to function at rather different spatial and temporal scales. However, whereas some penguin species and fur seals may operate at overlapping scales, there may be distinct differences in their predator/prey interactions by virtue of constraints imposed on them by physiology and behaviour, especially when they are rearing offspring. Thus fur seals, making longer trips, predominantly feed at night. Penguins chiefly feed during the day. These two types of predator may, therefore, interact (either by choice or constraint) with prey at different dispersions and/or densities.

Prey Pattern-based Approach (bottom-up)

3.66 A local index can be described using a variety of methods of spatial statistical techniques, as illustrated by measures of the intensity and scale of pattern in space and time (e.g. Lloyd's index of patchiness, negative binomial k, spectral methods, spatial auto-correlation or semi-variogram).

3.67 The most successful local indices will be those that involve congruence (spatial and/or temporal) of the top-down and bottom-up approaches (e.g. Figure 1) (see paragraph 3.64).

3.68 WG-EMM-96/22 provides some indices, readily calculable from standard acoustic survey data, on:

(i) average prey density (i.e. overall mean volume back-scattering strength);
(ii) average prey depth;
(iii) average distance (over a specified depth range) from a particular predator colony; and
(iv) prey persistence over time (by comparing prey density between sequential surveys).

While these may provide useful information at scales of weeks and 10–100 km, they may not provide information at the most relevant scales of predator-prey interactions.

3.69 Nevertheless, these generalised indices summarise distributions at scales similar to those represented by several predator indices; future investigation and development of such prey indices is encouraged.

3.70 Following the discussion outlined in paragraphs 3.66 to 3.69 above, the Working Group noted that the topic of krill aggregation in relation to the availability of krill (prey) to predators has a long history within CCAMLR (e.g. SC-CAMLR-X, Annex 5, paragraphs 5.2 to 5.9 and SC-CAMLR-XIII, Annex 5, paragraphs 4.42 to 4.44). In this context, additional work by Members should be directed to investigations of the characterisation of krill aggregations through measures of the aggregation structure (Nero and Magnuson, 1989; Weill et al., 1993), the intensity of dispersion (e.g. Hewitt, 1981) and the scale of dispersion (Weber et al., 1986).

3.71 In addition, information on other characteristics of the prey itself needs to be obtained and summarised. Aspects of prey of particular relevance to predators include: (i) size composition (e.g. statistics derived from length frequency distributions of biomass estimates); (ii) sex and maturity stage composition; (iii) energy content (which is strongly influenced by prey size, sex and maturity stage). At present such data can only be obtained through analysis of net haul samples.

Synoptic Survey of Area 48

3.72 The Working Group recalled the reasons for the need for a new synoptic survey of Area 48 outlined in last year's report (SC-CAMLR-XIV, Annex 4, paragraph 4.61) and agreed that the requirement still existed.

3.73 It was noted that advances in technology and data handling would make the conduct of such a survey much less complex than it had been in the early 1980s. Issues of data management should be addressed early in the planning stage.

3.74 The time budget for such a survey was presented at last year's meeting and members were asked to detail for presentation at SC-CAMLR-XV the requirements of such a survey and work towards an analysis of the logistic arrangements that would be necessary.

3.75 The Working Group agreed that the completion of a synoptic survey within all or part of Area 48 was a high priority. It was agreed that completion of a synoptic survey was more feasible than previously thought because several Members are currently conducting long-term research programs which might be incorporated into a synoptic survey design and because other Members had expressed interest in participating in the survey. Therefore, the Working Group reviewed information available at previous meetings (WG-EMM-95/71; SC-CAMLR-XI, Annex 5, Appendix H; Trathan and Everson, 1994) and made the following recommendations:

(i) survey planning should be completed assuming a minimum of three ships participating in the survey for one month each. Surveys should be conducted simultaneously in the period January to February;

(ii) effort should be concentrated in Subareas 48.1, 48.2 and 48.3. If additional ships become available, the additional effort might be allocated to Subareas 48.4 and 48.6;

(iii) survey planning should take into consideration ongoing long-term sampling efforts of several national programs (e.g., UK five-year program, and US LTER and AMLR programs);

(iv) subareas should be examined to determine whether some regions may require no survey effort, and areas adjacent to the three subareas should be examined to ensure substantial krill concentrations are not omitted (e.g. the northwest corner of Subarea 48.3 may be omitted, whereas the area immediately above the northeast boundary of Subarea 48.1 should be included; Figure 2);

(v) sampling in each subarea should be conducted using an appropriate sampling design (e.g. SC-CAMLR-XIV, Annex 4, paragraphs 4.3 to 4.9). Strata should be defined for areas of known high krill density (e.g. areas most exploited by the fisheries; or areas surveyed annually by national programs – Figure 2);

(vi) whether to conduct sampling in daylight or throughout the 24-hour period should be discussed for each subarea;

(vii) acoustic sampling protocols (e.g. 120 kHz transducer frequency), data protocols (e.g. reporting data as MVBS) and documentation of measurement methods (e.g. see Appendix D) should be standardised;

(viii) standardised directed and random net sampling regimes consistent with those used in acoustic sampling should be used; and

(ix) standardised oceanographic sampling regimes (expendable bathythermograph (XBT) versus conductivity temperature depth probe (CTD); frequency of sampling, etc.) should be used.

Tracklines depicted in Figure 2 are presented to illustrate subparagraphs (i) to (v) above. Trackline distances are approximately 5 500 km in each subarea and the whole synoptic survey could be completed by three ships in approximately 20 days each (this does not include time for net sampling or oceanography). Specific sampling designs should be examined further.

Sites

4.1 Members were asked to report on the initiation of CEMP research at new sites and on changes in CEMP research at existing sites.

4.2 Further to his advice to WG-EMM in 1995 that the US would be closing the Seal Island site due to safety considerations, Dr R. Holt (USA) reported that only penguin fledging weight data had been collected at Seal Island in the 1996 season (WG-EMM-96/73). Surveys had been carried out to select a new site in the region that will be suitable for CEMP research. The location at Cape Shirreff had been selected. This had already been designated as a CEMP site and the site would now be run jointly by the USA and Chile.

4.3 Prof. D. Torres (Chile) reported on recent research undertaken at Cape Shirreff which included monitoring the size of Antarctic fur seal populations (WG-EMM-96/39). Fur seals continue to increase in numbers at Cape Shirreff at an average rate of ~9% per annum which, according to Dr Boyd, is similar to the apparent rate of increase at South Georgia. Therefore, this may be representative of the rate of increase generally for the Scotia Sea.

4.4 In addition, members reported that monitoring studies were continuing at Anvers Island (Antarctic Peninsula), Béchervaise Island (Prydz Bay), Bird Island (South Georgia), Edmonson Point (Ross Sea), Esperanza Station (Antarctic Peninsula), Laurie Island and Signy Island (South Orkney Islands), Stranger Point (South Shetland Islands), Syowa Station (Prince Olav Coast) and Ross Island (Ross Sea).

4.5 Dr Mehlum reported that Norway will be establishing a CEMP monitoring site at Bouvet Island during the forthcoming season. This will involve monitoring parameters relating to Antarctic fur seals and macaroni and chinstrap penguins using CEMP Standard Methods A3 to A9, C1 and C2.

4.6 Dr S.-H. Lorentsen (Norway) also provided information about Norwegian studies of Antarctic petrels at Svarthamaren (Queen Maud Land). This is the largest known breeding colony of Antarctic petrels and the site is recognised as an SSSI. However, it cannot be listed as a CEMP monitoring site until standard methods for monitoring Antarctic petrels are adopted.

4.7 Dr K. Kerry (Australia) also reported that monitoring studies of Adélie penguins at Casey Station and Dumont d'Urville using CEMP standard methods had taken place during 1996. These were coordinated with a major regional krill survey carried out by Australia (WG-EMM-96/29); there are no plans to repeat these studies in future.

4.8 Based on results from satellite-tracking of Adélie penguins in eastern Antarctica (WG-EMM-96/69; see also paragraph 4.84), Dr Kerry suggested that before establishing a CEMP site it would be prudent to assess (e.g. by using satellite tracking) the temporal and spatial overlap between the foraging range of penguins feeding their chicks and the area of an actual or potential fishery.

4.9 The Working Group noted that evidence of a lack of spatial overlap did not, however, indicate a lack of competition between predators and a fishery because, due to krill flux, a fishery could be affecting the krill population outside (e.g. upstream of) the predator foraging area. Moreover, there was no guarantee that krill fisheries would not expand into the foraging ranges of predators at some future date. Furthermore, penguin foraging ranges outside the chick-rearing period might be just as relevant for site selection.

4.10 Dr de la Mare suggested that site selection should take into account whether or not predators at the site are substantially dependent on krill.

Species

4.11 No proposals had been received suggesting incorporation of new species into the CEMP monitoring program.

Field Methods

Report of the Subgroup on Monitoring Methods

4.12 The Working Group considered the report of the Subgroup on Monitoring Methods (Appendix I) which had met in Bergen immediately prior to the current meeting of WG-EMM. Members of the subgroup and its convener, Dr Kerry, were thanked for their work and for preparing their report in time to be considered by the Working Group.

Review of Existing Standard Methods

4.13 The subgroup had reviewed each of the existing standard methods and suggested areas where changes were required. The report of the subgroup contains full details of proposed changes.

4.14 In approving the suggestions and recommendations of the subgroup, except as indicated below, WG-EMM provided additional comments. For convenience, Methods A1, A2, A5, A6 and A7, as drafted by the subgroup, have been modified in the subgroup report. Further details on these methods are provided in the paragraphs below.

4.15 The Working Group approved the alterations to Method A1 (adult weight on arrival at the breeding colony). In addition, Dr Lorentsen commented that it may be more appropriate to use a condition index (i.e. weight corrected for body size) rather than weight at arrival. It was noted that acceptance of this change or addition would be subject to the submission of an appropriate recommendation based on analysis of data, including comparing the alternative methods. Members able to collect and analyse such data were encouraged to conduct appropriate investigations and report to the Working Group.

4.16 The Working Group approved the alterations to Method A2 (duration of first incubation shift).

4.17 Dr P. Wilson (New Zealand) noted that Method A3 (breeding population size) in its present form does not allow for the collection and submission of data derived from aerial counts of penguins. If CEMP required submission of the extensive current and historical data on penguin population size in the Ross Sea collected using aerial photography, it would be necessary to prepare information on appropriate methodology for potential incorporation in a new procedure under Method A3. Dr Wilson offered to prepare materials for consideration during the next meeting of WG-EMM.

4.18 The Working Group approved the minor alterations to Method A5 (duration of foraging trips). The Working Group suggested that before other methods are incorporated into an appendix to the standard method (Appendix I, paragraph 54), it would be appropriate to have information on the accuracy of determining foraging trip duration by these other methods in comparison with radio frequency telemetry. It was recommended, however, that details of the method of attaching radio transmitters should be placed in an appendix to the standard method.

4.19 The Working Group approved the alterations to Method A6 (breeding success) and to Method A7 (chick weight at fledging).

4.20 In relation to the suggestion regarding Method A8 (chick diet) using the diameter of krill eyeballs as a substitute for carapace length (Appendix I, paragraph 61), the Working Group noted that major problems would arise from the sexual dimorphism in eye size and the difficulty in distinguishing between eyeballs of *E. superba* and *E. crystallorophias*. It was also noted that the accuracy of comparisons of length frequency of krill taken by nets and predators would be greatly improved if carapace length was also measured for krill caught by nets.

4.21 In respect of the preservation of samples taken using Method A8 (chick diet) (Appendix I, paragraph 62), Dr Kock noted that transference of krill samples to alcohol is likely to cause changes in krill mass and length. Equations for estimating krill length and mass have traditionally been based on formalin-preserved specimens. It was therefore recommended that krill samples for long-term storage should be preserved in buffered formalin. The formalin should be replaced at frequent intervals.

4.22 In relation to the recommendation of separating the first and subsequent vomits when sampling penguin chick diet (Appendix I, paragraph 65), which arose from detailed work on Adélie penguins in the Prydz Bay region (SC-CAMLR-XIV, Annex 4, paragraph 5.25), Dr Croxall commented that this procedure was not appropriate for all penguin species, not necessarily easy to implement in the field and might create additional complexity in reporting data to the CEMP database.

4.23 Dr Kerry, however, believed that for Adélie penguins the first and subsequent vomits should be analysed and reported separately, particularly since it has been demonstrated that there are different foraging strategies for male and female Adélies (WG-EMM-Methods-96/11) with males taking more food from the neritic zone. Food from such areas is more common in the first vomit as they are collected by birds as they return to their breeding colony.

4.24 The Working Group recommended that, for the present, appropriate text on the above subject should be added to the 'problems to be considered' section of the standard method.

4.25 The following observations were made concerning the problem of standardising estimates of wet weight of diet samples (Appendix I, paragraph 68):

(i) wet mass, rather than displacement volume, needs to be recorded for many applications in predator studies (especially conversion to energy content);

(ii) compression of samples using a standard heavy weight may create problems for subsequent determination of sex and maturity stage of krill; and

(iii) it might be more useful to emphasise the need to ensure consistency of technique at each site than to try to obtain overall standardisation across all sites and studies.

The Working Group therefore recommended that an advisory note on this topic be added to the 'problems to be considered' section of the standard method. It was considered that a workshop on this topic was not necessary at this stage.

New Standard Methods

4.26 The subgroup also considered proposals for new standard methods to be included within CEMP. These were reviewed by the Working Group and, after minor modification, were adopted and approved for publication in the *CEMP Standard Methods*. The approved new methods are for (i) attachment of instruments (WG-EMM-Methods-96/5), (ii) data collection using time depth recorders (TDRS) (WG-EMM-Methods-96/5) and (iii) monitoring methods for petrels, which include methods for the collection and analysis of chick diet in cape and Antarctic petrels (WG-EMM-Methods-96/4, WG-EMM-96/53) and monitoring population size, breeding success, recruitment and adult survival rate in Antarctic petrels (WG-EMM-95/86, 96/14, and 96/12).

Other Methodological Topics and Issues

Stomach Lavage of Procellariiformes

4.27 In respect of the subgroup's advice relating to the use of stomach lavage for albatrosses (Appendix I, paragraph 28), it was noted that the collection of regurgitations was probably far preferable to lavage in terms of minimising handling time and stress to the birds. The Working Group further noted that for many research purposes involving diet sampling, use of stomach lavage techniques would be preferable to methods which require the killing of birds.

Effects of Disease and Pollutants

4.28 The subgroup proposed that advice on appropriate methods for the collection of samples for toxicological and pathological analysis (WG-EMM-Methods-96/7 Rev. 1 and 96/13) should be added as an appendix to the *CEMP Standard Methods*. The Working Group endorsed this suggestion. In considering the text some additional observations were made (paragraphs 4.29 and 4.30).

4.29 Dr Boyd noted that it is also necessary to examine background levels of contaminants in tissues collected from birds or seals that have died of known causes, such as traumatic injury, where death is unlikely to have been caused by the poor health or condition of the individual. This is important because the collection of tissues from moribund individuals for examination of contaminant burdens has been shown to affect the measurements of contaminant concentrations. This is especially important for measurements involving lipid-soluble hydrocarbons. Dr Boyd also drew attention to the requirement, if total body burdens are to be measured, to measure the total body lipid content, in addition to the concentration of lipophilic hydrocarbons in a subsample of tissues. This would require considerably more work on the part of the investigators in the field, in addition to the need to develop appropriate protocols for carrying out this procedure.

4.30 Dr Kerry reiterated that the sole purpose of having methods for the collection of samples for toxicological analysis or the investigation of disease was to determine whether or not either were implicated in increased mortality or morbidity at CEMP sites.

4.31 Following on from the comments of Dr Boyd (paragraph 4.29), Dr Kerry noted that a number of laboratories had been studying the incorporation of pesticides and pollutants into the Antarctic organisms at different levels in the marine food chain. However, no baseline data are available for predators being monitored at CEMP sites and it would therefore be appropriate to obtain such baseline data. This could be done from biopsy material and other samples such as oil from the preen glands of birds as well as the samples from post-mortem material suggested by Dr Boyd.

4.32 The Working Group requested that the existing text should be reviewed in the light of the comments in paragraphs 4.29 and 4.30 above.

4.33 An appendix had also been included in WG-EMM-Methods-96/13 listing the materials required for the post-mortem analysis of carcasses. While the Working Group commended the comprehensiveness of this list, its extensive nature meant that it was unlikely that these materials would be available at remote field sites at short notice if unexpectedly high predator mortality occurred. Therefore, the Working Group requested that a listing of only those items considered absolutely essential for carrying out post-mortem analyses should also be provided. This would enable the minimum materials to be held at field sites where pathological studies are not a normal part of the ongoing research program. Similarly, the Working Group noted that the requirement for liquid nitrogen for sample storage in order to undertake biochemical analyses was unrealistic for many field sites.

4.34 It was emphasised that samples could only be analysed in specialist laboratories and that such analyses are very expensive. Contamination of collected samples is possible if the wrong containers are used and so care should be taken to have the correct containers in the field. Further, if samples are not collected or stored correctly then laboratory data will be difficult, if not impossible, to interpret.

4.35 The Working Group again drew attention to the need for scientists conducting field studies to consult with veterinary pathologists before going into the field to ensure that, if needed, urgent analysis of samples is possible and that any special sampling requirements of the laboratory can be accommodated (SC-CAMLR-XIV, Annex 4, paragraph 5.49).

Marking Birds for Long-term Studies

4.36 In relation to the use of implanted electronic tags (Appendix I, paragraph 39), it was noted that while these tags offered considerable potential for some CEMP purposes, they are unsuitable on their own for some other applications, such as detailed demographic studies. Such work still relies on externally visible marks; several research groups are currently investigating this problem.

4.37 Dr Croxall noted that the SCAR Workshop on Alternative Marking Methods for Penguins (Cambridge, UK, 31 July 1996) had received reports of successful subcutaneous implantation of tags into the upper leg and lower dorsum of king penguins. No tag loss had occurred in these studies, which were conducted over several consecutive years. Dr Kerry also noted that the same kind of tags had been used extensively in Adélie penguins where they had been implanted into the neck (WG-EMM-Methods-96/8). Although the use of the tags had been very successful and the survival of tagged adults was equal to or better than that of banded birds, a problem that had been detected was that tags may migrate from the site of implanting.

4.38 The Working Group recommended that the investigations of tag migration proposed by the subgroup (Appendix I, paragraph 41) should also include studies of the relative suitability of different implantation sites.

4.39 The Working Group noted that until the results of such studies were available it would be premature to develop standard methods for the use of implanted tags (Appendix I, paragraph 42), though scientists using these devices were encouraged to make details of their methods and experience widely known.

4.40 It was also noted that there was currently no central directory of research groups and studies using implantable transponder tags in Antarctic seabirds. This problem is compounded by the fact that South Africa, as notified to SCAR, can no longer continue to support the bird banding database for Antarctic seabirds without additional funding. The Working Group considered that it was important to ensure that information about the types and identification codes of bands and transponder tags should be available to the research community to ensure compatibility of numbering sequences and types of instrumentation at different sites as well as to provide a point of reference for bands or transponder identification sequences recovered from birds. The Working Group agreed this was an important issue but noted that there were financial implications for the maintenance of such a directory.

At-sea Behaviour

4.41 At its 1994 meeting, WG-CEMP began the process of developing indices of predator foraging performance and at-sea behaviour for inclusion in the monitoring program (SC-CAMLR-XII, Annex 6, paragraphs 4.15 to 4.23). Draft standard methods for the attachment and deployment of instruments were considered by WG-EMM at its 1995 meeting and in the following intersessional period these were circulated for comments. The circulation list is given in WG-EMM-96/16, Appendix 1. These standard methods were redrafted incorporating the comments received (WG-EMM-Methods-96/5) and they were considered and endorsed with minor modifications by the Subgroup on Monitoring Methods (Appendix I, paragraphs 8 to 12) at its meeting in August 1996.

4.42 In addition, at its 1995 meeting, WG-EMM approved the move towards holding a workshop to develop standard methods for the analysis and interpretation of data on at-sea behaviour. During the following intersessional period, Dr Boyd wrote to a small group of scientists, including several not involved in studies related to CEMP but representative of those involved in studying at-sea behaviour, to propose holding a workshop as defined under the terms of reference given by WG-CEMP (WG-EMM-96/16).

4.43 The response to this letter indicated that there is insufficient interest to justify holding a workshop that would include others involved in related research. Nevertheless, the Working Group re-affirmed its commitment to the development of standard analytical methods for at-sea behaviour, including those which would ensure that relevant data are easily reduced into a format that would allow them to be readily incorporated into the CEMP database.

4.44 In order to maintain the momentum of this initiative, the Working Group decided that this issue should be considered by the Subgroup on Statistics as an agenda item at its next meeting. This would have the advantage that individuals with specific expertise could be invited to attend without the need to convene a full-scale workshop. In particular, the subgroup should be asked to consider sample datasets and analyses, and provide advice on the most appropriate indices for inclusion in the CEMP database and the appropriate methods used to derive these indices.

4.45 In response to the suggestion by the Subgroup on Monitoring Methods that a standard method for attachment of instruments to flying birds be developed (Appendix I, paragraph 13), the Working Group noted that:

(i) many different types of instrument are being attached to and implanted into flying birds and a wide variety of attachment techniques are in use; it would be premature to try to recommend standard attachment procedures;

(ii) unlike the situation with attaching TDRs to seals, no proposals have yet been made for the collection of standardised data on the foraging performance of flying birds; and

(iii) the appropriate procedure would be first to define what would be measured and then to provide advice relating to standardisation of instrumentation and attachment technique necessary to facilitate such measurements.

Crabeater Seals

4.46 Following consideration of crabeater seals at the 1995 meeting of WG-EMM, where concern was expressed that no proposals for standard methods (and thereby the provision of data to CEMP) had been made, SCAR-GSS had been asked by the Chairman of the Scientific Committee to provide assistance with drafting standard methods for CEMP.

4.47 This request was considered by SCAR-GSS at its meeting during July 1996 and an excerpt from the draft report of this meeting was available to the Working Group (SC-CAMLR-XV/BG/10).

4.48 The response from SCAR-GSS emphasised the central importance of its research program on Antarctic pack-ice seals (APIS). This program, which is due to run until the end of the decade, addresses both of the main concerns raised by CCAMLR: directed research on crabeater seals and the development of monitoring methods. Dr Øritsland commented that the issue of monitoring on crabeater seals was a two-step process involving, first, the development of standard methods (which is currently being undertaken by APIS), followed by the development of monitoring procedures (which will follow the completion of APIS).

4.49 With regard to directed research, Dr Boyd, who is a member of SCAR-GSS, described the general function of APIS. The program provides a framework within which process-oriented studies, focused mainly on crabeater seals, can take place. This includes, wherever possible, collaborative links with groups examining lower trophic levels and sea-ice and, to this end, linkages are being developed between the SCAR-EASIZ and SCAR-ASPECT programs and APIS.

4.50 The response from SCAR-GSS also highlighted the recent APIS workshop on the development of methods for measuring the distribution and abundance of pack-ice seals, including survey design, data collection protocols (including at-sea behaviour) and data analysis procedures. SCAR-GSS emphasised the relevance of this to CCAMLR's requirements for the development of CEMP standard methods for crabeater seals and for eventually establishing a CCAMLR database on crabeater seals.

4.51 The Working Group acknowledged and welcomed the significant steps that had been taken by SCAR-GSS towards the development of census methods and a database for crabeater seals. It also noted the advice from SCAR-GSS that it would be most appropriate to wait until the main results from the APIS program have been analysed before establishing standard methods for monitoring crabeater seals.

4.52 Dr Boyd also commented that such monitoring procedures could follow the example described in WG-EMM-96/33 where seal populations were monitored using shore-based counts. Only when there is more information about the movement patterns of crabeater seals in relation to season and ice conditions, which will be available as a result of the APIS program, will it be possible to establish the effectiveness of this type of monitoring, develop protocols for monitoring crabeater seals in this manner and provide an interpretation of variations in parameter estimates. In addition, the standard survey methods could be used to measure predator distributions during krill surveys. An example of the type of survey in which these methods could be applied is given in WG-EMM-96/63.

Future Work on Standard Field Methods

4.53 The Working Group noted the comments of the subgroup concerning the possible requirement for a comprehensive review of the existing methods to examine their ability to meet CEMP objectives (Appendix I, paragraph 6). The Working Group felt that, given the extensive appraisal of methods undertaken at the present meeting, it was no longer urgent to carry out such a review. It was felt that a better procedure would be for anyone who felt that a particular method was inappropriate for meeting CEMP objectives to submit to WG-EMM a paper detailing their concerns.

4.54 The Working Group approved the following initiatives which were the subject of advice from the Subgroup on Monitoring Methods (Appendix I, paragraph 81):

(i) develop additional new methods for Antarctic and Cape petrels, especially those for breeding chronology (Appendix I, paragraph 30);

(ii) request a study of the effects on birds of using fresh or seawater for stomach lavage (Appendix I, paragraph 20);

(iii) request the Subgroup on Statistics to consider analysis of predator foraging performance data on at-sea behaviour (Appendix I, paragraph 16; see also paragraph 4.44); and

(iv) maintain close links with APIS (Appendix I, paragraph 46; see also paragraphs 4.46 to 4.52).

Analytical Methods

4.55 At its 1995 meeting, WG-EMM highlighted several areas in which the analysis and presentation of data from CEMP could be improved and extended. This included (i) the calculation of indices of dependent species parameters and, in particular, the need for an improved method to identify anomalous years; (ii) extension of indices to cover harvested species and environmental parameters and; (iii) improvements to the way in which data were presented. Consequently these issues were referred to the Subgroup on Statistics for consideration during the intersessional period.

Report of the Subgroup on Statistics

4.56 Dr D. Agnew (Data Manager) presented the report of the Subgroup on Statistics (Appendix H).

4.57 A new method had been developed by the subgroup to identify anomalous years in time series of indices of dependent species parameters. This was required because the old method was sensitive to the length of the time series and tended to indicate large numbers of statistically significant anomalies in the values of monitoring parameters.

4.58 The method, which was suggested by Dr B. Manly (New Zealand), was based upon the development of a table of critical values that depend on the length of the time series. These values were developed from bootstrap simulations based on the assumption that the data fitted an empirical normal distribution (see WG-EMM-96/14). Thus it was necessary to transform data so that they were normally distributed. Since few of the monitoring parameters are normally distributed this remains problematic.

4.59 Dr M. Mangel (USA) suggested that, as a further modification, it may be appropriate to develop tables of critical values for each of the parameters, depending on their empirical distributions. However, this would require identification of an appropriate distribution of each parameter to allow parametric bootstrap simulations to be carried out.

4.60 Dr Agnew had used the new method to identify anomalous years and reported that this method was a substantial improvement on the previously used method. However, in consultation with Dr Manly, some adjustments had had to be made to the method because in its original form the method had been over-conservative and therefore had identified too few anomalous years (WG-EMM-96/13). Dr Croxall commented that in some indices the method still failed to identify anomalous years where these would have been expected. Examples of this were noted in the review of anomalies and trends given below. The Working Group recommended continued work on the application of this method by modifying it further to provide an improved match with known major anomalies in indices.

4.61 The Subgroup on Statistics recommended that quantiles would be used as a method for defining anomalous years in cases where data were not normally distributed or where they could not be transformed to normality. Dr Kirkwood enquired about the methods used for analysing quantiles and asked if any data had been presented using this method. In response, Dr Agnew explained that this method had not yet been used, mainly because it was difficult to calculate quantiles with the software currently available for analysing the database.

4.62 Dr Agnew noted other modifications recommended for the calculation of indices by the subgroup. These are described in detail in the subgroup report (Appendix H).

4.63 There is a problem associated with data absent from cells in a matrix from a group of colonies collected for a long time series. Additional work is required in order to examine methods for interpolating missing data for years when at least one colony out of a group has been counted. Dr A. Murray (UK) agreed to investigate this problem intersessionally.

4.64 With reference to the use of Method C2 (fur seal pup growth rate) which may result in biases caused by early mortality in years of low food availability, Dr Holt asked whether the same effect was likely to occur due to predation. In response, Dr Agnew indicated that predation would not lead to the same bias so long as each pup had an equal probability of being subject to predation.

4.65 With reference to unusual environmental events, the Working Group endorsed the recommendation of the subgroup that observations of this nature should be entered into the comments field of the data submission forms.

Data Submissions

4.66 Dr Agnew described the structure and rationale of WG-EMM-96/4 which tabulated the summaries and analyses of the CEMP database updated with data submitted for 1996.

4.67 The Working Group expressed its appreciation for the very substantial effort that had been put into the compilation of this information, both by those submitting data to the CEMP database and by Dr Agnew for his clear summary of the data. The Working Group also recognised that this dataset now contained time series that were becoming long enough to allow meaningful comparisons to be made between parameters and across sites that would help greatly in undertaking ecosystem assessments.

4.68 The Working Group reviewed all the monitoring parameters described in WG-EMM-96/4 for anomalies and trends but the current problems associated with the statistical analysis of anomalies (see paragraph 4.45) were reiterated and the Working Group agreed that these should be interpreted with caution at this stage.

4.69 A 17% decline in breeding population size of Adélie penguins (Method A3) at Anvers Island during the 1990s was observed. Dr Trivelpiece reported that the longer time series from Admiralty Bay indicated that the breeding population had been variable from the late 1970s to the late 1980s but that similar declines to those at Anvers Island had been observed through the 1990s. Chinstrap penguins at Signy Island also showed a significant decline for the full time series (WG-EMM-96/10) and a similar trend was indicated for Adélie penguins at this site although it was not statistically significant. Similarly, there had been recent declines in Adélie penguin populations in the Ross Sea since the late 1980s.

4.70 The inclusion in the tables of values for percentage change between years in penguin breeding population size is most helpful. Dr Croxall's illustration of this with the example of gentoo penguins from Bird Island (WG-EMM-96/4, page 6) showed the usefulness of percentage change as an aid to identifying potentially anomalous years. In future it may be appropriate to carry out analyses of the percentage change values to identify anomalies.

4.71 Dr Croxall noted that the number of macaroni penguins at South Georgia has decreased by about 50% since 1976. A major part of this decrease at the study colonies occurred in the late 1970s, although another decrease took place after 1994 (a year of extreme local krill scarcity). Gentoo penguin populations at South Georgia show considerable interannual variation, but there appears to have been an overall reduction of about 20% in the Bird Island population since 1977.

4.72 Dr Croxall provided several examples where the new method for identifying anomalies had apparently failed to identify biologically significant anomalies. Gentoo penguin breeding success at Bird Island (Method A6a, WG-EMM-96/4, page 15) shows four years of almost complete breeding failure. The anomaly index was successful in identifying only one of these failures. In addition, it was unsuccessful in identifying at least one biologically significant positive anomaly when the breeding success of gentoo penguins at Bird Island was close to its biological maximum. Similar problems existed for measures of penguin chick diet (Method A8a and A8b).

4.73 Attention was drawn to an apparent trend in increasing chick meal size (Method A8a) for Adélie penguins at Anvers Island and a recent decline in this parameter at Béchervaise Island. Comments relating to the former site will need to be referred to the originators of the data but Dr Trivelpiece noted that changes in the method of food sampling might be involved. Dr Kerry noted that at Béchervaise Island any apparent trend would be due to the low value in 1995 where the few samples obtained were all from early in the chick-rearing period. No samples were collected later in the chick-rearing period because by then almost all the chicks had died.

4.74 The Working Group also noted the trend of increasing fledging success (Method A6c) in Adélie penguins at Anvers Island. In addition, it noted that depressed fledging weight of penguins (Method A7) at Bird Island was associated with years of low krill abundance at South Georgia during 1991 and 1994.

4.75 Mr Ichii drew attention to the data for the foraging trip duration of chinstrap penguins at Seal Island (WG-EMM-96/4, A5 figure 2). He explained that individuals foraging overnight showed little variation in trip duration (Jansen, 1996). Therefore, he recommended that only daylight foraging trips should be used as an index. The Working Group noted that several aspects of this index need further investigation (see Appendix I, paragraphs 52 to 54) and recommended that Mr Ichii's suggestion be considered in any future work.

4.76 In concluding its review of the parameters on dependent species, the Working Group recommended that questions relating to the statistical definitions of anomalies in parameters should receive further attention.

Directed Research on Harvested and Dependent Species

Fish

4.77 *Pleuragramma antarcticum* is an important prey species for seals, penguins and fish in the high latitudes and has been considered as a monitoring species in the initial phase of CEMP. WG-EMM-96/65 provided new information on the hatching season and the growth of larvae and early juveniles of the species in the vicinity of the Antarctic Peninsula. Preliminary results indicated that assuming that micro-increments detected in otoliths were deposited daily, two hatching periods exist: one in June–July and the other in December. The maximum rate of growth for larvae that hatched in June–July was found to occur in August.

4.78 The Working Group noted that these findings were in contrast to previous observations by Dr G. Hubold (Germany) and others (SC-CAMLR-XIV, Annex 5, paragraph 6.14) who suggested that *P. antarcticum* spawns once a year at the end of the austral winter with larvae hatching in spring. Verification of a daily deposition of micro-increments assumed in WG-EMM-96/65 was still pending and was considered to be crucial for the outcome of this study.

4.79 WG-EMM-96/43 presented information on the interannual variation in the condition index of mackerel icefish, *Champsocephalus gunnari*, at South Georgia. Interannual variation was high with the higher condition indices, indicative of good feeding conditions, corresponding to years when krill was abundant in the region. Years of krill scarcity resulted in low condition indices. These low condition indices were consistent with years when CEMP indices from land-based predators, such as breeding success and the proportion of krill in the diet of gentoo and macaroni penguins and black-browed albatross and foraging trip duration in fur seals also indicated that krill abundance was low.

Seabirds and Marine Mammals

Diet

4.80 WG-EMM-96/17 and 96/44 reported on the diet of the Cape petrel, *Daption capense*, during the chick-rearing period at two localities in the South Shetland Islands and during the post-hatching period at Laurie Island (South Orkney Islands). In both regions, krill and fish formed the predominant items in the prey, in terms of mass and numbers, whereas other prey, such as amphipods and squid, was of minor importance. The most common fish prey was the lanternfish *Electrona antarctica*. This was in contrast to results from studies in colonies of Cape petrels on the Antarctic continent where *P. antarcticum* accounted for most of the fish prey.

4.81 WG-EMM-96/32 emphasised the importance of fish in the diet of the South Polar skua, *Catharacta maccormicki*, at the South Shetland Islands. A variety of fish species was found in the diet of this species during the breeding season at Half-Moon Island. The myctophid *E. antarctica* was the most common prey species.

4.82 Dr Trivelpiece noted that *P. antarcticum* and *E. antarctica* were the predominant prey items of the South Polar skuas breeding in the long-term study region in Admiralty Bay, King George Island. The occurrence of *P. antarcticum* in the skua's diet was found to be highly variable between years and seemed to be linked to the presence of small krill in the area. Reproductive success of the South Polar skuas increased in years when *P. antarcticum* was present in their diet. The proportion of myctophids in the diet appears to have increased since the late 1980s. Dr Croxall noted that myctophids form the main part of the diet of king penguins and that the number of king penguins in the Southern Ocean has doubled over the last decade. Otoliths of myctophids have been found consistently in scats of fur seals at Bird Island, South Georgia, since about 1990.

4.83 WG-EMM-96/31 presents results from six years of study of fish in the diet of blue-eyed shags, *Phalacrocorax atriceps*, at the South Shetland Islands. Results from 1995/96 were in close agreement with those presented to the Working Group in previous years. *Notothenia coriiceps* and *Harpagifer antarcticus*, which are the most abundant fish species in inshore waters, formed the bulk of the diet. *Gobionotothen gibberifrons* and *Notothenia rossii*, which were previously exploited in the area, comprised a low proportion of the diet with no apparent trend over the years.

Foraging

4.84 Foraging movements of dependent species were described in WG-EMM-96/12 and 96/69. Dr P. Trathan (UK) indicated that grey-headed albatrosses from South Georgia appeared to be targeting areas of high cephalopod abundance in the region of the Polar Frontal Zone to the north of South Georgia (WG-EMM-96/12). Dr Kerry reported that for six Adélie penguin colonies between 60°E and 140°E penguins feeding their chicks foraged between 100 and 120 km off shore (WG-EMM-96/69). This meant that for these birds along the Mawson coast there was potential for overlap with the fishery as shown by the location of fishery data given for squares of 30 n miles x 30 n miles. The overlap for colonies near Davis occurred only outside the chick-rearing period. At Casey and Dumont d'Urville the possibility of overlap has yet to be ascertained.

4.85 The foraging range of macaroni penguins from South Georgia was also examined from data on the at-sea distribution of macaroni penguins from ship observations during radial transects out from breeding colonies (WG-EMM-96/59). When weighted for the size of breeding colonies at South Georgia, this provided an estimate of the density distribution of breeding macaroni penguins foraging in the region of South Georgia.

4.86 Dr Trivelpiece noted that variability in the incubation shifts of Adélie penguins, described in WG-EMM-96/58, probably reflects variations in travel time to and from the food source rather than the quantity of food.

Population Dynamics

4.87 Dr Miller introduced WG-EMM-96/38 which examined trends in abundance and breeding success of macaroni and rockhopper penguins at Marion Island (Subarea 58.7). The Working Group welcomed the information contained in this paper. Although macaroni penguins at Marion Island eat few euphausiids, it is important that the Working Group should consider parallel data from other sites in the Southern Ocean. This provides a broader context for the interpretation of trends and anomalies at CEMP sites.

4.88 Dr Croxall described the long-term (20-year) patterns in breeding population size, breeding success and survival of black-browed albatrosses at Bird Island, South Georgia (SC-CAMLR-XV/BG/7). The study population decreased substantially in the late 1970s, recovered somewhat over the next decade and then declined significantly since 1988. Breeding success was significantly lower in the decade 1986–1996 than in the preceding decade, possibly reflecting more years of reduced krill availability in recent times. The early population decline coincided with notably low values of adult survival (1977–1979, 1981) which antedate any information suggesting incidental mortality associated with longline fisheries. Recent declines, however, involving both reduced adult survival and very low recruitment rates, are likely to be due primarily to incidental mortality.

4.89 Dr K. Shust (Russia) introduced WG-EMM-96/33 which describes counts of seals made at the Fildes Peninsula, King George Island. Five species of seals were observed. Elephant seals were the most abundant species. Monthly counts showed variation through the year in all species. Comparison between counts made during 1974, 1985 and 1996 showed little variation in the abundance of most species except Antarctic fur seals, which increased between 1985 and 1996.

4.90 WG-EMM-96/39 summarised CEMP activities of Chile at Cape Shirreff, South Shetland Islands. In addition to censuses of fur seals, which are dealt with in section 4, information was provided on numbers of elephant seals (536), Weddell seals (26), leopard seals (8), and crabeater seals (2) present in the area. Twenty-three penguin rookeries were recorded, with a total of 11 400 chinstrap and 294 gentoo penguin nests.

4.91 Shipboard marine mammal and seabird surveys have been conducted by Australia and Italy in the past year (WG-EMM-96/29 and 96/63). Dr M. Azzali (Italy) described the results of the Italian survey which was carried out within the pack-ice zone and used a 400-m-wide strip transect. The snow petrel was the most abundant species observed. Amongst the krill-dependent species, there was a positive association between krill density in the concurrent acoustic surveys and predator density, except for snow petrels, emperor penguins and South Polar skua, for which no correlation was observed. The Australian survey used the BIOMASS standard methods for seabirds and took place north of the sea-ice. Some of the practical problems of carrying out these observations on a ship which was also involved in oceanographic surveys were outlined, and preliminary analyses of the data were described. It was reported that passive acoustic methods for examining the distribution and abundance of odontocete whales had produced promising results.

4.92 The need for quantitative at-sea surveys of seabirds and marine mammals using standard methods was emphasised. New standard methodologies for seabirds and seals are being investigated for use in the Southern Ocean; Dr Croxall noted that a report on recent workshops on standardising quantitative seabird observations should be available soon and will be tabled at the next meeting of WG-EMM.

4.93 Mr Ichii presented WG-EMM-96/48 which provided the results of a survey of cetaceans in Division 48.4.1. The survey indicated spatial segregation of minke whales from humpback whales, and sperm whales from beaked whales. It was noted that the area covered by this study overlapped with that surveyed by Australia (WG-EMM-96/29). Moreover the Working Group recognised that the IWC-IDCR database could provide data useful to the Working Group for its ecosystem assessments.

ENVIRONMENT

Information Available

5.1 WG-EMM considered the comments of the Subgroup on Statistics relating to the monitoring of the environment (Appendix H). The development of two new indices was recommended by the subgroup following discussions at the WG-EMM meeting in Siena concerning the need to develop further indices (SC-CAMLR-XIV, Annex 4).

5.2 Use of the first of these indices, sea-surface temperature (SST), has been implemented by the Secretariat (WG-EMM-96/4). The second index recommended by the subgroup relates to the characterisation of current flow. During the Cape Town meeting (WG-Krill-94) the Working Group had considered aspects of krill flux and, although methods are being developed to examine this aspect, the work is still at an early stage. WG-EMM agreed that a practical index of current flow was important and needed to be developed.

5.3 The Working Group noted deliberations of the Subgroup on Statistics and its suggestions regarding various environmental indices (Appendix H, paragraphs 51 and 52). The outcome of WG-EMM's considerations of this matter can be found in paragraphs 6.35, 6.36, 7.40 and 7.41.

5.4 WG-EMM-96/13 reported on the development by the Secretariat, over the past year, of environmental monitoring indices. The main new development was the inclusion in the CCAMLR database of SST data obtained from the National Center for Atmospheric Research (NCAR) (USA).

5.5 These data are available at a spatial resolution of 1° latitude by 1° longitude (cells) with a temporal resolution of one month. The Secretariat identified those cells most closely adjacent to each CEMP site which were also ice-free during the summer period. The means for the three months from December to February were then calculated as an index of SST (WG-EMM-96/4).

5.6 WG-EMM agreed that inclusion of these data in the CCAMLR database was a useful development, although further consideration of an SST index would be possible only after interactions in the ecosystem had been studied.

5.7 WG-EMM reviewed the various indices of sea-ice which are included as part of CEMP (WG-EMM-96/4). The indices are: percentage ice cover, the date of sea-ice retreat past CEMP sites, the ice-free period, the distance from CEMP sites to the sea-ice edge and the number of weeks the ice is within 100 km of such sites. It was emphasised that these might not be the best indices for EMM purposes as they had been developed some time ago as part of CEMP.

5.8 General patterns of sub-decadal and regional variability in sea-ice indices were reported in papers presented at WG-EMM's meeting in Siena (WG-EMM-95/62 and 95/80).

5.9 Apparent correlations between sea-ice and SST indices were also indicated. Aspects of these links in the physical system were reported last year in WG-EMM-95/69 and 95/80. WG-EMM also acknowledged that there was a wider range of literature beyond the papers submitted to CCAMLR on aspects of the physical dynamics of the Southern Ocean.

5.10 It was suggested that some SST data did not fully accord with other analyses and that the index might not perform equally well in all areas. When selecting areas for deriving SST indices those where there may be rapid changes (e.g. at the frontal zones) or which include different water masses should be avoided. Values derived for areas close to the coast may also be less reliable. The Working Group requested members with relevant knowledge to examine the data and the areas from which they derive, and to recommend necessary adjustments and improvements.

Bathymetry

5.11 WG-EMM reiterated last year's conclusion regarding the value of detailed bathymetric data for an understanding of both ecological and fishery interactions. This was reiterated in WG-EMM-96/64, and there was some discussion on the interaction of water circulation with bottom topography and the contribution these factors make towards observed prey distributions. It was suggested that the compilation of detailed datasets in the same form as reported in WG-EMM-96/64 would be useful for other areas.

5.12 Dr E. Hofmann (USA) informed WG-EMM that high resolution bathymetric data were available for the west Antarctic Peninsula region and that such a dataset could be obtained from her. WG-EMM thanked Dr Hofmann for this offer.

5.13 Prof. Torres drew WG-EMM's attention to the fact that Chile had produced a bathymetric chart (No. 14301, 1994) on a scale of 1 : 50 000 for the sea area around the Cape Shirreff CEMP site and the San Telmo Islands.

Sea-ice

5.14 At its last meeting WG-EMM requested the Secretariat to prepare a document outlining the development of sea-ice indices in the Antarctic Peninsula region. The document had been prepared (WG-EMM-96/15). Members felt this paper gave a useful background to the sea-ice indices reported in WG-EMM-96/4.

5.15 Last year WG-EMM also considered the role of sea-ice in the ecosystem and recognised that this matter needed to be addressed intersessionally by a correspondence group (SC-CAMLR-XIV, paragraphs 6.48 and 6.49). Dr Miller, convener of this group, reported on developments over the past year. He noted that the group's major tasks were to identify key hypotheses, liaise with other programs and identify future requirements.

5.16 Dr Miller also informed WG-EMM that he had encountered problems, which probably resulted from the fact that the group's task was unclear, and required broader input from outside the group's membership. The Subgroup on Statistics suggestion of a workshop to develop relevant studies of the sea-ice offered a useful way forward.

5.17 The Working Group thanked Dr Miller for his efforts with the difficult task of addressing the issue of sea-ice characterisation. It was acknowledged that WG-EMM should consider other ways in which this could be achieved and the Working Group's discussions below should be viewed in this light.

5.18 Dr Trivelpiece informed the group of a conference on ice ecology, to be held in the USA in March 1997, which could provide useful background information. Developments within SCAR, particularly the EASIZ program, were also noted.

5.19 A more detailed discussion of the development of sea-ice indices followed. Dr Hewitt presented data on the areal extent and duration of sea-ice cover for the west Antarctic Peninsula region (WG-EMM-96/24). The data were derived from the same dataset as that used in the calculation of the CEMP indices (WG-EMM-96/4).

5.20 The analyses used pixel data (25 x 25 km resolution) to describe the presence or absence of sea-ice cover greater than 15% by area. This was displayed for each month as a function of a year. Following some discussion concerning the size and geographical coordinates of the box from which the information was derived, as well as the local oceanography and bottom topography, WG-EMM considered the approach to be a useful development which attempted to characterise sea-ice variation. The derived data encompass some of the aspects of ice variability which are likely to be most important in krill recruitment processes.

5.21 Four periods of extensive ice cover over the last 17 years are evident in the dataset. The first of these periods was centred on August 1980 with a relatively short seasonal duration. The second was centered on August–September 1986 and was extended over more months (within the year) and between years (e.g. in 1987 extensive ice cover peaked in July–August). The third ice event was centered on June–July 1991 and was more extensive between years than within the year. The fourth appears to be centered on August 1995 and looks as if it will be extensive both within the year and between years.

5.22 It was again noted that the above data reflect the larger-scale and/or longer-term processes generating variability in the sea-ice field reported in WG-EMM-95/69 and 95/80 submitted last year.

Circulation

5.23 WG-EMM-95/29 presented information on environmental aspects of an integrated study of the physical and biological components of an area off the coast of east Antarctica (Division 58.4.1) during 1996. Further analyses of data would be presented at later meetings of WG-EMM. It was noted that the direction of flow in open-ocean areas followed the general pattern expected in the West Wind Drift (WWD), whereas it was much more confused in the coastal regions. This has implications for the retention of organisms within an area. These results also emphasised the value of including other types of plankton, such as phytoplankton and salps, when attempting to understand processes determining krill distribution. WG-EMM acknowledged the importance of such integrated oceanographic and biological study programs and looked forward to the presentation of results of such analyses in the near future.

5.24 Links between atmospheric circulation patterns and hydrographic conditions in the WSC were considered in WG-EMM-96/35. The paper emphasised the complexity of the surface flow patterns in the region and indicated that the position of the WSC varies and that these variations are linked to atmospheric conditions. The hydrographic data on which the analyses were based were presented in WG-EMM-96/36. WG-EMM noted that processes generating oceanographic variability are likely to be of major importance in the marine ecosystem. Understanding the spatial and temporal scale of associated fluctuations in the regime of the physical environment is therefore crucial.

5.25 Data on current flow and krill distribution were presented and the question of krill flux in an area near the South Orkney Islands was addressed (WG-EMM-96/37). The Working Group had requested this type of study at earlier meetings. It considered this to be a very valuable study and noted the results with interest. Further development of such studies was encouraged as a matter of priority.

5.26 WG-EMM-96/12 reported results from an integrated physical and biological study. This work involved the use of satellite-tracked predators to identify general areas where predators were foraging. Oceanographic work along with remotely sensed SST data were then used to characterise regional oceanography. The importance of interactions between the water circulation and bottom topography in generating mesoscale oceanographic patterns was emphasised.

5.27 WG-EMM-96/61 presented preliminary results from a regional circulation model for the Antarctic Peninsula region and the southwest Atlantic. The model has been developed to address questions of transport and residence times of krill in the areas considered by the 1994 Workshop on Evaluating Krill Flux Factors (SC-CAMLR-XIII, Annex 5, Appendix D). Higher resolution models are being developed for the Western Antarctic Peninsula region and South Georgia. The initial results indicate that the area is characterised by extensive gyres with a spatial scale of about 200 km. The implications of this finding were in accordance with existing perceptions of the area's ocean dynamics topography.

General

5.28 WG-EMM-96/21 considered long-term changes in the climate and their implications on the marine food web in the Antarctic Peninsula area. The authors cite several studies which demonstrate a trend of increasing temperature and decreasing frequency of winters with extensive ice cover. They also note the correlation between winters of low ice cover and the occurrence of a population bloom of *Salpa thompsoni* during the following spring.

5.29 The authors estimate that a salp bloom could consume a substantial portion of primary production during the spring and thereby deprive adult krill of sufficient food to support their energy requirements. This would delay the maturation of adult krill, leading to poor spawning, and resulting in a weak year class.

5.30 A decrease in the frequency of strong krill year classes would result in lower average krill abundance and a reduction in the food available to obligate krill consumers. The reduction in juvenile survival and in population size of Adélie penguins were noted as supporting evidence.

5.31 Carbon cycle effects would also be expected: during years of good krill recruitment and elevated population size, a relatively large proportion of the primary production passes through krill to vertebrate predators, and is also transported to the sediments via dense, resilient fecal pellets. During years of salp blooms, less newly-fixed carbon will pass through the krill-based food web, and more will be transported into the microbial loop via relatively delicate salp fecal pellets.

5.32 It was emphasised that there is considerable information of direct relevance to understanding the observed characteristics of the physical environment being produced outside WG-EMM.

5.33 WG-EMM-96/60 raised the possibility of combining environmentally-based and fishery-based models, building on principles from agriculture and forestry. In discussion, it was recognised that a range of approaches would be useful in developing ecosystem assessments. Such an exercise would provide a useful feedback into the development of more detailed fishery models. It would also be a useful check of the validity of such models. WG-EMM encouraged the development of a range of modelling approaches to problems encountered in monitoring and managing the ecosystem.

5.34 WG-EMM-96/68 detailed a size-structured model for krill growth. The model utilised a physiological basis for growth allied to seasonal changes in food supply. The results indicated the need of krill to encounter food during winter. Sea-ice algae or microzooplankton are required during winter to maintain observed growth rates. WG-EMM agreed that the study reiterated the value of a range of modelling approaches which would help as a way of clarifying key environmental variables and the relevant time scales for monitoring.

5.35 It was noted a number of times, in discussion of the environmental variables, that the Working Group does not have a large group of people experienced in analyses of the physical components of the ecosystem. It was agreed that it would not be useful to try and increase too much the participation of such people. However, it was acknowledged that it was extremely valuable to have the input of physical oceanographers in particular.

5.36 Various mechanisms for ensuring the appropriate level of input of views on the physical environment into the Working Group were discussed. It was suggested that members ensure that intersessionally they communicate as much as possible with scientists engaged in more physical aspects of Southern Ocean research. This would help to identify key aspects of the physical environment and ensure that new developments were brought to the notice of WG-EMM. This is particularly important as the Working Group begins to consider links between environmental and biological components of the ecosystem, consistent with its philosophical approach as identified in 1995.

5.37 WG-EMM agreed that a small e-mail correspondence group should be formed in order to improve dissemination of literature on the physical aspects of the Antarctic marine environment.

5.38 Last year WG-EMM was notified of the forthcoming SCAR-COMNAP meetings on environmental monitoring (October 1995 and March 1996). Dr P. Penhale (USA) presented a paper (WG-EMM-96/62) summarising the developments of the meetings. The key points raised were noted by the Working Group and it was suggested that CCAMLR should continue to be kept informed of developments in this area.

5.39 Dr Kock notified the Working Group of a forthcoming meeting on the Southern Ocean organised by the IOC. Dr Kock would be attending this meeting in his capacity as Chairman of the Scientific Committee.

ECOSYSTEM ANALYSIS

By-catch of Fish in the Krill Fishery

6.1 Japanese scientists continued their investigations on the by-catch of fish in the Japanese krill fishery in the vicinity of the South Shetland Islands in February–March 1996. WG-EMM-96/52 provided preliminary information on the species composition and the amount of by-catch taken by the trawler *Chiyo Maru No. 3*. Onboard sampling and the presentation of results closely followed the standardised procedures agreed on by the Scientific Committee. Fish were encountered in 41 out of 147 hauls observed. Juveniles of notothenioid fish were primarily found in hauls carried out over the shelf, while mesopelagic species occurred only in tows over the shelf break and in oceanic waters. *Lepidonotothen larseni*[2] was the most abundant notothenioid, and *Electrona carlsbergi* the mesopelagic species most frequently encountered in the by-catch. The by-catch of fish tended to be highest when the krill CPUE was small.

6.2 The Working Group welcomed the continuing efforts of Japanese scientists to provide information on the by-catch of juvenile fish in the krill fishery. The Working Group suggested that this data should be augmented by length compositions of the most abundant species and then incorporated into the comprehensive review of the by-catch of fish in the krill fishery which is currently being undertaken by a group of specialists in this field and coordinated by the Science Officer, Dr E. Sabourenkov. An interim report on the status of this review will be submitted to the meeting of WG-FSA in October 1996. Prof. Torres informed the Working Group that Chile will provide information in the near future on the by-catch of fish in its krill fishery from 1991 to 1994.

6.3 The Working Group noted that most of the by-catch studies have been conducted during the austral summer. It reiterated requests from previous years to extend these studies to other seasons to cover spatial and seasonal differences in the occurrence of fish in krill catches, in order to better assess when fish are most vulnerable to the krill fishery. Mr Ichii suggested that stomach contents of fish taken incidentally in the krill fishery should be analysed more often in order to obtain a better understanding on the association of juvenile fish with krill aggregations.

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[2] Formerly known as *Nototheniops larseni*

Harvested Species and the Environment

6.4 To focus discussion, the Working Group considered the scales over which changes in krill standing stock or recruitment were observed and the implications of this on the degree of isolation and of advection between areas.

6.5 There was evidence that in the 1995/96 season strong krill recruitment had occurred in both Subareas 48.1 (WG-EMM-96/23) and 48.3 (WG-EMM-96/18), suggesting that factors affecting recruitment in this year had been similar across the southwest Atlantic sector of the Southern Ocean.

6.6 However, results from a large-scale survey in Area 58 (WG-EMM-96/29) showed only average recruitment in contrast to the high values observed in Subarea 48.1, indicating that changes were not occurring synchronously throughout the Southern Ocean.

6.7 Considering variation at smaller scales, the Working Group was reminded of two datasets presented to WG-EMM-95. Great variation in penguin chick survival at Béchervaise Island (WG-EMM-95/33) illustrated that local krill availability can vary widely from year to year. Data on krill recruitment estimated from penguin diet samples at Palmer Station (Anvers Island) and King George Island (WG-EMM-95/64) showed that the indications of strong recruitment at the two locations were one year out of phase.

6.8 Indices for distribution, abundance and depth of krill were derived from data collected during the US AMLR surveys off Elephant Island between 1990 and 1996 (WG-EMM-96/22). It was pointed out that the variation of these indices within the restricted foraging range of penguins was less than that occurring in the main survey area. Thus it appeared that krill aggregations may be reliably found in some areas. In addition, it was suggested that these areas may act as foci from which krill distributions extend outward in years of high krill abundance.

6.9 Summarising these discussions, the Working Group recognised that it was important:

(i) to establish the degree of linkage between major concentrations of krill;

(ii) to determine the size of areas in which similar variation takes place; and

(iii) to establish to what extent variation could be explained by changes in krill production within the area as opposed to movement of krill from area to area.

Furthermore, the implications of these points with respect to the size of management areas used by CCAMLR should be considered.

6.10 The Working Group discussed in some detail the estimates of krill recruitment proportion in Subarea 48.1 and the links between this and the extent of winter sea-ice.

6.11 At the previous meeting of the Working Group, WG-EMM-95/64 showed that the krill population structure derived from krill length frequencies taken from penguin diet samples at Palmer Station (Anvers Island) was different from that at Admiralty Bay (King George Island). These differences had been linked to a one-year time lag in pack-ice cycles between the areas.

6.12 During discussion it became apparent that the relationship between these factors was more complex than previously thought.

6.13 Oceanographic conditions at Palmer Station, at the western end of the Antarctic Peninsula, were likely to reflect those in the Bellingshausen Sea. However, while it was likely that the southern side of the Bransfield Strait would reflect Weddell Sea characteristics, the northern side of the Bransfield Strait could reflect Drake Passage and possibly even Bellingshausen Sea characteristics. Thus the same krill population structure might be expected from the study sites at Anvers Island and Admiralty Bay.

6.14 The effect of sea-ice on the biology of krill was also seen as complex. In 1995 there was extensive winter ice cover, large numbers of 1+ krill, good recruitment – one of the highest values for the proportions of recruits recorded over 18 years – and few salps (WG-EMM-96/21). Depending on the ice conditions in the 1996 winter, another strong year class is expected to emerge from spawning during the 1995/96 season.

6.15 During the winter of 1994 there was above-average extent of ice, and low krill and salp abundances during the summer of 1994/95 (WG-EMM-96/21). Low krill abundance was attributed to poor krill recruitment from spawning during 1992/93 and 1993/94. The lack of a salp bloom was attributed to above-average ice cover during the winter of 1994.

6.16 An analysis of these phenomena has been prepared by Siegel and Loeb (1995) who proposed that increased ice cover may act in two ways. First, it may enhance feeding of the adult population during winter and inhibit a spring salp bloom. This results in early spawning for the krill and successful recruitment. Second, greater ice cover improves the chances of survival of the larvae through the winter after spawning.

6.17 Dr S. Kawaguchi (Japan) considered, however, that if ice cover acts in these two ways, there should be more years with a high proportion of recruits than were observed in the scientific net surveys. Some evidence of a high proportion of recruits was observed from the fishery data when this was to be expected but was not detected in the scientific surveys. This evidence suggests that there may be a high possibility of underestimation of the proportion of krill recruits.

6.18 Some members cautioned that it is difficult to interpret proportions of recruits from commercial catches because these do not represent random samples from the population.

6.19 The Working Group noted that while the exact link between sea-ice and krill recruitment was not simple, it was suggested that the present relationship had some predictive power and that this should be explored further.

6.20 The recruitment indices available to the Working Group at present are estimates of proportional recruitment and thus have a number of restrictions. For instance, in a year of low stock abundance even low levels of absolute recruitment may appear as a high proportional value.

6.21 The Working Group recognised the importance of deriving an absolute recruitment index as the next step. However, it was also pointed out that even at the present level of development, recruitment indices derived from research cruises, the fishery and predators, together with ice indices, have considerable utility for both explanation and prediction of variations in the ecosystem.

6.22 The Working Group also recognised that while a medium-term goal of WG-EMM was to understand the underlying process of variation, in the short term the implications of the large variation in the values of proportional recruitment for the krill yield model were very important.

6.23 The present krill yield model is based on the assumption that the krill stock varies around a median level with no trend in recruitment. Bearing in mind the considerable effort put into investigating the links between climate change and sea-ice, and between ice cover and krill recruitment, it is possible that a long-term change in krill biomass and recruitment might be confirmed. The Working Group recognised that further development of the model may be required to take account of such changes (see Appendix F).

6.24 Finally, the Working Group noted that, while the environment affects krill growth and mortality, in the model such environmental effects are assumed to be absent. This question should be considered in the future, for instance using the approach described in WG-EMM-96/68.

Harvested Species and the Krill Fishery

6.25 A compilation of information on the location of the commercial krill fishery in Area 48 (WG-EMM-96/64) confirmed that key locations were fished regularly from year to year. Many of these key locations (particularly in Subareas 48.1, 48.3 and west of the South Orkneys in Subarea 48.2) were related to the position of shelf breaks or current gyres. Other fishing sites in Subarea 48.2 were more variable and were more likely to be related to the position of the ice edge or position of the current fields prevailing at that time.

6.26 In Area 58 the longitudinal position of the fishery was much more variable but it still tended to occur in the shelf break/slope region (WG-EMM-96/28).

6.27 WG-EMM-95/69 presented at the last meeting of WG-EMM, considered links between CPUE data from the Russian fishery in Subarea 48.3 and environmental parameters. Dr Murphy indicated that further analysis of these data had been undertaken and that the relationship between CPUE and SST was more complex than described in WG-EMM-95/69.

6.28 He also pointed out that, since searching time was very short in this particular fishery, the krill CPUE index based on towing time (WG-EMM-95/69) could provide an index of local density.

6.29 Attention was drawn to WG-EMM-96/4, in which the relationship between Japanese krill catches in tonnes/hour in Subarea 48.1 (index H1) and the percentage ice cover in the same subarea (index F2a) showed some agreement, with poor CPUE and low ice cover occurring in 1985, 1990 and 1993.

Interactions between Ecosystem Components

Dependent Species and the Environment

6.30 Some discussion on this topic took place during the Working Group's earlier reviews of harvested species, dependent species and the environment. Much of this discussion related to the potential interactions between ice cover, productivity and survival of prey and consequent effects on productivity and survival of predator populations (see paragraphs 3.53 to 3.57; also SC-CAMLR-XIV, Annex 4, paragraph 5.119, 6.22 to 6.32, 6.44 and 6.45).

6.31 Dr Trathan noted that the investigation reported in WG-EMM-96/10 was stimulated by the suggestions of Fraser et al. (1992) that sea-ice cover profoundly influenced penguin populations, and that recent declines in sea-ice cover in the Antarctic Peninsula region would be predicted to have opposite effects on Adélie and chinstrap penguin populations (based on the very different affinity of these two species for sea-ice habitat). No long-term trends were evident in the data on local sea-ice conditions at Signy Island, South Orkney Islands, 1947 to 1992 or on regional sea-ice conditions in this area from 1973 to 1988, although there were pronounced quasi-periodic fluctuations. However, this may simply reflect differences between the western Antarctic Peninsula, influenced mainly by Bellingshausen Sea conditions, and the South Orkney Islands, influenced mainly by Weddell Sea conditions. At Signy Island, predator population size and breeding performance, monitored annually since 1979, showed no correlation with local ice conditions. However, with regional sea-ice conditions there were relationships between winter sea-ice at a time (different for each penguin species) just before its maximum extent and subsequent penguin breeding population size.

6.32 Dr Trivelpiece reported that WG-EMM-96/58 indicated that almost all aspects of Adélie penguin biology are influenced by environmental variability at one scale or another. The results also indicated that the absence of breeding Adélie penguins along 500 km of coastline in the central Antarctic Peninsula region reflects the need for breeding birds to replenish body reserves in the early spring post-laying period by returning to predictable sea-ice habitat. Birds breeding at colonies in the southern Antarctic Peninsula can reach appropriate sea-ice areas in the Bellingshausen Sea. Breeders from northern colonies can travel to appropriate areas in the Weddell Sea. However, in between these areas distances to sea-ice may be too great for viable breeding populations to persist. The gap in Adélie penguin distribution is filled by abundant breeding populations of chinstrap penguins, a species which does not require access to sea-ice. The presence of submarine canyons which create sufficient upwelling of warm Circumpolar Deep Water (CDW) to provide open-water conditions earlier in the breeding season may have provided conditions favouring the establishment of large Adélie penguin colonies adjacent to these canyon areas.

6.33 Dr Kerry reported that both fledglings and post-moult adults leave the breeding colony at Béchervaise Island (67°S 63°E) in late February and March and overwinter at least until June in the pack-ice zone in close proximity to the continental shelf break. During this period they move progressively westward at approximately the speed of the sea-ice. Precise locations compared with sea-ice conditions derived from AVHRR satellite data show that they have access to the sea through leads or broken pack-ice (Kerry et al., 1995).

6.34 The sea-ice zone is also a key habitat for emperor penguins; results of satellite-tracking work emphasise the dependence of breeding birds on access to polynyas for breeding (Ancel et al., 1992). Post-fledging chicks, however, may cover large distances, travelling outside the sea-ice zone nearly as far north as the Polar Frontal Zone (Kooyman et al., 1996). Dr Kerry reported that Kirkwood and Robertson (in press) found through satellite tracking, dive analysis and stomach sampling that in the winter and spring of 1993 and 1994 emperor penguins feeding chicks at Auster rookery foraged in a polynya over the continental shelf and in a polynya at the junction between the fast-ice and pack-ice. Females in winter fed along the continental slope and males in spring fed in waters over a canyon that runs across the continental shelf and forms a polynya. Both sexes fed on *E. superba*, which constituted between 51 and 70% of the diet by mass. This evidence suggests that krill may be abundant in winter and early spring in waters over the shelf slope and in canyons on the continental shelf.

6.35 The report of the Subgroup on Statistics (Appendix H, paragraphs 51 and 52) noted that, although data relating to sea-ice as viewed from CEMP sites and local weather conditions and snow cover are defined in CEMP standard methods (F1, F3, F4), no data are currently being submitted and therefore no indices can be calculated. WG-EMM encouraged Members collecting these data to prepare standardised formats for data submission and to suggest how appropriate indices might be calculated.

6.36 The Working Group noted that methods for calculating indices of sea-ice (number of ice-free days and distance from CEMP sites to sea-ice edge) had already been implemented and that preliminary analyses of SST data were also available. Of the other environmental indices listed in Appendix H, paragraph 52, only for water flux had no progress been made in developing a standard method.

Dependent Species and Harvested Species

Diet, Energy Budgets and Foraging Ranges of Birds and Marine Mammals

6.37 The Working Group has made a standing request to Members to monitor and update annually data on diet, energy budgets and foraging ranges of birds and marine mammals in the Convention Area (SC-CAMLR-XIV, Annex 4, paragraph 5.101).

Diet

6.38 WG-EMM-96/11, 96/31 and 96/32 provide information on the quantitative composition of fish diets of black-browed and grey-headed albatrosses at South Georgia, and blue-eyed shags and South Polar skuas at the South Shetland Islands. WG-EMM-96/17 and 96/44 provide details of the diet of Cape petrels at the South Shetland and South Orkney Islands, showing that in 1995/96, although krill predominated in their diet, myctophids were also common.

6.39 WG-EMM-96/8 and 96/9 were primarily intended to address questions of krill selectivity by predators and the difference in selectivity between predators and research nets. However, these papers also contain considerable information on the size, sex and reproductive status of krill (and on the overall proportions of krill in the diet) taken by a range of top predators at South Georgia in 1986.

Energy Budgets

6.40 New data relevant to population energy budgets are contained in WG-EMM-96/7 (at-sea energy expenditure of Antarctic fur seals), and WG-EMM-96/66 (overall energy budgets of macaroni penguins and Antarctic fur seals at South Georgia).

6.41 WG-EMM-96/19 summarises data relevant to the calculation of energy budgets and food requirements of Southern Ocean krill predators. This was welcomed as a most timely and comprehensive document. Authors of early CCAMLR compilations on this topic (e.g. Croll, 1990 (WG-CEMP-90/30 Rev. 1); Croxall, 1990, 1991 (WG-CEMP-90/31, 91/37), Bengtson et al., 1992 (WG-CEMP-92/25)) and others familiar with this field were urged to review WG-EMM-96/19 in order to contribute additional information and to identify any errors or anomalies.

Foraging Ranges

6.42 New data on foraging ranges of top predators are provided in WG-EMM-96/12 (grey-headed albatrosses at South Georgia), WG-EMM-96/49 (chinstrap penguins at Seal Island), WG-EMM-96/58 (Adélie penguins in the Antarctic Peninsula region), WG-EMM-96/59 (macaroni penguins at South Georgia) and WG-EMM-96/69 (Adélie penguins along the coast of eastern Antarctica).

Interactions between Dependent Species and their Prey

6.43 Mr Ichii presented two papers (WG-EMM-96/49 and 96/55) which provide additional analyses of aspects of the data collected at and near Seal Island in 1994/95 (see SC-CAMLR-XIV, Annex 4, paragraphs 5.98 and 5.99). This study assessed krill and myctophid abundance (from acoustic surveys) in relation to diet and foraging of chinstrap penguins. Krill densities were higher over shelf areas (i.e. near shore) where myctophids were scarce or absent, but lower offshore, where myctophids were more common. Krill in offshore areas tended to occur in layers and were larger, more advanced in maturity stage and included gravid females (possibly more easily caught by predators); in inshore areas krill tended to occur in dense and discrete swarms and were smaller, less advanced in maturity stage and contained a greater proportion of males. Chinstrap penguins foraged in two distinct modes: birds making daytime (and shorter) trips foraging inshore, while those making longer trips (including overnight periods) foraged offshore. It was suggested that the advantages of foraging offshore – in an area of reduced overall krill abundance – included less patchy krill distribution, larger and easier-to-catch krill and the presence of myctophids.

6.44 Japanese and US researchers were commended for collecting such a range of valuable data and combining them into an interesting and informative summary. There were considerable discussions in regard to the analysis and interpretation of the data.

(i) The actual locations where penguins were feeding were apparently unknown except for a small number (7) of birds actually tracked while at sea; assignment of study birds to inshore/offshore categories was presumably therefore only made on the basis of the type of foraging trip undertaken.

(ii) The assignment of birds whose diet was sampled to daytime and overnight foraging categories appeared to be inferred from the time of return of birds without knowledge of their departure times.

(iii) Because birds foraging overnight also had the opportunity to forage in the daytime, the location where specific prey were captured had to be inferred. It would also be valuable to know the reproductive success of birds making daytime trips compared to those making overnight trips.

(iv) If the birds studied included both individuals of a pair during the brood-guard period, then the timing of return of one bird automatically determined the departure time of its partner; there were potential biases from this source in respect of departure time and also in respect of the sex of the birds.

(v) Dr Kim noted that the oceanographic studies in the Elephant Island area in 1994/95 (see SC-CAMLR-XIV, Annex 4, Appendix I) indicated that the ocean frontal zone north of Elephant Island moved south by 15 n miles during the course of the study. This could account for some differences in krill size as well as foraging distance of penguins between the two study periods (leg 1 and leg 2), described in WG-EMM-96/49.

(vi) The few diet samples taken in 1994/95 showed a very small proportion of myctophids. For the five years of samples (1988–90, 1991, 1994) the data submitted to CEMP suggested that only in 1994 did myctophids contribute more than 1% of the overall diet by mass (WG-EMM-96/4). Using a different method, the results of analysis of Mr Ichii's data indicate that the proportion by mass of myctophids ranged from 14–41% for overnight foragers (0–1% for daytime ones). However, Dr Croxall suggested that although myctophids may occur regularly in the diet of overnight (but not daytime) foraging birds from Seal Island, they appear to make a substantial contribution only in years when krill is scarce.

6.45 Dr Croxall introduced WG-EMM-96/7, which examined at-sea energy expenditure in relation to diving activity of Antarctic fur seals at South Georgia in 1992 and 1993. The results show a negative relationship between energy expenditure and several measures of diving activity, i.e. the more that an animal dived, the less energy it expended. Although the authors had expected a positive relationship, this finding suggests that most energy expenditure at sea may be associated with surface swimming, e.g. searching for krill swarms, and that those animals which spend the greatest proportion of their time diving are those that are most successful at finding swarms. It may well be that travelling, rather than feeding, is the expensive part of a foraging trip. The study also showed that there was no relationship between foraging efficiency and foraging trip duration; i.e. those animals with shorter-than-average foraging trips did not forage more efficiently than those with longer-than-average trips. However, it was stressed that this study was carried out in years of normal krill abundance and that the results might well be different in years with reduced krill availability.

6.46 In introducing WG-EMM-96/66, Dr Croxall noted that although it had been prepared in response to requests relating to the calculation of precautionary catch limits in Subarea 48.3 (see SC-CAMLR-XIV, Annex 4, Appendix H), it summarised extensive data relating to predator-prey interactions for the two most important top predators of krill in this subarea. The population energy budget provided includes information based on activity-specific energetics, in relation to age, sex and stage of life and reproductive cycle, estimates of population age structure for each sex and calculation of food intake in respect to, *inter alia*, each size class of krill.

Modelling Relations between Dependent Species and Prey

6.47 Dr Mangel introduced WG-EMM-96/20, which described the development of the first model to investigate the effects of fisheries on krill predators which considered processes at the level of a key interaction (foraging trip), rather than at the level of population effects.

6.48 The main components of the model are descriptions of:

(i) the spatial and temporal patterns of krill;

(ii) the mode of operation of the fishery (in a season lasting 100 days and operating within 200 km of the shore) and its effects on krill;

(iii) the foraging performance (determined by explicit decision rules) and survival of a model predator (here the Adélie penguin) throughout each of the five stages of its breeding season, incorporating a detailed empirical energy budget for chick-rearing; and

(iv) the effect of the removal of krill by the fishery on Adélie penguin reproductive success and adult survival.

The main aim of the model was to compare penguin reproductive success (chick survival) and adult survival in the absence and presence of a fishery.

6.49 In the model:

(i) krill biomass potentially available to predators and the fishery fluctuates in accordance with an age-structured stochastic recruitment model which generates the long-term frequency distribution of krill biomass (Butterworth et al., 1994);

(ii) fishing (conducted according to rules on minimum local biomass for starting and stopping fishing, daily and seasonal catch limits, etc.) is assumed to change the spatio-temporal structure (determined by diffusion and advection) of the krill available to predators foraging from their breeding site;

(iii) offspring survival depends on the cumulative amount of krill delivered, such that when the deficit exceeds 40% of the requirements for rearing a healthy chick, the chick dies; and

(iv) parental survival is influenced by the time it needs to spend at sea to accumulate krill to meet its own needs (during incubation) and also those of its offspring (during chick rearing).

6.50 The results of tracking accumulated food deficits of parents and offspring and accumulated adult mortality while foraging, in situations with and without fishing, are expressed as relative reproductive success and relative parental survival. The values derived from the present model indicate that:

(i) reproductive success (i.e. chick survival) declines in linear fashion with respect to krill catches by the fishery at an overall rate 50% greater than the rate at which krill is removed by fishing; and

(ii) relative parental survival is also a linear function of krill catches but with an overall slope of 0.65, i.e. parental survival declines at a rate 35% less than that at which krill are caught by the fishery.

6.51 The Working Group felt that this model has great potential for investigating interactions between predators, prey and fishery at the scales of greatest interest and concern to CCAMLR. The success of the model in reflecting biologically realistic trade-offs between adult and offspring survival was also noted.

6.52 Questions were raised about the model and its performance, concerning the:

(i) robustness of the model, given that the equations for reproductive success are based on a large number of parameters and assumptions;

(ii) likelihood that different distributions of krill could change the results substantially;

(iii) conservative nature of the assumption that the fishery proceeds to exploit krill from behind the direction of advection whereas predators operate from the opposite direction;

(iv) effect of using different types of fishing tactics (e.g. different options for different parts of the fleet, lie-in-wait tactics etc.); and

(v) degree of independence between the density-dependent responses relating to krill density/food availability and decreased survival with time at sea.

6.53 In response Dr Mangel stated that:

(i) the sensitivity analysis described in the paper indicates considerable robustness, particularly to the lesser-known parameters;

(ii) the model could be adapted for different krill distributions;

(iii) the fishery could proceed across the 'midpoint' peak of the krill distribution so the model was not entirely conservative in this respect;

(iv) other types of fishing tactics could fairly readily be incorporated; and

(v) the responses of the two factors are not independent but interact (i.e. there is a deficit-mortality interaction).

6.54 In response to questions concerning further development of the model, Dr Mangel noted that using observed krill densities would be productive and that further work on the nature and magnitude of differences between adult and offspring survival would be desirable.

6.55 The Working Group noted that the implications of this approach and its initial results would be of particular relevance to ecosystem assessment issues.

6.56 Dr Butterworth summarised the background to modelling functional relationships between predators and prey leading to the development of initial models for Antarctic fur seal, black-browed albatross and Adélie penguin. At last year's meeting (SC-CAMLR-XIV, Annex 4, paragraphs 5.104 to 5.113) problems that had been encountered in developing these models were discussed; agreement on how to proceed with the models was summarised in SC-CAMLR-XIV, Annex 4, Appendix F.

6.57 These models relate distributions of survival rate estimates to distributions of krill biomasses as predicted by the krill yield model, through functional relationships. To fit the data, it is necessary to relate the survival rate distributions to krill 'availability' rather than krill biomass, where the 'availability' in any one year is obtained by multiplying the biomass output of the krill yield model by a lognormally distributed random error term.

6.58 Progress had been made intersessionally on the models for Antarctic fur seals and black-browed albatrosses (WG-EMM-96/67). For Antarctic fur seals, using the revised procedure for correcting adult survival rates, the model indicated that the resilience of the Antarctic fur seal population at South Georgia to krill harvesting is strongly dependent on the estimate of the maximum annual growth rate (R) which the population can achieve. For R = 10% (the rate currently prevailing at South Georgia) a krill harvesting intensity rate (γ_{half}) of slightly more than 0.1 would be needed to reduce the seal population to half its pre-exploitation level. It was noted that this value of γ_{half} is close to $\gamma = 0.116$ as evaluated from the krill yield model to correspond to a median krill escapement of 75% of the level without fishing, the criterion currently used in respect of precautionary catch limits for the krill fishery. Further work may need to address the consequences of estimation imprecision and model uncertainty on the estimate of γ_{half} and the effect of density dependence on adult survival of fur seals.

6.59 For black-browed albatrosses the data are derived from a population declining (at least partly due to longline fishery-induced incidental mortality) from an undisturbed maximum to an average level of depletion taken to be 0.85 of the undisturbed level. The extent of the resilience of this species to krill harvesting will greatly depend on the value of β, a scaling parameter related to the effect of density dependence on survival. If β is as low as 0.55, then the albatross population becomes extinct; at higher values of β, population stabilisation would be possible under the present level of fishery-induced mortality. To resolve this problem, estimates of survival rates for black-browed albatrosses in the absence of fishery-induced mortality are needed.

6.60 Dr Croxall indicated that estimates of survival rates of adult black-browed albatrosses in the absence of fishery-induced mortality could be obtained by selecting from the data (a revised version of which is provided in SC-CAMLR-XV/BG/7) the values for 1976 to 1989 inclusive. These are from the period before there was evidence of any effect of incidental mortality on adult black-browed albatrosses. It was agreed to conduct this re-analysis intersessionally. Dr Kirkwood enquired whether the model would be improved by the use of *priors* in a Bayesian analysis and noted that density dependence is assumed to operate linearly; other assumptions (e.g. a power model) might produce different results. It was agreed that the sensitivity of the model to different functional forms for the density-dependent term should be checked.

6.61 Further work recommended on krill-predator modelling studies is detailed in Appendix F.

Fisheries and Dependent Species Overlap

6.62 For a number of years the Secretariat has been calculating the critical period-distance (CPD) index, the catch in the critical period-distance (100 km from land-based predator colonies over the December–March period of the breeding season). Last year WG-EMM requested that the Subgroup on Statistics re-examine critically the CPD index and the conceptual framework upon which it was based (SC-CAMLR-XIV, Annex 4, paragraphs 5.92 to 5.96).

6.63 In its report (Appendix H) the subgroup noted that problems associated with the overlap concept may have been due to the several different scales involved. It identified four general levels at which the analysis of niche overlap may be considered, as follows:

(i) precautionary overlap;
(ii) potential overlap;
(iii) realised overlap; and
(iv) dynamic overlap.

6.64 These were described in more detail in the subgroup report (Appendix H, paragraph 37 and Table 3).

6.65 The subgroup suggested that in order to make refinements in the existing CPD calculations of potential overlap, it required additional data on monthly estimates of diet composition and on maximum and modal foraging range, by colony locations, in areas of fishing operations. Development of the realised overlap index should proceed in parallel with development of the potential overlap index as it is perceived as a refinement of the latter.

6.66 The subgroup noted that the dynamic overlap analysis was potentially very appropriate for modelling fishery-predator interactions but information required for this approach is substantial and may not be currently available at the scales required.

6.67 The Working Group thanked the Subgroup on Statistics for this valuable contribution.

6.68 The results of the calculation of overlap indices were presented by Dr Agnew (WG-EMM-96/4). This paper includes both the potential and realised overlaps, the latter incorporating a modification suggested by Dr K. Hiramatsu (Japan) (see Table 3).

6.69 Indices 1 and 3 increased from 1985 to 1989, and have been declining since that time. Indices 2 and 4 have been declining since 1986. The Working Group agreed that each index provided different information. The fishery has been steadily reducing the amount of spatial congruence with predator foraging. In absolute terms, the amount of overlap with predators was greatest at a time when catches in Subarea 48.1 were high in the late 1980s. The recent decline in all indices has resulted from the fishery shifting to the autumn and winter months in Subarea 48.1 for operational reasons (see paragraph 2.5).

6.70 Mr Ichii indicated that CPD is a product of the past when there was uncertainty about the overlap between the fishery and predators. This index takes no account of the size and distribution of colonies, nor of the distance of the fishery from colonies of different sites, and therefore is not only inappropriate in terms of the theory of ecological niche overlap, but also distinctly overestimates the overlap between the fishery and predators. Now that the extent of overlap has been found to be less than expected (Agnew, 1995), the CPD index should be dropped in favour of calculating the realised overlap (Agnew and Phegan, 1995). The realised index incorporates the above information and should indicate more realistic and reasonable overlaps.

6.71 Dr Croxall responded by noting that discussion of the nature, extent and potential consequences of overlap between the krill fishery and dependent predators had a long history in the Scientific Committee and its working groups. Almost all aspects relevant to the assessment of this interaction have been debated at length previously[3] and there had been various attempts to suggest that the fishery and predators took krill of different sizes, that they exploited krill at different depths and, latterly, that overlap between the main fishing and penguin foraging areas is low at fine spatial scales. He recollected that the original CPD index (potential overlap *sensu* Appendix H) was developed to try to monitor a situation whereby a substantial krill fishery consistently operates within the foraging range of krill-dependent predators at a critical time of year for the predators. The point at issue now is whether it is possible to replace the current CPD index, which has resolution at relatively broad spatial (100 km) and temporal (3–4 month) scales at which krill flux is potentially of less importance, with a fine-scale index (realised overlap *sensu* Appendix H) which ignores flux.

6.72 Some members felt that the fine-scale approach as described in WG-Joint-94/8 and Agnew and Phegan (1995) clearly has some merit, but it is important to note that neither the approach, nor the parameter values, nor the conclusions in the latter document have been critically examined by the Scientific Committee or its working groups. Furthermore, the model is sensitive to the parameter values used and those selected by Agnew and Phegan (1995), which (except for gentoo penguins) are conservative in terms of calculating foraging range even for species at Seal Island, are not typical of values prevailing at other sites in Subarea 48.1 and certainly not applicable to other subareas of

[3] SC-CAMLR-X, paragraphs 6.27 to 6.39 and Annex 7, paragraphs 5.12 to 5.22; SC-CAMLR-XI, paragraphs 5.24 to 5.31 and Annex 7, paragraphs 6.37 to 6.57; SC-CAMLR-XII, paragraphs 8.31 to 8.45 and Annex 6, paragraphs 6.48 to 6.56; SC-CAMLR-XIII, paragraphs 7.8 to 7.18 and Annex 4, paragraphs 4.1 to 4.3; SC-CAMLR-XIV, paragraphs 5.18 to 5.20 and Annex 4, paragraphs 5.87 to 5.99 and 7.25 to 7.30.

Area 48. Finally, the model does not include fur seals, one of the species contributing substantially to the definition of spatial boundaries in the original CPD index. Therefore, even if krill flux were not an issue in assessing effective overlap between the activities of fisheries and predators at this time of year, the conclusions offered by Agnew and Phegan (1995) lack generality, being at best site and parameter dependent; considerable further work is required on fine-scale analysis and until this is done it would be premature to dispense with broader-scale assessments.

6.73 Dr Trivelpiece pointed out that it is important to recognise that there is potential for considerable overlap between the fishery and predators at other times during the breeding season when predators are no longer constrained by the need to provision chicks. Of particular importance is the post-fledging period when large numbers of chicks begin foraging independently and adults are feeding intensively in preparation for their annual moult. This period may be particularly important in Subarea 48.1 as the Japanese krill fishery is now most active during this period each year.

6.74 Dr Kerry noted that fledgling Adélie penguins tracked by satellite from Béchervaise Island move from their natal colony in late February and March and forage in the vicinity of the shelf break. This means they are foraging in an area of potential overlap with the krill fishery (WG-EMM-96/69).

6.75 It was noted that progress on analysis of finer scales of overlap, as envisioned under the realised and dynamic overlap models, would require data on the densities of predators as a function of distance from the breeding areas. In addition, some measure of movement of krill (krill flux) would need to be incorporated into the realised and dynamic overlap models.

6.76 In discussions on the importance of flux to the calculations of niche overlap it was suggested that flux is considered to be of minor relevance at the subarea scale but that it becomes increasingly important at finer scales of analysis. Flux may also be more important in some areas than in other areas at comparable scales (e.g. flux in the Peninsula versus Prydz Bay regions).

6.77 It was suggested that if an area with a known fishery catch and predator population is defined, then flux may not be important. However, a fishery upstream may affect predators downstream, and under these circumstances flux may be an important consideration.

6.78 The niche overlap of interest is actually the krill resource in an area which is not the area of the fishery. The original CPD index was designed to provide a measure of the degree of congruence between predators and fishing in areas of overlap. Dr Miller suggested that it may be desirable to refine this original concept by linking it with an approach that would describe the functional links between predators and the fishery during a critical period of time.

6.79 Dr Hewitt suggested that an experiment might be designed for Subarea 48.1 that coupled a synoptic survey of the krill resource with calculations of predator demand and fishery catch and then examine the differences. However, Dr Butterworth cautioned the Working Group that the two approaches measure krill in different units; the synoptic survey in tonnes, the fishery catch in tonnes per unit of time (in this case a year).

6.80 The Working Group suggested that progress could be made intersessionally on the realised overlap index if the Agnew and Phegan model were evaluated critically in terms of its assumptions and the values of parameters used. It was agreed that such a task could appropriately be initiated by referring the model to the Subgroup on Statistics and also inviting submissions to this group on additional or alternative values of parameters, including those suitable for extending the generality of the model beyond the Seal Island area. In particular, the Secretariat was asked to request data or analyses describing, for all relevant sites and species:

(i) monthly estimates of typical diet composition (along the lines of index A8b), maximum and modal foraging range, and direction;

(ii) finer scale foraging data where possible (such as specific foraging distribution functions in different directions from a colony); and

(iii) estimates of the above derived from close and/or similar sites if the information is not available for the specific CEMP site.

These data should apply to the current biological and temporal dimensions of the CPD calculations (the land-based phase of land-breeding predators, e.g. December to March). Additional contributions on times outside of the chick-rearing period are also solicited, especially the time immediately following fledging when adults and juveniles may still be concentrated around CEMP sites. Fine-scale fisheries data will continue to be required for all areas to evaluate calculations of overlap using the data requested above.

6.81 It was expected that this process would lead to one or more versions of a realised overlap model being developed that could be applied to some combination of species, sites, islands, island groups and subareas, depending on the nature of and variation in the empirical data.

6.82 The indices of overlap provided by this approach would be expected ultimately to replace those currently calculated using the potential overlap model, which would, however, continue to be calculated for the time being, particularly until implications relating to krill flux are better understood.

6.83 In due course, it would be appropriate to calculate for examination the performance of realised overlap models using different assumptions concerning the nature and magnitude of krill flux in appropriate areas.

6.84 It was also noted that the Mangel model (WG-EMM-96/20) could be developed to perform similar functions both in estimating realised niche overlap and in developing a dynamic overlap model. Further such work on the Mangel model was strongly encouraged.

Analysis of Data from CEMP Indices

6.85 Much of the discussion under Agenda Items 3 to 5 has included consideration of trends and anomalies in individual CEMP indices presented in WG-EMM-96/4. This section of the report describes integrated analyses of the indices.

6.86 WG-EMM-96/22 presented an investigation of the relationships between various indices of prey availability at Seal Island derived from the AMLR acoustic surveys (overall average volume backscattering strength, mean distance of prey from Seal Island, mean depth of prey and persistence over time) and indices of predator performance. Chinstrap foraging duration was positively correlated with depth of the prey field and its distance from Seal Island, and longer foraging durations were associated with heavier stomach weights and lower proportions of krill in the stomachs. The strongest correlations were found between chinstrap fledging weight and breeding success, but neither of these parameters were correlated with foraging duration, stomach weight or the proportion of krill in the diet.

6.87 Three explanations were suggested for the lack of correlation between indices of prey availability and breeding success for chinstrap penguins in WG-EMM-96/22:

(i) the short time series (8 years) and the low variability in breeding success may reduce the ability to detect relationships. It was noted that the method used for measuring breeding success at Seal Island only monitors chicks from hatching to the start of creching; this is only a minor factor in determining overall breeding success.

(ii) aspects of the dispersion of prey may be more important than its local abundance. There is clearly a need for the development of indices derived from the distribution of the prey field, perhaps as some combination of patchiness and depth. Theories of the response of foraging animals to patch composition and distribution, as derived from behavioural ecology studies, may prove useful in interpreting the behaviour of predators in such a prey field. For instance, where patches are identical, foraging time (a combination of travelling time and patch residence time) and distance may be expected to be positively correlated, but if patches are not identical the relationship between foraging time and distance is not easily predicted.

(iii) chinstrap breeding success may not be food-limited in the Elephant Island area (but see paragraph 6.91 below).

6.88 WG-EMM-96/22 indicates that paradoxically fur seal foraging duration appeared to be negatively correlated with distance of the prey field from Seal Island, and positively correlated with pup growth rate, the latter despite expectations that longer foraging duration would be associated with lower pup growth rates. Indices from Bird Island show similar positive correlations with pup growth and foraging durations of less than 100 hours, with pup growth only declining as foraging duration increases beyond 100 hours. Mean foraging duration has never risen beyond 100 hours at Seal Island. These results may indicate that fur seals have never been food-limited at Seal Island, possibly switching to a higher reliance on fish in poor krill years.

6.89 Whatever the reason, these results indicate that some CEMP indices may show rather different and more complex responses than those which were previously assumed.

6.90 WG-EMM-96/27 also examined the Seal Island CEMP indices, and found positive correlations between chinstrap breeding success and the density of krill in the larger South Shetlands area derived from net haul surveys. A regression model was constructed which linked breeding success to sea-ice extent in the previous two winters (R_2 = 0.78), on the basis of the conceptual model of Siegel and Loeb (1995) where successful krill recruitment is enhanced by prolonged sea-ice cover in the winters immediately before and after adult spawning. Because krill recruitment was also positively correlated with sea-ice extent and breeding success, its inclusion did not significantly improve the fit to the model.

6.91 This model, therefore, successfully captured most of the environmental influences on breeding success. The paper then used various indices of fishing activity to try to account for the residuals of the model. This approach was proposed as a method for determining the relative contributions that environmental change and harvesting activity may make to observed changes in predator parameters, since one of the core aims of CEMP is the separation of the effects of these two factors.

6.92 This approach was welcomed as the first attempt to draw together in a formalised fashion the multivariate data from the CEMP program. It was noted that it would only be possible to detect contemporaneous local effects of harvesting activity using such an approach, and that it would be vulnerable to being confounded by changes in regional prey abundance such as have been noted in Subarea 48.1 (see paragraph 6.72). The approach also assumed largely unchanging behaviours of predators and fishermen, assumptions which are unlikely to be satisfied. It was further pointed out that although the model was currently couched in linear terms, some of the relationships, especially with recruitment proportion, might be better modelled by non-linear relationships.

6.93 The Working Group agreed to hold a workshop to address the uncertainties regarding the relationship between indices of harvested and dependent species at specific site and also between subareas in Area 48. The main focus would be on examining long time series of data in the area.

ECOSYSTEM ASSESSMENT

Assessments Based on CEMP Indices

7.1 Considerable progress has been made this year in the analysis of the CEMP indices, particularly the identification of anomalies and trends. Some further work is required, however, particularly on the treatment of indices which are not normally distributed, before the working group can be confident of its identification of anomalies. It therefore agreed that it could not yet present a table of statistically reliable anomalies, but would instead present Table 4. Since Table 4 is a categorical presentation of normal deviates of the indices (derived through statistical analysis of the CEMP data), it is half-way between the previous qualitative, and somewhat subjective, presentation of data in last year's report (SC-CAMLR-XIV, Annex 4, Table 3) and a future quantitative presentation of anomalies.

7.2 Bearing in mind Table 4, and other indicators contained in papers presented to the meeting, the Working Group derived the following ecosystem assessment for 1995/96:

(i) Subarea 48.1: there was evidence from prey surveys of a very strong 1994/95 krill year-class (62% of the population was year 1) and that krill was quite abundant. This strong year-class followed two successive years of cold winters with extensive ice cover, in keeping with the hypothesis linking sea-ice to krill. The high abundance is in contrast to the relatively low levels of krill abundance that have been recorded since 1989. Predator breeding success was high.

(ii) Subarea 48.2: there are no time series data on prey abundance, but the predators experienced a good breeding year, in common with the situation in Subarea 48.1.

(iii) Subarea 48.3: there was evidence from prey surveys and predator indices that krill was more abundant than it has been in previous seasons. In common with most of Area 48, the subarea experienced lower water temperatures than usual, and predators experienced a better than average breeding year.

(iv) Area 48: based on the above assessment, it is clear that there is some coherence between events in Area 48, with 1995/96 being a cold year with better-than-average krill abundance and predator performance.

(v) Division 58.4.2: following the total failure of breeding Adélie penguins at Béchervaise Island in 1995, the result of a local krill shortage, most breeders returned in 1996 although breeding success was a little lower than normal. No information on prey abundance was available.

(vi) Division 58.4.1: a krill survey discovered higher krill abundance in the western portion of the subarea, than in the eastern portion, although no other historical surveys were available to enable an assessment of the relative abundance of krill in the 1996 season to be made.

(vii) Subarea 88.1: predator performance in the Ross Sea was at an average level in 1996.

7.3 The Working Group congratulated the Secretariat on its new analysis and presentation of the CEMP indices, and requested that similar presentations be made in future years. Further work is now needed to develop ways of further summarising and interpreting the indices beyond those presentations provided by the Secretariat. However, the Working Group suggested that this be undertaken by individual research communities with specific experience of individual CEMP sites rather than the Secretariat. Examples of the sorts of multivariate analyses which could be developed further at all CEMP sites were presented in WG-EMM-96/22 and 96/27. The full dataset of raw CEMP data, and a table of the indices calculated by the Secretariat (by site, year, species, sex and method) are now available for Members to use in such investigations within the rules of access to CCAMLR data.

Estimation of Potential Yield

7.4 Because annual krill recruitment varies naturally, the biomass of the krill population fluctuates even in the absence of exploitation. Thus this biomass could be above or below its median level at the time a pre-exploitation survey takes place. The krill yield model, which provides recommendations for precautionary catch limits for krill on the basis of such surveys, takes the existence of these fluctuations into account in its calculations. However, if extra information becomes available which allows estimation of the trend and extent of the difference between the krill biomass and its median pre-exploitation level at the time of a survey, the krill yield model could be refined to take this into account and thereby provide an improved estimate of potential yield.

7.5 Paragraph 4.48 of the Working Group's 1995 report (SC-CAMLR-XIV, Annex 4) draws attention to evidence presented suggesting that the 1981 FIBEX survey, which provides the biomass estimate upon which recommendations for a precautionary catch limit in Subareas 48.1, 48.2 and 48.3 have been based, took place in a year of relatively high krill abundance.

7.6 WG-EMM-96/45 presented refined indices of krill recruitment and density in the Elephant Island area for most years from 1977/78 to 1994/95. The density index was suggestive of relatively high krill abundance at the time of the FIBEX survey.

7.7 The extent of the variation in both the recruitment and the density index reported in WG-EMM-96/45 appeared inconsistent with the level of recruitment variability currently input for calculations using the krill yield model. Either this level of variability has increased, or the median recruitment level itself has changed over the period covered by these data for the Elephant Island area.

7.8 The question was raised as to whether the trends indicated by these Elephant Island data reflected only local variations, or changes in krill abundance on a regional scale.

7.9 In response, Dr Hewitt cited correlations between krill abundance levels in the Antarctic Peninsula and South Georgia regions in both 1994/5 and 1995/6 as supportive of the hypothesis that the Elephant Island survey data are reflective of regional-scale effects (see also paragraph 6.5).

7.10 A further question raised was whether the Elephant Island krill density index could reasonably be considered to be linearly proportional to krill abundance on a regional scale. For example, this index suggests a fall in krill abundance of some 10-fold or more from the time of the FIBEX survey (which estimates the krill biomass in Subareas 48.1, 48.2 and 48.3 to have been some 35 million tonnes) to the 1990/91 season. Given that the customary annual consumption of the krill predators of these subareas amounts to a few million tonnes, the assumption of linear proportionality of the index implies that wide-ranging deleterious effects on predators in these subareas should have been evident in 1990/91.

7.11 Although there is evidence:

(i) of declines in some predator populations in Area 48 (especially macaroni penguins and black-browed albatrosses in Subarea 48.3 and Adélie penguins in Subarea 48.1) from the 1980s to the 1990s;

(ii) that 1990/91 was a season of very poor reproductive performance by krill-dependent predators in Area 48; and

(iii) that some limited scope for switching from krill to other diets exists for some predators;

even all these together could not offset potential effects on the scale implied by a decrease in krill abundance within Area 48 directly proportional to the changes in density at Elephant Island. There remains, of course, the possibility that krill abundance is being substantially underestimated.

7.12 The Working Group had insufficient information to determine the degree to which the indices from the Elephant Island area are representative of abundance trends in the surrounding region (Subareas 48.1, 48.2 and 48.3). It agreed that the implications for the output from the krill yield model of the recruitment and density estimates reported in WG-EMM-96/45 should be investigated intersessionally. Detailed specifications of the work to be conducted are listed in Appendix G.

7.13 The Working Group agreed that these uncertainties reinforce the need for a new quasi-synoptic survey in Area 48.

7.14 The suggestion was made that the krill yield model be adjusted to take account of environmental determinants of krill recruitment success (note, for example, the correlation between such success and the extent of sea-ice cover reported in WG-EMM-96/24).

7.15 In response it was suggested that:

(i) environmental analyses be investigated to provide insight into both the temporal and areal scale (particularly whether local or regional) upon which measured krill recruitment fluctuations were likely to be correlated; and

(ii) rather than reformulate the yield model, analyses of environmental data be undertaken to provide information on the parameters of the statistical distribution to be expected for time series of krill recruitment on a regional scale (this is the key input to the krill yield model, and is at present inferred from the analysis of the length distribution data collected during scientific surveys).

7.16 It was noted that the functional relationship analysis for Antarctic fur seals (WG-EMM-96/67) suggests that the use of a value of the krill harvesting intensity parameter (γ) of slightly more than 0.1 would yield an estimated seal population level of some 50% of pre-exploitation abundance. Such a value for γ is compatible with that of 0.116 obtained from the krill yield model for maintaining median krill escapement at 75% of its pre-exploitation level. This value was previously adopted as an ad hoc means of taking account of the food requirements for krill predators in setting precautionary catch limits for the krill fishery.

7.17 It was noted that the krill predator functional relation model required an additional random variable (relating krill biomass to availability) in order to fit predator survival data (see paragraph 6.57 and WG-EMM-96/67, equation A4). This implies that additional care may be required when estimating precautionary catch limits until the relationship between krill biomass, krill availability and predator survival is better elucidated.

7.18 Previous meetings (e.g. SC-CAMLR-XIII, Annex 5, paragraph 4.56 and Annex 7, paragraphs 4.34 and 4.35) have noted that the estimate of γ provided by the krill yield model is sensitive to possible age-dependence in krill's natural mortality, specifically to larger values of this mortality at small ages.

7.19 WG-EMM-96/8 and 96/9 compared krill samples from contemporaneous net hauls with predator diet samples from Antarctic fur seals and six seabird species. A preponderance of gravid female krill in the predator diets was noted, probably reflecting some combination of selectivity by predators and superior escape responses of male krill.

7.20 In the light of these results, it was agreed that some tests should be conducted of the sensitivity of the krill yield model to a natural mortality schedule which increases at greater ages.

7.21 It was nevertheless noted that inferences from the observed distributions might be biased as a result of a preponderance of large krill in the population in the year of sampling. It was also pointed out that only land-breeding predators had been considered, and that the impact of other predators (e.g. fish) on small krill should not be overlooked.

7.22 The results presented also indicated that the effect of net selectivity on the procedure used to estimate M from krill length frequency distributions might require examination.

7.23 Results from a 1996 krill survey in Subarea 58.4 in the Indian Ocean were noted (WG-EMM-96/28). Estimates of R_2 were very similar to those used previously for inferring inputs to the krill yield model. Further the CV for the survey (0.27) was very close to that assumed (0.30) for previous calculations with this model. It was therefore agreed that there was no need to recompute γ from the model with input parameter values specific to the Indian Ocean, and that the current estimate of γ = 0.116 could be applied to compute a recommendation for a precautionary catch limit for this subarea.

Precautionary Catch Limits

7.24 The Working Group calculated the precautionary catch limit for Division 58.4.1 as 775 000 tonnes per year, based on the results of the Australian biomass survey (6.67 million tonnes) (WG-EMM-96/28) and the krill yield model (harvesting intensity 0.116).

7.25 At last year's meeting, the Working Group developed an intersessional work plan designed to enable the application of the method proposed by Everson and de la Mare (1996) for the calculation of precautionary catch limits based on predator consumption data (see SC-CAMLR-XIV, Annex 4, paragraph 8.2). This method uses estimates of krill consumption by predators, krill natural mortality and krill turnover times, and their variances, to calculate the biomass of krill which would be expected to be found in a given area if a synoptic survey were to be conducted there. Application of the method to Subarea 48.3 at this meeting would require a new estimate of predator krill consumption and an independent estimate of krill turnover based on oceanographic estimates of water mass turnover.

7.26 WG-EMM-96/66 presented new estimates of predator consumption in Subarea 48.3 based on the abundance and energetic requirements of fur seals and macaroni penguins at South Georgia. The estimates were derived from a generalised model of gross energy requirements of the predators in relation to age, breeding status, body mass and the stages of reproductive and life cycles (see also paragraph 6.46). Total krill requirements for the two predators combined was estimated to be 11.8 million tonnes per year, with an SD of approximately 1 million tonnes per year.

7.27 The Working Group welcomed this new analysis. The Working Group agreed with the points raised in the paper about future refinements to this model which would require predator diet data at finer temporal resolution, and the inclusion of spatial components such as dispersion in predator behaviour. Nonetheless, the Working Group also agreed that the estimates obtained with the current model were adequate for use in calculating precautionary catch limits based on predator consumption data.

7.28 Unfortunately, analyses aimed at obtaining an independent estimate of krill turnover could not be completed in time for this year's meeting. Dr Everson reported that estimates based on acoustic doppler current measurements were currently in progress, and should be ready for consideration at the Working Group's next meeting. Consequently, the Working Group was unable to calculate precautionary catch limits using this method at this meeting.

7.29 Dr V. Sushin (Russia) noted that, if calculations given in WG-EMM-96/66 are correct, krill fishing at current levels in Subarea 48.3 poses negligible or very little competition to predators. Even when maximum catches of about 250 000 tonnes of krill were taken in the past, these represented less than 2% of predators' food demand. Dr M. Naganobu (Japan) supported this view.

7.30 The Working Group, whilst noting these comments, considered it premature to draw conclusions about the impact of recent catch levels on dependent species until the analyses in paragraph 7.28 were completed.

Consideration of Possible Management Measures

7.31 The Working Group recommended a precautionary catch limit for Division 58.4.1 of 775 000 tonnes per year.

7.32 Noting the work still in progress for Area 48, and the additional tasks identified this year, the Working Group was unable to provide revised estimates of a precautionary catch limit for this area, or provide advice on the allocation of the limit to subareas. Pending the completion of this work, the Working Group recommended that existing management measures for Area 48 remain in force.

Extension of the Scope of CEMP

7.33 No extensions to the scope of CEMP were proposed at this meeting.

Strategic Modelling

7.34 Discussions on strategic modelling centred around the conceptual framework developed at the last meeting of WG-EMM. In particular, the Working Group reviewed Figure 4 in SC-CAMLR-XIV, Annex 4 with a view to identifying those areas where progress had been made in the past year.

It was agreed that in Figure 3 in that report, it was necessary to add an additional weak linkage from dependent species to the fishery, in order to take account of interference with fishing gear by seabirds and marine mammals (e.g. seabirds causing bait loss).

7.35 The Working Group noted that the work in the intersessional period has mainly concentrated on the strongest and most important of those processes and linkages in the conceptual model. These are designated by heavy arrows in the figures.

7.36 Tables 5 and 6 summarise where progress has been made on either the local-scale or regional-scale strategic models.

7.37 The Working Group was pleased to note that balanced progress had been made in enhancing understanding of each of the main linkages and processes at both local and regional scales.

7.38 The Working Group welcomed the carrying out of synoptic surveys by Italy (WG-EMM-96/63) and Australia (WG-EMM-96/29), during which data on a comprehensive suite of variables has been collected on dependent and harvested species and on the environment. Only preliminary analyses of results were available at this meeting, and the Working Group looked forward to subsequent presentation of integrated analyses of these data.

7.39 The work by the Subgroup on Statistics (Appendix H) and subsequently by the Secretariat on analysis of CEMP indices (WG-EMM-96/4) has greatly improved the ability of the Working Group to undertake quantitative, rather than qualitative, analyses of these indices. New methods have been developed for the identification of anomalies. The multivariate analysis in WG-EMM-96/27 gives an indication of the types of analyses that can now be conducted.

7.40 In addition to the considerable amounts of new data and analyses tabled at the meeting, a number of papers described new or improved models of processes underlying the linkages contained in the strategic model. These included models investigating the effects of fisheries on krill predators at the foraging trip level (WG-EMM-96/20), models of functional relationships between predators and prey (WG-EMM-96/67), models of growth dynamics of krill (WG-EMM-96/68), krill predator energetics models (WG-EMM-96/7, 96/66) and oceanographic circulation models (WG-EMM-96/61). While some of these models are in early stages of development, the Working Group was pleased that a wide variety of modelling approaches are now being attempted.

7.41 Revised indices of krill recruitment and biomass in the Elephant Island area were presented this year, along with plausible linkages with an environmentally driven variable (WG-EMM-96/45).

Although the extent to which these indices are representative of trends in the surrounding regions is as yet uncertain, the implications for the krill yield model of the variability observed in these indices is to be examined intersessionally (paragraphs 6.20, 6.21 and 7.6 to 7.15).

7.42 At present, most effort by the Working Group is devoted to improving the understanding of the processes and linkages between harvested species, dependent species, the environment and the fishery. The Working Group is very conscious, however, that the ultimate aim is to develop effective mechanisms for management of the ecosystem as envisaged in the CCAMLR Convention. It agreed that this aim must continue to be the overall focus for its work.

Ecosystem Implications of Proposed New Fisheries

7.43 CCAMLR-XV/8 to 11 gave notification of intent to initiate new fisheries by New Zealand, Australia, Norway and South Africa respectively. In each case, the principal target species was toothfish (*Dissostichus eleginoides*).

7.44 The Working Group agreed that a detailed review of these proposals, involving aspects of single-species fish stock assessment and of incidental mortality, would best be conducted by WG-FSA. It agreed, however, that there were several more general points raised by these proposals that warranted discussion within WG-EMM.

7.45 The first of these points was that there was virtually no information available about the target species in the widely separated areas proposed for the new fisheries. This highlighted the need to adopt a standard approach to the management of new fisheries and specification of the information required. It would also be helpful if a common format could be adopted both for proposals to initiate new fisheries and for submission of the information collected.

7.46 The second point was that each case involved initiation of a fishery on a trans-boundary stock that was able to move freely back and forth across the CCAMLR Convention boundary. Effective management of stocks that are part of an ecosystem that extends beyond CCAMLR boundaries requires close coordination between CCAMLR and other relevant organisations with responsibilities for waters near or adjacent to the Convention boundaries. The Working Group noted that this issue has been addressed in part by CCAMLR Resolution 10/XII.

7.47 Dr de la Mare noted that CCAMLR ecosystem boundaries are defined with respect to surface features. This is not appropriate for all species within the Antarctic ecosystem; a number of midwater and pelagic species, such as toothfish, myctophids and squid, have ranges extending beyond that Convention Area, as do flying birds such as albatrosses.

7.48 CCAMLR-XV/7 gave notification of the intention by the Republic of Korea and the United Kingdom to initiate a new fishery for the squid *Martialia hyadesi* in Subarea 48.3. While some aspects of the proposal would more appropriately be dealt with by WG-FSA, the Working Group agreed that it should discuss the wider ecosystem implications of harvesting this squid species.

7.49 This is the first proposal that has been received to initiate a fishery on this important group of marine organisms in the Convention Area. Though widely used outside the Convention Area, the fishing method proposed, jigging, is also a new method for CCAMLR. As with the other four proposals, the stock involved is a trans-boundary stock.

7.50 As noted briefly in CCAMLR-XV/7, dietary studies at South Georgia have shown that *M. hyadesi* is the major squid prey of a number of dependent species. Its main diet consists of myctophids and crustaceans, including krill, which means that it is also an important predator in the Antarctic ecosystem.

7.51 The Working Group agreed that, given the estimated annual consumption of *M. hyadesi* by predators in the Scotia Sea (400 000 tonnes), the proposed level of exploratory fishing (2 500 tonnes) is unlikely to have an impact on dependent species.

7.52 The Working Group agreed that important new knowledge could be gained from this new fishery given its important trophic links. It was important that further details be provided about the extent and format of data on catches of the target species, the by-catch and biological samples that would be collected. It was noted that a data form appropriate for squid fisheries has already been developed by the Scientific Committee. The Working Group recommended that an addendum to the proposal, detailing aspects of observation and data collection, should be prepared and submitted for consideration by WG-FSA at its next meeting.

7.53 Dr Miller suggested that precautionary catch limits for squid might be calculated in a manner similar to those developed by WG-FSA for the myctophid *E. carlsbergi*.

7.54 Dr Kock observed that it may be necessary to expand the scope of CEMP and WG-EMM to deal with fisheries for species such as myctophids and squid in view of their important role in the ecosystem.

7.55 In relation to any myctophid fishery that may recommence, the Working Group noted that procedures for resumption of a fishery were discussed in SC-CAMLR-XV/BG/11.

Future Work

7.56 The Working Group first reviewed the status of required work in relation to ecosystem assessment, as identified in section 8 of the report of the previous meeting of WG-EMM (SC-CAMLR-XIV, Annex 4).

Completed Tasks

7.57 The following tasks have been completed:

(i) Meeting of the Subgroup on Statistics. The Subgroup on Statistics had a very productive intersessional meeting and it produced a comprehensive report (Appendix H and paragraphs 4.56 to 4.65). The resulting quantitative presentation of CEMP indices (WG-EMM-96/4) has been widely referred to in discussions of the Working Group at this meeting. New tasks for the Subgroup on Statistics are discussed in paragraph 7.59.

(ii) Meeting of the Subgroup on Monitoring Methods. This subgroup met immediately before the current Working Group meeting. Its report is attached as Appendix I (see also paragraphs 4.12 to 4.55). A number of new standard methods were adopted (paragraph 4.26).

(iii) Consideration of the report of the Australian survey of Division 58.4.1. This survey has been successfully conducted and initial reports were considered by the Working Group (WG-EMM-96/28 and 96/29; paragraphs 3.31 to 3.36). The Working Group looks forward to submission of further papers describing analyses of this comprehensive dataset at future meetings.

(iv) Reporting of experience with gastric lavage and stomach sample techniques. Use of stomach lavage techniques is described in WG-EMM-Methods-96/6 and discussed in Appendix I, paragraphs 27 to 29 (see also paragraph 4.27).

(v) Methods for analysis of petrel diet samples and for petrel lavage. Standard methods have been agreed (WG-EMM-Methods-96/4, WG-EMM-96/53; paragraphs 4.26 and 4.27).

(vi) Instructions for the collection and preservation of samples to be taken in the event of disease outbreak. This has been completed subject to revision and a final circulation for comment (paragraphs 4.28 to 4.35).

(vii) Circulation for review of proposed changes to existing CEMP methods and proposals for new ones. This has been done and both existing and new methods were reviewed (paragraphs 4.13 to 4.26).

(viii) Acquisition of comprehensive SST data by the Secretariat. This has been done (WG-EMM-96/4; paragraphs 5.6 and 5.7). Information regarding the selection of data on SST is required.

(ix) CPD calculations. These have been presented in WG-EMM-96/4.

(x) Comparison of krill length frequency data from nets and predators, and examination of time series of krill length frequencies from predators for information on krill recruitment. This information is presented in WG-EMM-96/8 and 96/9 (see also paragraphs 7.19 to 7.22).

(xi) A correspondence subgroup should complete the analysis of recruitment estimates. The resulting paper is WG-EMM-96/45 (see also paragraphs 7.6 to 7.15).

(xii) A correspondence subgroup should consider Method A5. Preliminary discussions proposed minor alterations to Method A5 which have been adopted (WG-EMM-Methods-96/11, WG-EMM-Stats-96/5; paragraph 4.18).

Tasks Still Requiring Further Work

7.58 Some progress has been made on the following tasks, but they have not yet been completed:

(i) An effective mechanism for consideration of interactions between fish and their predators. The need to develop an effective mechanism was emphasised by the points raised in the discussion of the ecosystem implications of proposals to initiate new fisheries (see paragraphs 7.43 to 7.55).

(ii) Workshop on indices to monitor at-sea behaviour. The Working Group agreed that it would not be appropriate to hold such a workshop in the near future (paragraphs 4.41 to 4.44). Instead, it was agreed that the Subgroup on Statistics should be asked to consider analyses of sample datasets and to provide advice on the most appropriate indices and appropriate methods to derive them. This task was added to the terms of reference for the planned intersessional meeting of the subgroup (paragraph 7.59).

(iii) Further work on defining a strategic approach to ecosystem assessment and further development of methods appropriate for conducting an ecosystem assessment. Some progress has been made (paragraphs 7.34 to 7.42), but more work needs to be done.

(iv) Assessments should be developed from the current qualitative approach to a quantitative analysis. Considerable progress has been made on CEMP indices through the work of the Subgroup on Statistics and the Secretariat (WG-EMM-96/4), but further work is still needed.

(v) A new quasi-synoptic krill survey of Area 48 for krill. Plans for this were discussed at this meeting (paragraphs 3.72 to 3.75). This is considered to have high priority. Specific stratified random sampling designs need further examination.

(vi) Coordination of research in the Antarctic Peninsula. The ad hoc Subgroup on Coordination of International Research Activities in the Antarctic Peninsula also met during this WG-EMM meeting and a further meeting is planned (paragraph 2.13).

(vii) Further examination of uncertainty in acoustic surveys of krill. Several papers addressing this issue were discussed at this meeting (WG-EMM-96/28, 96/40, 96/41, 96/46, 96/71) and the immediate problems identified at the last meeting were resolved (paragraphs 3.6 to 3.10). It was agreed, however, that this topic should be kept open. Some aspects will be addressed at the Workshop on Acoustic Methods to be held immediately following the WG-EMM meeting.

(viii) The use of multifrequency acoustic techniques in surveying. This was discussed by an ad hoc Subgroup on Echo Classification (paragraph 3.11 and Appendix E).

Further work is needed before the issue of echo classification is fully resolved. Use of multifrequency acoustic techniques also needs further development.

(ix) Standard methods for Antarctic fur seal demography and diet studies should be prepared. Papers containing descriptions of appropriate methods have been published (Boyd et al., 1995; Reid, 1995; Reid and Arnould, 1995), but CEMP standard methods have not yet been developed. Some further intersessional work is needed. Further standard methods for fulmarine petrels have also been requested (paragraph 4.54).

(x) More extensive studies on the occurrence of fish in krill catches. WG-EMM-96/52 provided further information on by-catches in the Japanese krill fishery. It was agreed that additional studies covering the entire span of a fishing season are needed (paragraphs 6.1 to 6.3).

(xi) A table of existing spatio-temporal scales should be circulated for revision. It was originally intended that this would be discussed by the Subgroup on Statistics. Some progress was made at this meeting in defining relevant spatial and temporal scales (paragraph 3.66 and Table 2). Additional work is required on the realised overlap index has also been identified (paragraph 6.65).

(xii) All appropriate data on CEMP indicator species currently held by Members and which have not yet been submitted, including historical datasets, should be compiled and submitted in CCAMLR formats. This is a continuing request.

(xiii) A bibliography of publications on diets, energy budgets and foraging ranges of dependent species should be maintained by CCAMLR. The Secretariat maintains a full bibliography of papers tabled before CCAMLR. Additional literature is available as part of CEMP. It is beyond the resources of the Secretariat to actively seek out additional literature on this topic, however, it was agreed that, if sent by Members, modest amounts of key literature could be held and catalogued by the Secretariat. This could include literature not directly on Southern Ocean species if appropriate. The Working Group noted that WG-EMM-96/19 contained a particularly valuable and comprehensive bibliography on this topic.

(xiv) The acquisition of comprehensive bathymetric data should be pursued by the Secretariat. This remains to be done. Adjustments and improvements to the definition of areas from which SST indices are derived are also needed (paragraph 5.10).

(xv) Final calculations of the krill/dependent species model for black-browed albatrosses and Antarctic fur seals should be completed and presented, together with initial requests for a revised version of the Adélie penguin model. WG-EMM-96/67 contained calculations for Antarctic fur seals and black-browed albatrosses. Additional information is needed before calculations can be completed for black-browed albatrosses and Adélie penguins (see paragraphs 6.58 and 6.59 and Appendix F).

(xvi) The relationship between overall krill abundance and actual krill availability to predators within a CPD requires investigation. This is a continuing topic for study, though WG-EMM-96/49 and 96/55 addressed this issue (paragraphs 6.43 and 6.44).

(xvii) Further work on the submodels within the conceptual framework of Figures 3 and 4 in SC-CAMLR-XIV, Annex 4 is encouraged. Useful progress has been made on the specification of submodels. WG-EMM-96/20, 96/61, 96/67 and 96/68 each contain relevant models. There is an encouraging degree of potential or actual interrelationship between some of the models (e.g. the functional relationship models of WG-EMM-96/20 and 96/67). Further work on the krill yield model is outlined and discussed in paragraphs 7.14 to 7.23.

(xviii) A correspondence subgroup should consider the development of appropriate sea-ice indices and the formulation of specific hypotheses on the potential effects of sea-ice on components of the ecosystem. A start has been made on this, but more needs to be done (paragraphs 5.14 to 5.22).

(xix) A subgroup will carry out further work on the incorporation of information on predator demand in the calculation of precautionary catch limits and their allocation to subareas. The work on the energy budget calculations has been completed (WG-EMM-96/56) but further estimates of krill flux are needed to complete the precautionary catch limit calculations (paragraphs 7.25 to 7.30).

Additional Work Arising from Discussions at this Meeting

7.59 The need for the following tasks relating to ecosystem assessment to be completed arose from discussions at this meeting:

(i) Further intersessional meeting of the Subgroup on Statistics. There is a need for an intersessional meeting of the Subgroup on Statistics to address the following topics:

(a) development of indices of at-sea behaviour and methods of deriving them via analysis of sample datasets (paragraph 4.44);

(b) further review of identification of anomalies in CEMP indices (paragraph 4.60);

(c) methods for coping with missing values in multiple datasets (paragraph 4.63); and

(d) critical evaluation of the assumptions and parameter values of the Agnew and Phegan (1995) model of realised overlap (paragraph 6.81).

ADVICE TO THE SCIENTIFIC COMMITTEE

Management Advice

8.1 The Working Group recommended that the precautionary catch limit for krill in Division 58.4.1 should be set at 775 000 tonnes (paragraphs 7.24 and 7.31).

8.2 As relevant work is still in progress, the Working Group was unable to provide revised estimates of the precautionary limit for krill in Area 48 and could not offer further advice on the allocation of precautionary catch limits to subareas (paragraph 7.32).

8.3 Given the number of new fisheries developing in various parts of the Convention Area, the Working Group highlighted the need for a coordinated approach to managing these fisheries. The development of such an approach is seen as critical for species being harvested and species being monitored under CEMP which cross the Convention's boundaries (paragraphs 7.45 and 7.46).

General Advice with Budgetary/Organisational Implications

Cooperation with Other Groups

8.4 (i) Maintenance of close links with APIS (paragraphs 4.46 to 4.52 and 4.54).

(ii) An international krill symposium will be held in 1998 or 1999 (paragraphs 9.1 to 9.4).

Publications

8.5 (i) The updated *Scientific Observers Manual* along with logbooks for krill and finfish fisheries should be published in 1997 as a matter of urgency (paragraph 2.12).

(ii) The *CEMP Standard Methods* should be revised and distributed as soon as possible (paragraphs 4.15, 4.16, 4.18, 4.19, 4.21, 4.24, 4.26, 4.28, 4.32 and 4.33).

Meetings

8.6 (i) The workshop on indices to monitor at-sea behaviour will not now be held (paragraph 4.43).

(ii) The Subgroup on Statistics should meet in 1997. The Convener is to be announced (see paragraph 7.57).

(iii) A workshop on linkages between monitoring sites within Area 48 and the interrelationships between Subareas in Area 48 is planned for the 1997 intersessional period (local organiser, Dr Holt) (paragraph 6.94).

Future Work for WG-EMM

Development of an Ecosystem Assessment

8.7 Approaches to improve on current ecosystem assessments and to develop new initiatives should be encouraged. The details of relevant work are contained in paragraphs 7.34 to 7.42.

Surveys

8.8 (i) The carrying out of a quasi-synoptic krill survey of Subareas 48.1, 48.2 and 48.3 is recommended as a matter of priority. Detailed plans for this survey should be prepared for the next meeting of WG-EMM (paragraphs 3.72 to 3.75).

(ii) Given the difficulties experienced in surveying large statistical subareas and divisions, further consideration should be given to subdividing such areas to make them more manageable (paragraph 3.41).

Data Collection/Analysis Methods

8.9 (i) The continued collection/analysis of time budget data from the krill fishery is encouraged (paragraph 2.11).

(ii) Because of their utility, the submission of haul-by-haul data from the krill fishery should continue to be encouraged (paragraphs 3.28 and 3.29).

(iii) Studies on the occurrence of fish in krill catches should continue in accordance with the recommended methods (paragraph 6.1).

Data Submission/Acquisition/Access

8.10 (i) The adaptations to and expansions of the standard methods should be included in the revised version of the *CEMP Standard Methods* (see 'Publications' above) (paragraphs 4.24 to 4.26 and 4.28 to 4.32).

(ii) The Secretariat should request relevant CPD index data during the next year (paragraph 6.81).

Modelling/Analysis

8.11 Although there is insufficient interest to justify holding the at-sea behaviour workshop (see above), the need to develop analytical methods for at-sea behaviour is re-affirmed along with the requirement to ensure that data are reduced into a format compatible with the CEMP database (paragraph 4.43). The Subgroup on Statistics should place the issue on the agenda of its next meeting (paragraph 4.44).

Correspondence Groups

8.12 (i) The Secretariat should contact the Polish authorities in order to ascertain that nation's plans for future krill fishing (paragraph 2.6).

(ii) The group led by Dr Kim should continue to coordinate research activities in Area 48 by intersessional correspondence and meetings whenever possible (paragraph 2.13).

(iii) An e-mail correspondence group should be set up to improve the dissemination of literature on the physical aspects of the Antarctic marine environment (paragraph 5.37).

(iv) The Subgroup on Statistics should correspond towards the development of a proposal for its meeting in 1997.

OTHER BUSINESS

9.1 The Scientific Committee has proposed to set aside a sum of A$7 000 in its 1997 forecast budget in support of the proposed International Symposium on Euphausiid Biology and Ecology discussed by WG-EMM at its 1995 meeting (SC-CAMLR-XIV, Annex 4, paragraphs 9.1 to 9.5).

9.2 Subsequent developments and discussions during WG-EMM's 1996 meeting explored further the format and timing of such a symposium.

9.3 It is now proposed that the symposium should comprise a series of working sessions aimed at promoting dialogue and information exchange between scientists working in the field of euphausiid biology and ecology.

9.4 It is therefore proposed that a new proposal for the symposium will be prepared by Dr Mangel who has offered to host the symposium in 1998 or 1999. This proposal will be presented to the 1997 meeting of the Scientific Committee. It is anticipated therefore that SC-CAMLR's budgetary commitment is only likely to fall due in the 1998 or 1999 budget.

ADOPTION OF THE REPORT

10.1 The report of the second meeting of WG-EMM was adopted.

CLOSE OF THE MEETING

11.1 In closing the meeting, the Convener, Dr Everson, expressed the sincere thanks of the Working Group to Dr Øritsland and his colleagues in Bergen for the substantial amount of work they had done to ensure that the meeting ran smoothly. He also thanked the rapporteurs and the Secretariat for their work.

11.2 The Working Group expressed its thanks to the Convener for conducting the meeting in an efficient and productive fashion.

11.3 Dr Kock thanked Dr Agnew for his work with the Secretariat during his term as CCAMLR Data Manager and the Secretariat staff presented him with a Norwegian drinking horn on behalf of his friends in the Scientific Committee.

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Table 1: Results of krill biomass surveys.

Statistical Area and Year of Survey	Conducted By	Area Surveyed (km^2)	$\bar{X}$ Density $g\ m^{-2}$	Biomass (millions of tonnes)	CV (%)	Reference
48.2 (1996)	Russia	68 562	38.3	2.6	9.6	WG-EMM-96/36
48.1 (1996)	USA	41 673	76.26	3.37	11	WG-EMM-96/23
(two surveys)		“	69.37	2.92	23	“
48.3 (1992)	UK	36 267	94.96 (day)	3.4		WG-EMM-96/42
48.3 (1992)	UK	36 267	22.71 (night)	3.4		“
48.3 (1996)	UK	8 000	40.57		13.37	WG-EMM-96/18
(two survey boxes)		8 000	26.48		54.30	
58.4.1 (1996)	Australia	873 000	7.65	6.67	27	WG-EMM-96/28
88.1 (1994)	Italy	170 814	132.48	5.14	-	WG-EMM-96/63
(two surveys)		156 408	75.6	3.37	-	“

Note that these figures are not comparable between surveys because the methods used to allocate echos to krill and other targets were not consistent. Appendix E gives a full explanation of these problems.

Table 2: Estimates of average temporal and spatial scales at which information relevant to indices of local prey distributions is collected for predator species.

Variable	Scale: Temporal/Spatial (Horizontal)				
	Gentoo Penguin	Adélie Penguin*	Macaroni Penguin	Antarctic Fur Seal	Black-browed Albatross
Dive	1–3 min/<0.1 km	1–3 min/< 0.1 km	1–3 min/< 0.1 km	1–3 min/< 0.1 km	<0.1 min/< 0.001 km
Dive bout	1–5 hr/1–5 km	?/?	1–3 hr/1–10 km	0.1–5 hr/0.1–10 km	0.5 hr/0.1–10 km
Foraging trip	0.3 days/1–10 km	1–3 days/100–200 km	1–2 days/10–50 km	4–6 days/50–200 km	2-3 days/50–300 km
Incubation shift	1 day/10 km	5–18 days/100–300 km	15–30 days/100 km	-	10–20 days/100–500 km
Hatching success (diet)	80 days/10 km	55 days/100–120 km	50 days/10–50 km	-	120 days/50–300 km
Breeding success	120 days/10 km	90 days/120–300 km	90 days/100 km	120 days/50–200 km	190 days/100–500 km

* There may be substantial differences between birds at breeding sites on Antarctic Peninsula and eastern Antarctica. Values given here are mainly from the latter area.

Table 3: Levels of overlap between fisheries and dependent species.

	Index	Description	Sensitive to
1	Catch of krill in the CPD	Tonnage of krill taken within 100 km of predator colonies from December to March.	Catch size and distribution
2	Percentage of krill catch taken in CPD	Percentage of the total catch in a subarea taken within 100 km of predator colonies from December to March.	Catch distribution
3	Realised overlap (Agnew and Phegan)	Product of the expected consumption of krill by penguins in a fine-scale square and the catch in that square.	Catch size and distribution
4	Realised potential overlap (Modified Agnew and Phegan)	Realised overlap divided by the maximum possible realised overlap, calculated by assuming the areas of maximum catch coincide with the areas of maximum krill consumption by penguins.	Catch distribution

Table 4: Categorised standardised normal deviate of an index.

The standardised normal deviate of an index is calculated as the deviation from the mean over all years, expressed in units of standard deviation. Where the distribution of the index over all years is known not to approximate a normal distribution, it is transformed according to the table below, and the normal deviates of the transformed index are presented here.

The size of the deviate is represented by the following symbols:

deviate > 1.5	*
1.5 > = deviate > 0.5	+
0.5 > = deviate > -0.5	o
-0.5 > = deviate > -1.5	-
-1.5 > = deviate	=

If the deviate is identified as ‘anomalous’ using the methodology described in the Subgroup on Statistics report (Appendix H), it is represented by ** or == depending on whether it is in the upper 2.5% or lower 2.5% of the time series distribution of indices.

Note: data from each time series of less than three years are not shown since it is not possible to calculate valid anomalies, e.g. South African data.

According to discussions and hypotheses presented in this report, not all indices may be expected to behave in the same way in response to similar changes in conditions. For instance, when krill is more abundant, one would expect sea-ice extent to be greater, breeding success to be greater, foraging duration to be lower, and SST to be lower. This table presents the indices simply as they are recorded in the CCAMLR databases, which means that even when all the indices are responding to the same phenomenon, one may expect a mixture of positive and negative responses in the table. It is not appropriate to modify the

Table 4 (continued)

indices themselves, because their interpretation is based on hypotheses put forward in this report, which may change. However, it is appropriate to indicate how the Working Group expects the standard normal deviates to behave in response to similar phenomena. The table below specifies whether the standardised normal deviate is EXPECTED to be positive (+, * or **) or negative (-, = or ==) in 'good' years, where 'good' is understood to mean years of high krill abundance (see previous sections of the report for hypotheses on the relationships between parameters, especially for the expected responses of sea-ice and foraging duration).

Index Name	Transformation	Response
A1 arrival weight (g)	No transformation	+ (heavier birds = more food)
A2 first incubation shift (days)	Ln transform	- (longer shift = less food)
A2 second incubation shift (days)	Ln transform	- (longer shift = less food)
A3 number of pairs	Delta ln; difference between logs of adjacent years	+ (more birds = more food)
A5 foraging during brood (hr)	Ln transform	- (longer foraging = less food)
A5 foraging during creche (hr)	Ln transform	- (longer foraging = less food)
A6a % breeding success A (potential chicks)	Log Odds transform [ln(p/(1-p))]	+ (greater success = more food)
A6c % breeding success C (potential chicks)	Log Odds transform [ln(p/(1-p))]	+ (greater success = more food)
A7 fledging weight (g)	No transformation	+ (heavier chicks = more food)
A8 mean ration weight (g)	No transformation	+ (heavier stomachs = more food)
A8 proportion fish in diet	Log Odds transform [ln(p/(1-p))]	- (more fish = less krill)
A8 proportion stomachs containing krill	Log Odds transform [ln(p/(1-p))]	+ (more krill = more krill)
B1a albatross population, n. nests (colony H)	Delta ln; difference between logs of adjacent years	+ (more birds = more food)
B1b albatross % breeding success (colony H)	Log Odds transform [ln(p/(1-p))]	+ (greater success = more food)
C1 cow foraging (hr)	Ln transform	- (longer foraging = less food)
C2 pup growth (kg/month)	Ln transform	+ (faster growth = more food)
F2a September ice % cover	Log Odds transform [ln(p/(1-p))]	+ (greater sea-ice = more krill)
F2b proportion of the year free of ice	Log Odds transform [ln(p/(1-p))]	- (greater proportion = less krill)
F2c weeks sea-ice within 100km	No transformation	- (increasing weeks = less krill)
F5 summer sea-surface temperature	No transformation	- (higher temperature = less sea-ice = less krill)
H1a Japanese CPUE (tonnes/hr)	Ln transform	+ (higher CPUE = more krill)
H1b Japanese CPUE (tonnes/day)	No transformation	+ (higher CPUE = more krill)
H2 krill catch in CPD (tonnes)	No transformation	+ (higher catch = more krill)
H3a standardised realised overlap	Log Odds transform [ln(p/(1-p))]	unknown
H3b realised potential overlap	Log Odds transform [ln(p/(1-p))]	unknown

Table 4 (continued)

Group	Series	ASD Code	Site Code	Species Code	Sex	Index Name	58	73	74	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
A	1	481	_	_	_	F2a September ice % cover								o	**	+	+	-	=	-	+	+	o	-	o	o	-	o	o	
A	2	481	_	_	_	H1a Japanese CPUE (tonnes/hr)									+	+		o	==		o	o	o	-	o	+	o	o	o	
A	3	481	_	_	_	H1b Japanese CPUE (tonnes/day)									-	-		-	=		o	o	+	o	o	*	+	+	+	
A	4	481	_	_	_	H2 krill catch in CPD (tonnes)												-	-	o	+	+	**	o	o	+	-	-	-	
A	5	481	_	_	_	H3a standardised realised overlap									*	o		o	-	o	o	o	**	o	o	o	-	-	-	
A	6	481	_	_	_	H3b realised potential overlap									+	+		**	o	+	o	o	o	o	o	-	-	=	-	
B	1	481	AIP	_	_	F2b proportion of the year free of ice								-	-	-	o	o	o	o	-	-	o	**	+	-	o	o	o	
B	2	481	AIP	_	_	F2c weeks sea-ice within 100km								o	=	o	o	+	+	+	=	o	+	*	-	-	+	o	o	
B	3	481	AIP	_	_	F5 summer sea-surface temperature										+	o	+	+	+	=	+	o	+	-	-	-	o	o	-
B	4	481	CSS	_	_	F5 summer sea-surface temperature										+	-	o	+	o	==	+	o	+	-	-	o	o	o	-
B	5	481	EIS	_	_	F5 summer sea-surface temperature										+	-	o	+	o	=	o	-	+	-	o	o	o	+	-
B	6	481	ESP	_	_	F5 summer sea-surface temperature										*	-	+	*	+	-	o	-	+	-	o	-	-	o	-
C	1	481	SES	_	_	F2b proportion of the year free of ice								-	-	-	+	*	+	o	-	-	+	+	-	-	o	o	-	
C	2	481	SES	_	_	F2c weeks sea-ice within 100km								o	-	-	+	+	+	o	=	o	+	+	-	-	+	o	-	
C	3	481	SES	_	_	F5 summer sea-surface temperature										+	-	o	+	o	=	o	-	+	-	o	o	o	+	-
C	4	481	SPS	_	_	F2b proportion of the year free of ice								-	-	o	o	*	+	o	-	-	o	o	-	-	+	**	o	
C	5	481	SPS	_	_	F2c weeks sea-ice within 100km								-	-	o	+	+	+	o	=	o	+	+	-	-	+	o	o	
C	6	481	SPS	_	_	F5 summer sea-surface temperature										*	-	+	*	+	-	o	-	+	-	o	-	-	o	-
D	1	481	AIP	PYD	U	A3 number of pairs																				=	o	+	-	+
D	2	481	AIP	PYD	U	A5 foraging during brood (hr)																		+	+	-	o	-	o	
D	3	481	AIP	PYD	U	A5 foraging during creche (hr)																		-	*	+	o	o	-	
D	4	481	AIP	PYD	U	A6c % breeding success C (potential																		-	-	o	+	o	+	+
D	5	481	AIP	PYD	U	A7 fledging weight (g)																		-	+	+	+	-	-	-
D	6	481	AIP	PYD	U	A8 mean ration weight (g)																		-	-	+	o	o	+	-
D	7	481	AIP	PYD	U	A8 proportion fish in diet																		+	-	o	+	-	o	+
D	8	481	AIP	PYD	U	A8 proportion stomachs containing krill																		o	o	o	==	o	o	o
G	1	481	ESP	PYD	U	A1 arrival weight (g)																						+	=-	o
G	2	481	ESP	PYD	U	A2 first incubation shift (days)																						-	+	o
G	3	481	ESP	PYD	U	A2 second incubation shift (days)																						-	+	o
G	4	481	ESP	PYD	U	A6a % breeding success A (potential																						+	o	-
G	5	481	ESP	PYD	U	A3 number of pairs																						=	-	+
H	1	481	SES	EUC	U	A6c % breeding success C (potential															+		*	o	o	-	o	-	
H	2	481	SES	PYN	U	A5 foraging during brood (hr)															-	+	+	o	o	-	+		

Table 4 (continued)

Group	Series	ASD Code	Site Code	Species Code	Sex	Index Name	58	73	74	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
H	3	481	SES	PYN	U	A5 foraging during creche (hr)																	+		o	o	-	o		
H	4	481	SES	PYN	U	A6c % breeding success C (potential																+	+	-	-	o	o	-	o	
H	5	481	SES	PYN	U	A7 fledging weight (g)																*	+	-	==	o	o	-	o	o
H	6	481	SES	PYN	U	A8 mean ration weight (g)																-	o	**	-			o		
H	7	481	SES	PYN	U	A8 proportion fish in diet																-	o	o	=			+		
H	8	481	SES	PYN	U	A8 proportion stomachs containing krill																o	==	o	o			o		
I	1	481	SES	SEA	F	C2 pup growth (kg/month)																-	**	-	+	-	o	o	o	
I	2	481	SES	SEA	M	C2 pup growth (kg/month)																+	+	==	+	-	o	o	-	
I	3	481	SES	SEA	U	C1 cow foraging (hr)																-		-	*	o	+	o	-	
I	4	481	CSS	SEA	M	C2 pup growth (kg/month)																						-	o	+
I	5	481	CSS	SEA	F	C2 pup growth (kg/month)																						-	+	o
J	1	482	_	_	_	F2a September ice % cover								o	**	o	o	o	-	-	o	*	+	-	o	o	o	o	o	
J	2	482	_	_	_	H1a Japanese CPUE (tonnes/hr)										-	-	+	+	-	*	o	+		-	o	+	o		
J	3	482	_	_	_	H1b Japanese CPUE (tonnes/day)										==	-	o	+	o	+	o	+		o	=	o	+		
J	4	482	_	_	_	H2 krill catch in CPD (tonnes)															o	+	-	o	**	+	-	-	-	
J	5	482	LAO	_	_	F5 summer sea-surface temperature										*	o	o	+	o	-	+	-	+	o	-	+	o	o	==
J	6	482	SIO	_	_	F2b proportion of the year free of ice								-	-	o	-	o	o	o	-	-	o	+	-	-	+	**	o	
J	7	482	SIO	_	_	F2c weeks sea-ice within 100km								-	=	o	o	o	+	+	-	-	-	*	-	-	*	o	o	
J	8	482	SIO	_	_	F5 summer sea-surface temperature										*	o	o	+	o	-	+	-	+	o	-	+	o	o	==
K	1	482	SIO	PYD	U	A3 number of pairs																		=	-	+	o	o	-	+
K	2	482	SIO	PYD	U	A6a % breeding success A (potential																		o	o	o	*	-	o	
K	3	482	SIO	PYN	U	A3 number of pairs																		=	-	+	o	+	-	o
K	4	482	SIO	PYN	U	A6a % breeding success A (potential																		==	+	+	+	-	o	o
K	5	482	SIO	PYP	U	A3 number of pairs																		=	==	+	o	o	o	o
K	6	482	SIO	PYP	U	A6a % breeding success A (potential																		-	+	+	o	-	o	o
K	7	482	LAO	PYD	U	A1 arrival weight (g)																-	o	+						
L	1	483	_	_	_	F2a September ice % cover								-	**	o	-	-	o	-	o	**	o	-	-	+	o	+	o	
L	2	483	_	_	_	H1a Japanese CPUE (tonnes/hr)																			o	-	o	*	-	
L	3	483	_	_	_	H1b Japanese CPUE (tonnes/day)																			o	-	o	**	o	
L	4	483	_	_	_	H2 krill catch in CPD (tonnes)																-	*+	o	-					
L	5	483	BIG	_	_	F5 summer sea-surface temperature										**	o	+	o	o	-	-	o	+	o	-	+	o	o	==
M	1	483	BIG	DIM	U	B1a albatross population, n. nests (colony				=	o	o	o	o	o	o	o	o	o	o	o	=	*	o	o	o	o	o	==	**
M	2	483	BIG	DIM	U	B1b albatross % breeding success (colony				+	+	o	+	==	o	+	+	o	+	o	o	-	o	+	==	o	+	-	==	+

Table 4 (continued)

Group	Series	ASD Code	Site Code	Species Code	Sex	Index Name	58	73	74	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
N	1	483	BIG	EUC	F	A1 arrival weight (g)																	+	+	+	-	o	o	o	-
N	2	483	BIG	EUC	M	A1 arrival weight (g)																	+	o	==	+	o	o	-	o
N	3	483	BIG	EUC	U	A3 number of pairs	=				=	**	-	o	o	+	o	+	o	o	-	-	+	-	o	o	o	o	==	o
N	4	483	BIG	EUC	U	A6a % breeding success A (potential					o	-	o	+	o	o	o	==	o	o	-	-	+	+	+	o	+	o	o	o
N	5	483	BIG	EUC	U	A7 fledging weight (g)																	+	o	-	+	o	-	-	o
N	6	483	BIG	EUC	U	A8 mean ration weight (g)																		o	-	**	+	o	-	-
N	7	483	BIG	EUC	U	A8 proportion fish in diet																		-	-	-	+	+	+	-
N	8	483	BIG	EUC	U	A8 proportion stomachs containing krill																		+	-	+	o	-	-	+
O	1	483	BIG	PYP	U	A3 number of pairs		=			=	o	==	*		=	o	-	o	+	o	o	+	o	=	+	o	o	o	o
O	2	483	BIG	PYP	U	A6a % breeding success A (potential					+	==	o	+		-	o	o	o	o	o	o	o	o	==	+	*	-	+	+
O	3	483	BIG	PYP	U	A7 fledging weight (g)																	o	+	-	+	o	-	-	o
O	4	483	BIG	PYP	U	A8 mean ration weight (g)																		o	-	+	o	==	+	+
O	5	483	BIG	PYP	U	A8 proportion fish in diet																		o	+	o	==	+	o	+
O	6	483	BIG	PYP	U	A8 proportion stomachs containing krill																		o	-	+	+	-	o	-
P	1	483	BIG	SEA	F	C2 pup growth (kg/month)																		-	+	-	+	+	-	o
P	2	483	BIG	SEA	M	C2 pup growth (kg/month)																		-	+	-	+	-	+	o
P	3	483	BIG	SEA	U	C1 cow foraging (hr)																		-	+	-	o	**	o	-
P	4	5841	_	_	_	H1a Japanese CPUE (tonnes/hr)				-	-								o	+	o				-		+	+	-	
P	5	5841	_	_	_	H1b Japanese CPUE (tonnes/day)				=	o								o	+	+				o		**	o	o	
Q	1	5842	SYO	PYD	U	A3 number of pairs										=	+	-	+	-	+	o	*	==	+	-	o	o	-	=
Q	2	881	EDP	_	_	F5 summer sea-surface temperature										-	*	*	+	+	o	-	+	o	-	o	o	-	o	=
Q	3	881	ROS	PYD	U	A3 number of pairs																	=	+	-	o	+		=	
Q	4	pbis	_	_	_	F2a September ice % cover								=	+	+	o	+	o	+	o	o	o	*	o	-	-	-	=	
R	1	5842	_	_	_	H1a Japanese CPUE (tonnes/hr)			=	o	+	o			o		o													
R	2	5842	_	_	_	H1b Japanese CPUE (tonnes/day)			==	o	+	o			o		+													
R	3	5842	_	_	_	H2 krill catch in CPD (tonnes)			-		+	+	+	o	-	-	-					o								
R	4	5842	BEE	_	_	F2c weeks sea-ice within 100km								o	+	o	o	o	+	+	+	o	==	o	o	o	-	+	==	
R	5	5842	BEE	_	_	F5 summer sea-surface temperature										+	+	+	+	-	o	-	-	-	-	+	+	+	-	==
R	6	5842	MAD	_	_	F5 summer sea-surface temperature										**	+	+	o	o	o	-	-	-	-	o	o	+	o	==
R	7	5842	SYO	_	_	F5 summer sea-surface temperature										o	+	o	*	o	+	+	-	-	-	+	o	o	o	==
S	1	5842	BEE	PYD	F	A1 arrival weight (g)																				-	-	+	+	o
S	2	5842	BEE	PYD	M	A1 arrival weight (g)																				-	o	+	o	-
S	3	5842	BEE	PYD	U	A1 arrival weight (g)																				+	o		-	

Table 4 (continued)

Group	Series	ASD Code	Site Code	Species Code	Sex	Index Name	58	73	74	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
S	4	5842	BEE	PYD	U	A2 first incubation shift (days)																			o	o	-	=	+	o
S	5	5842	BEE	PYD	U	A2 second incubation shift (days)																			+	+	-	=	+	o
S	6	5842	BEE	PYD	U	A3 number of pairs																				=	-	+	+	o
T	1	5842	BEE	PYD	U	A6a % breeding success A (potential																				o	+	=	=-	+
T	2	5842	BEE	PYD	U	A6c % breeding success C (potential																				o	o	+	==	o
T	3	5842	BEE	PYD	U	A7 fledging weight (g)																				o	o	+	==	+
T	4	5842	BEE	PYD	U	A8 mean ration weight (g)																			-	o	o	+	-	
T	5	5842	BEE	PYD	U	A8 proportion fish in diet																			o	+	o	o	-	
T	6	5842	BEE	PYD	U	A8 proportion stomachs containing krill																			o	-	o	+	o	

Table 5: Local-scale strategic model.

Linkage or Process	New Information Available
Fishery-harvested species	Changes in timing and distribution of Japanese fishery in Subarea 48.1 (WG-EMM-96/64).
Harvested-dependent species	Chinstrap penguin foraging and prey distribution, Seal Island (WG-EMM-96/49, 96/55; paragraphs 6.43 and 6.44). Predator foraging ranges (paragraph 6.42). Predator energy budgets, South Georgia (WG-EMM-96/7, 96/66; paragraphs 6.45 and 6.46). Predator foraging model (WG-EMM-96/20; paragraphs 6.47 to 6.54). Standardised CEMP indices (WG-EMM-96/4).
Environment-dependent species	Effect of sea-ice on penguins (WG-EMM-96/10, 96/27, 96/58; paragraphs 6.31 to 6.34). Oceanographic models (WG-EMM-96/61). Standardised CEMP indices (WG-EMM-96/4).
Environment-harvested species	Krill recruitment, biomass and environmental indices, Subarea 48.1 (WG-EMM-96/21 to 96/23, 96/27) and Subarea 48.3 (WG-EMM-96/18) (see also paragraphs 6.5 to 6.22). Standardised CEMP indices (WG-EMM-96/4).

Table 6: Regional-scale strategic model.

Linkage or Process	New Information Available
Fishery-harvested species	Fine-scale krill catch and effort data (WG-EMM-96/25; paragraphs 2.2 to 2.9). Distribution of krill catches in Area 48 (WG-EMM-96/64; paragraph 6.25)
Harvested-dependent species	Predator energy budgets (WG-EMM-96/7, 96/10, 96/66; paragraphs 6.40 and 6.41). Models of functional relationships (WG-EMM-96/67; paragraphs 6.56 to 6.60) Standardised CEMP indices (WG-EMM-96/4).
Environment-dependent species	Effect of sea-ice on penguins (WG-EMM-96/10, 96/58; paragraphs 6.31 to 6.34). Oceanographic models (WG-EMM-96/61). Standardised CEMP indices (WG-EMM-96/4). Krill flux in Subarea 48.2 (WG-EMM-96/37).
Environment-harvested species	Krill recruitment, biomass and environmental data, Subarea 58.4 (WG-EMM-96/28, 96/29), Ross Sea (WG-EMM-96/63). Standardised CEMP indices (WG-EMM-96/4).

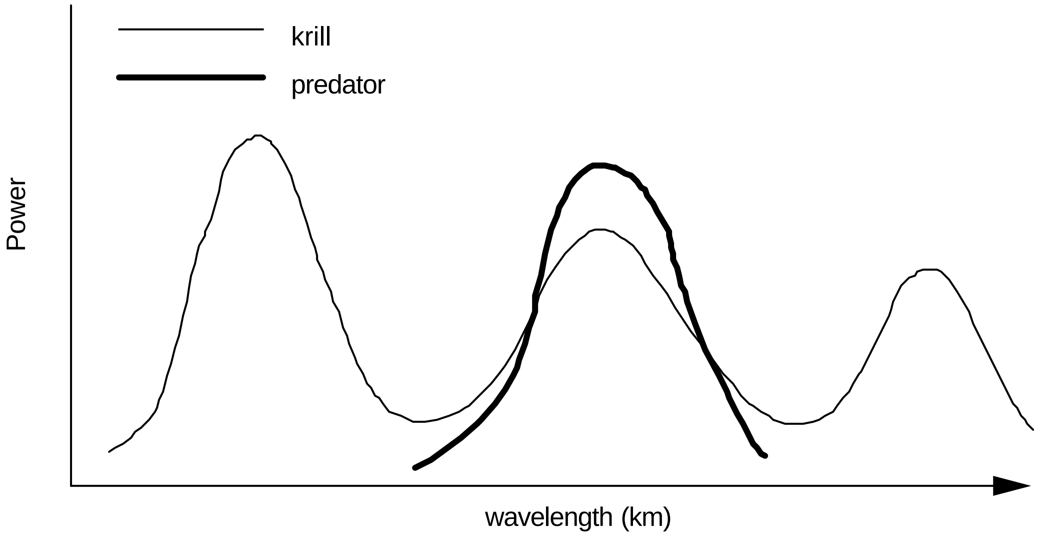

Figure 1: Hypothetical illustration of the congruence of top-down and bottom-up approaches. In this example the spectrum of the krill pattern has three peaks, showing three levels of spatial organisation of krill. The spectrum of predator behaviour has a single peak that overlaps with one of the krill peaks, indicating that this is the relevant local index.

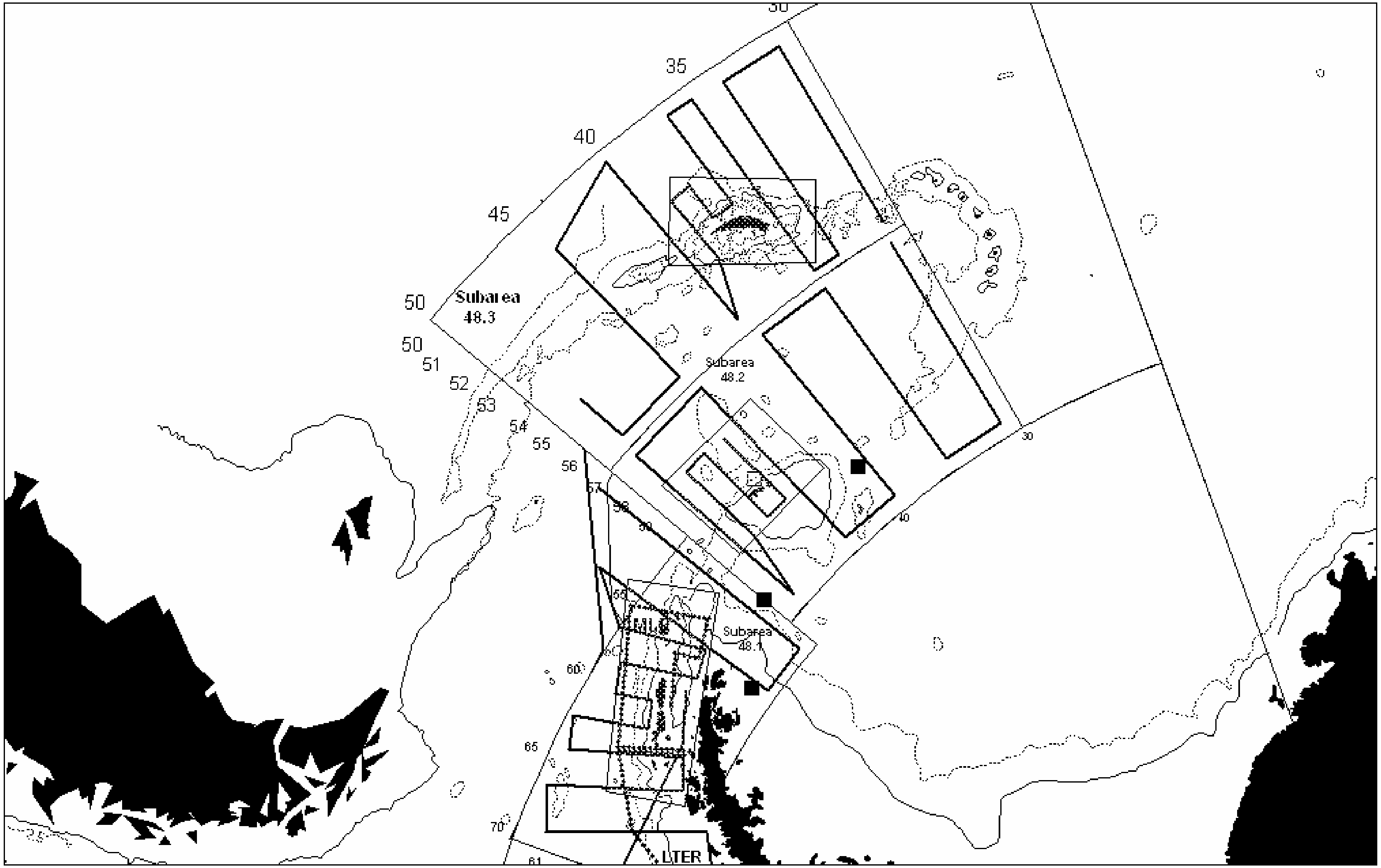

Figure 2: Map showing a possible synoptic survey in Subareas 48.1, 48.2 and 48.3 using three months of ship time. Trackline lengths and placement are illustrative only and do not represent any statistical scheme. Dotted lines in Subarea 48.1 delineate the US LTER and AMLR study regions. Filled squares represent mean ice position in January. Large boxes around islands represent areas of historically high krill density and are the basis for survey stratification.

APPENDIX A

AGENDA

Working Group on Ecosystem Monitoring and Management
(Bergen, Norway, 12 to 22 August 1996)

1. Introduction
   - (i) Opening of the Meeting
   - (ii) Organisation of the Meeting and Adoption of the Agenda

2. Data
   - (i) Fisheries
     - (a) Catches, Status and Trends
     - (b) Harvesting strategies
     - (c) Observer Scheme
     - (d) Other Information
   - (ii) Surveys on Harvested Species
   - (iii) Dependent Species
   - (iv) Environment
   - (v) Biology and Ecology of Harvested and Dependent Species of Particular Relevance to Fisheries Management and CEMP

3. Harvested Species
   - (i) Methods for Estimating Distribution, Standing Stock, Recruitment and Production of Harvested Species
   - (ii) Analysis and Results of Studies on Distribution and Standing Stock
   - (iii) Analysis and Results of Studies on Recruitment and Production of Harvested Species
   - (iv) Indices of Harvested Species Abundance, Distribution and Recruitment
   - (v) Future Work
     - (a) Synoptic Krill Survey in Area 48
     - (b) Other Work

4. Dependent Species
   - (i) Sites
   - (ii) Species
   - (iii) Monitoring Methods

(a) Report of the Subgroup on Monitoring Methods
(b) Revisions
(c) New Methods
(d) At-sea Behaviour
(e) Marking Birds
(f) Crabeater Seals

(iv) Analytical Methods
(a) Report of the Subgroup on Statistics
(b) Calculation of Indices
(c) Extension of Indices

(v) Data Submission

(vi) Future Work

5. Environment
(i) Methods for Monitoring Environmental Variables of Direct Importance in Ecosystem Assessment
(ii) Consideration of Studies on Key Environmental Variables
(iii) Indices of Key Environmental Variables

6. Ecosystem Analysis
(i) By-catch of Fish in the Krill Fishery
(ii) Interactions between Ecosystem Components
(a) Harvested Species and the Environment
(b) Harvested Species and the Krill Fishery
(c) Dependent Species and the Environment
(d) Dependent Species and Harvested Species
(i) Diet
(ii) Food Consumption/Energy Budgets
(iii) Predator/Prey Models
(e) Fishery and Dependent Species Overlap
(iii) Analysis of Data from CEMP Indices

7. Ecosystem Assessment
(i) Assessments Based on CEMP indices
(ii) Estimation of Potential Yield
(iii) Precautionary Catch limits
(iv) Consideration of Possible Management Measures
(v) Extension of the Scope of CEMP

(vi) Strategic Modelling

(vii) Ecosystem Implications of Proposed New Fisheries

(viii) Future Work

8. Advice to the Scientific Committee

(i) General Advice

(ii) Management Advice

(iii) Future Work

9. Other Business

10. Adoption of the Report

11. Close of the Meeting.

LIST OF PARTICIPANTS

Working Group on Ecosystem Monitoring and Management
(Bergen, Norway, 12 to 22 August 1996)

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APPENDIX C

LIST OF DOCUMENTS

Working Group on Ecosystem Monitoring and Management
(Bergen, Norway, 12 to 22 August 1996)

WG-EMM-96/1 Rev. 1	PROVISIONAL AGENDA AND PROVISIONAL ANNOTATED AGENDA FOR THE SECOND MEETING OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT (WG-EMM)
WG-EMM-96/2	LIST OF PARTICIPANTS
WG-EMM-96/3	LIST OF DOCUMENTS
WG-EMM-96/4	CEMP INDICES 1996: SECTIONS 1 TO 3 Secretariat
WG-EMM-96/4 Errata	CEMP INDICES 1996: SECTIONS 1 TO 3 Secretariat
WG-EMM-96/5	GEOGRAPHICAL ASPECTS OF UTILISING RESOURCES OF KRILL (*EUPHAUSIA SUPERBA*) R.R. Makarov (Russia)
WG-EMM-96/6	REPORT OF THE MEETING OF THE SUBGROUP ON STATISTICS (Cambridge, UK, 7 to 9 May 1996) (Attached to WG-EMM this report as Appendix H)
WG-EMM-96/7	THE RELATIONSHIP BETWEEN FORAGING BEHAVIOUR AND ENERGY EXPENDITURE IN ANTARCTIC FUR SEALS (*J. Zool., Lond.* (1996), 239) J.P.Y. Arnould, I.L. Boyd and J.R. Speakman (UK)
WG-EMM-96/8	A COMPARISON OF ANTARCTIC KRILL (*EUPHAUSIA SUPERBA* DANA) CAUGHT BY NETS AND TAKEN BY MACARONI PENGUINS (*EUDYPTES CHRYSOLOPHUS* BRANDT): EVIDENCE FOR SELECTION? H.J. Hill, P.N. Trathan, J.P. Croxall and J.L. Watkins (UK)
WG-EMM-96/9	KRILL CAUGHT BY PREDATORS AND NETS: DIFFERENCES BETWEEN SPECIES AND TECHNIQUES K. Reid, P.N. Trathan, J.P. Croxall and H.J. Hill (UK)

WG-EMM-96/10 DYNAMICS OF ANTARCTIC PENGUIN POPULATIONS IN RELATION TO INTER-ANNUAL VARIABILITY IN SEA-ICE DISTRIBUTION
(*Polar Biol.* (1996), 16: 321–330)
P.N. Trathan, J.P. Croxall and E.J. Murphy (UK)

WG-EMM-96/11 THE FISH DIET OF BLACK-BROWED ALBATROSS *DIOMEDEA MELANOPHRYS* AND GREY-HEADED ALBATROSS *D. CHRYSOSTOMA* AT SOUTH GEORGIA
(*Polar Biol.* (1996), 16)
K. Reid, J.P. Croxall and P.A. Prince (UK)

WG-EMM-96/12 CEPHALOPODS AND MESOSCALE OCEANOGRAPHY AT THE ANTARCTIC POLAR FRONT: SATELLITE TRACKED PREDATORS LOCATE PELAGIC TROPHIC INTERACTIONS
(*Mar. Ecol. Prog. Ser.* (1996), 136: 37–50)
P.G. Rodhouse, P.A. Prince, P.N. Trathan, E.M.C. Hatfield, J.L. Watkins, D.G. Bone, E.J. Murphy and M.G. White (UK)

WG-EMM-96/13 DEVELOPMENTS IN THE CEMP INDICES 1996
Secretariat

WG-EMM-96/14 TESTING FOR NORMALITY IN COLONY COUNTS
Secretariat

WG-EMM-96/15 A HISTORY OF THE ACQUISITION AND ANALYSIS OF SEA-ICE DATA BY CCAMLR
D.J. Agnew (Secretariat)

WG-EMM-96/16 WG-EMM WORKSHOP ON AT-SEA BEHAVIOUR
I.L. Boyd (UK)

WG-EMM-96/17 DIET OF THE CAPE PETREL *DAPTION CAPENSE* DURING THE CHICK-REARING PERIOD AT FILDES PENINSULA AND HARMONY POINT, SOUTH SHETLAND ISLANDS, ANTARCTICA
G.E. Soave, N.R. Coria, P. Silva, D. Montalti and M. Favero (Argentina)

WG-EMM-96/18 KRILL BIOMASS ESTIMATES FOR TWO SURVEY BOXES TO THE NORTH-EAST AND NORTH-WEST OF SOUTH GEORGIA IN JANUARY 1996: THE BEGINNING OF A FIVE-YEAR MONITORING PROGRAM
A.S. Brierley, J.L. Watkins and A.W.A. Murray (UK)

WG-EMM-96/19 A SYNOPTIC REVIEW OF ENERGETIC REQUIREMENTS OF SOUTHERN OCEAN KRILL PREDATORS
A.M. Stansfield (USA)

WG-EMM-96/20	A MODEL AT THE LEVEL OF THE FORAGING TRIP FOR THE INDIRECT EFFECTS OF KRILL (*EUPHAUSIA SUPERBA*) FISHERIES ON KRILL PREDATORS P.V. Switzer and M. Mangel (USA)
WG-EMM-96/21	CLIMATE CHANGE AND ZOOPLANKTON DOMINANCE IN THE ANTARCTIC MARINE ECOSYSTEM: IMPLICATIONS FOR THE FOOD WEB V. Loeb (USA), V. Siegel (Germany), O. Holm-Hansen, R. Hewitt, W. Fraser, W. Trivelpiece and S. Trivelpiece (USA)
WG-EMM-96/22	INDICES OF PREY AVAILABILITY NEAR THE SEAL ISLAND CEMP SITE: 1990 THROUGH 1996 R.P. Hewitt, G. Watters and D.A. Demer (USA)
WG-EMM-96/23	DISTRIBUTION, BIOMASS AND ABUNDANCE OF ANTARCTIC KRILL IN THE VICINITY OF ELEPHANT ISLAND DURING THE 1996 AUSTRAL SUMMER R.P. Hewitt, D.A. Demer and V. Loeb (USA)
WG-EMM-96/24	AREAL AND SEASONAL EXTENT OF SEA-ICE COVER OFF THE NORTHWESTERN SIDE OF THE ANTARCTIC PENINSULA: 1979 THROUGH 1995 R.P. Hewitt (USA)
WG-EMM-96/25	REPORTING OF FINE-SCALE KRILL DATA IN THE 1994/95 SEASON Secretariat
WG-EMM-96/26	OBSERVATIONS OF FISHING VESSEL ACTIVITY, RKTS *GENERAL PETROV*, MARCH TO JULY 1995 Submitted by Ukraine (with additional notes by the Secretariat)
WG-EMM-96/27	A WAY FORWARD IN THE MULTIVARIATE ANALYSIS OF ANTARCTIC PREDATOR, PREY AND ENVIRONMENT INDICES: PREDATOR-ENVIRONMENT INTERACTIONS AT SEAL ISLAND D.J. Agnew (Secretariat), G. Watters and R. Hewitt (USA)
WG-EMM-96/28	RESULTS OF A HYDROACOUSTIC SURVEY OF ANTARCTIC KRILL POPULATIONS IN CCAMLR DIVISION 58.4.1 CARRIED OUT IN JANUARY TO APRIL 1996 T. Pauly, I. Higginbottom, S. Nicol and W. de la Mare (Australia)
WG-EMM-96/29	AN OVERVIEW AND SOME PRELIMINARY RESULTS OF A BIOLOGICAL/OCEANOGRAPHIC SURVEY OFF THE COAST OF EAST ANTARCTICA (80-150°E) CARRIED OUT IN JANUARY TO MARCH 1996 S. Nicol, N. Bindoff, W. de la Mare, D. Gillespie, T. Pauly, D. Thiele, E. Woehler and S. Wright (Australia)

WG-EMM-96/30	VACANT
WG-EMM-96/31	FISH IN THE DIET OF THE BLUE-EYED SHAG *PHALACROCORAX ATRICEPS* AT THE SOUTH SHETLAND ISLANDS: SIX YEARS OF MONITORING STUDIES R. Casaux and E. Barrera-Oro (Argentina)
WG-EMM-96/32	THE IMPORTANCE OF FISH IN THE DIET OF THE SOUTH POLAR SKUA *CATHARACTA MACCORMICKI* AT THE SOUTH SHETLAND ISLANDS, ANTARCTICA D. Montalti, R. Casaux, N. Coria and G. Soave (Argentina)
WG-EMM-96/33	MONITORING OF SEAL POPULATIONS ON KING GEORGE ISLAND, 1995–1996 (VNIRO, Russia)
WG-EMM-96/34	ON SELECTIVITY OF COMMERCIAL AND RESEARCH TRAWLS WHEN KRILL CATCHING S.M. Kasatkina (Russia)
WG-EMM-96/35	HYDROMETEOROLOGICAL CONDITION FEATURES IN SOUTH ORKNEYS SUBAREA IN FEBRUARY–MARCH 1996 M.I. Polischuk and V.N. Shnar (Russia)
WG-EMM-96/36	RESULTS OF ACOUSTIC ASSESSMENT OF KRILL BIOMASS IN SUBAREA 48.2 DURING SUMMER 1996 S.M. Kasatkina, V.A. Sushin, V.M. Abramov, V.I. Sunkovich, M.I. Polischuk and V.N. Shnar (Russia)
WG-EMM-96/37	EVALUATION OF KRILL TRANSPORT FACTOR RESULTS IN SUBAREA 48.2 IN SUMMER PERIOD OF 1996 S.M. Kasatkina, V.N. Shnar, M.I. Polischuk V.M. Abramov and V.A. Sushin (Russia)
WG-EMM-96/38	TRENDS IN SIZE AND SUCCESS OF BREEDING COLONIES OF MACARONI AND ROCKHOPPER PENGUINS AT MARION ISLAND, 1979/80-1995/96 J. Cooper, A. Wolfaardt and R.J.M. Crawford (South Africa)
WG-EMM-96/39	SUMMARY OF CEMP ACTIVITIES AT CAPE SHIRREFF D. Torres (Chile)
WG-EMM-96/40	UNCERTAINTY IN ECHOSOUNDER CALIBRATIONS D.A. Demer and M.A. Soule (USA)
WG-EMM-96/41	MEASUREMENTS OF FISH SCHOOL VELOCITIES WITH AN ACOUSTIC DOPPLER CURRENT PROFILER D.A. Demer (USA)

WG-EMM-96/42 AN ACOUSTIC SURVEY OF ANTARCTIC KRILL ON THE SOUTH GEORGIA SHELF, CCAMLR SUBAREA 48.3, IN JANUARY 1992
C. Goss and I. Everson (United Kingdom)

WG-EMM-96/43 INTER-ANNUAL VARIATION IN CONDITION INDEX OF THE MACKEREL ICEFISH *CHAMPSOCEPHALUS GUNNARI*
I. Everson (United Kingdom), K.-H. Kock (Germany) and G. Parkes (United Kingdom)

WG-EMM-96/44 DIET OF THE CAPE PETREL *DAPTION CAPENSE* DURING THE POST-HATCHING PERIOD AT IAURIE ISLAND, SOUTH ORKNEY ISLANDS, ANTARCTICA
N.R. Coria, G.E. Soave and D. Montalti (Argentina)

WG-EMM-96/45 LONGTERM MONITORING OF KRILL RECRUITMENT AND ABUNDANCE INDICES IN THE ELEPHANT ISLAND AREA (ANTARCTIC PENINSULA
V. Siegel (Germany), W. de la Mare (Australia) and V. Loeb (USA)

WG-EMM-96/46 EFFECT OF MISSING MODES ON CALIBRATION SPHERE TARGET STRENGTHS (ICES CM 1996/B: 37, Fish Capture Committee)
K.G. Foote (Norway)

WG-EMM-96/47 CPUES AND BODY LENGTH OF ANTARCTIC KRILL DURING 1994/95 SEASON IN THE FISHING GROUNDS AROUND THE SOUTH SHETLAND ISLANDS
S. Kawaguchi, T. Ichii and M. Naganobu (Japan)

WG-EMM-96/48 REPORT OF THE 1995/96 JAPANESE WHALE RESEA RCH PROGRAMME UNDER SPECIAL PERMIT IN THE ANTARCTIC (JARPA) IN AREA IV AND EASTERN PART OF AREA III
S. Nishiwaki, H. Ishikawa, D. Tohyama, M. Kawasaki, K. Shimamoto, S. Yuzu, T. Tamura, T. Mogoe, T. Hishii, T. Yoshida, H. Hidaka, H. Nibe, K. Yamashiro, K. Ono and F. Taguchi (Japan)

WG-EMM-96/49 COMPARISONS IN PREY DISTRIBUTION BETWEEN INSHORE AND OFFSHORE FORAGING AREAS OF CHINSTRAP PENGUINS AND ANTARCTIC FUR SEALS AT SEAL ISLAND
T. Ichii (Japan), J.L. Bengtson (USA), T. Takao (Japan), P. Boveng, J.K. Jansen, M.F. Cameron, L.M. Hiruki, W.R. Meyer (USA), M. Naganobu and S. Kawaguchi (Japan)

WG-EMM-96/50 CPUE AND RECRUITMENT INDICES CALCULATED FROM LOG BOOK DATA OF JAPANESE KRILL FISHERIES
S. Kawaguchi, T. Ichii and M. Naganobu (Japan)

WG-EMM-96/51	CPUE, NET TOWING DEPTH AND BODY LENGTH OF KRILL DURING THE WINTER OPERATION OF JAPANESE KRILL FISHERY AROUND SOUTH GEORGIA S. Kawaguchi, T. Ichii and M. Naganobu (Japan)
WG-EMM-96/52	PRELIMINARY RESULTS ON BY-CATCH OF FISHES CAUGHT BY THE FISHERY VESSEL *CHIYO MARU NO. 3* TO THE NORTH OF THE SOUTH SHETLAND ISLANDS (FEBRUARY TO MARCH, 1996) S. Kawaguchi, T. Ichii and M. Naganobu (Japan)
WG-EMM-96/53	DRAFT METHODS RECOMMENDED TO WG-EMM FOR APPROVAL BY THE SUBGROUP ON MONITORING METHODS
WG-EMM-96/54 Rev. 1	REPORT OF THE SUBGROUP ON MONITORING METHODS (Bergen, Norway, 8 to 10 August 1996) (Attached to this report as Appendix I)
WG-EMM-96/55	COMPARISONS IN DIET BETWEEN DIURNAL AND OVERNIGHT FORAGING CHINSTRAP PENGUINS AT SEAL ISLAND T. Ichii, T. Hayashi (Japan), J.L. Bengtson, P. Boveng, J.K. Jansen, M. F. Cameron (USA) and A. Miura (Japan)
WG-EMM-96/56	CALCULATING PRECAUTIONARY CATCH LIMITS BASED ON MASS OF KRILL CONSUMED BY PREDATORS I. Everson (UK) and W. de la Mare (Australia)
WG-EMM-96/57	COOPERATIVE PROJECT BELGIUM – ARGENTINA INTO EMM: ‘GERLACHE – SOBRAL’ D. Vergani (Argentina), L. Holsbeek (Belgium), Z. Stanganelli (Argentina) and C. Joiris (Belgium)
WG-EMM-96/58	THE BREEDING BIOLOGY AND DISTRIBUTION OF ADELIE PENGUINS: ADAPTATIONS TO ENVIRONMENTAL VARIABILITY (In: Ross, R., E. Hofmann and L. Quetin (Eds). *Foundations for Ecological Research West of the Antarctic Peninsula*. American Geophysical Union, Washington, DC, 1996) W.Z. Trivelpiece and W.R. Fraser (USA)
WG-EMM-96/59	USE OF AT-SEA DISTRIBUTION DATA TO DERIVE POTENTIAL FORAGING RANGES OF MACARONI PENGUINS DURING THE BREEDING SEASON P. Trathan, E. Murphy, J. Croxall and I. Everson (UK)
WG-EMM-96/60	A CONCEPTUAL FRAMEWORK FOR MODELING ANTARCTIC KRILL E.E. Hofmann (USA)

WG-EMM-96/61 — OCEANOGRAPHIC CIRCULATION MODELS FOR THE WESTERN ANTARCTIC CONTINENTAL SHELF AND DRAKE PASSAGE
J.M. Klinck, E.E. Hofmann (USA) and E. Murphy (UK)

WG-EMM-96/62 Rev. 1 — EXECUTIVE SUMMARY OF SCAR/COMNAP WORKSHOPS ON 'MONITORING OF ENVIRONMENTAL IMPACTS FROM SCIENCE AND OPERATIONS IN ANTARCTICA'
(Oslo, Norway 17-20 October 1995 and College Station, Texas, US, 25-29 March 1996)

WG-EMM-96/63 — ESTIMATION OF BIOMASS OF KRILL *EUPHAUSIA SUPERBA* AND BIRDS AND MAMMALS CENSUS DURING THE XTH ITALIAN EXPEDITION TO ROSS SEA, NOVEMBER/DECEMBER 1994
M. Azzali, J. Kalinowski and N. Saino (Italy)

WG-EMM-96/64 — DETAILED DISTRIBUTION OF KRILL FISHING AROUND SOUTH GEORGIA
E.J. Murphy, P.N. Trathan, I. Everson and G. Parkes (UK)

WG-EMM-96/65 — HATCHING SEASON AND GROWTH OF *PLEURAGRAMMA ANTARCTICUM* LARVAE NEAR THE ANTARCTIC PENINSULA IN AUSTRAL SUMMER 1993/94
Tae won Lee, Suam Kim and Seong Sik Cha (Republic of Korea)

WG-EMM-96/66 — PRELIMINARY ESTIMATES OF KRILL CONSUMPTIONS BY ANTARCTIC FUR SEALS AND MACARONI PENGUINS AT SOUTH GEORGIA
I.L. Boyd and J.P. Croxall (UK)

WG-EMM-96/67 — EXTENSION TO THE KRILL-PREDATOR MODELLING EXERCISE
R.B. Thomson and D.S. Butterworth (South Africa)

WG-EMM-96/68 — MODELING THE GROWTH DYNAMICS OF ANTARCTIC KRILL
C.M. Lascara and E.E. Hofmann (USA)

WG-EMM-96/69 — THE FORAGING RANGE OF ADELIE PENGUINS – IMPLICATIONS FOR CEMP AND INTERACTIONS WITH THE KRILL FISHERY
K.R. Kerry, J.R. Clarke (Australia), S. Corsolini (Italy), S. Eberhard, H. Gardner, R. Lawless (Australia), D. Rodary (France), R. Thomson (South Africa), R. Tremont and B. Wieneke (Australia)

WG-EMM-96/70 — EVALUATION OF THE KRILL STOCK IN SUBAREA 48.3, JUNE–AUGUST 1995
V.A. Bibik (Ukraine)

WG-EMM-96/71 — ICES WORKING GROUP ON FISHERIES ACOUSTICS SCIENCE AND TECHNOLOGY (FAST); SUMMARY OF TOPICS DISCUSSED AT THE 1996 MEETING
I. Everson (UK)

WG-EMM-96/72	VACANT
WG-EMM-96/73	AMLR 1995/96 FIELD SEASON REPORT – OBJECTIVES, ACCOMPLISHMENTS AND TENTATIVE CONCLUSIONS Delegation of USA

OTHER DOCUMENTS

CCAMLR-XV/7	NOTIFICATION OF THE INTENTION OF KOREA AND THE UNITED KINGDOM TO INITIATE A NEW FISHERY Delegations of Korea and the United Kingdom
CCAMLR-XV/8	NOTIFICATION OF NEW ZEALAND'S INTENTION TO INITIATE NEW FISHERIES Delegation of New Zealand
CCAMLR-XV/9	NOTIFICATION OF AUSTRALIA'S INTENTION TO INITIATE NEW FISHERIES Delegation of Australia
CCAMLR-XV/10	NOTIFICATION OF NORWAY'S INTENTION TO INITIATE A NEW FISHERY Delegation of Norway
CCAMLR-XV/11	NOTIFICATION OF SOUTH AFRICA'S INTENTION TO INITIATE NEW FISHERIES Delegation of South Africa
SC-CAMLR-XIV/BG/20	REPORT OF BIOLOGIST-OBSERVER ON FISHING VESSEL RKTS *GENERAL PETROV*, MARCH TO AUGUST 1994 Delegation of Ukraine
SC-CAMLR-XV/BG/2	DRAFT CEMP TABLES 1 TO 3 Secretariat
SC-CAMLR-XV/BG/7	POPULATION CHANGES IN ALBATROSSES AT SOUTH GEORGIA Delegation of the United Kingdom
SC-CAMLR-XV/BG/10 Rev. 1	EXCERPTS FROM THE REPORT OF THE MEETING OF THE SCAR GROUP OF SPECIALISTS ON SEALS (Cambridge, UK, 1–2 August 1996)
SC-CAMLR-XV/BG/11	NEED FOR PROCEDURES TO GOVERN THE RESUMPTION OF FISHERIES TARGETING SPECIES NOT PRESENTLY HARVESTED BUT FOR WHICH A FISHERY PREVIOUSLY EXISTED Delegation of USA

DETAILS THAT SHOULD BE INCLUDED IN REPORTS OF ACOUSTIC SURVEYS OF KRILL BIOMASS AND/OR DISTRIBUTION

Recommended details to be added to reports of acoustic surveys of krill biomass and/or distribution. These details are additional to those given in SC-CAMLR-XI, Annex 4, Appendix H, points 2 and 3.

Description of echosounder and associated systems:

Echosounder
- make
- model
- software version

Data logging
- software description
- data types logged (e.g. ping or integration interval)

Data processing
- software description
- noise removal techniques
- background noise thresholding methods

Calibration description:

General
- date
- location

Methods
- technique (e.g. sphere)
- sphere type
- ship mooring type (eg. 1, 2, 4 anchors etc.)

Environmental conditions

- water temperature*
- salinity*
- sound velocity*
- bottom depth
- sphere depth
- qualitative descriptions of sea state, swell, wind, currents etc.

(* profiles of these as a function of depth would be ideal)

Transducer description for each channel logged

- frequency
- manufacture
- model
- type (single, dual- or split-beam)
- mounting method (flush or sea chest; window material etc.)
- location (hull, keel, pole or towed body)
- orientation (downward, upward looking etc.)
- depth (or depth range of towed body)

Transceiver settings

- power
- bandwidth
- pulse length
- absorption coefficient
- time varied gain (TVG)
- noise rejection level
- noise margin
- S_v threshold

Calibration results

e.g.	or	or
peak S_v transducer gain	source level	source level
two-way beam angle	receiver sensitivity	beam width
beam width	narrow beam factor	echosounder constant
along ship		
athwart ship		
narrow		
wide		

(Note: the parameters required from a calibration vary from one echosounder type to another and also for different transducer types. We have listed here only indicative parameters determined in calibrations.)

Survey operating and processing conditions:

nominal ship speed
integration interval type (distance, time etc.)
integration interval value (in n miles, seconds etc.)
integration depth layers
pulse repetition rate

REPORT OF THE SUBGROUP ON ECHO CLASSIFICATION

A total of seven papers (WG-EMM-96/18, 96/23, 96/28, 96/36, 96/42, 96/49 and 96/63) discussed the use of acoustic methods to estimate krill biomass. The Working Group noted that there was considerable variation in the amount of detail given in the description of methods used to classify the acoustic signal. As a result, a subgroup comprising Drs J. Watkins (UK), D. Demer (USA), T. Pauly (Australia), M. Naganobu (Japan), M. Azzali (Italy), V. Sushin (Russia), R. Hewitt (USA), K. Foote (Norway) and D. Miller (South Africa) was formed to:

(i) describe the different echo classification techniques;
(ii) assess how comparable the results were; and
(iii) recommend common criteria to be used for comparative purposes.

2. Detailed information was obtained from the authors of all the above-mentioned papers during the meeting.

3. In WG-EMM-96/23 and 96/28 signals thought to be non-biological, including background noise, were removed. The remaining acoustic backscatter was considered to be due to krill. If other scatterers are also present in the water column, then such a technique is likely to overestimate krill density.

4. In WG-EMM-96/18, 96/42 and 96/63 the biological signal remaining after noise removal was classified on the basis of a dB difference (dB difference = 120 kHz S_V - 38 kHz S_V). The effectiveness of such a classification is yet to be consistently determined.

5. WG-EMM-96/18 classified the acoustic backscatter into three classes: nekton (dB difference < 2 dB), krill (2 dB < dB difference < 12 dB) macrozooplankton (dB difference > 12 dB).

6. WG-EMM-96/42 classified acoustic backscatter into two classes: nekton (dB difference < 2 dB), krill and zooplankton (dB difference > 2 dB).

7. WG-EMM-96/63 classified acoustic backscatter first into two classes: fish (dB difference < 0 dB) and krill plus zooplankton (dB difference > 0 dB). The krill was then separated from the zooplankton on the basis of TS of individual scatterers (-73 dB < krill TS < -68 dB).

8. WG-EMM-96/36 used a method based on *in situ* TS to separate krill from other scatterers. Minimum and maximum TS values were derived from net catches using the size of krill and TS to length relationship described in SC-CAMLR-X. Acoustic backscatter with *in situ* TS values estimated by the echosounder as falling within the minimum and maximum values calculated from the net catch was then classified as krill.

9. WG-EMM-96/49 used a classification system based on net hauls and a video camera deployed on nets, CTDs and ROVs.

10. In addition, WG-EMM-96/28 and 96/63 used net hauls to identify the dominant euphausiid in the area and so determine which areas to exclude from biomass estimates.

11. Given the differing techniques used to classify acoustic backscatter mean that krill biomass estimates are not directly comparable. At present there is no universally agreed method for classifying the acoustic backscatter to separate krill from other targets.

12. The subgroup recommended that all papers on echo classification should contain a full description of the echo classification procedures used.

13. Each paper should also contain average mean volume backscattering strength (S_v) and average mean area backscattering coefficient (S_A) for each transect before any biological classification is undertaken. Furthermore, estimates of krill volumetric density and krill areal density can be computed from the above S_V and S_A using the methods described in Hewitt and Demer, 1993 and Demer and Hewitt, 1995. Although this may lead to overestimates of krill density, it will provide baseline values suitable for comparative purposes. Authors are encouraged to present results classified into krill and other scatterers.

14. Finally, the subgroup recognised that both multifrequency and single-frequency echo classification techniques were being developed and encouraged most strongly the further development, validation and description of such techniques.

REFERENCES

Demer, D.A. and R.P. Hewitt. 1995. Bias in acoustic biomass of *Euphausia superba* due to diel vertical migration. *Deep Sea Res.*, 1 (42): 455–475.

Hewitt, R.P. and D.A. Demer. 1993. Dispersion and abundance of Antarctic krill in the vicinity of Elephant Island in the 1992 austral summer. *Mar. Ecol. Prog. Ser.*, 99: 29–39.

NOTES REGARDING FURTHER WORK ON KRILL-PREDATOR MODELLING STUDIES

Note: Comments pertain to the Thomson-Butterworth approach (e.g. WG-EMM-96/67) to analysis except where indicated otherwise.

(i) Antarctic fur seal

(a) Sensitivity of results to density dependence with adult survival rate, and to alternative functional forms (i.e. alternative to linear functional forms) for the density dependence remains to be investigated.

(b) The assumption made in recent analyses that the estimated population growth rate reflects the maximum possible (i.e. corresponds to an absence of density dependent effects) is considered reasonable for the population viewed as a whole (although there are indications that the population has reached, and perhaps even exceeded, pre-exploitation levels in localised areas).

(c) A further year's data which has now become available should be incorporated into analyses.

(ii) Black-browed albatross

(a) Further analyses should assume that the estimated survival rates include a component related to fishery-induced mortality from the year 1989 when longlining commenced in the vicinity of South Georgia, and should incorporate the survival rate estimates subsequent to 1990/91 which are now available. The analyses need to take account of differences in population trend before and after 1989.

(b) Data suggest that the population size was high and stable during the 1970s, but dropped to a lower but still stable level in the 1980s. Such behaviour is not immediately compatible with the structure of the present krill-predator and krill yield models, and modifications to these which permit reconciliation with these data should be investigated.

(c) There are no series of population size estimates which would allow estimates to be made of maximum population growth rate from periods of population increase – an analysis in any case rendered the more problematic because of the long lag from fledging to recruitment to the breeding population. Instead, maximum growth rate estimates based on plausible maxima for values of demographic parameters for survival and reproduction need to be considered.

(iii) Adélie penguin

(a) Dr M. Mangel (USA) will liaise directly with Dr W. Trivelpiece (USA) to obtain local-scale data pertinent to the further development of the Switzer-Mangel krill-Adélie penguin functional response model (WG-EMM-96/20).

(b) Dr Mangel will liaise with Dr D. Butterworth and Miss R. Thomson (South Africa) to effect input of results from a refined Switzer-Mangel model into computations allowing estimation of the effect of different krill fishing intensities (measured by γ) on the size of the Adélie penguin population.

(c) Further work to amend the Thomson-Butterworth Adélie penguin model as per Appendix F of SC-CAMLR-XIV, Annex 4 is unlikely to commence before 1997. Dr Trivelpiece will, if possible, extract the requisite data (annual estimates of the number of colony birds and fledging success rates) for these analyses by early 1997.

(d) The population in question appears to have changed from a stable level in the 1980s via a sudden drop in 1988/89 to a subsequent near stable but lower level. The latter period shows much lower levels of cumulative survival from fledging to recruitment to the breeding population. This combination of events implies that other demographic parameters must also have changed, and available data on age at first laying and adult survival rate should be examined for evidence of this.

(e) The present approach assumes that only the juvenile (first year) survival rate depends on krill availability. This approach should be extended to allow sub-adult survival rates to depend upon this as well. Data available on cumulative survival to first breeding could be used to attempt the estimation required.

(iv) Crabeater seals

(a) As survival rate data do not exist, indices of relative cohort strength (inferred from investigations of teeth and ovaries) would need to be used as a substitute for juvenile survival rate in any analysis.

(b) Information on maximum possible population increase rates would need to be inferred by analogy from other species. As results for resilience to krill harvesting seem likely to be very sensitive to this value, and given the questionable reliability of such arguments by analogy, analysis for this species should be accorded a lesser priority.

(v) Gentoo penguins

(a) Dr Trivelpiece has data for this species similar to those he has collected for Adélie penguins. Investigation would be of interest because this species has a different life history to Adélie penguins (including, in particular, a much lower age at first laying).

(b) Extraction of the data required for a modelling exercise will, however, be time-consuming. Thus work on this species should first await progress with the analyses for Adélie penguins.

CALCULATIONS FOR SENSITIVITY TESTS OF THE KRILL YIELD MODEL

1. Use the R_1 and R_2 estimates from Table 3 of WG-EMM-96/45 in the recruitment model (de la Mare, 1994). These will probably not be suitable for use in the beta distribution model, in which case they should be incorporated using a re-sampling method. The consequent estimates of the recruitment distribution and natural mortality provide a distribution for the pre-exploitation biomass, which is to be compared with the distribution of densities given in Table 4 of WG-EMM-96/45 to see whether the recruitment proportion and density data are consistent with an absence of trend in median recruitment (as assumed by the recruitment model). The relative frequency of model trajectories which closely match the observed density series is to be assessed.

2. Re-calculate the values of γ pertinent to Subareas 48.1, 48.2 and 48.3 taking account of:

   (i) the revised joint distribution for M and krill recruitment distribution parameters from 1 above; and

   (ii) an estimate of the biomass level at the time of the FIBEX survey relative to the median pre-exploitation biomass.

3. Use the R_1 and R_2 estimates in conjunction with density estimates to calculate an index of absolute recruitment. Re-sample from these to calculate yield and a distribution of population trajectories. Again use the distributions and relative frequency of similar trajectories as comparative measures. Examine the stock recruitment relationship indicated by these estimates.

4. Investigate the robustness of the precautionary limits calculated from the yield model by using recruitment data generated from two types of models. The first model is to include the effects of serial correlation in recruitment. The serial correlation used is to be based on serial correlation estimated from the observed recruitment series. The second model is to generate recruitment from a model in which krill recruitment switches from time to time from a higher level to a lower level. The amplitude and period of the level shifts are to be based on those required to emulate the abundance indices given in Table 4 of WG-EMM-96/45. The precautionary yield from the usual krill model is then to be compared with the known yield from the simulation models used to generate the data.

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de la Mare, W.K. 1994. Modelling krill recruitment. *CCAMLR Science*, 1: 49–54.

de la Mare, W.K. 1994. Estimating krill recruitment and its variability. *CCAMLR Science*, 1: 55–69.

REPORT OF THE SUBGROUP ON STATISTICS

(Cambridge, UK, 7 to 9 May 1996)

REPORT OF THE SUBGROUP ON STATISTICS

(Cambridge, UK, 7 to 9 May 1996)

INTRODUCTION

The Subgroup on Statistics, convened by Dr D. Agnew (Secretariat), met from 7 to 9 May 1996 in Cambridge, UK, to consider a number of items referred to it by the meeting of WG-EMM in 1995. These items are identified in the agenda, which is given in Attachment A. The lists of participants and documents are given in Attachments B and C respectively. The report was prepared by the Secretariat.

CALCULATIONS OF INDICES OF DEPENDENT SPECIES PARAMETERS

2. The methods of calculating indices from the data collected by CEMP have been described in WG-EMM-95/10 to 95/14. In brief, data collected by each standard method are analysed to calculate one or more indices for each combination of site/species/sex and year. Each combination of index/site/species/sex is thus a time series. In addition to the documents listed in Attachment C, the subgroup had available to it a version of WG-EMM-95/14 which had been revised by the Secretariat in accordance with requests by WG-EMM-95 (SC-CAMLR-XIV, Annex 4, paragraphs 5.69 to 5.73). The subgroup examined these indices and discussed a number of desirable modifications.

3. There are two fundamentally different types of variance included in the standard presentation of indices produced by the Secretariat: within- and between-year variances.

4. Included in the presentations in WG-EMM-95/13 are the within-year variance of an index for each year in a time series, the value of the index itself and the statistical significance of the difference between that index and the previous year's value. In general, these statistics are being appropriately applied and are of some value.

5. The between-year variance has been used in these presentations to calculate confidence limits of the mean (over years) index; years with values outside these confidence bounds have been identified as apparently anomalous.

6. The subgroup recognised that both the anomalies and trends, within an index series, are of interest. The identification of anomalous values should continue to be carried out using the mean and variance of the series when the value of the index between years is expected to be normally

distributed. However, when normality cannot be assumed, identification of anomalous values should be carried out either using quantiles of the empirical distribution of the values, or by transformation to normality (for instance the log-odds transformation $log(p/(1 - p))$ for proportional data).

7. Where anomalies are identified from normal distributions (either naturally normal or transformed to normality) the length of the time series is critical in determining the level at which values are to be considered anomalous. An empirical analysis described in Attachment D was used to derive the values of z_c in Table 1, to be used in the identification of anomalies; a value is considered anomalous where $value < mean - z_c\ sd$ or $value > mean + z_c\ sd$.

Table 1: Values of z_c to be used in the identification of anomalies.

Series Length (no. of years)	Critical Value z_c	Series Length (no. of years)	Critical Value z_c	Series Length (no. of years)	Critical Value z_c	Series Length (no. of years)	Critical Value z_c
		11	2.36	21	2.72	31	2.92
		12	2.41	22	2.75	32	2.94
3	1.15	13	2.46	23	2.77	33	2.95
4	1.49	14	2.51	24	2.80	34	2.96
5	1.72	15	2.55	25	2.82	35	2.98
6	1.89	16	2.58	26	2.84	36	2.99
7	2.02	17	2.61	27	2.86	37	3.00
8	2.13	18	2.64	28	2.87	38	3.02
9	2.22	19	2.67	29	2.89	39	3.03
10	2.29	20	2.70	30	2.91	40+	3.04

8. Identification of anomalous values should in all cases only be performed when a series is composed of three or more years of data. Indices where normality may be assumed were identified as A1, A7, A8a and C2. The proportion indices (A6, A8b, B2) should be investigated for normality, and subject to the log-odds transformation and subsequent treatment as normal distributions if necessary. Indices where normality was unlikely were those involving foraging duration (A2, A5 and C1), and these may be transformed using logs if this gives approximate normality. The population size indices (A3 and B1) might be best studied by log-transforming them and investigating the year-to-year differences as changes in logs. Detection of anomalies and trend in any indices which cannot be treated in this way should be carried out using quantiles.

9. All indices should be examined for evidence of trends although, until recently, time series have been too short to analyse using standard trend statistics (such as Mann-Kendal statistics). In the cases where trends can be identified, consideration should be given to ways to de-trend the data to assist the identification of anomalous years. However, the methodologies for de-trending these data, and the appropriate z_c values to use on de-trended series, require further investigation.

10. It was recognised that as the demand for identification of anomalies and trends becomes greater, the computational challenges involved in performing these analyses using database software will increase. It is highly desirable to retain the present software design, which is linked directly to the CCAMLR database and enables additional data to be rapidly incorporated into the analysis, although this necessitates the employment of standardised, general methodologies. For this reason, the presentations of the indices should clearly state that the identification in these presentations of significant between-year changes, anomalous years and trends should be treated simply as guidelines to assist examination of the data. Formal statistical analysis will continue to require the detailed examination of individual series on a case-by-case basis.

11. A number of points were made concerning specific indices.

A3 – Breeding Population Size

12. The addition of year-to-year percentage change would be helpful in identifying trends for this index.

13. The problem of ensuring data continuity for indices of population size was discussed in some detail. A good example of the problem is given by the data on Adélie penguins from Syowa station (Table 2).

14. Situations such as that at Syowa are most likely to arise where logistic or operational reasons prohibit the monitoring of a colony in a particular year. They may also arise if the colony count was zero but was erroneously reported as a null, or where colonies have coalesced. In the latter case, the problem may be overcome by creating a new colony code to cover both the coalesced colony and its previous parent colonies.

15. Where there are cells missing from the matrix of colonies by year, the situation is currently treated by including only those colonies which have time series of similar lengths in the final index calculation. For Syowa, only the Ongul colony was included in the calculation of the index. The subgroup agreed that although the current method omits several colonies which may contribute useful data, the alternative method, that of omitting all years where there are data missing for one or more colonies, was not appropriate. As a better solution, methods of interpolating missing data for years when at least one colony out of a group has been counted should be investigated.

16. As an interim measure, the subgroup requested that a table similar to Table 2 should be presented whenever missing data are identified in Method A3.

Table 2: Colony counts from Syowa site.

Site Code	Species Code	Split-year	Colonies				
			Huku	Mame	Mizu	Ongul	Rumpa
SYO	PYD	1966			39	103	
SYO	PYD	1967			134		960
SYO	PYD	1968			180		1000
SYO	PYD	1971				113	
SYO	PYD	1972				88	
SYO	PYD	1974				73	
SYO	PYD	1975	140	21		50	533
SYO	PYD	1977				55	
SYO	PYD	1978				46	
SYO	PYD	1980		24		43	473
SYO	PYD	1981		70		102	1145
SYO	PYD	1982	480	60		122	1500
SYO	PYD	1983	310	53		59	1200
SYO	PYD	1984	500	53		77	1550
SYO	PYD	1985	670	53		83	1224
SYO	PYD	1986	520	68		158	1450
SYO	PYD	1987	434	72	247	82	1437
SYO	PYD	1988	750		493	59	2270
SYO	PYD	1989	439		258	78	1338
SYO	PYD	1990	398	115	416	124	1893
SYO	PYD	1991	352	139	318	91	1498
SYO	PYD	1992	290	180	413		1485

A5 – Foraging Duration

17. Some evidence was presented at the 1995 meeting of WG-EMM that male and female Adélie penguins showed different foraging behaviour (SC-CAMLR-XIV, Annex 4, paragraph 5.17). Currently, few datasets submitted to CCAMLR enable separation of this index by sex (WG-EMM-Stats-96/5) to be carried out, and the subgroup, while feeling unable to comment on the significance of inter-sex differences in foraging duration, noted that the collection and reporting of data by sex would enable separation to be carried out in the future should this be deemed necessary. Sex should also be identified when reporting data under Method A2 (incubation shift).

18. The subgroup endorsed the current method of calculating foraging duration during the brood and creche stages separately, but requested that the tables of mean foraging duration by five-day period presented in WG-EMM-Stats-96/5 should be routinely produced along with the A5 indices to aid interpretation.

19. It was noted that a t-test was currently being employed for pair-wise interannual comparisons of foraging duration. The within-year normal distribution assumed by this test was unlikely to hold for the foraging data, but given the large sample sizes currently employed it is most

likely that the means would be approximately normally distributed, leading to results which were probably not misleading. The current methodology should therefore be retained.

A6 (A6a – Chicks Fledged per Eggs Laid;
A6c – Chicks Fledged per Chicks Hatched)

20. The subgroup agreed that the current method of calculating binomial standard error of breeding success was appropriate. The unit of sampling is the nest rather than the egg, leading to: *se(p)* = v*(p(l-p)/n)* for one-egged species; and *se(p)* being somewhere between v*(p(l-p)/n)* and v*(p(*1*p)/*2*n)* for two-egged species, the largest of these *(v(p(l-p)/n))* being taken to provide the most conservative estimate of *se*. This approach is also adopted in the comparison of pair-wise year differences, where the chi-squared is divided by 2 for two-egged species. To avoid confusion in the future, the rationale for using these tests should be explained more fully in the text of the indices. Several other editorial changes were suggested, including an explanation of the result of coalescing of colonies between and within years (see paragraph 14).

A8a – Ration Size

21. WG-EMM noted that at Béchervaise Island some cases of known breeding birds returning to the CEMP site with empty stomachs had been reported (WG-EMM-95/32). It requested the Subgroup on Monitoring Methods to consider how data on empty stomachs should be incorporated into the calculation of indices. Because the question also has relevance to the Subgroup on Statistics, it was also considered by this group.

22. The subgroup recognised that it was essential that birds found to have empty stomachs were known to be breeding birds with living chicks, and that empty stomachs be clearly defined and separated from stomachs with very few contents. Given this assurance, two options for incorporation of empty stomach data were considered. Firstly, a non-normal distribution could be fitted to describe within-year variation. However, this requires further investigation and is not suggested as a solution at the moment.

23. Secondly, the present (assumed normal distribution) calculation of the index could be enforced for non-zero stomachs only, with the additional presentation of the proportion of empty stomachs. If necessary, comparative and trend statistics on the proportion of empty stomachs could be calculated, for instance using the log-odds ratio transformation. The indices produced using this method would probably be the easiest to interpret, and would also be simplest to compute.

24. The easiest way to report this information would be as a single figure for the number of empty stomachs on form A8.

A8b – Prey Categories

25. New categories for specific prey items of particular importance at some sites should be recorded in the database (e.g. *Themisto* at South Georgia). These should not necessarily be presented in the indices document. However, under the indices of 'mean proportion by weight' an 'others' column should be introduced to complement the current categories of squid, fish and krill and demonstrate that the total proportions sum to approximately 1.

26. It was noted that the proportion given was calculated as the mean proportion of diet component in individual stomachs, and not the proportion of that component in all stomachs (i.e. $mean(p(x)_i)$ not $p(sum(x_i))$ where x_i is the weight of diet component x in bird i and $p(x)_i$ is the proportion of diet component x in bird i). The former calculation is considered to reflect the population condition more accurately because it takes the sampling unit to be the individual animal rather than the group of animals. Both methods, however, are vulnerable to biases due to weighting problems where birds have particularly variable stomach content masses.

27. Mr T. Ichii (Japan) reported that some recent data (Jansen, unpublished) had indicated that there were both diurnal and overnight foragers within the chinstrap penguin population, which resulted in chicks being fed twice per day during the early rearing period, and that the prey composition found in penguins foraging at these different times of day was distinct. For instance, both fish and krill were taken at night and only krill was taken during the day. Previously, it had been assumed that these penguins undertook only one, daytime, foraging trip.

28. If sampling of diet was confined to a single time of day, then this could lead to biases in the monitoring results. However, it was recognised that this did not affect the method of calculation of the indices or their statistics, but should be referred to the Subgroup on Monitoring Methods to examine the problem in more detail and determine ways to ensure consistency of sampling.

C1 – Fur Seal Female Foraging Duration

29. This method involves placing transmitters on seals to record the duration of foraging for their first six perinatal trips. Failure of animals to complete six trips usually results in the transmitter being

recovered and placed on another female, but failures are currently not reported. It was suggested that the number of failures be reported in addition to the foraging details of seals which successfully complete a full six foraging trips; this suggestion should be referred to the Subgroup on Monitoring Methods.

30. The text of the indices should be amended to reflect changes in the method of calculating the index determined at the 1994 meeting of the Subgroup on Statistics.

C2 – Fur Seal Pup Growth

31. The three data series being compiled for this parameter (Cape Shirreff, Seal Island and Bird Island) all use procedure A where a number of pups are weighed at intervals throughout the growing season. The indices calculated from these data may be biased because it is impossible to identify (and thus eliminate from the analysis) pups weighed early in the season which will not survive to weaning. These pups are often smaller than average, and are most likely to die in the first month, thereby depressing the regression near the origin. Further, in poor seasons when more pups are likely to die, the biasing effect on the calculated regression is likely to be greater, leading to greater apparent growth rates in poor seasons than good seasons.

32. To examine this problem further, growth rates calculated using data from early and late parts of the season should be compared in an attempt to identify consistent biases. This would best be done by Members using original data rather than the data submitted to CCAMLR.

Environmentally Unusual Years

33. WG-EMM requested that the Subgroup on Statistics develop methods of highlighting anomalous years where the reason for the anomaly is known and, if necessary, excluding them from trend analyses (SC-CAMLR-XIV, Annex 4, paragraph 5.83). This report will refer to these years as ‘unusual’ to distinguish them from the statistical description of ‘anomalous’ years given in paragraphs 6 to 8.

34. An example of the problem was discussed with reference to black-browed albatrosses at South Georgia. Occasionally heavy snow and ice conditions at Bird Island prevent many albatrosses from nesting. In these years breeding success for birds that do lay is often zero or near-zero. Although snow, ice and local weather conditions are considered by monitoring methods F3 and F4,

these land-ice conditions at Bird Island are not monitored regularly so as to form a continuous series which would serve as an environmental index.

35. The subgroup agreed that where significant environmental events occur which are noted by researchers as affecting monitored parameters but which are not part of a continuous environmental monitoring regime, they should be recorded and reported to CCAMLR on the data submission forms for CEMP methods. They will then be entered as presence/absence data into the database, presented alongside the indices, and can be incorporated as binomial variables in any multivariate analysis of the indices. Accordingly, all forms need to be amended to include an entry for 'unusual environmental conditions'.

EXTENSION OF INDICES TO COVER HARVESTED SPECIES AND ENVIRONMENTAL PARAMETERS

CPD Index

36. The subgroup has been asked to provide a critical re-examination of the concept of the CPD index (SC-CAMLR-XIV, Annex 4, paragraphs 5.92 to 5.96). This index is currently calculated as the krill catch within 100 km of predator colonies during the period December to March. It is not a measure of competition between predators and the fishery, but is a simple expression of potential niche overlap. This index is intended to be used to assist in understanding some of the predator-fishery interactions identified in the schematic representation of the ecosystem described by WG-EMM (SC-CAMLR-XIV, Annex 4, Figure 3). The concept has been developed in some depth by Ichii et al. (1994), and Agnew and Phegan (1995), who attempted to further refine the calculation of realised niche overlap.

37. The four general levels at which analysis of this niche overlap may be viewed are shown in Table 3.

Table 3: Levels of analysis of niche overlap.

Name	Scale/Operation	Description	Example
Precautionary overlap	Subarea or Southern Ocean.	Covers whole area of krill distribution and all krill predators.	Potential yield model.
Potential overlap	Broad-scale spatial (100-km radius) and temporal resolution.	Very broad scale. Local overlaps or separations between predators and the fishery may be missed or misrepresented, but flux can be ignored.	Current CPD calculations (WG-EMM-95/41).
Realised overlap	Fine-scale horizontal distributions of predators and the fishery (30 n mile x 30 n mile) combined with estimates of predator consumption rates.	Fine-scale overlap is measured, but the major problem of flux between fine-scale areas is not addressed.	Modelling approach suggested by Agnew and Phegan (1995).
Dynamic overlap	Very fine-scale vertical and horizontal distributions of predators and the fishery, together with modelling of flux effects and the common availability of prey to both resource users.	This would be the best descriptor of the functional link between predators and the fishery, but would require a much larger knowledge base than is available at the moment.	Some discussion in Ichii et al. (1994).

38. The subgroup agreed that all levels of analysis of niche overlap should be developed. It was felt that worthwhile progress could be made with the potential and realised overlap indices using available data and current knowledge, but that substantial progress with the dynamic overlap index would require additional data and new biological knowledge. Development of the potential and realised indices should proceed in parallel – the latter being perceived as a refinement of the former.

39. A dynamic overlap index will require detailed data at a fine spatial and temporal scale appropriate to the scale of predator-prey-fishery interactions. Members should be encouraged to develop research programs to collect data and generate analyses.

40. The subgroup noted the reservations about the spatial and temporal scales of the existing CPD calculations expressed in SC-CAMLR-XIV, Annex 4, paragraphs 5.92 to 5.95, but felt that it did not have the expertise to determine adequately the values of parameters necessary for these models. Accordingly, it requested WG-EMM to provide information for known colonies on monthly estimates of:

(i) typical diet composition (along the lines of index A8b); and
(ii) maximum and modal foraging range.

Where data are not available for a colony, values should be inferred from the closest or most similar colony.

41. These data can then be aggregated on the most appropriate spatial and temporal scales to calculate indices of potential overlap with the fishery. It was suggested that the largest scale on which such aggregation would be useful was annually for a statistical subarea. Within this scale, the data aggregation should be set at a level appropriate to the predator species in question. It was clear that it would be unlikely that any one spatial or temporal scale would be suitable for all species or areas, but the subgroup felt that it did not have sufficient data or expertise to determine these scales and requested advice from WG-EMM accordingly.

42. In order to make progress with the realised overlap approach of Agnew and Phegan (1995), data on the density of predators as a function of distance and bearing to colonies will be required. There are two methods of acquiring this information: through satellite tracking of known breeding animals and through standardised shipboard surveys. Research data on the distribution of predators at sea, obtained via satellite tagging and through aerial and shipboard observation, are becoming increasingly available, and Members who have such data are encouraged to analyse them in such a way as to provide the necessary input for the calculation of a realised overlap index. However, using data on predator distribution and density at sea requires that such data be collected in a standardised fashion using recommended procedures (e.g. taking account of biases caused by moving animals, species-specific detectability, etc.) and that they be analysed taking account of biases due to local aggregation effects, travelling as opposed to foraging or feeding, temporal patterns of foraging/diving, etc.

43. For the time being, the CPD index (describing potential overlap) should continue to be calculated according to the methods described in WG-EMM-95/41, and the approach of Agnew and Phegan (1995) towards the calculation of a realised overlap index should be re-assessed for presentation to WG-EMM. Modifications of these calculations will be undertaken when the requested data are available and the appropriate spatial and temporal scales have been determined.

Harvested Species Indices

44. Indices of harvested species are essential for both the interpretation of predator indices and the development of WG-EMM’s conceptual model of the Antarctic ecosystem. The group identified a number of indices which could be calculated from existing datasets or data which will become available in the near future (Table 4).

45. It is essential that this part of the ecosystem monitoring system be developed as soon as possible to complement the existing indices of predators and the development of environmental indices. It is strongly suggested that investigations of the feasibility of calculating these indices, the availability of data, and the applicability of the indices to the objectives of WG-EMM be initiated as soon as possible, and that interim results be presented to WG-EMM in 1996.

46. It was recognised that krill flux could potentially complicate the interpretation of many of these indices. The spatial scale of an index should be set sufficiently large that, assuming the turnover rates calculated by the Workshop on Evaluating Krill Flux Factors (SC-CAMLR-XIII, Annex 5, Appendix D), the biomass of krill subject to flux across the boundaries of an area should be negligible, compared with the total stock within the area, over the time scale over which the data are collected.

Environmental Parameters Influencing Harvested Species

47. A number of indices of sea-ice distribution are currently being calculated by the Secretariat (WG-EMM-95/41), and a correspondence group convened by Dr D. Miller (South Africa) is studying the indices and other aspects of the interaction of sea-ice with other components of the Antarctic ecosystem. The subgroup made no further comment about this parameter.

48. Data are currently available for a number of additional environmental parameters which may be important in determining the state of the marine environment, and which could influence harvested species distribution and abundance. These are:

(i) the presence/position of frontal zones;
(ii) sea-surface temperature (SST); and
(iii) shelf surface water flow (ADCP measurements).

Table 4: Suggested harvested species indices.

Aim: To Determine...	Index	Data Source and Availability	Scale	Description
Large-scale harvested species population trends	CPUE by area	Commercial [Statlant B data (subarea resolution) is available now]	Subarea Season (summer only)	Calculate catch/hour and catch/day at the subarea level by fleet, or for a standardised fleet/vessel established by GLM analysis. Different CPUE indices are likely to respond differently depending on area/fleet. For instance, catch/day is likely to be appropriate for the Japanese fleet in the Indian Ocean sector where a considerable searching effort is required, but catch per hour is more likely to reflect swarm density in the Atlantic Ocean sector where searching is not usually necessary. However, in view of the lack of confluence between fishing areas and CEMP sites in the Indian Ocean sector, it is suggested that effort be put into developing this index for the Atlantic Ocean sector for the time being.
Large-scale harvested species distribution	Relative catch or CPUE distribution between defined areas	Commercial [fine-scale catch data available now. Fine-scale CPUE data present for some fleets now]	Subarea Season	Within a subarea, assume that fleets operate as a single unit. Assume also that within subareas, favoured fishing areas identified through experience are preferentially targetted, but that the fleets will move between favoured areas depending on catch rates in those areas. For instance, in Subarea 48.1 the Japanese fleet preferentially targets the Livingston Island fishing area, unless it finds that the Elephant Island area is particularly profitable. The fleet is then acting as a selective predator and its distribution will reflect the distribution of harvested species. An index of this distribution might be calculated by choosing two or more known fishing areas and calculating the ratio of catches between these areas over the season being considered.
Local abundance	Mean krill density from a number of surveys	Research [local acoustic surveys]	100 x 100 n mile scale areas, for specific months	Local krill surveys have shown that krill distribution and abundance may be highly variable in space and time. A number of surveys of a restricted area are therefore required in a restricted time interval, for instance six weeks in January/February each year.
Local distribution	Local krill density relative to colonies	“	“	A number of measures of krill distribution could be used: for instance, the distance between predator colonies and the centroid of krill density; minimum and maximum distances from a site to krill densities of a defined size; changes in krill density spectral analyses. This index needs considerable research.
Local vertical distribution	Depth of krill swarms	“	“	Calculate maximum and minimum depth of high densities of krill, or the proportion of krill within depth strata (for example the depth of the mixed layer) and by time of day.
Population abundance	Krill density by subarea/region	Research [synoptic acoustic surveys]	Subarea or other large region	A synoptic survey every year is clearly impractical. However, a survey at intervals of several years is essential for calibrating other indices of population density, and for determining long-term trends in krill abundance.
Demography	Recruitment proportion	Research [net hauls]	Subarea or other large region	Methods for estimating recruitment proportion (R_1) are being developed by a number of researchers (see for instance de la Mare (1994) and Siegel and Loeb (1995)).
Demography	Commercial length composition	Commercial [net hauls]	Regional	Kawaguchi and Satake (1994) have previously shown that trends in the length composition of the commercial catch can be correlated with environmental parameters. Commercial length composition data should be separated by region where major biogeographical differences are known to exist – for instance, in Subarea 48.1 small animals are found inshore and large animals offshore, so separation into inshore and offshore components is necessary.

Wind stress, sea-surface roughness and geopotential anomaly are other variables for which information is available from satellites, but these are considered to be of secondary importance for the present exercise.

49. From these data one could construct two indices:

(i) SST anomaly, measured at positions of relevance to CEMP sites, for each month of the breeding season; and

(ii) water flux (transport), measured in January/February, in a number of fine-scale squares close to CEMP sites.

50. The former of these can be calculated using freely available data, and should be attempted by the Secretariat prior to WG-EMM in 1996. The latter will only be available through the design of standard monitoring areas by research organisations. Members are encouraged to investigate the development of standard methods for monitoring this parameter.

Environmental Parameters Influencing Dependent Species

51. A number of methods for monitoring sea-ice as viewed from the CEMP site, as well as local weather conditions and snow cover at a CEMP site have already been defined by CCAMLR (Methods F1, F3 and F4). Although data are being collected by Members, none are currently submitted and this precludes the calculation of indices for these parameters. It was strongly recommended that standard formats for submitting these data be developed by WG-EMM and that Members be encouraged to submit the data in time series that are comparable to the predator data already available. Recording extraordinary environmental conditions should also be encouraged as noted in paragraphs 33 to 35.

52. It is recommended that attempts be made to develop methods for calculating the complete suite of environmental indices which have now been defined, that is:

(i) sea-ice indices
  (a) number of ice-free days
  (b) distance from CEMP site to sea-ice edge;

(ii) marine indices
  (a) SST anomaly

(b) water flux; and

(iii) terrestrial indices

(a) sea-ice viewed from the CEMP site

(b) local weather (e.g. temperature, wind-speed anomalies by month)

(c) snow cover.

PRESENTATION

53. WG-EMM had requested the Secretariat to develop a mechanism for representing index status and trend data quantitatively to replace the current qualitative tabulations in SC-CAMLR-XIV, Annex 4, Table 3. WG-EMM-Stats-96/7 suggested a method for these displays in which a standardised normal variate ($z = (x - \bar{x})/sd$) was calculated for each index. Additional tabulations were made of a qualitative presentation of these data and the original indices.

54. The subgroup considered this to be a useful first step in the transition from a qualitative to a quantitative analysis of the indices. However, concerns were expressed that the dimensionless standardised series masked important information contained in the indices, both because the indices were not necessarily normally distributed (see paragraph 8) and because the magnitude of the indices themselves may be important. There was also some concern that the standardised series would change each year as the time series from which the means and standard deviations were calculated increased in length.

55. The first of these concerns would be addressed by the following transformations prior to calculation of the standardised normal variate:

(i) normally distributed data: no transformation;

(ii) proportions: log-odds transformation;

(iii) foraging distribution: log transformation (pending further investigation); and

(iv) population size: yearly changes, expressed as differences between logs of the colony counts in adjacent years, may be normally distributed, but this should be investigated further.

These transformations should be displayed along with each index in the Secretariat's report of CEMP indices.

56. The second and third points of concern would be addressed if the standardised series was presented graphically, as a guide to the interpretation of anomalies and trends in the indices, rather than as numbers which could be used for further analysis. It would then be understood that further investigative analysis should use the original indices and not the standardised series.

57. The subgroup also considered the problem of the presentation of trends by WG-EMM in its report. It is clear from the analyses presented in WG-EMM-Stats-96/7 that the subjective, qualitative display currently employed (SC-CAMLR-XIV, Annex 4, Table 3) can be misleading. The current display, by site, species, method and year is also rather complex to interpret. A more useful output from WG-EMM might be a summary of the anomalies and trends by site, species and year (i.e. an ecosystem assessment following quantitative analysis of all indices for a particular site and species).

58. The following suggestion is made for a structured approach by which WG-EMM might analyse the indices:

(i) examination of a document presenting anomalies and trends by site and species, to be prepared by the Secretariat;

(ii) perform a systematic analysis of the indices, by area, site and species. This should proceed by iterations of:

(a) examination of a graphical display of standardised series (as in WG-EMM-Stats-96/7) to identify general trends and associations between parameters and species. An associated qualitative display of these anomalies, and table of index values will be provided for reference;

(b) further detailed analysis of features indicated by the standardised series, through examination of the actual indices and figures given in presentations similar to those in WG-EMM-95/13 and 95/14; and

(iii) modification, as necessary, of the document described in (i) above presenting anomalies and trends by site and species. This document should then act as the basis for presentation within the report of WG-EMM.

59. It was recognised that step (ii) would require a considerable amount of analysis by the working group. This would be facilitated if the data and software necessary for the calculation of the indices was made available to Members in the intersessional period. It was recognised that data would be available under the normal CCAMLR data access rules, but that only software written in the software package being used by the Secretariat could be provided. This is currently MS Access.

60. The mechanism described above would act to assist the transfer of information from the Secretariat to WG-EMM and from WG-EMM to the Scientific Committee. However, it will require a considerable amount of work by the Secretariat, and may take several years to develop. The three levels of analysis required of the Secretariat are: indices and figures as in WG-EMM-95/13 and 95/14; standardised series figures, qualitative change and tabulations of source indices as in WG-EMM-Stats-96/7; and a summary of significant anomalies and trends.

CLOSE OF THE MEETING

61. The report was adopted. In closing the meeting the Convener thanked the British Antarctic Survey for hosting the meeting. He also thanked all participants for their enthusiasm and contributions to a meeting whose results should significantly advance the work of CCAMLR, and WG-EMM, towards a quantitative ecosystem assessment.

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ATTACHMENT A

AGENDA

Subgroup on Statistics
(Cambridge, UK, 7 to 9 May 1996)

1. Introduction
   (i) Opening of the Meeting
   (ii) Organisation of the Meeting and Adoption of the Agenda

2. Calculations of Indices of Dependent Species Parameters
   (i) Review progress with all tasks assigned to the Secretariat at WG-EMM (SC-CAMLR-XIV, Annex 4, paragraphs 5.69 to 5.76)
   (ii) Develop methods for the incorporation of empty stomach data in diet indices (This task was allocated to the Subgroup on Monitoring Methods (SC-CAMLR-XIV, Annex 4, paragraph 5.27) but it more appropriately fits within the expertise of the Subgroup on Statistics)
   (iii) Develop methods of highlighting anomalous years, where the reason for the anomaly is known and, if necessary, excluding them from trend analyses (SC-CAMLR-XIV, Annex 4, paragraph 5.83)

3. Extension of Indices to Cover Harvested Species and Environmental Parameters
   (i) Provide a critical re-examination of the concept of the CPD index (SC-CAMLR-XIV, Annex 4, paragraphs 5.92 to 5.96)
   (ii) Develop satisfactory indices for harvested species and environmental data (SC-CAMLR-XIV, Annex 4, paragraphs 7.89 and 7.95)

4. Presentation
   (i) Develop a mechanism for representing index status and trend data quantitatively to replace Table 3 (by, for instance, deviations, in SD units, from a short- or long-term mean). This needs to be addressed for predator, harvested species and environmental indices (SC-CAMLR-XIV, Annex 4, section 8)

5. Advice to WG-EMM

6. Close of the Meeting.

ATTACHMENT B

LIST OF PARTICIPANTS

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(Cambridge, UK, 7 to 9 May 1996)

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ATTACHMENT C

LIST OF DOCUMENTS

Subgroup on Statistics
(Cambridge, UK, 7 to 9 May 1996)

WG-EMM-Stats-96/1	PRELIMINARY AGENDA FOR THE 1996 MEETING OF THE WG-EMM SUBGROUP ON STATISTICS
WG-EMM-Stats-96/2	LIST OF PARTICIPANTS
WG-EMM-Stats-96/3	LIST OF DOCUMENTS
WG-EMM-Stats-96/4	BACKGROUND INFORMATION FOR THE SUBGROUP ON STATISTICS MEETING, CAMBRIDGE, 7–9 MAY 1996 Secretariat
WG-EMM-Stats-96/5	DATA REQUIREMENTS FOR METHOD A5 D.J. Agnew (Secretariat)
WG-EMM-Stats-96/6	A FINE-SCALE MODEL OF THE OVERLAP BETWEEN PENGUIN FORAGING DEMANDS AND THE KRILL FISHERY IN THE SOUTH SHETLAND ISLANDS AND ANTARCTIC PENINSULA D.J. Agnew and G. Phegan (Secretariat)
WG-EMM-Stats-96/7	CALCULATION OF A STANDARDISED INDEX ANOMALY D.J. Agnew (Secretariat)

OTHER DOCUMENTS

WG-EMM-95/10	DEVELOPMENTS IN THE CALCULATION OF CEMP INDICES 1995 Data Manager
WG-EMM-95/11	CALCULATION OF INDICES OF SEA-ICE CONCENTRATION USING DIGITAL IMAGES FROM THE NATIONAL SNOW AND ICE DATA CENTRE D.J. Agnew (Secretariat)
WG-EMM-95/12 Rev. 1	INDEX PART 1: INTRODUCTION TO THE CEMP INDICES 1995 Data Manager

WG-EMM-95/13 Rev. 1	INDEX PART 2: CEMP INDICES: TABLES OF RESULTS 1995 Data Manager
WG-EMM-95/14 Rev. 1	INDEX PART 3: CEMP INDICES: FIGURES 1995 Data Manager
WG-EMM-95/32	STOMACH FLUSHING OF ADELIE PENGUINS (CEMP METHOD A8) Judy Clarke (Australia)
WG-EMM-95/41	KRILL CATCH WITHIN 100 KM OF PREDATOR COLONIES FROM DECEMBER TO MARCH (THE CRITICAL PERIOD-DISTANCE) Data Manager
WG-EMM-95/46	DRAFT: DIFFERENCES IN THE FORAGING STRATEGIES OF MALE AND FEMALE ADELIE PENGUINS Judy Clarke and Knowles Kerry (Australia) and Enrica Franchi (Italy)

CRITICAL VALUES FOR RANDOM NORMAL TIME SERIES

Suppose that a yearly time series consists of random independent values X_1, X_2, ..., X_n from a normal distribution with mean μ, standard deviation σ. Let the mean and variance of the observations be denoted by $M = X_i/n$ and $s^2 = (X_i - M)^2/(n - 1)$. Then the statistics

$$Z_i = (X_i - M)/s, \tag{1}$$

$i = 1, 2, ..., n$ will have the same distribution for all values of μ and σ, but this distribution will depend upon the series length n.

To detect unusual years it is possible to compute the absolute values Z_i, $i = 1, 2, ... n$, and see which of these, if any, is 'significantly' large. To determine whether Z_i is significantly large it can be compared with the value that is only exceeded for (say) 5% of time series by chance. This allows one or more of the years in a series to be defined as being unusual.

A procedure for determining the critical value for Z_i is as follows for a series of length n:

(a) simulate n values X_1, X_2, ..., X_n from a standard normal distribution with μ = 0 and σ = 1.

(b) convert the X_i values to Z_i values using equation (1).

(c) find Z_{max} = Max{ Z_1, Z_2, ... Z_n }, the maximum of the absolute Z values.

(d) repeat (a) to (c) many times to determine the distribution of Z_{max}.

(e) choose the critical value for Z to be the value that is exceeded for 5% of the series.

The critical value obtained in this way controls for the multiple testing that is inherent in considering n values of Z for each series because if the time series being considered does consist of random values from a normal distribution then the probability of declaring one or more years to be significant is only 0.05. The critical values for this procedure are shown in Table 1 of the main text.

APPENDIX I

REPORT OF THE SUBGROUP ON MONITORING METHODS

(Bergen, Norway, 8 to 10 August 1996)

REPORT OF THE SUBGROUP ON MONITORING METHODS

(Bergen, Norway, 8 to 10 August 1996)

INTRODUCTION

The Subgroup on Monitoring Methods held its meeting from 8 to 10 August 1996 in Bergen, Norway, immediately before the meeting of WG-EMM. The meeting was convened by Dr K. Kerry (Australia).

2. The agenda of the meeting comprised all the tasks referred to the subgroup by WG-EMM in 1995 (SC-CAMLR-XIV, Annex 4, paragraphs 5.19, 5.24, 5.26, 5.27, 5.29 to 5.32, 5.39, 5.41, 5.42, 5.44, 5.48, 5.51 and 5.53). The agenda adopted by the subgroup, the list of participants and the list of papers considered at the meeting are appended to this report as Attachments A, B and C respectively.

3. Dr E. Sabourenkov (Secretariat) was rapporteur. Additional sections were prepared by Drs D. Miller (South Africa) and W. Trivelpiece (USA).

REVIEW OF NEW METHODS AND TECHNIQUES

4. Drafts of several new methods (WG-EMM-Methods-96/4 to 96/7, 96/13 and 96/14) as well as sampling techniques were developed during the intersessional period and submitted for examination by the subgroup. These drafts were also submitted to SCAR for consideration by SCAR-BBS (WG-EMM-Methods-96/12). The subgroup noted with thanks the comments of SCAR-BBS. It was noted that the SCAR-BBS received the drafts late in July and had not had sufficient time to circulate them among its members. However, the Subcommittee's comments were taken into account, as appropriate, throughout the subgroup's discussions. Matters raised in the report of the intersessional meeting of WG-EMM's Subgroup on Statistics (Appendix H) and excerpts from the report of the meeting of SCAR-GSS (SC-CAMLR-XV/BG/10) were also taken into consideration by the subgroup.

5. It was agreed that when only minor amendments and editorial changes were required to draft standard methods, these drafts would be revised accordingly and recommended for publication in *CEMP Standard Methods*. In cases where drafts required an extensive revision, the subgroup identified those points which needed to be taken into account in the revision as well as scientists whose assistance would be required for revision(s) during the forthcoming intersessional period.

6. In its review of methods, the subgroup considered the development of procedures to examine the suitability of monitoring methods to meet CEMP objectives. Where appropriate these deliberations are incorporated into the relevant sections of this report. However, the subgroup was unable to establish a framework for a comprehensive review of existing methods and reiterated WG-EMM's call to develop this framework as a matter of urgency (SC-CAMLR-XIV, Annex 4, paragraph 4.42).

7. The comments and recommendations of the subgroup in respect of standard methods and techniques given in this report should be read in conjunction with original papers tabled at the meeting.

New Standard Methods

Attachment of Instruments

8. A technique for attaching external instruments, including TDRs and satellite tracking devices, to penguins and Antarctic fur seals was prepared by Dr I. Boyd (UK) at the request of WG-CEMP. It was agreed that this technique (WG-EMM-Methods-96/5) was practical, comprehensive and, with minor amendments, including those suggested by SCAR-BBS, should now be included as an appendix to the *CEMP Standard Methods*.

9. The subgroup recalled that a Workshop on Researcher-Seabird Interactions had been held in 1993 in Minnesota, USA, and noted that much useful information was contained in the subsequent report. Similarly, it was noted that the work of Dr R. Bannasch (1995) provided important information. Both reports contained theoretical and practical information to be considered when attaching instruments to birds and seals.

10. It was noted that the wrapping of instruments in electrical tape before they were glued onto an animal allowed subsequent removal with minimal damage to fur, hair or feathers. Where larger instruments are used, or where longer deployments (a month or more) are required, it may be necessary to glue unwrapped instruments directly onto an animal. The instruments are then removed by carefully cutting the feathers or pelage close to the instruments. Instruments not recovered in this way will fall off during moult. It was noted that some Members have carried out over 100 platform transmitter terminal (PTT) deployments of Adélie penguins using this method without any demonstrable adverse effects on the survival of the birds.

11. The subgroup noted that some of the fast-setting epoxy glues (e.g. Loctite 401) are exothermic when setting and that the structural strength of the feathers and thus their ability to hold the instrument may be compromised if too much heat is generated. Care should be exercised, therefore, to delay the attachment of the instrument to the feathers by a few seconds to allow some of the initial heat to dissipate.

12. The subgroup reiterated the requirement that instruments attached to penguins should be neutrally buoyant and that their total weight in air should be less that 5% of the bird's weight.

13. The subgroup noted that many scientists are tracking flighted birds, including CEMP-designated species. However, the techniques used for attaching instruments to flighted birds are different to those used on penguins and include the use of harnesses. The subgroup recommended that scientists with experience in attaching instruments to flying birds be asked to provide details of methods they have used and to develop recommendations for a CEMP standard method.

Data Collection Using TDRs

14. A detailed method for the collection of at-sea behaviour data using TDRs had been prepared by Dr Boyd (WG-EMM-Methods-96/5). It was noted that the deployment of these instruments was straightforward and that the method as presented was appropriate and in a form suitable for immediate use. In some instances, and for penguins in particular, where the duration of foraging trips is less than one day, it may be necessary to set the sampling rate for depth intervals at one second. This will use available electronic memory much faster and may require shorter deployment times or instruments (TDRs) with expanded memory. It was agreed that, with this addition, the standard method be adopted.

15. At its 1994 meeting, WG-CEMP began the process of developing indices of predator foraging performance based on at-sea behaviour for inclusion in the monitoring program (SC-CAMLR-XII, Annex 6, paragraphs 4.15 to 4.23). At its first meeting, WG-EMM approved the proposal to hold a workshop on the measurement of at-sea behaviour of krill predators (SC-CAMLR-XIV, Annex 4, paragraphs 5.29 to 5.32).

16. The subgroup strongly supported the proposal for the workshop to examine the methods for analysis and interpretation of TDR data and the development of indices of predator foraging performance and requested WG-EMM to support the holding of such a workshop in the first half of 1997.

Methods for Monitoring Petrels

17. The subgroup considered the proposed methods for dietary studies of the Cape petrel (WG-EMM-Methods-96/4), for monitoring the population size and breeding success of the Antarctic petrel (WG-EMM-Methods-96/14) and describing a lavage technique for sampling diets of Procellariiformes (WG-EMM-Methods-96/6).

Chick Diet – Cape and Antarctic Petrel

18. The subgroup welcomed the draft method developed by Drs N. Coria, G. Soave and D. Montalti (Argentina) for dietary studies of the Cape petrel (WG-EMM-Methods-96/4). It was noted that the method was based largely on Method A8, which had been developed for penguins. Because of similarities between the Cape petrel and the Antarctic petrel, it was agreed that both species could be investigated using the same procedure.

19. It was agreed that the monitoring method should be based on the collection of food from parent birds and not from chick regurgitations. Adults should be caught beside their nest to ensure that they are, in fact, breeding.

20. The question of whether seawater, fresh water or water of intermediate salinity should be used for flushing petrels (and also penguins) was discussed. Although both fresh and seawater have been used, there are insufficient data to determine the relative value or effect of either. It was agreed that until appropriate investigations have been carried out, scientists could use either, but they must note which had been used when reporting the data to CCAMLR. It was emphasised that water used for stomach flushing should be warmed. Where possible, the recovery of birds after flushing should be monitored.

21. Several problems have been encountered in preserving and analysing food items. These problems were generic and concerned samples obtained from all bird species. They were therefore considered along with a more detailed examination of parameter A8 (paragraphs 62, 63 and 66 to 69).

22. The method was revised in light of the above discussions and it was agreed that it is suitable for publication as a CEMP standard method. The revised text is given in WG-EMM-96/53.

Antarctic Petrel

23. Draft methods prepared by Dr F. Mehlum (Norway) and Dr J. van Franeker (Netherlands) for the determination of breeding population size and adult survival rate were presented in WG-EMM-95/86 and WG-EMM-Methods-96/14. The latter paper included the comments received from SCAR-BBS (WG-EMM-Methods-96/12). The subgroup expressed its thanks to the authors for the considerable effort in preparing the documents.

Breeding Population Size

24. It was agreed that the proposed method was appropriate but that further drafting was required to take account of the following points before finalisation as a standard method.

(i) Following courtship, Antarctic petrels undertake a pre-laying exodus and are away from the colony for a few days. The recording of nests and eggs should commence immediately the birds return to lay.

(ii) Colonies of Antarctic petrels vary enormously in size from a few nests to colonies in excess of 100 000. Different methods of counting birds (including photographic surveys) are therefore required.

(iii) The list of 'Mandatory Data' should include only those data which are to be used in the calculation of CEMP indices. All supplementary data recorded during observation should be included in the data recording forms developed for this purpose.

(iv) If observations do not take place at a standard time each day, then they should be made each day at a random time over the 24-hour period, and the time of these observations recorded. Later analysis will show whether any bias is introduced by sampling at a particular time of day.

(v) Consideration should be given to determining the applicability of this method to Cape petrels.

Adult Survival Rate

25. This method was drafted originally to monitor both annual survival and recruitment (WG-EMM-Methods-96/14). The subgroup, however, felt that for large and dense colonies it would be

difficult to determine recruitment because it would be virtually impossible to find all the banded birds and also because birds often do not return to breed in their natal colony. Once adults commence breeding, they apparently return each season to the same nest. It was agreed, therefore, that a new parameter of 'adult annual survival' be adopted and that the text of the method be rewritten accordingly.

26. A detailed procedure for the establishment of sampling plots for large colonies was prepared by Dr S.-H. Lorentsen (Norway). This procedure was adopted for inclusion as an appendix to the *CEMP Standard Methods*.

Stomach Lavage for Procellariiformes

27. A paper on the use of stomach lavage techniques to sample diets of Procellariiformes was prepared by Dr R. Veit (USA) (WG-EMM-Methods-96/6) at the request of WG-CEMP. The subgroup welcomed this paper, which gives a useful background for the use of this sampling technique. The paper primarily addressed the sampling of birds caught at sea and did not relate directly to the determination of chick diet. The information contained in the paper was considered in the development of methods for the collection of food samples from petrels (paragraphs 18 to 22).

28. The subgroup noted that for species of birds which are of special conservation concern, stomach lavage would be the most appropriate procedure because it does not involve killing birds.

29. It was emphasised that in sampling stomach contents multiple flushing is necessary unless no food items were obtained in the first flush.

Breeding Chronology – Antarctic and Cape Petrels

30. The subgroup recommended that a method for breeding chronology similar to Method A9 should be developed for petrels.

Effects of Diseases and Pollutants

31. At last year's meeting of WG-EMM, it was noted that the outbreak of disease or presence of pollutants may mask the effects on monitored parameters of food availability or changes in the environment. Therefore, it was agreed that protocols should be developed for the collection and

preservation of samples taken from birds in the field for later pathological and/or toxicological analysis (SC-CAMLR-XIV, Annex 4, paragraphs 5.46 to 5.51).

32. Papers submitted to the subgroup dealt with protocols for collecting samples for both toxicological (WG-EMM-Methods-96/7) and pathological analysis (WG-EMM-Methods-96/13). The latter document was submitted as an extension of WG-EMM-Methods-95/44.

33. The subgroup made some editorial changes to the protocol for collecting samples for toxicological analysis and recommended that the protocol should be published as an annex to *CEMP Standard Methods*. Note was taken that samples could only be analysed in specialised laboratories and that such analyses were very expensive. Contamination of collected samples is possible if the wrong sort of containers are used and so care should be taken to have the correct containers on hand in the field.

34. The subgroup noted that the instructions for the collection of diagnostic samples if and when an outbreak of disease or a parasite infestation is observed in a seabird colony (WG-EMM-95/44) had been available to Members and that comments were to be forwarded to Dr Kerry for inclusion in a revised document (SC-CAMLR-XIV, Annex 4, paragraphs 5.46 to 5.48). No comments were received, so the document was revised by Dr H. Gardner (Australia) in the light of experience gained by a number of veterinarians and other scientists working on the Australian CEMP program. The revised document was tabled as part of WG-EMM-Methods-96/13. The subgroup thanked Dr Gardner for its preparation.

35. The subgroup agreed that the revised instructions provided an excellent approach to the examination of birds for disease and the collection of samples for diagnostic investigations. They could be used immediately if required. The subgroup felt, however, that it did not have sufficient expertise to thoroughly evaluate the content of the protocol and recommended that time be given for examination by other veterinarians. Due to the important nature of the document and the fact that scientists may need to collect specimens in the field this season, it is requested that Members forward comments to the Secretariat before the 1996 meeting of the Scientific Committee. Dr Gardner will then be asked to revise the text, which in turn should be forwarded to those undertaking field programs. Inclusion as an appendix to the *CEMP Standard Methods* would then follow.

36. The subgroup requested that diagrams or colour photographs should be included in the protocol to aid dissection and identification of organs and tissues to be sampled. Dr Kerry agreed to consult with Dr Gardner on the provision of such illustrative material.

37. The recommendation of WG-EMM was reiterated that upon publication of the protocol, scientists conducting field studies should consult with a veterinary pathologist before going into the field, to ensure that, if needed, urgent analysis of samples is possible and any specialised sampling requirements can be accommodated (SC-CAMLR-XIV, Annex 4, paragraph 5.49). It was recommended that scientists make contact with appropriate laboratories before going into the field to ensure analyses can be undertaken if necessary and that collection techniques appropriate to that laboratory are used.

Other Methods

Marking of Birds for Long-term Studies

38. Many of the CEMP parameters require that penguins be permanently marked for identification. Banding has been generally used to do this. There is, however, increasing evidence that flipper bands may be lost or that they may injure individuals of some penguin species (see for example WG-EMM-Methods-96/8). Alternative methods are now being sought. It was noted that a workshop on alternative marking techniques had been held recently in conjunction with the meeting of SCAR-BBS, but unfortunately the report of this workshop was not available to the subgroup.

39. The use of implanted electronic tags is increasing as an alternative to bands. These tags have the advantage of permitting automated identification and monitoring. A study on the use of implanted identification tags in penguins was submitted for consideration at the meeting (WG-EMM-Methods-96/8). The paper had been sent earlier to SCAR-BBS as a contribution to its workshop (see paragraph 38 above).

40. The subgroup agreed that for some applications the use of implanted tags makes monitoring easier and helps avoid the multiple handling of birds. Currently, tags are implanted in Adélie penguins under the skin of the neck and care should be taken not to implant into muscle tissue. Introduction of bacteria during tag implantations has the potential to lead to chronic localised infections and the development of recurrent acute infections or disseminated foci of persistent infection, following detachment, of bacteria from the initial site and dispersion via the bloodstream. Detailed information is contained in WG-EMM-Methods-96/8.

41. It was also noted that implanted tags may migrate away from the original injection site. The subgroup recommended that studies be conducted as soon as possible on the prevalence of tag

migration. The use of X-ray examination for such studies is preferable to killing the bird for dissection.

42. The subgroup recommended that since the use of implanted tags is increasing in CEMP monitoring studies, protocols for their use should be developed and published in *CEMP Standard Methods*. Dr Kerry agreed to draft these methods in conjunction with Dr J. Clarke (Australia).

Crabeater Seals

43. The subgroup reviewed an extract from the report of the August 1996 meeting of SCAR-GSS (SC-CAMLR-XV/BG/10) presented by Dr T. Øritsland (Norway) on behalf of SCAR-GSS. It was noted that SC-CAMLR had requested the assistance of SCAR-GSS in the drafting of standard methods for the monitoring of crabeater seals.

44. SCAR-GSS had advised that its APIS program should provide much new information on circumpolar population numbers and that standard methods for surveying crabeater seals should become available in 1997. Further, ancillary information on the ecology of crabeater seals is also likely to arise from APIS fieldwork. The subgroup noted that SC-CAMLR had supported the development of APIS (SC-CAMLR-XIII, paragraphs 9.2 to 9.9).

45. The subgroup drew WG-EMM's attention to the advice of SCAR-GSS that, given the difficulties of working in the pack-ice and the general paucity of knowledge on crabeater seals, it is too soon to determine which, if any, data are relevant for CEMP purposes. SCAR-GSS also advised that the development of appropriate monitoring methods and indices for crabeater seals is only likely to be possible when APIS is completed in 2000.

46. The subgroup, therefore, recommended that members with experience in working on crabeater seals should continue towards developing monitoring indices for this species. Furthermore, WG-EMM should encourage the maintenance of close contact with, and support for, APIS in the interests of developing monitoring methods and indices for crabeater seals.

REVIEW OF EXISTING METHODS AND TECHNIQUES

47. The subgroup discussed the existing standard methods and suggested the following changes, additions and/or comments.

Method A1 – Adult Weight on Arrival at Breeding Colony

48. There were no suggested changes to this method.

49. The subgroup noted that very few scientists were able to be in the field in time to observe the first arrival of birds at the breeding colony. Last year, a possible new method was suggested which may help to assess the variability in early-season breeding condition among Adélie penguins (SC-CAMLR-XIV, Annex 4, paragraph 5.16). This method involves comparing interannual variability in weights of adults and first eggs at peak egg laying, using nests with two adults present but at the stage at which only the first egg had been laid.

50. Dr Trivelpiece reported that this method looks promising, although additional years of data are needed before a judgment can be made. There were significant differences between years in the weights of male and female Adélie penguins and in the weights of the eggs. However, not all of these years also had data on the length of time between arrival and egg laying, making it impossible to determine whether these differences reflected differences in actual arrival condition or in the length of the courtship fasting period. This study is continuing and results will be presented when available.

Method A2 – Duration of First Incubation Shift

51. The subgroup suggested the following changes to the data collection and analysis methods of this parameter:

Data Collection: General Procedure

1. Select 100 pairs prior to the beginning of the egg-laying period. Note: these can be the same birds as used to determine breeding success by Procedure B.

2. Band or mark (with dye) both pair members, capturing (marking) them close to egg laying to minimise the possibility of the birds deserting.

3. Check nests daily, note dates of relief. When both birds are present at the nest during a nest check, each receives a half-day credit for that day.

4. Continue monitoring nests daily until the chicks hatch <u>and</u> both members of the pair are seen, indicating they are both still alive.

Analytical Methods

1. For analysis purposes, use only pairs which laid two eggs and successfully hatched both chicks (note: this will minimise differences in age/experience among the sample nests between years).

2. For each nest, day 0 equals the date of clutch completion.

3. Calculate the duration of the first incubation shift for males and females.

4. Calculate total number of days spent by males and females on the nest throughout the incubation period.

5. Determine the total number of reliefs at the nest during the incubation period.

6. Note the dates and causes of nest failures.

Interpretation of Results

Add paragraph 2:
Analysis of incubation shift durations within and among sites indicates that incubation shifts at specific sites are fairly constant year-to-year while significant differences exist between different sites (Trivelpiece, ms in prep.). Adélie penguins may be returning to areas of known productivity during their first long incubation shifts (WG–EMM-96/58), hence the fairly consistent, year-to-year, duration of shifts at each site. Differences between sites may reflect differences in travel time needed to reach productive areas in the early spring from different breeding locations.

Method A5 – Duration of Foraging Trips

52. Highly Desirable Data

Add paragraph 2:
The number of chicks a pair is feeding should be recorded as it may influence the foraging behaviour (and diet) of the adults.

Interpretation of Results

Add paragraph 3:

Interannual differences in foraging trip durations from sites adjacent to broad-shelf regions may reflect differences in krill distribution, not availability or biomass *per se*. For example, long trips by Adélie penguins at Anvers Island occur in conjunction with the dominance of large size classes in the krill population, short foraging trips correlate with the dominance of juvenile krill. Large krill are distributed at the shelf break where spawning occurs, small krill are found inshore. For sites such as Anvers Island where the shelf break is 120+ km distant, large interannual variability in foraging durations reflects differences in krill distribution and the distances Adélie penguins must travel to obtain food.

Additional Comments on Method A5

53. At the 1995 meeting of WG-EMM, evidence was presented that male and female Adélie penguins showed differences in foraging behaviour (SC-CAMLR-XIV, Annex 4, paragraph 5.17). These differences, as determined for Béchervaise Island and Edmonson Point, are set out in WG-EMM-Methods-96/11. Based on the above considerations, the subgroup agreed that it was essential that the foraging trip durations be recorded and analysed separately for males and females. Further, because Adélie penguins alternate variously short and long trips, it may be necessary to examine the foraging behaviour of individual birds; scientists undertaking CEMP studies should report the sequential foraging trips of individual birds. With this in mind, the subgroup noted the suggestions of the Secretariat contained in WG-EMM-Stats-95/6.

54. The subgroup noted that, in addition to radio frequency telemetry, there are now a number of methods available for determining foraging trip duration, including Automated Penguin Monitoring Systems, as used by Australia, and satellite tracking. It would be preferable to include descriptions of such automated means as an appendix to the *CEMP Standard Methods* and update them regularly.

Method A6 – Breeding Success

55. Last year, WG-EMM suggested that Procedure C does not reflect breeding success but rather fledging success (chicks fledged per chick hatched) (SC-CAMLR-XIV, Annex 4, paragraph 5.20). In fact, Procedure C explicitly does include hatching, fledging and overall breeding success.

56. The subgroup noted that Procedure A was considerably less rigorous (and therefore potentially less useful) than Procedures B and C. It was therefore recommended that for new studies it should be mandatory to use either Procedure B or Procedure C. Editorial changes to the standard method should be made as necessary. This would be undertaken by the Secretariat prior to the forthcoming meeting of the Scientific Committee.

Method A7 – Chick Weight at Fledging

57. The subgroup suggested that the comments in Procedure A, paragraph 2, relating to banded birds would be more appropriate if included in a separate procedure. Therefore, the last sentence of paragraph 2 in the standard method should be deleted.

An outline of an additional procedure relating to obtaining chick weight at fledging for banded birds was proposed:

General Procedure – Procedure C:

Procedure C involves weighing chicks that are banded as part of ongoing demographic studies (Method A4).

1. Capture banded chicks which are on the beach and about to fledge. Weigh each chick (to nearest 10 to 50 g) and record its band number.

2. Make regular (1 to 2 times daily) visits to all beaches throughout the fledging period, continuing to capture and weigh banded chicks.

3. Attempt to capture 200 to 300 individuals per year.

Comments

Procedure C will provide a chronology of fledging dates each year and will allow later examination of the relationship between chick fledging weights and survival. See also comments in paragraph 69.

Method A8 – Chick Diet

58. The subgroup considered the SCAR proposal that General Procedure A of Method A8 should be redrafted as suggested in WG-EMM-Methods-96/12. In considering this proposal, the subgroup decided that the stomach flushing procedure represents a sample collection technique and as such it should be published as an appendix to the *CEMP Standard Methods*. The proposed text of the stomach flushing procedure was compared with the existing procedure contained in Appendix 7 in the *CEMP Standard Methods*. It was found that the SCAR and CEMP versions were very similar, and it was recommended that Appendix 7 be retained in its present form.

59. As a precautionary measure, it was recommended that the tube used for flushing the stomach should not be inserted deep into the stomach and generally should be stopped when it reaches the bird's oesophagus.

60. The subgroup suggested that if the procedure of taking the diet sample resulted in the bird's death, the bird should be retained for post mortem analysis. An example of the value of this was shown by the post mortem investigation of a little penguin (*Eudyptula minor*) described in WG-EMM-Methods-96/10.

61. It was noted that eyeball measurements could provide good estimates of the length of euphausiids and that some regression equations for this had already been published (e.g. Nemoto et al., 1984).

62. The subgroup recommended that diet samples comprising krill which may require long storage times should be first fixed in formalin (4–10%, 12 h) prior to being preserved in 70% alcohol.

63. WG-EMM had requested the Subgroup on Statistics to consider how data on empty stomachs should be incorporated into the calculation of indices (SC-CAMLR-XIV, Annex 4). WG-EMM noted that it was essential to determine if birds found with empty stomachs were breeders and suggested that the easiest way to report this information would be as a single figure on form A8 for the number of empty stomachs (Appendix H, paragraphs 21 and 22). The subgroup also recommended that whether or not birds with empty stomachs were found, the total number of birds sampled with food in their stomachs should still be five for each five-day period as required by General Procedure A.

64. The subgroup recommended that the following additional data should be recorded as part of Method A8 (chick diet):

(i) the sex of the sampled birds (see *CEMP Standard Methods*, Appendix 2); and

(ii) the number of chicks of each bird at the time of sampling.

The latter data could be obtained by either capturing the bird at its nest site instead of on the beach or by marking the bird following sampling and following it to the nest.

65. The subgroup noted the comments of the Scientific Committee (SC-CAMLR-XIV, Annex 4, paragraph 5.25) concerning the differences between the first and subsequent vomits (noted in WG-EMM-95/32). The subgroup recommended separating the fresh food fraction of the stomach content from the more digested fraction during collection by switching trays while lavaging the bird. This would make the subsequent analysis of the stomach content easier.

66. Differences in foraging patterns of males and females had recently been documented for Adélie penguins at Edmonson Point and Béchervaise Island (WG-EMM-Methods-96/11). It was recommended that diet samples collected in accordance with Method A8 should also be separately analysed by sex.

67. The subgroup recommended that comments relating to possible bias for species with individuals whose foraging trips may or may not include overnight periods at sea (WG-EMM-96/49 and 96/55) be added to the 'Problems to be Considered' section of the standard method.

68. The need to develop a standardised procedure for Method A8 which would enable a quantitative evaluation of the stomach content was discussed. Several approaches were considered, including evaluation: of the sample wet weight versus displacement volume, methods of removing excess water from the sample, and using a standard volume of water for each sample. The subgroup felt that the best way of dealing with the issue would be to convene a special workshop with participation of experts in sampling zooplankton.

Method A9 – Breeding Chronology

69. The proposed procedure for selecting a sample of nests (see also Method A6, Procedure B, 1) appears to be too restrictive. The procedure should be made more flexible to allow for differences in site conditions and colony size while maintaining the required sample size. The subgroup called for the preparation of modified text for consideration at the next meeting of WG-EMM.

Methods B1, B2 and B3 – Flying Birds

70. No expertise on the subject was available among the subgroup members present, therefore no comments were made with regard to these methods.

Method C1 – Duration of Cow Foraging/Attendance Cycles

71. The recommendation of the Subgroup on Statistics that the method should be amended to allow for reporting failures of animals with transmitters to complete their first six post-natal trips was adopted (Appendix H, paragraph 29).

Method C2 – Pup Growth

72. The subgroup felt that observations carried out in accordance with Procedure A might also be also used to collect information on mortality of pups, i.e. information on the survival of marked pups. However, it was noted that at many sites this would be very difficult, if not impossible, to achieve.

73. The comment of the Subgroup on Statistics that there might be a bias in Procedure B indices because it is impossible to identify pups weighed early in the season which will not survive to weaning, has raised an important point, also relevant to Method A7 (see Williams and Croxall, 1990). This might be also pertinent for penguin chicks (Method A7) and the matter should be investigated.

MONITORING OF ENVIRONMENTAL PARAMETERS

74. Standard methods for the monitoring of environmental parameters were adopted by WG-CEMP in 1990 (SC-CAMLR-IX, Annex 4, paragraph 120). Since these methods have not been developed to the same degree of detail as the predator methods, they are currently appended to the *CEMP Standard Methods*.

75. The above methods are preliminary and submission of the relevant data to CCAMLR is not yet required. The methods are allocated codes in accordance with the proposed CCAMLR nomenclature for CEMP standard methods and include:

F1 Sea-ice cover as viewed from the colony
F2 Sea-ice within the study region
F3 Local weather
F4 Snow cover in the colony.

76. The subgroup noted the comments by the Subgroup on Statistics dealing with the monitoring of environmental parameters influencing harvested species (Appendix H, paragraphs 47 to 50) and dependent species (Appendix H, paragraphs 51 and 52). In particular, the subgroup noted that significant environmental events (i.e. those which fall outside a continuous monitoring regime) are encountered and that these may directly affect monitored parameters. The subgroup agreed that these should be noted and reported to CCAMLR on the predator reporting forms. Accordingly, all forms should be amended to include an entry for 'unusual environmental conditions'.

77. The subgroup noted that the identification and recording of environmental parameters for monitoring purposes requires further development as a matter of priority. Such development needs to be encouraged through a series of workshops to identify essential parameters and to develop decision rules which may be used to select 'critical' parameters which exert demonstrable influences on monitored indices.

OTHER BUSINESS

78. The subgroup noted the discussions of the Subgroup on Statistics on the CPD index. This index is currently calculated as the krill catch within 100 km of predator colonies during the period December to March and is intended to indicate the degree of spatial overlap between the foraging area of the birds and the fishery. The subgroup agreed that this was a useful index, but noted that in some instances Adélie penguins regularly forage farther afield. The foraging range of the Adélie penguin varies with the stage in the breeding cycle and the sex of the bird. There is also increasing evidence to suggest that birds regularly travel to specific areas to forage and in any event to the edge of the continental shelf. With this in mind, the subgroup endorsed the recommendations of the Subgroup on Statistics (Appendix H, paragraphs 38 to 40).

79. The subgroup noted that the book *CEMP Standard Methods* would be improved by the addition of an introductory section which described the development of CEMP, its objectives and structure and explained the choice of monitored species and parameters. Such an introduction would be of particular value to scientists who are planning to commence field programs and to field staff.

80. Electronic submission (on disc, e-mail or other internet systems) is now being encouraged by the Secretariat, provided that the data conform to the structure of the CCAMLR databases. Members wishing to submit data electronically should contact the Secretariat to obtain a description of the format in which their data should be submitted.

SUMMARY ADVICE TO WG-EMM

81. (i) Drafts of standard methods recommended for inclusion in *CEMP Standard Methods* (paragraphs 8, 14, 22, 26, 33 and 34) and those which have been prepared but require further revision (paragraphs 24 and 25) are presented in WG-EMM-96/53.

(ii) The following new methods were recommended for development:

(a) breeding chronology of Antarctic and Cape petrels (paragraph 30);
(b) attachment of instruments to flying birds (paragraph 13); and
(c) marking of birds for long-term studies (paragraph 42).

(iii) Several amendments were proposed for existing standard methods (paragraphs 48 to 77).

(iv) An investigation should be carried out on the effect on birds of fresh- and sea-water used for stomach flushing (paragraph 20).

(v) The workshop on the analysis of TDR data and the development of indices of predator foraging performance should be held in the first half of 1997 (paragraph 16).

(vi) Close contact with and support of APIS should be continued in the interests of developing monitoring methods and indices for crabeater seals (paragraph 46).

(vii) A special workshop should be convened to develop a standardised procedure for a quantitative evaluation of the stomach content used for dietary studies (paragraph 68).

CLOSE OF THE MEETING

82. The report was adopted. In closing the meeting the Convener thanked the Institute of Marine Research in Bergen and Dr Øritsland for hosting the meeting. He also thanked all participants.

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Nemoto, T., M. Okiyama and M. Takahashi. 1984. Squid in food chains of the Antarctic marine ecosystem. *Memoirs of the National Institute of Polar Research*, Tokyo, Special Issue 32: 89–92.

Williams, T.D. and J.P. Croxall. 1990. Is chick fledging weight a good index of food availability in seabird populations? *Oikos*, 59: 414–416.

ATTACHMENT A

AGENDA

Subgroup on Monitoring Methods
(Bergen, Norway, 8 to 10 August 1996)

1. Introduction

2. Review of New Methods
   (i) Attachment of Instruments
   (ii) Petrels
   (iii) Diseases and Pollutants
   (iv) Other Methods

3. Amendments to Old Methods

4. Comprehensive Review of Methods

5. Advice to WG-EMM and Future Work

6. Close of Meeting.

ATTACHMENT B

LIST OF PARTICIPANTS

Subgroup on Monitoring Methods
(Bergen, Norway, 8 to 10 August 1996)

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ATTACHMENT C

LIST OF DOCUMENTS

Subgroup on Monitoring Methods
(Bergen, Norway, 8 to 10 August 1996)

WG-EMM-Methods-96/1	PROVISIONAL AGENDA FOR THE 1996 MEETING OF THE WG-EMM SUBGROUP ON METHODS
WG-EMM-Methods-96/2	LIST OF PARTICIPANTS
WG-EMM-Methods-96/3	LIST OF DOCUMENTS
WG-EMM-Methods-96/4	A METHODOLOGICAL PROPOSAL TO DIET STUDIES OF THE CAPE PETREL, *DAPTION CAPENSE* N.R. Coria, G.E. Soave and D. Montalti (Argentina)
WG-EMM-Methods-96/5	DRAFT STANDARD METHODS FOR ATTACHMENT OF INSTRUMENTS AND THE COLLECTION OF DATA ABOUT AT-SEA BEHAVIOUR I.L. Boyd (UK)
WG-EMM-Methods-96/6	USING STOMACH LAVAGE TO SAMPLE DIETS OF PROCELLARIIFORMES R. Veit (USA)
WG-EMM-Methods-96/7 Rev. 1	PROTOCOLS FOR COLLECTING SAMPLES FOR TOXICOLOGICAL ANALYSIS S. Focardi, S. Corsolini and E. Franchi (Italy)
WG-EMM-Methods-96/8	IMPLANTED IDENTIFICATION TAGS IN PENGUINS: IMPLANTATION METHODS, TAG RELIABILITY AND LONG-TERM EFFECTS (DRAFT VERSION) J. Clarke and K. Kerry (Australia)
WG-EMM-Methods-96/9	CCAMLR STANDARD METHOD A8: PROCEDURE A J. Clarke (Australia)
WG-EMM-Methods-96/10	POST MORTEM REPORT ON A LITTLE PENGUIN J. Clarke (Australia)
WG-EMM-Methods-96/11	GENDER DIFFERENCES IN ADELIE PENGUIN FORAGING TRIPS (CCAMLR STANDARD METHOD A5: DURATION OF FORAGING TRIPS) J. Clarke and K. Kerry (Australia)

WG-EMM-Methods-96/12	CEMP MONITORING METHODS: REPORT FROM THE SCAR BIRD BIOLOGY SUBCOMMITTEE TO THE CCAMLR WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT (WG-EMM) SUBGROUP ON MONITORING METHODS SCAR Bird Biology Subcommittee
WG-EMM-Methods-96/13	PROTOCOLS FOR TAKING SAMPLES FOR PATHOLOGICAL ANALYSIS IN THE EVENT OF DISEASE BEING SUSPECTED AMONG MONITORING SPECIES K. Kerry (Australia)
WG-EMM-Methods-96/14	DRAFT STANDARD METHODS FOR FULMARINE PETRELS: A) ANTARCTIC PETREL *THALASSOICA ANTARCTICA* F. Mehlum (Norway) and J.A. van Franeker (Netherlands)

OTHER DOCUMENTS

WG-EMM-95/44	PROTOCOLS FOR TAKING SAMPLES FOR PATHOLOGICAL ANALYSIS IN THE EVENT OF DISEASE BEING SUSPECTED AMONG MONITORED SPECIES K.R. Kerry, J. Clarke, D. Opendorf (Australia) and J. Cooper (South Africa)
WG-EMM-95/46	DRAFT: DIFFERENCES IN THE FORAGING STRATEGIES OF MALE AND FEMALE ADELIE PENGUINS J. Clarke and K. Kerry (Australia) and E. Franchi (Italy)
WG-EMM-95/86	DRAFT STANDARD METHODS FOR FULMARINE PETRELS: A) ANTARCTIC PETREL F. Mehlum (Norway) and J. A. van Franeker (The Netherlands)
WG-EMM-STATS-96/5	DATA REQUIREMENTS FOR METHOD A5 D.J. Agnew (Secretariat)
WG-EMM-96/6	REPORT OF THE MEETING OF THE SUBGROUP ON STATISTICS (Cambridge, UK, 7 to 9 May 1996) (Attached to WG-EMM report as Appendix H)
SC-CAMLR-XV/BG/10	EXCERPTS FROM THE REPORT OF THE MEETING OF THE SCAR GROUP OF SPECIALISTS ON SEALS (CAMBRIDGE, UK, 1–2 AUGUST 1996)

ANNEX 5

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 7 to 16 October 1996)

TABLE OF CONTENTS

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 7 to 16 October 1996)

INTRODUCTION

1.1 The meeting of WG-FSA was held at CCAMLR Headquarters, Hobart, Australia, from 7 to 16 October 1996. The Convener, Dr W. de La Mare (Australia), chaired the meeting.

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

2.1 The Convener welcomed participants to the meeting and introduced the Provisional Agenda which had been circulated prior to the meeting. The following additions were made:

- Subitem 3.2(e) 'Unreported Catches'; and
- Subitem 4.13 'Reopening Fisheries'.

With these additions the Agenda was adopted.

2.2 The Agenda is included in this report as Appendix A, the List of Participants as Appendix B and the List of Documents presented to the meeting as Appendix C.

2.3 The report was prepared by Drs A. Constable (Australia), J. Croxall and I. Everson (UK), Prof. G. Duhamel (France), Drs S. Hanchet (New Zealand), R. Holt (USA), G. Kirkwood (UK), Lic. E. Marschoff (Argentina), Drs D. Miller (South Africa), G. Parkes (UK), G. Watters (USA) and the Secretariat.

REVIEW OF AVAILABLE INFORMATION

Data Requirements Endorsed by the Commission in 1995

3.1 It had been the experience of the Working Group that responses to general data requests had been poor. In an attempt to improve this situation the Working Group had, at its 1995 meeting, set out a specific list of data requirements (SC-CAMLR-XIV, Annex 5, paragraph 11.2) which had then been endorsed by the Scientific Committee and Commission. The Secretariat had been asked to pursue these requests with appropriate scientists or other authorities.

3.2 The responses to these requests had been good, with information being provided on most topics. In view of this, the Working Group agreed to use the same approach in presenting this year's data requirements (see paragraphs 9.2 and 9.3).

Fisheries Information

Catch, Effort, Length and Age Data

3.3 A summary of catch data from the 1996 split-year had been prepared by the Secretariat from the STATLANT B database (SC-CAMLR-XV/BG/1 Rev. 1). In some cases STATLANT B data had not been received by the Secretariat. In these cases total catches had been estimated based on data in the fine-scale database, or else, if those data were unavailable, from five-day catch reports.

3.4 Information on the levels of reported catches is set out in Table 1.

Table 1: Summary of reported catches of finfish and crabs by species and subarea/division.

Species Name	Subarea/Division			Total
	48.3	58.5.1	58.6	
Champsocephalus gunnari		5		5
Channichthys rhinoceratus		1		1
Dissostichus eleginoides	3821*	4915	3	8739
Lepidonotothen squamifrons		15		15
Macrourus spp.	26			26
Paralomis spinosissima	497			497
Rajiformes spp.	40			40
Total	4384	4936	3	9323

* This figure took into account an additional 704 tonnes from Chilean five-day catch reports.

3.5 In response to requests included in SC-CAMLR-XIV, Annex 5, paragraph 11.2, Ukraine had provided clarification of data previously submitted by the former Soviet Union. The revised datasets have now been incorporated into the database.

3.6 Members were encouraged to check their own data held in the Commission's databases and provide revisions if any discrepancies are detected. In the past, when some revisions have been provided, there have been problems in determining precisely how the data tables should be changed. This is particularly important where information is provided indicating how data originally submitted for a subarea should be divided between divisions, or else where a general species category has been used and the revision provides a species breakdown. The Secretariat requested that if such revisions are made in future they should contain sufficient information to identify unequivocally the data entries that are being changed. The best way of achieving this would be to provide complete tables for all the categories and years in question. Further discussion on future work on improving the database is given in paragraphs 9.2 to 9.4.

Scientific Observer Information

Observer Programs undertaken in 1995/96

3.7 Conservation Measure 93/XIV required the placement of international scientific observers on board each longline vessel fishing for *D. eleginoides* in Subarea 48.3 in the 1995/96 season. A total of 16 vessels took part in this fishery and all carried observers. All data were submitted to the Secretariat. Details of data submission are given in paragraphs 7.26 to 7.31. Results of observation programs are discussed in paragraphs 7.32 to 7.54.

3.8 The UK reported observations conducted on board the Korean squid jigging vessel *Ihn Sung 101*, which undertook a research fishery for the squid *Martialia hyadesi* at South Georgia in June 1996 (WG-FSA-96/21). Results of this survey are considered in paragraphs 4.10 and 4.14.

3.9 A preliminary report was received from a South African observer on board the longline vessel *American Champion* (USA) fishing on the high seas close to the CCAMLR Convention Area (see paragraph 7.50).

Design of Data Forms for Observers

3.10 Following the request of last year's meeting of WG-FSA (SC-CAMLR-XIV, Annex 5, paragraph 11.8), the Secretariat has drafted forms for the Scientific Observer Logbook for recording observations in trawl fisheries (WG-FSA-96/51). The Working Group discussed these forms in detail and several changes were proposed and agreed (WG-FSA-96/51 Rev. 1).

3.11 The Working Group considered it appropriate to examine only finfish observation forms, and suggested that krill forms should be referred for consideration by krill specialists participating in WG-EMM.

3.12 Comments from observers have been received regarding the design of the existing Scientific Observer Logbook for longline fisheries. These comments have been considered by WG-FSA and the forms have been modified accordingly (WG-FSA-96/51 Rev. 1).

3.13 The Secretariat will distribute revised longline and trawl fishery observation forms for information at the forthcoming Scientific Committee meeting so they may be available to Members for use in the forthcoming season.

Observer Operational Procedures and Data Processing

3.14 Experience gained by the Secretariat in processing longline fishery Scientific Observer Logbooks and cruise reports has led to a number of recommendations which would allow significant improvements in both data quality and timeliness of submission in future.

3.15 At present, in some cases the Secretariat is unaware of the number of observers operating in the Convention Area until the data are received. Significant problems with interpretation of data supplied by observers could be easily rectified by directing specific questions to the observer (preferably through technical coordinators nominated by Member countries).

3.16 The following recommendations regarding general Scientific Observer Logbook design and operational procedures were made:

(i) in future, the *Scientific Observers Manual* should include all instructions and procedures detailed in the current Scientific Observer Logbook. Loose-leaf master copies of the most recent version of data collection forms should be included in the *Scientific Observers Manual*, and photocopies of these forms should be made by Members and used as required. Depending on observer priorities for a particular fishery or vessel, logbooks can be compiled to include the required set of forms. Any new forms which may be suggested by the Scientific Committee for new types of fishery or fishing gear would be distributed to Members as an update to the *Scientific Observers Manual*;

(ii) examples of completed daily observer data recording forms are to be included in the *Scientific Observers Manual*;

(iii) to reduce erroneous entry of data due to misinterpretation of instructions (evidenced already in some data received), priority should be given to publication of the *Scientific*

Observers Manual in all four languages of the Commission, to be distributed accordingly;

(iv) version numbers should be clearly visible on all loose-leaf pages of the *Scientific Observers Manual*, and a complete list of current versions of all sections should be provided by the Secretariat with any future updates;

(v) each Member providing observers should nominate a technical coordinator (advising the Secretariat of the name, address, fax, phone and e-mail if available) who will be responsible for: (a) the receipt and distribution of observer instructions and data forms; (b) notifying the Secretariat, preferably by fax or e-mail, of observer departures from port to the Convention Area and also on return to port; (c) ensuring timely submission of data to the Secretariat by observers; and (d) answering or relaying questions from the Secretariat regarding data supplied by observers;

(vi) to allow more timely processing and provision of data by the Secretariat, Scientific Observer Logbooks and cruise reports should be submitted no later than one month after the end of the observed cruise; and

(vii) some observer data has been received in formats other than that provided by CCAMLR. Although this data is valuable, and an effort will be made to process such data as has already been received, it will not be possible to continue to process this data indefinitely. It is recognised that longline fishery logbooks may not have been available in time for some observers during 1995/96, and that trawl fishery observer data recording forms may take a short time to reach observers after initial publication and distribution.

3.17 Comments were also received from one longline fishery observer that there was insufficient time to complete all the tasks indicated in the longline fishery logbook when only a single observer was present. WG-FSA recognised that the data collection procedure has been designed for either one or two observers, and that not all tasks may be completed in detail by a single observer, depending on circumstances. With this in mind, the Working Group suggested priorities for major data collection tasks. A single observer must complete tasks nominated as high and medium priority, and should complete those given low priority as far as possible. The Working Group also noted that all currently required tasks have been successfully completed by some observers operating alone.

3.18 The following suggested priority list for observers working on board commercial longline vessels (Table 2) is designed to be kept under constant review, and is able to be changed depending on the current needs of the Scientific Committee. Should research priorities change, updated priority lists will be made available for inclusion into the regular updates of the *Scientific Observers Manual.*

Table 2: Suggested priorities for CCAMLR scientific observers on board longline fishing vessels.

Priority	Form	Description
High	L5 (vi)	As many length measurements of fish as possible per haul, not exceeding 60.
High	L5 (vii)	Fish sex and maturity information.
High	L5 (v)	Monitoring the incidental mortality of seabirds. Collecting and recording of bird band information.
High	L2 (ii)	Description of streamer lines used.
High	L4 (iv)	Information on whether the streamer line was used during every longline set.
Medium	L5 (viii)	Estimation of commercial and by-catch species in numbers and weight, per number of hooks observed for each set.
Medium	L5 (viii)	Recording fish discards (both target and by-catch species) per number of hooks observed for each set.
Medium		Evaluation of the efficiency of mitigation measures.
Medium	L5 (vii)	Collection of fish scales and otoliths for age determination.
Medium	L4 (iv)	Monitoring the location and time of offal discharge.
Low	L5 (v)	Retaining (whole or head and leg) samples of birds for age and species identification.
Low	L5 (iv)	The estimation of the number of fish per haul damaged during interaction with marine mammals.
Low	L5 (ii)	Estimation of the number of hooks lost.

3.19 The Working Group recognised that improving the quality of scientific observation (including the production of reports and logbooks) would require the development of a scheme for training observers – such as those run by a variety of countries in relation to their domestic fisheries. A first step in this direction might be to undertake comprehensive briefing and training of the technical coordinators when they are nominated.

Research Surveys

3.20 A survey to monitor the status of *Champsocephalus gunnari* in Subarea 48.3 was reported in WG-FSA-96/27.

3.21 The report of a research survey using a Korean squid jigger in Subarea 48.3 to investigate the distribution of *M. hyadesi* is given in WG-FSA-96/21. The Working Group noted that the catch data from this research survey have not yet been submitted to the CCAMLR database.

Mesh/Hook Selectivity and Related Experiments Affecting Catchability

3.22 No papers were tabled describing studies on these topics. Even so, the Working Group still considers information on these topics important for refining assessments. Estimates of hook and trawl selectivity were derived during the meeting for use in assessments (see paragraph 4.234).

Unreported Catches

3.23 At its 1995 meeting the Working Group had noted that the reported catch for *D. eleginoides* probably represented only about 40% of the total removals from the fishery. Since the total removals is an essential component of any assessment, this level of uncertainty had been viewed with considerable concern.

3.24 Members were aware of significant unreported fishing taking place within, and close to, the Convention Area during the 1996 season. For example, it was suggested that around 25 vessels had been longlining for *D. eleginoides* in the southwest Indian Ocean close to Subareas 58.6 and 58.7 and that catches of around 10 000 to 20 000 tonnes may have been taken from waters within or adjacent to the Convention Area were possible. It was noted that some of this unreported fishing was thought to have been undertaken by vessels sailing under the flags of CCAMLR Member States.

3.25 Concern was also expressed that fishing companies were alleged to be operating under 'flags of convenience' in order to conceal their activities and intentions. The Executive Secretary noted that the procedure necessary to frequently reflag a vessel was time-consuming and costly and consequently the frequent changes alluded to in the popular press were probably unrealistic.

3.26 The Working Group viewed the information in paragraph 3.24 with considerable concern, noting that without information on total removals the quality of the assessments was being seriously prejudiced.

Fish and Crab Biology/Demography/Ecology

Dissostichus eleginoides

3.27 A tagging study associated with the commercial trawl fishery at Macquarie Island was reported in WG-FSA-96/39. The results demonstrated that, with care, tagging with Texas Instruments

Radio Identification System (TIRIS) transponder internal tags and T-bar external tags was effective. The results had been used to estimate standing stock in the region.

3.28 A sequential population analysis (SPA) based on catch-at-age data from Subarea 48.3 between 1992 and 1996 was described in SC-CAMLR-XV/BG/14. The results are similar to those derived by the Working Group in 1995. This paper was considered further under Agenda Item 4 (see paragraphs 4.60 to 4.63).

3.29 Studies on the diet of *D. eleginoides* were described in WG-FSA-96/16 (Division 58.5.1), 96/29 (Subarea 48.3) and 96/43 (comparing data from Subarea 48.3 with information from the Argentinian continental shelf). All these studies highlight the importance of fish at all localities and krill in Subarea 48.3 in the diet of this species.

3.30 The analysis in WG-FSA-96/44 of the sex ratio of fish in Chilean longline catches from Subarea 48.3 indicated that there had been significant changes throughout the fishing season which may have been associated with migrations around the time of spawning.

3.31 A study during the period October 1995 to March 1996 in Division 58.5.1 indicated a relationship between catch rate in longline operations and barometric pressure (WG-FSA-96/48).

3.32 Several papers reported developments in the estimations obtained and in validation of methods for age determination. A comparison of age readings using otoliths and scales in WG-FSA-96/42 indicated that otoliths frequently appeared totally opaque, making it impossible to read them, whereas scale images were consistently clear. A method of estimating fish growth parameters using the estimated age and the radius of the otolith was described in WG-FSA-96/53. This method has been successfully tested, using data for the mackerel *Scomber japonicus*.

3.33 Several participants noted that estimations obtained from age determination methods were reasonably satisfactory for fish up to around age 20 years, but that otoliths and scales from older fish were frequently difficult to read. It was also noted that there were significant differences in the growth rates of male and female fish.

3.34 A progress report on studies of annulus formation, micro-increments and also the use of laser ablation inductively coupled mass spectrometry was provided in WG-FSA-96/55. The Principal Investigator, Dr J. Ashford (Old Dominion University, USA, and British Antarctic Survey), had submitted the research plan to several WG-FSA participants for comments and they met, as an ad hoc group, during the course of the meeting.

3.35 The research proposal was seen as being well organised and highly relevant to the needs of the Working Group. Samples of otoliths had already been provided and further samples were offered during the meeting. Further financial support was currently being sought for the project.

3.36 Dr R. Williams (Australia) noted that evidence was emerging that *D. eleginoides* had a lifespan of over 50 years. A project to test this, using carbon isotope analysis of otoliths, was already in progress, and it was noted that further material from large (>150 cm length) fish was urgently required. Participants agreed to check sample collections to see if such material might be available.

3.37 Dr Everson reported on an investigation using parasite load as an indicator of stock separation and noted that requests for material had been made of several participants.

3.38 The Working Group welcomed these developments and encouraged further collaboration and cooperation in support of these studies.

Champsocephalus gunnari

3.39 An acoustic survey carried out during January 1996 by Russia (WG-FSA-96/59) indicated that there were concentrations of *C. gunnari* all around South Georgia.

3.40 Biological information arising from the Argentinian survey around South Georgia in March/April 1996 is given in WG-FSA-96/27. The size composition of the catches indicated few 1-year-old fish which it was thought may have been due to a greater proportion being present close to the bottom rather than an indication of recent poor recruitment. Compared to previous years there was an increase in the numbers of fish in older age classes, although few fish older than four years were present. The results indicate that there has been an increase in standing stock on the South Georgia shelf compared to previous years.

3.41 Diet and feeding activity of *C. gunnari*, investigated during the Argentinian survey around South Georgia, were described in WG-FSA-96/28. Krill appeared to be the dominant food item in the stomachs of fish from all localities around the island. The samples were unusual in that a high proportion of stomachs were empty in spite of the high availability of krill. Since the sampling scheme was the same as had been employed in previous seasons, it was considered that the cause was unlikely to be fish vomiting stomach contents on capture. The survey was undertaken during the spawning season and consequently there may be some link between feeding and reproduction, although no correlation was found between stomach fullness and maturity stage.

3.42 Analysis of data from a series of surveys, described in WG-EMM-96/43, showed a strong correlation between the condition index and CEMP indices associated with krill availability. This study and that described in paragraph 3.41 above demonstrate the importance of krill in the ecology of this species and highlight the need to take into account in any future management plan, extrinsic factors contributing to interannual variability.

3.43 An analysis of research catch rates at the same station on three annual surveys (WG-FSA-96/30) indicated that there was a positive correlation in density between stations up to eight miles apart. It was noted that such correlations need to be taken into account in designing surveys.

3.44 A series of six pelagic surveys conducted during the years 1984 to 1990 to assess one-year-old fish in the South Georgia and Shag Rocks region was reported in WG-FSA-96/58 and 96/60.

3.45 Dr P. Gasiukov (Russia) explained that the same random stratified design as used on demersal fish surveys was used, with sampling restricted to waters of depths of 70 to 500 m. All vessels were equipped with the same midwater trawl gear. Sampling was carried out by day and night at three depth layers: near surface, midwater and 5 to 15 m from the seabed. Towing speed was 3 to 3.5 knots and hauls and sampling were undertaken for 10 minutes from each layer. Between 81 and 141 hauls were made during each survey and the depth was monitored acoustically. A total of 27 species of fish and invertebrates from 11 families were found during these surveys.

3.46 Dr Gasiukov submitted a copy of the data from these surveys to the CCAMLR database. The Working Group welcomed the provision of these data, noting that they should contribute to studies on the ecology of the species.

3.47 During the surveys additional sampling was undertaken to investigate the vertical migration of *C. gunnari* by sampling at six-hour intervals over two 24-hour periods at 50, 75, 125, 150 m and close to the seabed. The results from these studies indicated that juvenile fish were near the seabed at night but migrated upwards during the pre-dawn period.

3.48 In comparing the distribution of juvenile fish with that of the commercial krill fishery, WG-FSA-96/60 concluded that the main concentrations of *C. gunnari* were away from the krill aggregations.

3.49 WG-FSA-96/24 provides a comprehensive review of the biology and ecology of *C. gunnari* throughout its distribution range. The review is of direct relevance to future assessments and the development of a long-term management plan. Further discussion is given in paragraphs 4.136 and 4.137.

Other Fish

3.50 WG-FSA-96/14 describes a new record of the shark *Squalus acanthias* reported from Kerguelen waters during a recent ichthyofaunal survey in Division 58.5.1.

3.51 Results of deepwater trawling on the southern part of the Kerguelen ridge (WG-FSA-96/13) indicated low concentrations of fish. These included *Macrourus whitsoni* and *D. eleginoides*.

Crabs (*Paralomis* spp.)

3.52 WG-FSA-96/15 describes information on *P. aculeata* taken as by-catch in the *Lepidonotothen squamifrons* fishery on the Ob Bank (Division 58.4.4).

3.53 Results from experimental fishing at South Georgia during the 1994/95 and 1995/96 seasons were described in WG-FSA-96/34. These results, along with those in WG-FSA-96/35 regarding size at maturity, were considered in detail under Agenda Item 4 (paragraphs 4.173 to 4.178).

3.54 During the course of these studies, a number of crabs had been tagged with T-bar tags in order to estimate local movement; although these tags are likely to have been cast during moulting it is possible that they may persist and appear in trawl survey catches.

3.55 The prevalence of parasites (*Briarosaccus callosus*) and hyperparasites (cryptoniscid isopods) on *P. spinosissima* from three habitats around South Georgia is described in WG-FSA-96/33. Host size, followed by habitat and local density were the major factors explaining parasite prevalence, whereas habitat was the only variable that explained a significant amount of the variation in hyperparasite prevalence.

Squid

3.56 Biological information on *M. hyadesi* caught during a research jigging cruise in Subarea 48.3 was presented in WG-FSA-96/21. The squid were caught in an area where echotraces at 400–500 m had been noted. Female squid predominated in the catches. The mantle lengths of male squid ranged from 220 to 350 mm (mode – 300 mm) and females 212 to 370 mm (modes – 290 and 320 mm).

3.57 An assessment of *M. hyadesi*, based on predator food consumption rates, was presented in WG-FSA-96/20 and was discussed fully under Agenda Item 4 (paragraphs 4.10 to 4.13).

3.58 Prespawning concentrations of the squid *Moroteuthis ingens* were reported from the Ob Bank as by-catch during target fishing for *L. squamifrons* in WG-FSA-96/15. It was noted that this species has a high ammonia content and is consequently unlikely to be of commercial interest.

Developments in Assessments Methods

3.59 Four papers presenting methods for assessing fish stocks were presented to WG-FSA. Two papers addressed assessment of the abundance of *D. eleginoides* (WG-FSA-96/39 and SC-CAMLR-XV/BG/14), one paper examined the estimation of an appropriate size limit for *P. formosa* (WG-FSA-96/35) and the fourth introduced refinements to the generalised yield model (WG-FSA-96/46).

3.60 WG-FSA-96/39 describes a successful method for tagging *D. eleginoides* in the Australian trawl fishery at Macquarie Island. This method was developed in conjunction with a localised trawling operation during the summer of 1995/96. Fish were double-tagged with TIRIS 23 mm transponders and a numbered yellow T-bar tag. A total of 490 fish were tagged, with 43 fish being recaptured during two fishing trips (at least another six fish were recovered but unreported during the first trip). Preliminary estimates of abundance of *D. eleginoides* around Macquarie Island (3 658 tonnes) were possible from this data. The paper presents the analysis required for estimating the abundance of fish from these data and discusses the potential biases associated with these calculations.

3.61 The Working Group noted the success of this tagging program, commenting on the ease with which electronic tags can be recovered during commercial operations; electronic tags can be detected with a TIRIS electronic reader as the fish pass along the processing line. The Working Group noted that this work demonstrates clearly that *D. eleginoides* can be tagged successfully and that these methods could be employed to assess stock abundance, migration patterns over small and large spatial scales, growth of individual fish and, in conjunction with tetracycline marking, validation of annual marks in otoliths. In addition, this study, undertaken on a small spatial scale, shows that the fish are mobile and that depletion experiments may not work because of large numbers of fish moving through an area.

3.62 The Working Group agreed that more tag-release studies were needed. In particular, the Working Group noted that tagging of fish from trawl surveys would be a useful addition to tagging fish taken on longliners as trawled fish were less likely to be fatally injured during fishing operations.

3.63 SC-CAMLR-XV/BG/14 develops a method for assessing the status of *D. eleginoides* in Subarea 48.3 using SPA based on catch-at-age data. The Working Group noted the new developments outlined in this paper and considered it in more detail during the assessment of *D. eleginoides* (see paragraphs 4.60 to 4.63).

3.64 WG-FSA-96/35 uses a weighted smoothing spline method to estimate size at maturity of male *P. formosa*. The Working Group considered this method in detail in its deliberations in the assessment of crab stocks and the appropriateness of current size limits in this fishery (see paragraphs 4.177 and 4.178).

3.65 Refinements to the generalised yield model were presented in WG-FSA-96/46. This paper describes the options available for undertaking projections with the model in its current form. The Working Group noted the improvements to the model and, in particular, noted the changes in the examination of the effects of fishing on the stock in relation to the decision rules used by the Commission (see SC-CAMLR-XIV, Annex 5, Appendix F for the formulation of the model used at WG-FSA-95).

3.66 Two main refinements will have affected the results from the model since 1995. The first refinement was to make consistent the calculation of spawning stock biomass at Time 0 and the spawning biomass in any year of the projection. In the 1995 version, the spawning stock biomass at Time 0 was estimated at the beginning of the year while in other years of the projection the spawning biomass is estimated at a specified time other than the beginning of the year. Consequently, the spawning biomass appeared larger at Time 0 than at other times in the projection, leading to a slight overestimate in the probability of depletion, and a slight underestimate in the status of the spawning stock (see Table 3).

3.67 The second refinement improves the assessment of the status of the stock at the end of a projection and the degree to which the stock was depleted during the projection. The aim of these two aspects of the assessment is to examine the status of the stock relative to the median spawning biomass at Time 0 ($SB_0 median$). The method used in 1995 was to test the two criteria by accumulating all values of spawning biomass at Time 0 from all projections, determining the median of these values and using this for the comparisons. However, this procedure does not allow comparisons of stock status within a projection given the basic biological parameters for the projection. In the current form of the model, the main variation in spawning biomass from year to year within a single projection is caused by variation in recruitment. Variation in the stock trajectory between projections can be caused by varying underlying biological parameters such as mean recruitment, the magnitude of variability in recruitment, natural mortality, maturity and fishing selectivity. These underlying parameters are varied because of uncertainty in their magnitude, not because of natural interannual variability. The effects of fishing on a stock need to be determined for a given set of biological parameters. Interannual variability of each of these parameters, e.g. variability in recruitment, needs to be defined separately. Thus, the $SB_0median$ needs to be determined in a way that accounts only for interannual variability; $SB_0median$ needs to be determined at the beginning of each run once the underlying biological parameters have been set. This modification has been incorporated into the model so that the assessment of the status of the spawning stock at the end of a specified period is made using the median ratio (from all runs) of the spawning biomass at the end of a run compared to the $SB_0median$ calculated at the beginning of the run. In a similar way, the level of depletion occurring during the run is calculated as the ratio of the lowest spawning biomass during the run compared to the $SB_0median$ for that run. The probability of depletion is then the proportion of runs for which this ratio falls below the critical level (e.g. 0.2).

3.68 Table 3 shows the effect of this refinement on the assessments of the effects of fishing on a stock using the parameters for the assessment of *D. eleginoides* in 1995. The original formulation was more conservative than the current formulation. Thus, catch levels determined to satisfy the two decision rules in 1995 using the original formulation of $SB_0median$ are likely to increase with the application of the new method of determining the $SB_0median$ for each run.

Table 3: Results of assessments of the status of *D. eleginoides* in Subarea 48.3 using the generalised yield model from 1995 and with two new refinements for 1996. Parameters are the same as for WG-FSA-95 and the results are for the effects of a long-term annual yield of 4 000 tonnes.

Program Structure	Probability of Depletion below $0.2.SB_0median$	Median Status of the Stock at the End of a Projection Relative to $SB_0median$
1995	0.100	0.74
Revised timing of assessment of spawning stock at Time 0	0.093	0.81
Revised method for estimating $SB_0median$	0.020	0.78

3.69 The Working Group noted that attempts to have the program validated by the Secretariat were disrupted by the resignation of the Data Manager. Validation will not be possible until a new Data Manager has been appointed and, even then, may not be completed in time for the meeting of the Working Group in 1997. The Working Group agreed that independent validation of the program should be undertaken once the refinements specified at this meeting have been incorporated (see paragraph 9.5). The Working Group also agreed that, in the interim, the model could be used for assessments.

ASSESSMENTS AND MANAGEMENT ADVICE

Definition of Fishing Grounds

4.1 As a matter of priority, the Commission has requested WG-FSA's advice on the current definitions of 'fishing grounds' given in various conservation measures (CCAMLR-XIV, paragraph 8.5).

4.2 Conservation Measures 78/XIV, 89/XIV and 96/XIV require that vessels move to another 'fishing location' at least 5 n miles distant for a period of not less than five days when the level of by-catch species exceeds 5% of the overall catch taken in one location. By contrast, Conservation Measures 94/XIV and 98/XIV are aimed at ensuring representative length samples from single 'fishing grounds' which are defined as single fine-scale rectangles (0.5° latitude by 1.0° longitude).

4.3 WG-FSA agreed that the term 'fishing ground' is confusing and should be avoided unless accompanied by a specific geographical definition.

4.4 The Working Group considered that the development and revision of measures to reduce by-catch should take account of the specific details of a given by-catch problem and fishery. From time to time, the Working Group has provided specific advice on measures to limit by-catches, and will continue to provide and review such advice as part of future assessments. The Working Group agreed that the formulation used in current conservation measures may cause practical problems in that a single haul containing few fish may still contain the 5% by-catch, thus triggering the requirement to relocate the fishing activities.

New Fisheries

4.5 Conservation Measure 31/X ensures that the Commission is notified of new fisheries in the Convention Area in advance of their commencement. Such notification is necessary for the accrual of adequate information from the very beginning of a fishery so as to evaluate its potential yield and impacts on target stocks or species dependent on them.

4.6 After a year, any new fishery is then defined as an 'exploratory fishery' under Conservation Measure 65/XII. Its expansion is then not allowed to proceed faster than the acquisition of information necessary to ensure that the fishery can and will be conducted in accordance with the principles of Article II. To ensure that adequate information is made available to the Scientific Committee during the period when a fishery is classified as exploratory, Conservation Measure 65/XII also requires the annual development/review of a Data Collection Plan and a Research and Fishery Operations Plan for the fishery concerned.

4.7 In 1996/97 the Commission received five notifications of intent to initiate new fisheries under Conservation Measure 31/X. These are summarised in Table 4.

Table 4: Summary of notifications of intent to initiate new fisheries under Conservation Measure 31/X in 1996/97.

Member	Fishery	Area	Document No.
Republic of Korea/UK	Squid	Subarea 48.3	CCAMLR-XV/7
Australia	*D. eleginoides*, *D. mawsoni*, other species	Division 58.4.3	CCAMLR-XV/9
	Miscellaneous species	Division 58.5.2	
New Zealand	*D. eleginoides*	Subareas 88.1, 88.2	CCAMLR-XV/8 (Rev. 1)
Norway	*D. eleginoides*	Subarea 48.6	CCAMLR-XV/10 (Rev. 1)
South Africa	*D. eleginoides*	Subareas 48.6, 58.6, 58.7 Divisions 58.4.3, 58.4.4	CCAMLR-XV/11

4.8 The joint Republic of Korea/UK notification (CCAMLR-XV/7) is aimed at squid while the other four proposals are for finfish fisheries (three for longlines and one for bottom trawls).

4.9 All of the above notifications were considered in light of the provisions of Conservation Measure 31/X. While acknowledging that relevant information for most of the fisheries being proposed is limited, WG-FSA noted that in most cases the notifications mentioned above provided sufficient information on which to base advice.

4.10 The Republic of Korea/UK notification (CCAMLR-XV/7) and ancillary information (WG-FSA-96/20 and 96/21) concerns a proposed new fishery for *M. hyadesi* in Subarea 48.3. Based upon the review of a previous experimental fishery and research investigations, this joint venture aims to allow two vessels to harvest up to 2 500 tonnes of *M. hyadesi*.

4.11 The Working Group noted that the proposed squid catch level of 2 500 tonnes was likely to be conservative since it represents only a small fraction (approximately 1%) of the estimate of annual predator consumption of *M. hyadesi* in the Scotia Sea (approximately 245 000 tonnes). In addition, *M. hyadesi* is taken as a by-catch in the Illex fishery in areas adjacent to Subarea 48.3. In one year (1986) this by-catch reached 26 000 tonnes.

4.12 If such a fishery develops, WG-FSA-96/20 suggested that the timing of the fishery with respect to the requirements of dependent species should be reviewed. It is suggested in the paper that the fishery should be designed to minimise effects on dependent species by confining the fishing season to the period from June to August when the chick-rearing season of the most sensitive predator (grey-headed albatross) has ended and before recruitment of the next squid year class.

4.13 Given that there is a lack of data upon which to base an objective assessment of the status of *M. hyadesi* stocks in Subarea 48.3, WG-FSA agreed that the Republic of Korea/UK notification has attempted to follow a precautionary approach upon which the initiation of this new fishery may be based.

4.14 The Working Group noted that WG-FSA-96/21 recommended specific data to be collected during the development of the proposed squid fishery. It requested the Secretariat to compare these data elements with those of CCAMLR's standard fine-scale catch and effort data form for a squid jig fishery (Form C3 Version 1) to ensure that critical data are collected. Revised data forms should be developed as soon as possible in consultation with Dr P. Rodhouse (British Antarctic Survey).

4.15 The Norwegian notification for Subarea 48.6 (CCAMLR-XV/10 Rev. 1) provided no information on proposed catch levels of finfish, on the biology of proposed harvested species, on the effects on dependent/associated species or on comparisons with similar or other fisheries.

4.16 The Australian proposal (CCAMLR-XV/9) was similar to that submitted last year (CCAMLR-XIV, paragraph 6.1) for a bottom trawl fishery in Division 58.5.2. It is planned to take up to 50 tonnes per species (other than *C. gunnari* and *D. eleginoides* which are subject to TACs under Conservation Measure 78/XIV) and to conduct a bottom trawl fishery in Division 58.4.3 with a catch limit of 200 tonnes for *D. eleginoides* and *D. mawsoni* together.

4.17 The New Zealand notification (CCAMLR-XV/8 Rev. 1) is for a longline fishery for *D. eleginoides* in Subareas 88.1 and 88.2. The notification includes a plan which aims to set out a data collection and fishery operation protocol. It proposes setting precautionary catch limits of 2 500 tonnes per statistical area with subareal limits between 200 and 1 500 tonnes being distributed by rectangles of 0.25° latitude by 0.25° longitude on the basis of catch rates established during limited periods of fishing. Such catch rates could also be used to terminate fishing in specific rectangles and to provide criteria to be applied to the resumption of fishing.

4.18 The South African notification (CCAMLR-XV/11) was similar to that of New Zealand and applies to a longline fishery for *D. eleginoides* in a number of areas in the Indian Ocean which have never been fished (e.g. Subareas 48.6 and 58.7) or where South Africa has not fished (Divisions 58.4.3 and 58.4.4). The attached management plan sets out a data collection and fishery operation protocol. It proposes setting precautionary catch limits by statistical area (a limit of 3 200 tonnes per area was chosen, based on historic catches from Subarea 48.3) with subareal limits between 200 and 800 tonnes being distributed by rectangles of 0.5° latitude by 1.0° longitude depending on the catch rates established during specific periods of fishing. Declines in catch rates are used to terminate fishing in the fine-scale rectangles and to provide criteria to be applied in the subsequent resumption of fishing in such rectangles.

4.19 WG-FSA noted that a number of general principles (particularly in respect of finfish) were common to the above notifications. Most of the notifications included some form of precautionary approach which limited catch and/or fishing effort. In the case of finfish, the general lack of knowledge concerning the distributional separation of *D. eleginoides* and *D. mawsoni* necessitates that, for the time being, these two species be considered together (i.e. catch limits should apply to both species combined). Finally, the need for regular scientific review of fisheries development was recognised.

4.20 Taking account of these generalities, the Working Group agreed that for the new fisheries for *D. eleginoides*:

(i) CCAMLR should adopt a common and integrated approach to areas likely to be developed by new fisheries;

(ii) as part of such an integrated approach, the application of Conservation Measure 31/X should anticipate the requirements of Conservation Measure 65/XII by setting up scientifically-based data collection and fishery/research operation plans. This will facilitate the acquisition of data necessary to manage the development of new fisheries in accordance with CCAMLR's precautionary approach;

(iii) precautionary catch limits should be developed for statistical areas using available information (e.g. based on catches from similar fisheries elsewhere and/or on areas likely to be suitable for fishing). Limits for smaller areas (e.g. rectangles of 0.5° latitude by 1.0° longitude) should also be developed. These will serve to distribute catch and fishing effort while augmenting the collection of relevant information over a wide geographic area in a way that should reduce the risk of localised over-fishing;

(iv) the collection of crucial fisheries and biological information requires the deployment of scientific observers; and

(v) objective verification of positional information is essential, particularly if fine-scale rectangles are applied (see paragraphs 4.25 and 4.26 below) or if the fishery should follow stock across the Convention Area's boundaries (as appears to be the case for *D. eleginoides* in Subarea 58.7 and on the banks adjacent to Subarea 48.3).

4.21 The Working Group agreed that the generalities set out in paragraph 4.20 above could be applied to other new fisheries to a greater or lesser degree. Future investigation of their wider applicability should therefore be undertaken as a matter of priority so as to facilitate the development of a coordinated management approach to new and developing fisheries in line with the principles of the precautionary approach set out by WG-FSA in 1995 (SC-CAMLR-XIV, Annex 5, paragraphs 10.2 to 10.8).

4.22 In the specific case of the proposed new fisheries for *Dissostichus* spp. in the Australian, New Zealand, Norwegian and South African notifications, WG-FSA agreed that the adoption of precautionary catch limits in small areas could be based on historic longline catches by fine-scale rectangle in Subarea 48.3 (average – 330 tonnes for the period 1990 to 1996, range – 1 to 2 390 tonnes) and Division 58.5.1 (average – 71 tonnes for 1996, range – 1 to 264 tonnes). This gives an overall average for the two areas of about 200 tonnes.

4.23 Accepting that the purpose of fine-scale areal limits is to provide some scope for a spread of fishing effort as well as minimising the risk of localised overfishing, the Working Group agreed that a fine-scale areal catch limit in the order of 100 tonnes would meet these criteria. A 100-tonne limit would also have the advantage of being conservative.

4.24 The Working Group drew the attention of the Scientific Committee and the Commission to two important considerations inherent in the setting of fine-scale areal limits.

4.25 The first is that the administration of such limits requires that catch data and positional information should be collected and reported in as close to real time as possible. For practical purposes the former could be based on the five-day catch and effort reporting system already in place for the *D. eleginoides* fishery in Subarea 48.3, while the latter would be best achieved by some form of automated vessel monitoring system, especially if more than one vessel is fishing in a particular fine-scale area. The added advantage of having such systems to monitor the passage of fishing vessels across the Convention's boundaries has already been highlighted (paragraph 4.20).

4.26 The second important consideration is the definition of small areas. An appropriate area would be a fine-scale rectangle defined by 0.5° latitude by 1.0° longitude. The identification of each rectangle is by the latitude of its northernmost boundary and the longitude of the boundary closest to 0°. The northern boundary must be a whole or half degree of latitude and the longitude of the boundary must be a whole degree.

4.27 The Working Group strongly emphasised that the application of the approach outlined in paragraph 4.20 should be conditional on the collection of detailed catch and effort data from both longline and trawl fisheries. Such data will not only provide information on catch rates but also on how such rates may affect fishing activity (e.g. when vessels leave or remain in a specific fishing locality). They may also be useful for assessment and management purposes (e.g. in the derivation of standardised catch rates).

4.28 The Working Group agreed that a conservative approach would be to apply calculated yields from assessments of *D. eleginoides* in Subarea 48.3 and Division 58.5.2 in a manner which is discounted to take implicit account of incomplete knowledge of previously unexploited areas and/or adjusted for the relative area of fishable seabed as a proportion of total seabed available within the statistical area. The former approach is directly analogous to that adopted for krill during the early formulation of management measures for that fishery.

4.29 For example, the calculated mean of the yields of *D. eleginoides* in Subarea 48.3 (5 000 tonnes) and Division 58.5.2 (3 800 tonnes) for 1996 is 4 400 tonnes. A 50% adjustment would then set a precautionary catch limit of 2 200 tonnes to be applied to previously unfished statistical areas for the 1996/97 season.

4.30 WG-FSA emphasised that the precautionary catch limit given in paragraph 4.29 is provided as an example of how such limits could be derived for previously unfished areas. It warned that the given limit does not imply that such quantities of fish would be available for each new statistical area, or that it represents an accurate assessment of potential yield in areas subject to new fisheries.

4.31 Adjustment of areal precautionary limits based on proportionate seabed area is not possible at this time as this procedure depends on calculations of seabed area for specific depth ranges in previously unfished areas being compared with fished areas. The Secretariat was requested to undertake such calculations during the forthcoming intersessional period.

4.32 WG-FSA agreed that all relevant conservation measures and data collection and submission requirements pertinent to the prosecution of *D. eleginoides* fisheries should apply to any new fishery for *Dissostichus* spp. as a matter of course. The Working Group emphasised that the provisions of Conservation Measure 29/XIV must be rigorously applied in order to minimise incidental mortality associated with longline fishing. The application of all conservation measures should be regularly reviewed (see 4.33 below).

4.33 Finally, WG-FSA recognised that it would not be possible during the initial phase of any new fishery to collect sufficient data to allow for the determination of stock status on the basis of fisheries-dependent methods alone. At this stage the practical application of such methods is unclear (e.g. little is known about the viability of many of the new fisheries being proposed or their precise location). This requires that fisheries-dependent data collection procedures must be as comprehensive as possible during the 'new' phase and, assuming that the fishery continues, must also be carried over to the 'exploratory' phase as defined by Conservation Measure 65/XII. WG-FSA must also strive as a matter of urgency to set priorities for future data collection and assessment procedures. The development of such procedures should include the identification of essential data (both fisheries-dependent and independent) to be collected, the design and deployment of research effort and the application of catch (or effort) limits on fisheries during their exploratory phases.

4.34 The coding and validation of data being submitted to CCAMLR from the rapidly expanding fishery for *Dissostichus* spp. will add substantially to the already considerable workload of the Secretariat. The Working Group noted that processing the data in time for the next meeting of WG-FSA would have additional financial implications.

Antarctic Peninsula (Subarea 48.1)

4.35 No new information was available to the Working Group on stocks in this subarea. WG-FSA noted that a bottom trawl survey of Subarea 48.1 will be carried out by the German RV *Polarstern* in November and December 1996 (see paragraph 6.12).

Management Advice

4.36 In the absence of new information on stocks in this subarea, the Working Group noted that fisheries in Subarea 48.1 will remain closed in accordance with Conservation Measure 72/XII.

South Orkney Islands (Subarea 48.2)

Champsocephalus gunnari (Subarea 48.2)

4.37 Taking into account the long period of time that the fishery in this region has been closed Dr Gasiukov proposed a similar approach to that adopted for *C. gunnari* in Subarea 48.3 for the 1995/96 season in Conservation Measure 97/XIV. He recommended an experimental fishery for *C. gunnari* be permitted in this region. He proposed a precautionary TAC of 1 500 tonnes based on the approximate midpoint of the range of minimum (392 tonnes) and maximum (3 010 tonnes) MSY calculated for this stock by WG-FSA in 1991 (SC-CAMLR-X, Annex 6, paragraphs 7.214 to 7.217). This proposal depends on an approved research bottom trawl survey being carried out prior to the experimental fishery, and an international scientific observer being on board each fishing vessel.

4.38 Dr Gasiukov considered that a fishery could provide valuable information on the size and age distribution of commercial stocks in the area, spatial distribution of the fish, and commercial CPUE data which could be compared with CPUE data obtained before the fishery was closed.

4.39 The Working Group noted that Conservation Measure 73/XII requires a survey to be carried out, its results reported to and analysed by WG-FSA, and a decision made by the Commission based on the advice of the Scientific Committee before the fishery is reopened. This situation is not analogous to the situation in Subarea 48.3.

Management Advice

4.40 In the absence of new information on stocks in this subarea, the Working Group noted that fisheries in Subarea 48.2 remain closed in accordance with Conservation Measure 73/XII.

South Georgia (Subarea 48.3)

Dissostichus eleginoides (Subarea 48.3)

Catch and Effort Data

4.41 The total reported catch of *D. eleginoides* in Subarea 48.3 during the 1995/96 season was 3 871 tonnes (five-day catch reports). The longline season opened on 1 March 1996 and was closed on 24 July 1996. The catch was taken entirely by longline vessels, including six from Chile, two from Argentina, one from the Republic of Korea, one from Russia and one from the USA. There was no vessel from Bulgaria fishing this year. The catches by month are shown in Table 5.

Table 5: Catches by month from Subarea 48.3 reported to CCAMLR during the 1995/96 split-year. Haul-by-haul catches reported between 1 September and 30 November 1996 represent by-catches in the fishery for Antarctic crab.

Month	Total Catch of *D. eleginoides* (tonnes)[1]	Total catch of *D. eleginoides* (tonnes)[2]	Catches of *D. eleginoides* Reported by Argentina on Statlant Forms[3]	Catches used in the Yield Model
July	3			3
August				
September	5		224[4]	229
October	3		435[4]	438
November	1		167[4]	168
December				
January				
February				
March	1066	1145		1145
April	796	949		949
May	742	789		789
June	501	641		641
July (1996/97)		346		
Total	3117[5]	3871		4362

1 Compiled from haul-by-haul catch reports (SC-CAMLR-XV/BG/1)
2 Compiled from five-day catch reports (COMM CIRC 96/56)
3 WG-FSA-96/37
4 Argentina reported during SC-CAMLR-XV that these catches were erroneously reported for Area 48 and in fact related to areas adjacent to Convention waters.
5 This figure includes only 2 360 tonnes from the Chilean catch, which from the five-day catch reports totals 3 064 tonnes.

4.42 As in previous years, longline fishing effort was concentrated on the 1 000-metre contour around both South Georgia and Shag Rocks. The distribution of longline fishing effort in Subarea 48.3 over the last three seasons is shown in Figures 1(a) 1993/94, (b) 1994/95 and (c) 1995/96. There was a notable increase in the proportion of fishing effort applied on the slope around Shag Rocks in 1995/96 compared with previous years. The area to the west of Shag Rocks, fished extensively in 1994/95, was fished substantially less in 1995/96.

4.43 The Working Group noted that the map of locations of longline sets in 1994/95 provided in the 1995 report (SC-CAMLR XIV, Annex 5, Figure 1) was incorrect. This was in fact the map for 1993/94 (see Figure 1).

4.44 No information was available to the Working Group on locations of catches on banks adjacent to Subarea 48.3 (North and Rhine Banks) in 1995/96.

4.45 Catches of *D. eleginoides* from areas of the southwest Atlantic outside the Convention Area were presented in the report of last year's meeting. New data have been submitted to the Secretariat for Area 41 by Argentina, in which the total reported catch in 1995 was 10 177 tonnes. This was an increase compared to 1994, when the reported catch was 4 814 tonnes, but was in line with historical catches, which peaked at 15 461 tonnes in 1992. No new data had been submitted for Area 87 since last year's meeting.

4.46 The Working Group considered information on the possible magnitude of unreported catches of *D. eleginoides* in Subarea 48.3 during the 1995/96 season. Information provided to the Secretariat by the Chilean authorities during the intersessional period indicated that there were no unreported catches by Chilean vessels in Subarea 48.3 during 1995/96. However, there was information regarding the presence of a fishing vessel in Subarea 48.3 outside the fishing season. During the intersessional period the Secretariat circulated information from the UK on two inspection reports regarding the Argentinian longliner *Estela*, which was present in Subarea 48.3 in December 1995 and January 1996, prior to the start of the 1995/96 season on 1 March 1996 (COMM CIRC 96/9, 15 February 1996).

4.47 The best estimates of real catches of *D. eleginoides* since 1990 are shown in Table 6. The Working Group noted that the TACs set by the Commission in recent years have been set for a period between the end of one Commission meeting and the start of the next, whereas the catch data are normally presented on a split-year basis (July to June). This has led to some difficulties in the past in matching up catch data and corresponding TACs in tables presented in the report. In order to avoid confusion, catch data are presented in Table 6 both by season and by split-year.

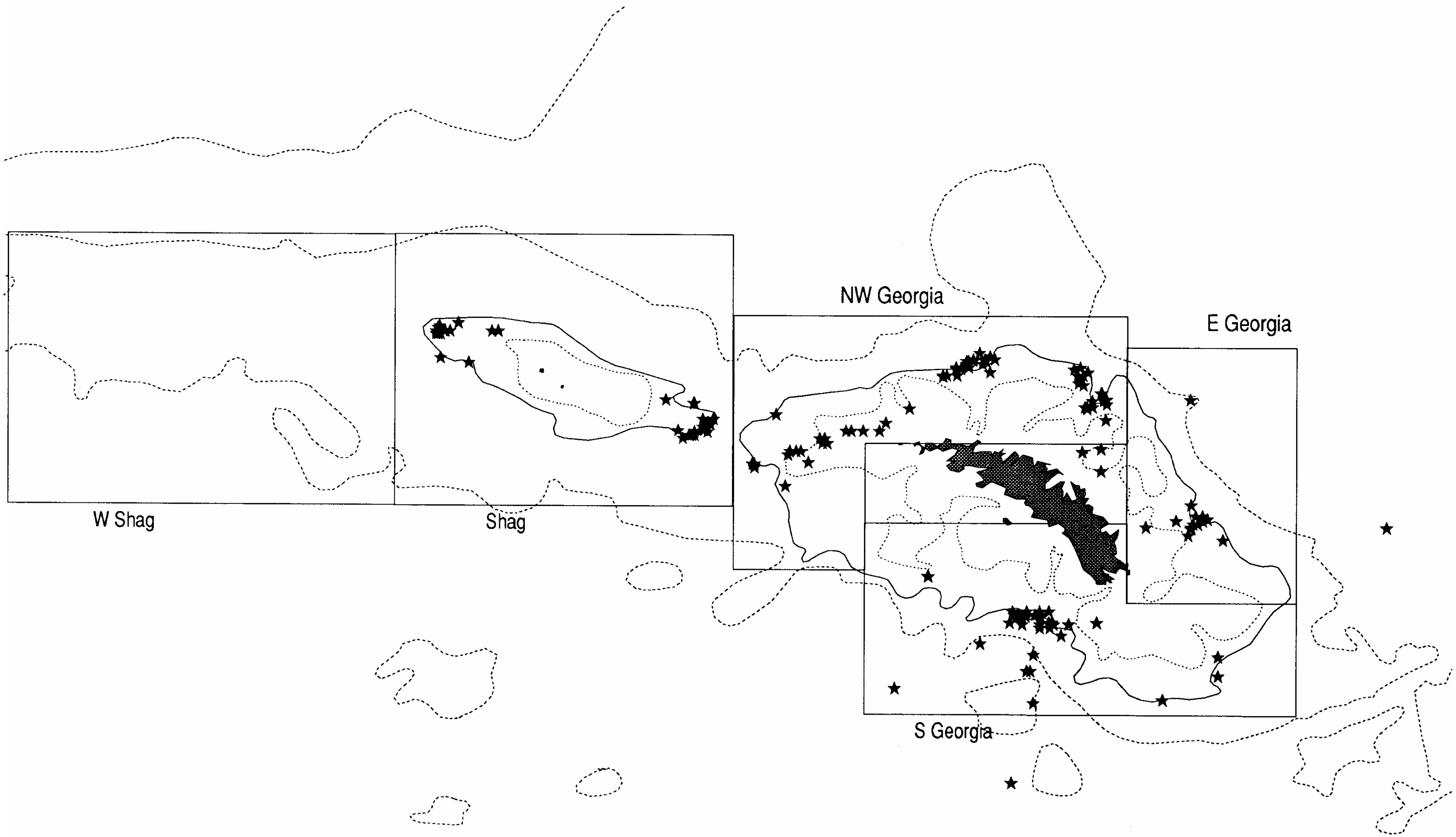

Figure 1(a): Locations of longline catches in Subarea 48.3 during 1993/94.

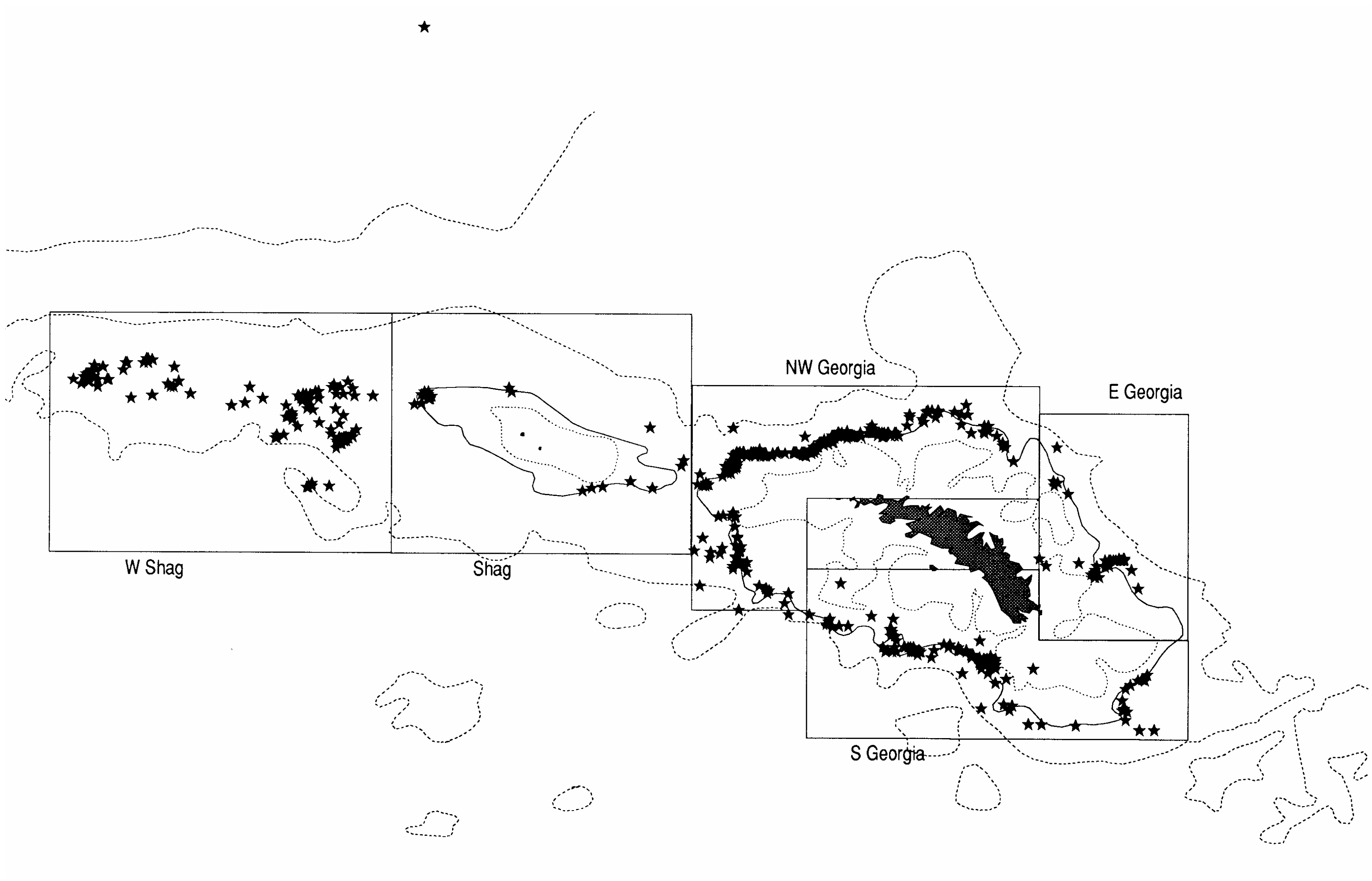

Figure 1(b): Locations of longline catches in Subarea 48.3 during 1994/95.

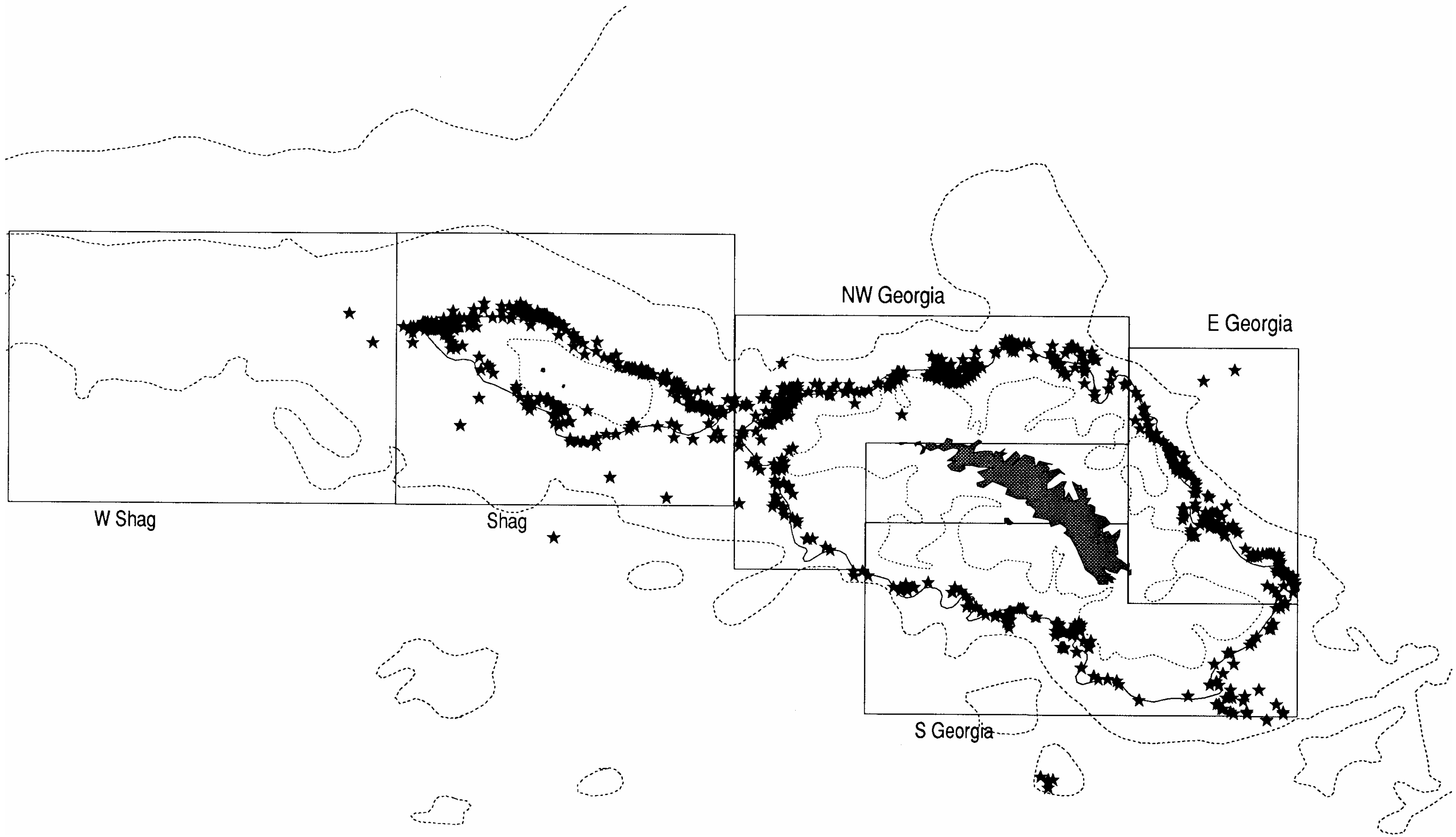

Figure 1(c): Locations of longline catches in Subarea 48.3 during 1995/96.

Table 6: Estimated catches of *D. eleginoides* in Subarea 48.3 and adjacent Rhine and North Banks and TACs agreed by the Commission for Subarea 48.3 (tonnes).

Split-year	Fishing Season	TAC	Catch Reported to CCAMLR for the Fishing Season[1]	Catch Reported to CCAMLR for the Split-year	Estimate of Unreported Catch (split-year)	Best Estimate of Real Catches
1989/90				8156	345	8501
1990/91	2 November 1990 – 25 August 1991	2500	2200[2]	3639	565	4206
1991/92	2 November 1991 – 10 March 1992	3500	3150	3842	3470	7312[5]
1992/93	6 December 1992 – 5 February 1993	3350	2694	3089	2500	5589
1993/94	15 December 1993 – 15 September 1994	1300	537	460	6145	6605
1994/95	1 March – 10 May 1995	2800	2635	3301	2870	6171
1995/96	1 March – 24 July 1996	4000	3871[3]	4362	?[4]	4362 + ?

[1] From form C2 except where indicated
[2] From Statlant reports
[3] From five-day catch reports
[4] No new quantitative information was available to the Working Group to estimate unreported catches during 1995/96.
[5] The best estimate of real catch for 1991/92 was erroneously given as 6 309.6 in Table 6 of last year's report (SC-CAMLR-XIV, Annex 5) due to an arithmetical mistake.

Scientific Observer Reports

4.48 As in 1994/95, all longline vessels operating in Subarea 48.3 were required to have on board scientific observers appointed under the CCAMLR Scheme of International Scientific Observation. The Working Group received a number of reports from observers (WG-FSA-96/21, 96/22, 96/40, 96/47 and 96/52). Only information of relevance to assessment work was considered under this agenda item.

4.49 At the start of the meeting, the majority of the data recorded by observers and submitted to the Secretariat had not been entered into the CCAMLR database. This was because in most cases the data were submitted only shortly before the meeting and mostly not using the standard CCAMLR format. Data from only 4 out of 16 vessels were entered into the database. Length frequency data from only one vessel had been entered. The problems of data formats and submission are discussed under Agenda Item 3 (paragraphs 3.10 to 3.19).

Conversion Factors

4.50 The conversion factor being used on the Chilean longliner *Puerto Ballena* to calculate total fresh weight from product was 1.43 (fresh weight = 1.43 x product weight). The CCAMLR observer on board calculated that 1.53 would have been more appropriate (WG-FSA-96/22). However, there was an additional problem leading to underestimation of the fresh weight of the catch. The weight of product was routinely being measured from individual fish to the nearest kilogram below (i.e. a fish of 1.7 kg would be recorded as 1.0 kg). This practice leads to an underestimation of the weight of product, and consequently an underestimation of the size of the total catch. The observer estimated that in order to obtain a realistic estimate of the catch, a conversion factor of 1.7 should have been applied. According to these figures, therefore, the catch of the *Puerto Ballena* reported to the Secretariat was underestimated by about 16%.

4.51 Table 7 summarises the conversion factors for *D. eleginoides* applied by longline vessels in the Convention Area. According to the CCAMLR database, all of these factors relate to headed and gutted product. However, the range of values is from 1.408 to 1.86. The Working Group noted that the variation between vessels may arise from differences in the method of processing and also the season when the values were estimated. The data indicate that some factors may be standard values used in the industry. For example, 1.408 is used by both a Chilean vessel and a vessel from the Republic of Korea. Also, one vessel may use more than one factor. The Republic of Korea had only one vessel operating in the Convention Area during 1995/96, but there are four different conversion factors listed. The Working Group welcomed the report of the CCAMLR observer on the *Puerto Ballena*, which highlighted a potential problem of underestimation of the size of the catch arising from the application of an inappropriate conversion factor. The Working Group agreed that more information was needed on values of conversion factors and methods of their estimation and application on board fishing vessels. This information should be collected by CCAMLR observers placed on board longline vessels in the Convention Area (paragraphs 3.7 to 3.19).

Table 7: Summary of conversion factors for *D. eleginoides* applied by longline vessels in the Convention Area.

Split-year	Country	Vessel Code	Conversion Factor *D. eleginoides* Headed and Gutted[1]
1995	Argentina	6018	1.54
1995	Argentina	6019	1.86
1996	Argentina	29	1.5264
1996	Argentina	42	1.5
1996	Argentina	42	1.765
1995	Chile	2031	1.538
1995	Chile	2032	1.408
1995	Chile	6001	1.538
1995	Chile	6002	1.538
1995	Chile	6003	1.538
1995	Chile	6004	1.538
1996	Chile	2022	1.408
1996	Chile	2022	1.538
1996	Chile	2022	1.631
1996	Chile	2031	1.408
1996	Chile	2032	1.408
1996	Chile	6003	1.43
1996	Chile	6004	1.43
1996	Chile	6005	1.54
1996	Chile	6025	1.408
1996	Chile	6026	1.43
1997	Chile	2022	1.538
1997	Chile	2031	1.408
1997	Chile	6025	1.408
1995	Republic of Korea	4	1.398
1996	Republic of Korea	4	1.408
1996	Republic of Korea	4	1.47
1996	Republic of Korea	4	1.68
1997	Republic of Korea	4	1.47
1996	Ukraine	844	1.563
1996	Ukraine	1336	1.563
1996	USA	27	1.613

[1] WG-FSA-96/47 reported a conversion factor of 1.67 used by the US longliner *American Champion* outside the Convention Area.

Information on Discards of *D. eleginoides* and Loss Rates from Hooks

4.52 At previous meetings the Working Group has expressed Country over the possible scale of discards of *D. eleginoides*, particularly due to the condition known as 'jellymeat'. No new information was available at this year's meeting. The Working Group recommended that the Scientific Observer Logbook format be amended to include provision for the recording of discards (see also paragraphs 3.10 to 3.13).

4.53 Observers commented that it was difficult to estimate rates of loss of fish from hooks. WG-FSA-96/22 noted that loss rates increased when the ship was rolling heavily. The Captain of the *Puerto Ballena* estimated that the loss rate was in the order of 10%, however the Working Group considered that this needed further investigation.

Information on By-catch and Incidental Mortality

4.54 Information on by-catch of various fish species in the longline fishery is discussed under Agenda Item 5. Information on incidental mortality arising from longline fishing is discussed under Agenda Item 7.

Gear Loss

4.55 WG-FSA-96/57 presents information on loss of hooks during longline fishing in Subarea 48.3. This is reviewed under Agenda Item 7.

Baiting Efficiency

4.56 According to WG-FSA-96/6, the proportion of hooks baited in mechanised longline fishing (i.e. using the autoliner method) varies between 85% and 95%. This paper, which also reports on the loss of baits due to seabirds (mainly fulmars) in the north Atlantic, is discussed further under Agenda Item 7.

Non-reporting of Zero Catches

4.57 At last year's meeting the Working Group expressed concern at the apparent non-reporting of zero catches from longline fishing in Subarea 48.3. During the intersessional period, the Secretariat circulated revised instructions for the reporting of information from longline fisheries. This included specific instructions that data from all longlines should be reported, including those with zero catch. No zero catches are recorded in the CCAMLR database for the period 1991/92 to 1994/95. Forty-eight longlines with zero catch, out of a total of 1 251 fished, have been reported to date in format C2 for fishing during the 1995/96 season. The Working Group welcomed this apparent improvement in data reporting and noted that the number of lines with zero catches missing from previous years is probably only a small proportion of the total number fished.

Fish Movements

4.58 WG-FSA-96/44 presented information on changes in the sex ratio of *D. eleginoides* between March and July 1996. Females were more abundant in longline samples, except during May, when the proportion of males at the size of sexual maturity in the catch increased. Several possible explanations were proposed, including the suggestion that the fish undertake reproductive migrations. Information from the observer data indicates that females mature earlier in the season than males. The Working Group agreed that consideration would have to be given to separating males and females in future assessment work on this species and that more studies on the reproductive behaviour of *D. eleginoides* should be undertaken.

Environmental Factors

4.59 Several papers submitted to the Working Group reported information on the relationship between CPUE and environmental factors (WG-FSA-96/4, 96/22 and 96/48). At present the format for reporting data from the commercial fishery does not include environmental information, however, the observer format includes a summary of meteorological conditions, including weather and sea conditions. No analysis of this relationship was undertaken at this year's meeting, but the Working Group agreed that it should be considered in future analyses. With this in mind, the Working Group requested the Secretariat to investigate the possibility of obtaining meteorological information from Subarea 48.3 and other areas where there are fisheries for *D. eleginoides*.

Assessments and Other New Information Presented to the Working Group

Separable Sequential Population Analysis (SPA)

4.60 SC-CAMLR-XV/BG/14 presented an analysis of catch-at-age and effort data from the period 1992 to 1996 from the *D. eleginoides* fishery in Subarea 48.3 using a separable SPA. This is the first time that catch-at-age data have been estimated and analysed for this fishery. The source of the length frequency data was not given in the paper, but the age/length key from a single vessel fishing in 1991 was used to convert length distributions into catch at age. The effort data was an estimate of nominal effort in terms of total number of hooks set per year in the fishery.

4.61 To reduce the number of parameters estimated by the model, several assumptions were made. A single mean value for recruitment was estimated for all ages in year 1 and for subsequent recruitments. A single selectivity function (of the form proposed by Deriso et al., 1985) was estimated for all years. A fully recruited F was estimated for each year.

4.62 The results of the analysis suggested a dome-shaped selectivity function, peaking at age 10. Fully recruited F ranged from 0.05 to 0.12 during the period. Spawning stock biomass declined from 105 000 tonnes to 89 000 tonnes over the period 1992 to 1996. Mean recruitment at age 4 was about 3 million fish. This compares to a mean value of 2.8 million fish calculated from swept-area trawl surveys at this year's meeting.

4.63 The Working Group considered that catch-at-age analysis using approaches such as SPA or VPA provides a useful alternative approach to estimating exploitation rates and spawning stock biomass. However, the Working Group noted the preliminary nature of the analysis and suggested that further developments could investigate the use of standardised CPUE data. The Working Group would also welcome further information on the source and derivation of the catch-at-age data. Further application of these models will require additional age/length data. However, the Working Group encouraged further analyses of such models, because they have the potential to provide an independent assessment of the stock, which can be compared to the results from the generalised yield model.

Other Information

4.64 Several papers submitted to the meeting contained new information of relevance to stock assessment. WG-FSA-96/22 included information on length-at-sexual-maturity and length-weight parameters estimated from fish sampled during the 1995/6 season. WG-FSA-96/43 provided length-weight parameters estimated from fish measured on the Argentinian shelf (1994/95) and in Subarea 48.3 (1994). WG-FSA-96/42 provided von Bertalanffy growth parameters estimated from samples taken from longline vessels in Subarea 48.3 in 1995 (January to May) and from research vessel trawl catches in 1995. SC-CAMLR-XV/BG/14 provided an age/length key based on samples taken by the Chilean longliner *Friosur V* in Subarea 48.3 in January to May 1991.

Work Undertaken at WG-FSA-96

4.65 Several recommendations for future work on the assessment of *D. eleginoides* in Subarea 48.3 were made by the Scientific Committee and Working Group at last year's meetings (SC-

CAMLR-XIV, paragraphs 4.48 and 4.51; Annex 5, paragraphs 5.72, 5.75 and 5.76 and Appendix E, paragraph 2.72). In accordance with these recommendations, the work undertaken at this year's meeting focused on four main areas:

(i) revision of the length-density analysis undertaken at last year's meeting, using additional survey data;

(ii) consideration of the effects of varying the decision rule criteria applied in the generalised yield model;

(iii) revision of the stock simulations undertaken at last year's meeting, using the improved generalised yield model with various alternative input parameters, including revised parameters in the recruitment function; and

(iv) examination of methods of monitoring the status of the population, including analysis of trends in standardised CPUE and length samples taken from the fishery.

Length-Density Analysis

4.66 The procedure used last year to derive a recruitment function for *D. eleginoides* from stratified trawl survey data (SC-CAMLR-XIV, Annex 5, paragraphs 5.44 to 5.49; de la Mare, 1994) was repeated at this year's meeting. Additional data were analysed from the following bottom trawl surveys in Subarea 48.3:

Russia	1985/86
US/Poland	1986/87
US/Poland	1987/88
Argentina	1995/96

4.67 One problem which has arisen previously in this type of analysis is that, in some strata, only a small number of hauls contained *D. eleginoides*. The maximum likelihood method for fitting the mixture distribution requires at least two non-zero observations for each length class. However, this condition is frequently not met for all length classes for those strata with only a few hauls. WG-FSA-96/38 presented a method for pooling density-at-length data across strata to give an equivalent single-stratum dataset, to which the mixture-fitting method can be applied. Data are rescaled to take account of different sampling intensities in each stratum, such that the mean of the rescaled data is the same as the stratified mean of the raw data. This was achieved using the following expression:

4.68 For k strata, the density data from each haul are rescaled by the composite sampling fraction:

$$D_{i,j} = d_{i,j} \frac{A_i}{\sum_k A_k} \cdot \frac{\sum_k n_k}{n_i}$$

where $D_{i,j}$ is the rescaled density at length for haul I in stratum j, $d_{i,j}$ is the original density-at-length estimate for that haul, and A_i and n_i are the area and number of hauls in stratum I respectively.

4.69 The absolute abundance estimates for each year class in the surveys analysed at this year's and last year's meetings are shown in Table 8. The number of recruits was standardised to age 4 by correcting the numbers of 3- and 5-year-olds for the effects of natural mortality. In some cases the same cohort is represented as a different year class in different surveys. In these cases, the number of recruits was estimated from the average of the recruit numbers from the different surveys. The resultant estimates of recruits at age 4 in each year are given in Table 9.

Table 8: Estimated abundance at age (millions of fish) from a series of trawl surveys carried out at South Georgia.

Survey	N_3	Standard Error (N_3)	N_4	Standard Error (N_4)	N_5	Standard Error (N_5)
Argentina 1996	4.993	1.649	1.15	0.223	0.751	0.293
Argentina 1995 South Georgia	-	-	1.212	0.599	2.118	0.627
Argentina 1995 Shag Rocks	2.384	1.644	3.360	1.163	1.092	0.726
Total	2.384	1.644	4.572	1.308	3.210	0.959
UK 1994 depth 1	0.269	0.172	0.186	0.097	0.208	0.159
UK 1994 depth 2	1.306	0.919	1.160	0.262	-	-
UK 1994 depth 3	0.456	0.240	0.611	0.231	0.691	0.300
Total	2.031	0.965	1.957	0.363	0.899	0.340

Table 8 (continued)

Survey	N_3	Standard Error (N_3)	N_4	Standard Error (N_4)	N_5	Standard Error (N_5)
UK 1992 depth 1	2.410	0.791	-	-	-	-
UK 1992 depth 2	10.236	3.651	0.171	0.949	0.213	0.239
UK1992 depth 3	4.449	1.101	0.879	0.756	0.633	0.443
Total	17.095	3.895	1.050	1.213	0.846	0.503
UK 1991 depth 1	0.263	0.118	0.049	0.038	0.107	0.064
UK 1991 depth 2	0.109	0.068	0.048	0.024	0.105	0.054
UK 1991 depth 3	0.053	-	0.245	0.134	1.294	0.961
Total	0.425	0.136	0.342	0.141	1.506	0.965
UK 1990 depth 1	2.680	2.662	12.262	11.239	7.813	7.000
UK 1990 depth 2	0.107	0.064	0.150	0.116	0.306	0.191
UK 1990 depth 3	0.020	-	0.017	-	0.075	0.056
Total	2.807	2.663	12.429	11.240	8.194	7.003
US/Poland 1988	0.555	0.177	0.528	0.267	0.145	0.044
US/Poland 1986	1.853	0.533	1.947	1.492	0.084	0.049
USSR 1986	-	-	0.593	0.296	2.323	1.016

Table 9: Recruitment to the stock of *D. eleginoides* in Subarea 48.3 as numbers of fish by year-class at age-class 4, estimated from trawl surveys at South Georgia.

Cohort	Number of Fish at Age 4 (millions)
1993	4.255
1992	1.591
1991	2.395
1990	2.862
1989	7.811
1988	0.706
1987	1.242
1986	7.098
1985	5.044
1984	0.528
1983	0.583
1982	1.270
1981	1.359

4.70 As at last year's meeting, the recruitment estimates were used to estimate a lognormal recruitment function for use in the stock projections undertaken with the generalised yield model. The numbers of fish at age 4 in each year of the simulation are drawn from a lognormal distribution. The mean and standard deviation of the distribution were derived by the sample mean and variance of the numbers of fish. The Working Group again noted that this procedure assumed that there was no trend in recruitment over the time period of the estimated recruitments. The parameters of the recruitment function estimated at this year's meeting are compared to those from last year in Table 10.

Table 10: Parameters for the lognormal recruitment function.

	WG-FSA-95	WG-FSA-96
Mean number of recruits at age 4	4 463 000	2 826 000
Standard deviation		2 478 000
Lognormal mean	14.637	14.569
Lognormal standard error		0.209
Lognormal standard deviation	1.161	0.755

4.71 Absolute recruitment estimated from the enlarged dataset of nine surveys was about 37% lower than last year's estimate, and the variance was reduced.

4.72 The Working Group agreed that the recruitment function shown in Table 10 above was the best information currently available on the recruitment of *D. eleginoides* for use in the generalised yield model. It was noted that additional data from surveys by Russia, Germany and Argentina would be available for analysis at next year's meeting.

4.73 The Working Group reiterated its concern expressed last year that trends in recruitment could introduce bias into the recruitment function and that care should be taken to examine the data for such trends. Information from earlier surveys (e.g. Germany 1975/76 and 1977/78) would provide additional information on this.

Generalised Yield Model

4.74 The generalised yield model has been refined since last year's meeting. A detailed description and explanation of the current method is provided in Constable and de la Mare (1996) and in paragraphs 3.65 to 3.69.

Application of the Decision Rule in the Generalised Yield Model

4.75 In using the generalised yield model at last year's meeting, the Working Group considered the results of the projections in relation to the decision rule for γ_1, i.e. that the probability of the spawning stock biomass falling below 20% of its initial level during the projection period, should not exceed 10%. This was considered to be the most reasonable basis on which to base guidelines for the limits on total removals of *D. eleginoides* in Subarea 48.3 in the 1995/96 season. The Scientific Committee noted that the probability level (10%) in the γ_1 decision rule was not purely a scientific question and that the Commission may wish to consider this matter further. However, before this could be done, the Commission would require more information and advice from the Scientific Committee. To this end, the Scientific Committee tasked the Working Group with giving this issue detailed consideration at this year's meeting.

4.76 A series of test runs of the yield model was made, in order to explore the implications of variations in the decision rule criteria. These test runs were made using the same data inputs as in Table 14 (see paragraph 4.95). The results of these runs are illustrated in Figures 2(a) and 2(b). Catch levels in these graphs are presented in relative terms. This is because the graphs are not meant to be used to consider specific catch levels, but rather to illustrate the relative effects of changing the basis of the decision rule.

4.77 The first component of the decision rule is the critical level of spawning stock biomass used to characterise a depletion event during the course of a projection run. Five critical levels of spawning stock biomass, ranging from 0.1 to 0.5 of the median level at Time 0, are represented by the five lines on the graph in Figure 2(a). The critical level used last year is represented by the line labelled 0.2.

4.78 The second component of the decision rule is the probability of the spawning stock falling below a particular critical level. This is represented by the vertical axis of the graph in Figure 2(a). The γ_1 decision rule is therefore represented by the intersect of the line labelled 0.2 with the probability level of 0.1. At this point on the line the level of the relative catch is 1.0.

4.79 Having identified a particular reference point on the graph such as γ_1, it is straightforward to explore the implications of changing the decision rule criteria. For instance, increasing the critical level of spawning stock biomass to 0.3, at a probability of 0.1, reduces the level of relative catch by 0.2, from 1.0 to 0.8. Similarly, if the critical level remains fixed at 0.2, but the probability level is reduced from 0.1 to 0.05, the level of relative catch falls by about 0.17 to 0.83.

4.80 Figure 2(b) illustrates the status of the median spawning stock biomass at the end of a projection period relative to the median spawning stock biomass at Time 0. At the relative catch level of 1.0, the status of the spawning stock biomass is about 0.53. A drop in the relative catch of 10% increases the relative spawning stock by about 5%.

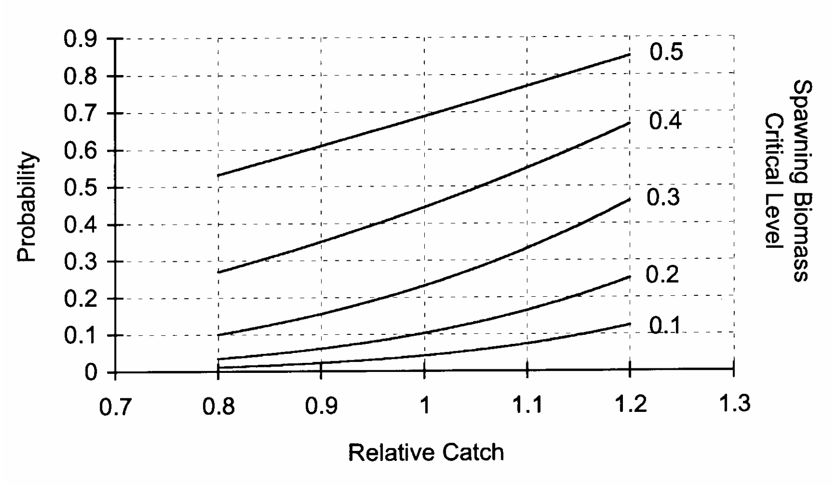

Figure 2(a): *D. eleginoides* – Subarea 48.3: relationship between the decision rule criteria and relative catch level. Probabilities of falling below a critical level of spawning biomass relative to the median spawning biomass at Time 0 for a range of catches using parameters from the final run.

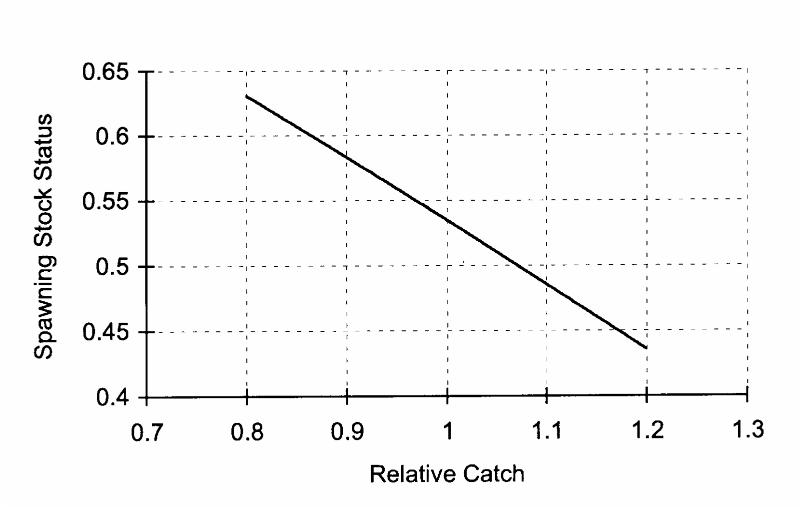

Figure 2(b): *D. eleginoides* – Subarea 48.3: relationship between the status of spawning stock biomass and relative catch. Median status of the spawning biomass at the end of a projection period relative to the median spawning biomass at Time 0 for a range of catches using parameters from the final run.

Data Inputs and Sensitivity Analyses

4.81 Table 11 presents the data inputs for the base case test run of the generalised yield model. In summary, the parameters shown are the same as those used at last year's meeting with the exception of the new parameters for the recruitment function (estimated from the length-density analysis), a revised maturity ogive and the 1995/96 reported catch.

Table 11: Input parameters for projections of the generalised yield model for the baseline test of an annual catch of 5 000 tonnes of *D. eleginoides* in Subarea 48.3.

Category	Parameter	*D. eleginoides*
Age composition	Recruitment age in simulation Number of age classes (21 oldest classes were combined into a single group)	4 56
Resolution	Number of increments per year	360
Natural mortality	Mean annual M Age-specific variation in M (m_{a+t})	0.16 constant = 1
Fishing mortality	Length of fish when 50% of individuals of that size are recruited to fishery (l_m) Length range over which recruitment occurs (l_r) Age-specific selection Reasonable upper bound for annual fishing mortality Tolerance (error) for determining fishing mortality in each year	70 10 none 5 1E-05
von Bertalanffy growth	time 0 L K	0 170.8 0.088
Weight-length ($W = aL^b$)	a b	2.5E-05 2.8
Spawning biomass	Maturity ogive by length (m_m) Proportion mature = $\dfrac{1}{1+e^{-(a+b.Length)}}$ Increment in year when spawning begins Number of increments in spawning season	a = -10.588, b = 0.1144 180 1 (knife edge)
Recruitment	Log (mean) Lognormal standard error Lognormal standard deviation	14.569 0.209 0.755
Simulation characteristics	Number of runs in simulation for each catch Years to project stock to remove effects of initial age structure Vector of real catches for projecting over known catch period (tonnes) Number of years to project stock following known catch period Random no. seed	1001 1 8501,4206,7309, 5589,6605,6171, 4362 35 -24189
Decision rules	Reference point for assessment of long-term annual yield	$0.2.SB_0 median$

4.82 Two new length-weight relationships were submitted to the Working Group this year. One, in WG-FSA-96/43, was estimated from a combination of samples from the Argentinian shelf and from South Georgia. The other was estimated from data collected by the observer on the Chilean longliner *Puerto Ballena* (WG-FSA-96/22):

	a	b
WG-FSA-96/43	$5.32\ e^{-6}$	3.15
WG-FSA-96/22	$1.23\ e^{-5}$	2.96
WG-FSA-95	$2.5\ e^{-5}$	2.8

4.83 The relationship from WG-FSA-96/22 was very similar to the relationship used for the assessment at last year's meeting. The relationship from WG-FSA-96/43 was different, however the

Working Group was concerned that the sample from which these parameters were estimated contained only a few fish over 80 cm in length. The Working Group agreed that the best approach for this year was to use the same relationship used at last year's meeting.

4.84 A revised maturity ogive by length was estimated from data analysed at last year's meeting, with the addition of maturity-at-length data compiled by the observer on the Russian longliner *Itkul*. Additional length and maturity data for *D. eleginoides* had been submitted to the Secretariat for the 1995/96 season, however these data were not in the standard CCAMLR format and had not been entered into the database at the time of the meeting. They were therefore not available for analysis this year.

4.85 Three criteria were considered for calculating the percentage of mature fish at length:

(i) considering all fish of stage II and above as mature;
(ii) considering all fish of stage III and above as mature; and
(iii) considering all fish of stage III and above as mature, with the addition of all fish of stage II which were larger than 75 cm.

The third criterion was applied in an attempt to distinguish between stage II fish which had previously spawned and stage II fish which were entering maturity for the first time. Data from the *Itkul* were used to test the effect of these three criteria on the maturity ogive. Maturity functions were calculated for each of the three datasets by non-linear regression. The three resulting logistic curves of maturity at length were very similar, with only 3 cm difference between L_{50} for criteria (i) and (iii). The Working Group agreed that the best approach for this year's meeting was to consider only fish of stage III and above as mature. The resulting logistic curve of maturity-at-length is illustrated in Figure 3.

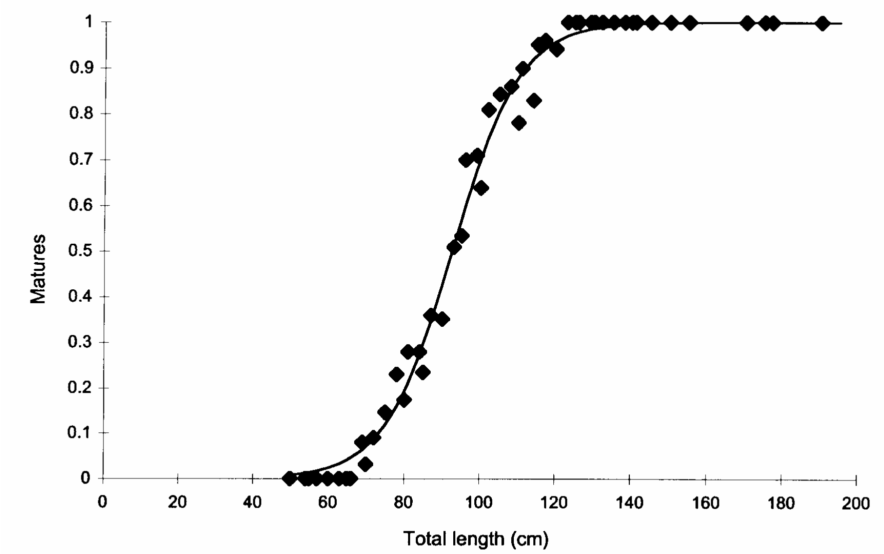

Figure 3: Logistic curve fitted to maturity-at-length data for *D. eleginoides* sampled from commercial longline fishing in Subarea 48.3.

4.86 During the course of the analysis of maturity at length, marked differences were noticed between males and females. Males mature earlier than females. L_{50} for males is about 70 to 75 cm, whilst that for females is about 90 to 95 cm (see also WG-FSA-96/22). The present version of the generalised yield model requires the specification of a single maturity ogive. However, the Working Group agreed that consideration should be given to splitting males and females in future assessments.

4.87 Having completed the base case test run, a number of additional runs were undertaken to test the sensitivity of the results of the projections to certain input parameters. The input parameters tested in these runs are listed in Table 12. A nominal annual catch of 5 000 tonnes was used for the base case test run and all the subsequent tests for sensitivity.

Table 12: Input parameters used in sensitivity tests.

Input Parameter to be Tested	Rationale
Duration of the projection period	The projection period used at last year's meeting was 35 years, chosen because it was considered to be in line with the estimated lifespan of the fish. Two alternative durations were investigated: 25 years and 45 years.
Catches in the most recent year	In the past, reported catches were thought to have formed only part of the total removals of fish from Subarea 48.3. Although there were reports that the level of unreported fishing had fallen in 1995/96, the Working Group had no specific information on the actual level of such catches. Values for the period 1990 to 1995 have remained reasonably constant. It was therefore agreed to calculate the average best estimate of real catches provided at last year's meeting (SC-CAMLR-XIV, Annex 5, Table 6), i.e. 6 230 tonnes[1], and test the sensitivity of the model to the input of this catch in 1995/96 instead of the reported catch. This would also provide a test of the sensitivity to under-reported catch arising from the use of poorly-estimated conversion factors.
Size of fish selected in the fishery	Previous studies have demonstrated strong size selectivity by longline gear, which can vary considerably with hook type (e.g. Moreno, 1991). Also, length frequency distributions indicate that a greater proportion of larger fish are females (e.g. WG-FSA-96/22). At last year's meeting all fish greater than 70 cm were considered to be fully recruited. However, catch samples indicate that larger fish are under-represented in the catch. In samples analysed at this year's meeting, 95% of fish were between 63.5 cm and 130 cm. A simple knife-edge selectivity function was devised, which assumes that all fish between these lengths are fully recruited. Fish outside this range were assumed to have a selectivity of 0. The sensitivity of the model to these two selectivity functions (last year's and this year's) was tested.
von Bertalanffy growth parameters	WG-FSA-96/42 provided new growth parameters for *D. eleginoides* in Subarea 48.3 (L_∞ = 207cm, k = 0.075, t_0 = -0.29). The curve is quite different to the one used at last year's meeting (see Figure 4). The Working Group agreed to test the sensitivity of the results to change in the growth parameters.
M	In a test similar to that performed at last year's meeting, the effect of varying M over the range 0.12 to 0.2 was investigated.

[1] This figure was calculated and used in the assessment before the arithmetical error in Table 6 of last year's report (SC-CAMLR-XIV, Annex 5) was discovered and corrected (see Table 6 of this report). The corrected mean value is 6 397 tonnes. The Working Group considered that this minor error in the history of known catches would have negligible effect on the outcome of the projections.

Results of Sensitivity Analyses

4.88 The results of the sensitivity analyses are shown in Table 13. This table lists the input parameters for each test. Code 'B' indicates the base case – i.e. the parameters shown in Table 11. The results are presented as the probability of depletion below 0.2 of median spawning stock biomass at Time 0 (γ_1), and the relative status of the spawning stock biomass at the end of the projection period (γ_2).

Table 13: Results of sensitivity tests.

Test	Years of Projection	Known Catches	Size of Fish Selected in Fishery	von Bertalanffy Parameters	M	Probability of Depletion below $0.2.SB_0$ *median*	Status at End
1	B	B	B	B	B	0.019	0.611
2	B	B	63.5-130 cm[1]	B	B	0.086	0.531
3	B	Recent-year estimated catch = 6230	B	B	B	0.019	0.610
4	B	B	B	WG-FSA-96/42[2]	B	0.015	0.630
5	B	B	B	B	0.12-0.2	0.043	0.615
6	25	B	B	B	B	0.013	0.631
7	45	B	B	B	B	0.029	0.611

B Base conditions as in Table 11

[1] Knife-edge boundaries to selection in fishery
[2] von Bertalanffy $K = 0.0748$, $L = 207.0$, $t_0 = -0.2898$

4.89 The results of the sensitivity analyses should be considered in relation to the results of the base case test. The probability of depletion on this run was 0.019.

4.90 The introduction of the adjusted selectivity function in Test 2 has a substantial influence on the results. The probability of depletion increased by more than 4.5 times to 0.085. This is because the catch is assumed to be taken over a more restricted range of lengths than in the original selection function.

4.91 The increase of the catch from 4 362 to 6 230 tonnes in the most recent year had no discernible effect on the results. The Working Group noted that this was to be expected since the change in catch represented only 4% of the estimated total historical catch used in the projection.

4.92 The alternative von Bertalanffy growth parameters (WG-FSA-96/42) resulted in a lower probability of depletion of the spawning stock biomass, because in this model fish of a given length were heavier. No adjustment of M was made for these alternative parameters (at last year's meeting M was estimated from the growth parameters using the Beverton and Holt method).

4.93 The results were sensitive to the introduction of uncertainty in M. The level of uncertainty applied increased the probability of depletion from 0.019 to 0.043, although the status of the spawning stock at the end of the projection was unchanged. Sensitivity to uncertainty in M was also investigated at last year's meeting, but in that case there was no appreciable change in the probability of depletion compared to M fixed at 0.16. The result achieved at this year's meeting is different from last year due to the refinements in the program introduced during the intersessional period, which have improved the way in which stock status is assessed during the projection (see paragraphs 3.65 to 3.69; Constable and de la Mare, 1996).

4.94 Reducing the period of the projection to 25 years reduced the probability of depletion to 0.013. Increasing it to 45 years increased the probability to 0.029.

4.95 On the basis of these sensitivity analyses, the Working Group agreed on the parameters to be used for the final run of the yield model, which would correspond to the γ_1 decision rule. The decisions taken by the Working Group, and the underlying rationale, are summarised in Table 14. Several areas were identified where further analyses would be desirable, but limited time during the meeting precluded the undertaking of additional work. Suggested additional work is discussed in paragraph 9.5.

Table 14: Summary of decisions taken by the Working Group and the underlying rationale for those decisions.

Agreed Input for Final Convergence Run of the Yield Model	Rationale
Years of projection = 35	A 35-year duration was used in the projections at last year's meeting on the assumption that this was a reasonable approximation to the lifespan of the fish. The Working Group agreed that this remained the most reasonable basis for the duration of the projection runs.
Catch in the most recent year = 6 230 tonnes	Although the Working Group had little information on the magnitude of unreported catches, the average over the period 1990 to 1995 was considered to be a reasonable best guess. In addition, the Working Group noted that the catches reported to the Secretariat might be underestimates due to problems with conversion factors (paragraphs 4.50 and 4.51).
Size of fish selected in the fishery = 63.5 to 130 cm	There was strong evidence from length frequency distributions that larger fish are under-represented in the catch. The Working Group noted that using this selection function substantially increased the probability of depletion for a given level of catch. It was agreed that pending the development of a more realistic selection function, this approach would be taken at this year's meeting. The Working Group also noted that the independent analysis carried out using SPA showed that the selectivity function was dome-shaped (SC-CAMLR-XV/BG/14).
von Bertalanffy growth parameters = as in Table 11	Curves for the alternative von Bertalanffy growth parameters are plotted in Figure 4. Mean ages at length calculated from the age/length key provided in SC-CAMLR-XV/BG/14 are superimposed on this graph. The Working Group expressed concern that the ages of larger fish might be underestimated. The parameters from WG-FSA-96/42 resulted in a substantial decrease in the probability of depletion.

M integrated over the range 0.12 to 0.2	In view of the sensitivity of the results to uncertainty in M, the Working Group agreed that the most reasonable approach for this year was to integrate over the range 0.12 to 0.2.

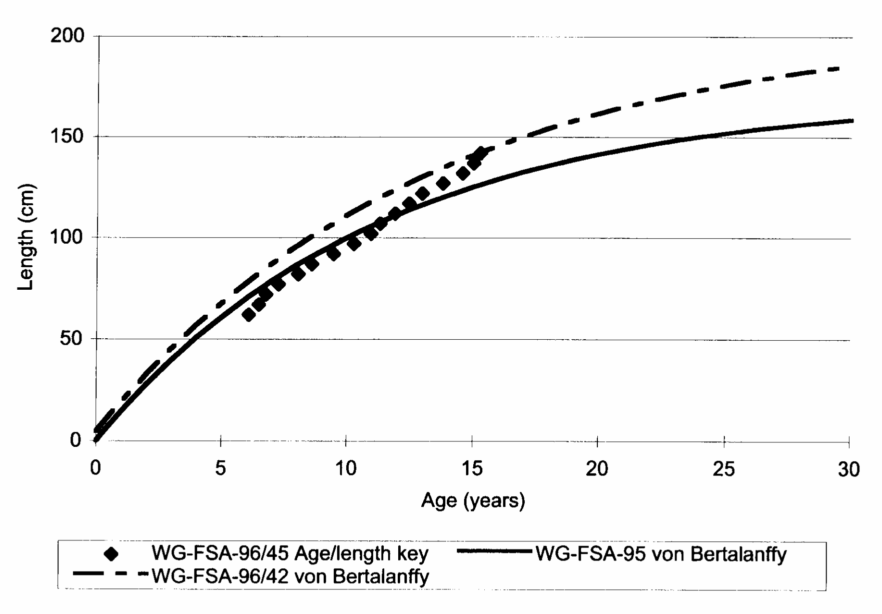

Figure 4: von Bertalanffy growth curves for *D. eleginoides* in Subarea 48.3.

4.96 Using the input parameters specified in Table 14, a final convergence projection was run to determine the catch level consistent with the γ_1 decision rule. This catch level was 5 000 tonnes. At this level of catch the ratio of median spawning stock biomass to the pre-exploitation level was 53%. The Working Group noted that this catch level was an increase of 25% compared to the result from last year's meeting. A change from last year's result was to be expected for three principal reasons:

(i) refinements in the formulation of the yield model which improve the method of identifying depletion below a critical level within a simulation run (see paragraphs 3.67 and 3.68);

(ii) revision of the recruitment function based on data from four additional bottom trawl surveys in Subarea 48.3; and

(iii) changes in other input parameters (see Table 14).

Standardisation of CPUE Indices

4.97 Estimates of annual catches per vessel-day for the fishing seasons 1991/92 to 1995/96 are shown in Table 15. Measured in this way, the 1995/96 catch rate was lower than that in the previous year, although it was higher than the catch rate in 1993/94. The Working Group noted, however, that such a comparison failed to take account of changes in the fishing fleet, location and timing of catches and the numbers of hooks deployed.

Table 15: Estimates of annual catch per vessel-day calculated from data submitted on form C2 and in five-day catch and effort reports. Fishing seasons are defined as the period 1 October to 30 September.

Fishing Season	Tonnes/Vessel-Day
1991/92	8.02
1992/93	6.95
1993/94	3.18
1994/95	5.46
1995/96	3.38

4.98 Following the work conducted at its last meeting, the Working Group used generalised linear models (GLMs) to standardise CPUE data from the *D. eleginoides* fishery in Subarea 48.3. The aim of this analysis was to determine whether there are any annual trends in CPUE after accounting for the effects of any other factors/covariates that add to the variability in observed CPUE.

4.99 The GLM analyses followed the approach used at the 1995 meeting of the Working Group. Details of the methodology are provided in SC-CAMLR-XIV, Annex 5, Appendix G.

4.100 The GLMs were fitted to haul-by-haul data submitted on form C2 over the period 1992 to 1996. Data from years prior to 1992 were not available in haul-by-haul format so they could not be used in the analyses. Numbers per hook and kilogram per hook were used as response variables, and vessel, year, month, area, depth and bait type were considered as predictor variables. Year was defined as fishing season rather than split-year, and a single fishing season was defined as the period 1 October to 30 September.

4.101 Last year the Working Group considered four indices of CPUE: kilogram per hook, numbers per hook, kilogram per hook-hour and numbers per hook-hour. At this year's meeting it was decided to confine the analysis to numbers per hook and kilogram per hook due to concerns over the measurement of soak time (SC-CAMLR-XIV, Annex 5, paragraph 5.35).

4.102 The data were checked for errors before conducting the analyses. This was necessary to exclude records that were spurious or incomplete. The number of records with at least one data omission or inconsistency are provided in Table 16. Some of the hauls had multiple omissions or inconsistencies. Summing the numbers in Table 16 therefore overestimates the total number of data problems. The raw dataset contained 5 163 records, and the final dataset contained 2 740 records.

Table 16: Number of records affected by data problems in GLM analyses of CPUE data from the *D. eleginoides* fishery in Subarea 48.3.

Problem	Number of Records
Position not reported	1595
Number of hooks not reported	10
Number of hooks > 0 but < 1000	2
Number of hooks = 0	38
Start depth not reported	27
Start depth = 0	479
Start depth > 3000	29
Bait type not reported	53
Soak time not reported	3
Soak time < 0	17
Month not reported	1
Catch kilograms not reported	40
Catch numbers not reported	64
Catch kilograms = 0 but catch numbers > 0	737
Catch numbers = 0 but catch kilograms > 0	136

4.103 The Working Group noted that, while checking for errors was necessary to conduct the GLM analyses, it resulted in a substantial loss of information. The Working Group recalled its view that when haul-by-haul data are submitted to the Commission they should be of the highest possible quality and every effort should be made to ensure that all data types are reported (SC-CAMLR-XIV, Annex 5, paragraph 5.36). In this regard, the Working Group encouraged Members to resubmit historical haul-by-haul data for observations that have been omitted or are inconsistent. In particular, the Working Group noted that many more hauls could be included in the GLM analyses if positional data were reported for hauls where that information is currently missing.

4.104 Vessel, year, area and depth contributed significant sources of variation to haul-by-haul CPUE (Table17). The vessel effect was the most significant component of variability in CPUE. The year effect was the second most significant component of variability in catch rates.

Table 17: Analysis of deviance tables from GLMs fitted to catch rate data from the longline fishery for *D. eleginoides* in Subarea 48.3. Factors/covariates were entered into the models in order from top to bottom.

Factor/Covariate	Residual df	Residual Deviance	p
	Numbers/Hook		
NULL	2739	4982	< 0.01
Vessel	2714	3421	< 0.01
Year	2710	3336	< 0.01
Area	2706	3260	< 0.01
Depth	2705	3226	< 0.01
	Kilogram/Hook		
NULL	2739	8696	< 0.01
Vessel	2714	5929	< 0.01
Year	2710	5769	< 0.01
Area	2706	5621	< 0.01
Depth	2705	5571	< 0.01

4.105 The time series of predicted year effects on numbers per hook is plotted in Figure 5, and the corresponding time series for kilogram per hook is plotted in Figure 6. Standardised numbers per hook have been fairly stable during the period 1992 to 1996. There was an increase in standardised numbers per hook during the 1992/93 fishing season, but the effect of this year was poorly estimated. Similar comments can be made for standardised kilogram per hook. This measure of CPUE has also been fairly stable during the period 1992 to 1996 with a slight increase during the 1992/93 fishing season.

4.106 Figures 5 and 6 also illustrate the annual trends in non-standardised catch rates (depicted by the dashed lines). These trends are consistent with the trends in standardised catch rates and show an increase in 1993, with relative stability during the rest of the time series.

4.107 In general, the GLM analyses indicated that there has not been an appreciable decline in standardised CPUE during the period 1992 to 1996. The Working Group recalled its view that standardised catch rates should be more sensitive to declining abundance than non-standardised catch rates (SC-CAMLR-XIV, Annex 5, paragraph 5.40), but questioned whether standardised CPUE would be useful for validating predictions from the generalised yield model (SC-CAMLR-XIV, Annex 5, paragraph 5.41).

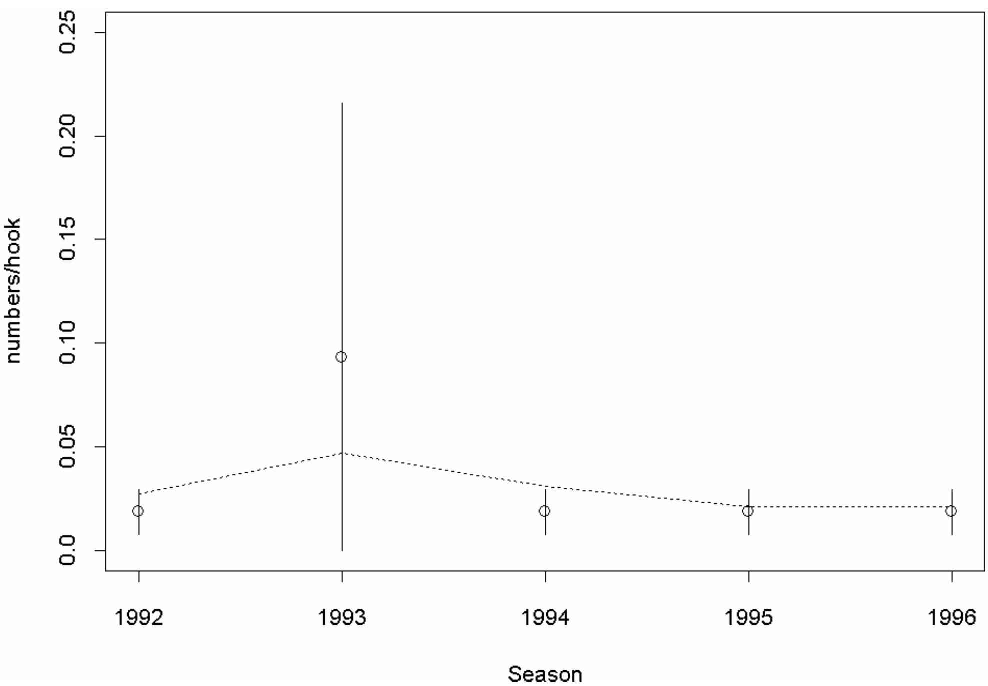

Figure 5: Time series of predicted year effects on numbers per hook.

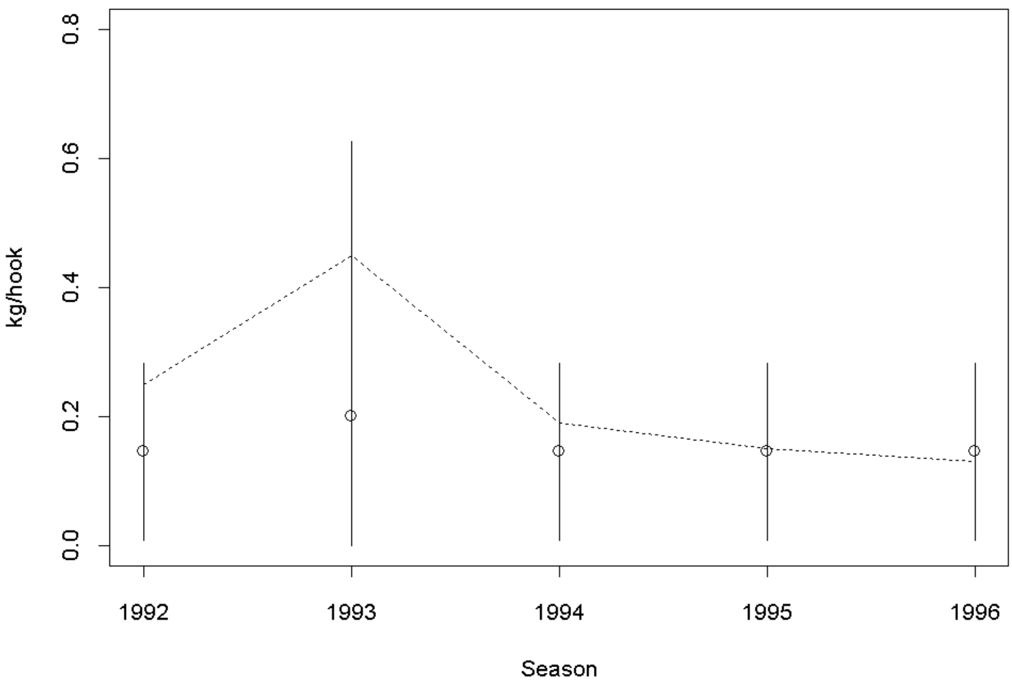

Figure 6: Time series for kilogram per hook.

4.108 The Working Group agreed to consider whether information other than CPUE would be useful for validating predictions from the generalised yield model.

Length Frequency Data

4.109 Data for haul-by-haul analysis of length frequencies were available for only 10 ships (9 from the commercial dataset and 1 observer's dataset) in the 1996 season. Data from other commercial or observer sources were either a combination of several hauls or have not yet been entered into the CCAMLR database. It was noted that the whole dataset needs validation and completion before it can be used fully by the Working Group.

4.110 Since no interannual comparisons could be performed at this meeting, the analysis was restricted to the general properties of statistics derived from length frequencies from each haul.

4.111 The mean length was consistently larger than the median, indicating a right-skewed distribution. Highly significant, positive Spearman coefficients were found for the association between mean length in the catch and starting depth of the haul, in all areas where sufficient information was available. Overall and regional mean lengths stratified by ship and haul for 1996 had CVs in the region of 5%. Variability among regions was small (in the order of 3 to 4 cm).

4.112 Frequency distributions of the mean-median difference were rather homogenous in all regions, while the correlation between mean and variance was low.

4.113 It was agreed that the analysis of the length distribution of catches should be pursued in the intersessional period. The Working Group recommended that the Secretariat be requested to complete and validate the available dataset.

Conclusion

4.114 The analyses of standardised CPUE did not indicate any trends in the status of the stock. The Working Group therefore considered that the results of the yield model projection, using the input parameters shown in Table 10, was a reasonable basis on which to set guidelines for the limits on total removals of *D. eleginoides* in Subarea 48.3 during the 1996/97 season.

Future Work

4.115 At last year's meeting, the Working Group identified a number of areas of future work, some of which have been investigated at this year's meeting. The following areas of future work were identified at this year's meeting:

(i) Length-density analysis:

Any data from trawl surveys in Subarea 48.3 that have not been resubmitted to the Secretariat since the 1995 meeting of the Working Group should be resubmitted to enable them to be re-entered into the CCAMLR database, which has undergone some restructuring in the intersessional period. This will enable the data to be analysed using the length-density method to provide further information on recruitment of *D. eleginoides* in Subarea 48.3.

(ii) Generalised yield model:

(a) The Working Group identified a number of further sensitivity analyses, including:

age-dependent M
alternative selectivity functions
errors associated with von Bertalanffy parameters
differences in maturity ogives and selectivity between males and females.

(b) The Working Group also recommended a study on the biological rationale for the critical level of spawning stock biomass in the γ_1 decision rule, particularly in relation to the issue of stock recovery embodied in Article II of the Convention.

(iii) Methods of monitoring the status of the population:

(a) Standardisation of CPUE:

In order to increase the amount of data available for the analysis of CPUE, the Working Group strongly encouraged the reporting of existing haul-by-haul data from the longline fishery prior to 1992. Information missing from the database for haul-by-haul data for 1992 onwards was also required as a matter of urgency. The Working Group recommended that the Secretariat be requested to undertake a data audit during the intersessional period and submit specific requests to the appropriate national authorities for the submission of data missing from the database.

An investigation of the potential for developing age-specific indices of CPUE is required.

(b) Analysis of length distributions:

The Working Group agreed that the analysis of length distribution should be pursued in the intersessional period. This will require entry of all available length-frequency data into the CCAMLR database, validation of the dataset and circulation of a request to Members to supply additional historical data where positional information is missing.

(c) The Working Group considered that other methods of validating the results of the generalised yield model should be investigated. Possible approaches include scientific surveys on the recruited stock and catch-at-age assessment methods. The Working Group agreed that catch-at-age methods might prove useful in the future as the time series of data increases and more data on length distributions and age at length become available (see also paragraphs 4.60 to 4.63).

(iv) Stock structure:

(a) The Working Group again noted that catches of *D. eleginoides* are taken both inside Subarea 48.3 and outside the Convention Area in waters adjacent to Subarea 48.3. The Working Group requested that Members with information relating to catches taken in waters adjacent to the Convention Area be urged by the Commission to submit this information to the Secretariat for consideration in assessments.

(b) Although the question of stock structure of *D. eleginoides* remains open the Working Group welcomed information on progress being made in this area (see paragraph 4.58).

Management Advice

4.116 The Working Group welcomed the refinements to the analysis using the generalised yield model made during the intersessional period and at this year's meeting, and noted a number of further refinements which could be undertaken in the future.

4.117 Although the Working Group had little information on unreported catches during the 1995/96 season, the assessment had been undertaken under the assumption that the true removals of fish in Subarea 48.3 in the 1995/96 season were equal to the average of the best estimate of real catches over the period 1989/90 to 1994/95 (equal to 1.43 times the reported catch in 1995/96). The Working Group reiterated its advice of last year that future illegal catches would continue to hinder severely attempts to make reliable stock assessments and requested that the problem be addressed as a high priority.

4.118 The Working Group noted that, as at last year's meeting, the assessment of yield was based on the expectation that future catches would be taken only by longline vessels. Use of other types of fishing gear, such as trawls, would change the age structure of the catch. The Working Group made no assessment of the effects of such catches for this fishery at this year's meeting. The Working Group therefore recommended that the directed fishery for *D. eleginoides* in Subarea 48.3 should be restricted to longliners during the 1996/97 season. Should there be an interest in trawling for *D. eleginoides* in Subarea 48.3 in the future, then the assessment using the generalised yield model could be adjusted to take this into account. However, the Working Group recalled previous advice on bottom trawling in Subarea 48.3 (SC-CAMLR-XIV, Annex 5, paragraphs 6.27 to 6.29).

4.119 As requested by the Scientific Committee, the Working Group has provided advice, in paragraphs 4.75 to 4.80 and Figures 2(a) and 2(b), on the relative effects on catch levels of departing from the γ_1 decision rule (i.e. that the probability during the projection period of the spawning stock biomass falling below 20% of its initial level should not exceed 10%). No specific decision rule criteria, other than γ_1 and γ_2 (the median status of the spawning stock biomass at the end of the projection period should not fall below 50% of the median pre-exploitation level), were considered at this year's meeting, however the Working Group agreed that more detailed consideration should be given to the critical level of spawning stock biomass in the γ_1 decision rule at next year's meeting.

4.120 The results of the projections using the generalised yield model indicated that an annual catch of 5 000 tonnes, applied over a period of 35 years, was consistent with the γ_1 decision rule. At this level of catch, the ratio of median spawning stock biomass at the end of the projection period to the pre-exploitation level was 53%. The Working Group recommended that this should be the basis for setting the catch limit for *D. eleginoides* in Subarea 48.3 during the 1996/97 season. However, the Working Group noted that this assumed that the actual removals of fish would be no greater than the catch limit.

4.121 Additional information on the implications of changing the period of the fishing season to reduce incidental mortality of seabirds is given in paragraphs 7.72 to 7.77.

4.122 The analysis of CPUE data undertaken at this year's meeting was hindered by omissions from the haul-by-haul dataset, particularly of positional information. This highlighted the importance of collecting catch and effort information in as much detail as possible. The Working Group recommended the continuation of the current provisions for reporting haul-by-haul and biological information from the fishery. The Working Group also strongly encouraged the reporting of existing haul-by-haul data from the longline fishery prior to 1992, and of information missing from the database for haul-by-haul data from 1992 to the present (paragraphs 4.103).

4.123 The Working Group again recognised the importance of the biological data and other information collected by scientific observers to assessment work and recommended that the 100% observer coverage applied to this fishery over the past three seasons be maintained. The Working Group also noted the importance of timely submission to the Secretariat of data from observer trips, in the appropriate formats, to enable them to be made available for consideration by the Working Group (paragraph 3.16(vi)).

Champsocephalus gunnari (Subarea 48.3)

Commercial Catch

4.124 In accordance with Conservation Measure 97/XIV, a 1 000-tonne TAC was in place for the fishery for *C. gunnari* during the 1995/96 season. However, there was no commercial catch of *C. gunnari* for the season and there has now been no substantial reported commercial catch in Subarea 48.3 since March 1990.

Research Surveys

4.125 A research bottom trawl survey was conducted in Subarea 48.3 in March/April 1996 using the RV *Dr Eduardo L. Holmberg*. The methods and results of this survey are reported in WG-FSA-96/27 and 96/30.

4.126 This is the third such survey of the area using the same gear and methodology and the three surveys are regarded as the start of a time series of relative abundance indices of *C. gunnari* in this subarea. The three abundance indices have shown a steady increase which suggests some increase in the stock during this period.

4.127 Another aim of the surveys has been to investigate the variability in the spatial distribution of *C. gunnari* in Subarea 48.3. The results of this work suggested a positive spatial correlation of catch rates between stations up to a distance of at least 8 n miles apart and a degree of concordance between catch rates at the same stations between successive years.

4.128 The length- and age-composition data collected during the 1994, 1995 and 1996 Argentinian surveys from South Georgia were compared. The size distribution of catches taken in the 1996 survey was very similar to that in 1995 with two modes, one at 17 cm (1-year-old fish) and one at 27 cm (2- and 3-year-old fish) (WG-FSA-96/27). In contrast, the 1994 survey had a much greater proportion of fish larger than 30 cm, and a dominant mode at about 24 cm (2-year-old fish).

4.129 An acoustic survey of the area surrounding South Georgia and Shag Rocks (Subarea 48.3) was carried out in February 1996 using the RV *Atlantida* (WG-FSA-96/59). The survey was confined to a depth range of 100 to 500 m, and regular transects were followed. Forty-five pelagic trawls were carried out to identify species and obtain representative length frequency distributions. The estimate of *C. gunnari* biomass from the acoustic survey equalled 43 600 tonnes.

4.130 The Working Group noted that this was the first time that standing stock estimates had been made for Channichthyidae as part of a major acoustic survey. Bearing in mind that any commercial trawl fishery in Subarea 48.3 would be restricted to the use of midwater trawls, the use of acoustics, whereby the pelagic component of the stock is identified, is a potentially valuable method to employ and as such was welcomed by the Working Group.

4.131 Given the time available, however, the Working Group was unable to consider the results in full. There were a number of questions regarding the survey design, calibration and target identification which were unable to be resolved at the meeting. In particular:

(i) the acoustic equipment was calibrated in Norway in water temperatures of 14°C and it was unclear whether a correction had been made to account for the lower water temperatures experienced during the survey;

(ii) there were substantial amounts of krill in the survey area at the time and it was unclear whether this had been excluded from the biomass estimates;

(iii) it is unclear how the stratification used in the survey was derived and how the transects were allocated into those strata, and how possible autocorrelation between adjacent portions of the transects have been treated; and

(iv) there was uncertainty over the values used for target strengths for *C. gunnari* and other species in the analysis.

4.132 Dr Gasiukov drew the attention of the Working Group to the fact that the estimates from the acoustic survey could be improved if the data from the Argentinian bottom trawl survey carried out this season were used for species identification and calculation of the mean weight of fish. The Working Group agreed that further consideration of the methods used to separate krill from the overall biomass estimate would be useful.

4.133 The Working Group hoped that these issues could be addressed in the intersessional period and would consider the results in detail at the next meeting with a view to using them in future assessments.

4.134 The size distribution of fish caught by pelagic trawl during the Russian survey was very similar to that from the Argentinian bottom trawl survey.

4.135 Because of the shortness of the time series of relative abundance from the Argentinian trawl survey, questions surrounding the single estimate of abundance from the Russian acoustic survey, and the clearly-identified need to develop an appropriate long-term management plan, the Working Group considered that an assessment at this time was inappropriate.

Development of a Long-term Management Plan for *C. gunnari* in Subarea 48.3

4.136 The Working Group considered that a number of issues need to be considered and tasks carried out before a long-term management plan could be developed. These issues are listed below.

Literature Review

4.137 The biology and ecology of *C. gunnari* throughout the Convention Area were recently reviewed by Kock and Everson (WG-FSA-96/24). It is recommended that a review of previous stock assessments and of the data requirements for such assessments be carried out.

Commercial Fishery

4.138 Historical landings, haul-by-haul, length frequency, and catch-at-age data from the commercial fishery are probably incomplete. The Working Group recommended that the existing data be made available on databases for modelling purposes. The Working Group also recommended that every effort be made to forward any outstanding historical commercial fisheries data to the Secretariat.

Stock Structure

4.139 The current knowledge of stock structure throughout the Convention Area was reviewed by Kock and Everson (WG-FSA-96/24). Differences in biological characteristics, morphometric and meristic characters, and parasite loadings suggest different stocks of *C. gunnari* on each of the major shelf areas. It is currently considered that fish from Subarea 48.3 (including both South Georgia and Shag Rocks) comprise one stock. However, the absence of larger adult fish from this area remains an enigma. The Working Group noted that research on gene flow is planned to be carried out by the UK, and that this may resolve some of the uncertainty.

Abundance Indices

Bottom Trawl Surveys (recruited biomass)

4.140 The Working Group noted there had been a number of surveys carried out by different countries using different gear, different vessels, different methods and at different times of year, etc., and analysed using different programs. They considered that time series of relative abundance using standardised bottom trawl gear and a standardised methodology was probably the most promising method of monitoring the stock.

4.141 The Working Group was pleased to note that Dr Gasiukov had submitted data from eight Russian bottom trawl surveys in Subarea 48.3 from the period 1974 to 1991.

4.142 The Working Group recommended that:

(i) a comprehensive list of the surveys be compiled;

(ii) data from any outstanding surveys be requested;

(iii) all appropriate surveys be analysed using a standard trawl survey biomass program;

(iv) where possible, the data be disaggregated by age (1, 2, ε3 years old?);

(v) the results be tabled for each time series; and

(vi) an attempt to standardise the different trawl survey time series be made using GLMs.

Juvenile Fish Surveys

4.143 A number of trawl surveys of pre-recruit and young fish have been carried out by USSR/Russia (WG-FSA-96/60). The Working Group noted that it would be very useful to have an index of juvenile fish for predicting future strong recruitment to the fishery. It was also noted that existing surveys of adult fish are providing indices of abundance of pre-recruits (2-year-olds).

4.144 The Working Group recommended that a comprehensive list of pre-recruit surveys needs to be compiled, any outstanding survey data requested and the surveys analysed in a standard manner.

Acoustic Surveys

4.145 The first quantitative acoustic survey of this stock was carried out in 1996. The Working Group was very interested in this new approach, and considered that a time series of such surveys could be very useful in monitoring trends in relative abundance. However, it also noted that target identification was a major problem which would need to be overcome. Distinguishing *C. gunnari* from other species such as krill and myctophids requires the use of multifrequency transponders and pelagic trawling to identify echo marks.

4.146 The Working Group noted that the timing of the survey and survey design are both important issues which could usefully be reviewed. The Working Group also considered that a big improvement in our knowledge could be made by running bottom trawl and acoustic surveys simultaneously.

Catch per Unit Effort

4.147 The Working Group noted that a standardised CPUE analysis was carried out in 1990 (SC-CAMLR-IX, Annex 5, paragraphs 46 and 47) using multiplicative models (GLMs). Attempts to carry out CPUE analysis may be thwarted by the paucity of haul-by-haul data, the mixture of bottom and pelagic trawling and the reduced usefulness of such an index without length frequency data. The Working Group considered that an analysis of CPUE data may be useful in the future if the fishery is re-established, and recommended that the previous analysis be re-examined.

Biological Parameters

4.148 Biological parameters were not considered in detail by the Working Group. Possible sources include recent Working Group reports, G. Parkes' PhD thesis, and Kock and Everson (WG-FSA-96/24). The Working Group considered that the biological parameters would need to be reviewed before an assessment can be made, but also noted that the models are likely to be most sensitive to uncertainty over the interannual variability in M, and age-dependent M.

Ecosystems/Environmental Interactions

4.149 A number of recent papers have recently considered interactions between *C. gunnari*, krill, and fur seals (e.g. WG-EMM-96/43 and WG-FSA-96/17). The current working hypothesis is that in krill-rich years seals and icefish both feed on krill and icefish are in good condition, show increased growth, and possibly good recruitment (in terms of numbers of eggs and larvae). In krill-poor years, the icefish condition indices are low, gonadal development is poor, and the importance of icefish in the diet of fur seals increases and the icefish consequently suffer a high natural mortality. Evidence on which this hypothesis is based comes from icefish condition indices, seal diet, krill availability and food budget modelling exercises.

4.150 Work is already planned on studies to investigate the relationships between krill distribution and abundance in Subareas 48.1, 48.2 and 48.3 at a workshop planned for 1997 and requested by WG-EMM (Annex 4, paragraph 6.93). The Working Group welcomed this development and looked forward to considering the workshop report in its review of ecosystem interactions involving *C. gunnari*.

4.151 The Working Group considered it essential to understand the ecosystem processes occurring. A number of issues still need to be addressed, including:

(i) the value of natural mortality in krill-rich and krill-poor years;
(ii) the seasonality of natural mortality due to seal predation;
(iii) the ability to predict krill availability in the area;
(iv) appropriate escapement levels of *C. gunnari* in krill-rich and krill-poor years; and
(v) the mechanisms of interaction between fish and predators.

Modelling

4.152 Single-species assessment models could include the use of a wide variety of biomass-dynamic and age-structured models (e.g. modified de Lury model, stock reduction analysis, VPA etc.).

4.153 However, the Working Group considered that conventional single-species models were not suitable and that multispecies models which took into account both the population dynamics of *C. gunnari* and this species' interactions with krill and fur seals would be more appropriate. The Working Group considered that the development of such models should be given high priority.

Long-term Management Strategy

4.154 The Working Group considered that two steps were necessary in the development of a management strategy. The first step was to develop a model which could encompass all possible alternative states of nature. This model would need to include the various alternative hypotheses, assessment methods and data types. The second step would be to determine how a particular management strategy would work given a certain hypothesis and assessment method.

4.155 The Working Group recognises that it would require a large amount of resources to develop a long-term management strategy for this fishery. However, there are a number of reasons why such a strategy should be given a high priority:

(i) although the plan would be focused on *C. gunnari* in Subarea 48.3, the procedures and methodology developed would be applicable to the future development of management plans for *C. gunnari* in other areas and for other species;

(ii) in the past the catch of *C. gunnari* in Subarea 48.3 has exceeded 100 000 tonnes, and there is likely to be a continued interest in reopening this fishery;

(iii) the biological system being modelled is relatively simple (compared with other multispecies systems), and there is strong evidence that the inter-relationships have a major impact on the stock, and these interactions are probably tractable; and

(iv) this provides a very good opportunity to try and develop a multispecies model which would show the commitment of CCAMLR to take into account ecosystems and environmental interactions when managing fisheries within its region.

Management Advice

4.156 Because of the short nature of the time series of relative abundance from the Argentinian trawl survey, and the questions surrounding the single estimate of abundance from the Russian acoustic survey, and because of the clearly-identified need to develop an appropriate long-term management plan, the Working Group considered that an assessment at this time was inappropriate.

4.157 The Working Group reiterated its advice from last year that a long-term management plan be developed for this fishery and noted that, despite the magnitude of the task, this remains a high priority (see paragraph 4.155).

4.158 The Working Group noted that at last year's meeting, the Commission stated (CCAMLR-XIV, paragraph 8.26) that the fishery should be closed until the Scientific Committee has:

(i) provided advice on a long-term management strategy for the stock; and

(ii) provided advice on the reopening of closed fisheries;

or has provided unanimous advice on an appropriate TAC for *C. gunnari* in Subarea 48.3.

4.159 Drs P. Gasiukov (Russia), V. Gerasimchuk and E. Gubanov (Ukraine) considered that data collected during bottom trawl surveys carried out by Argentina from 1994 to 1996 could be used to evaluate the current status of the *C. gunnari* stock. As this survey was carried out over three consecutive years and its design has not changed, the indices of abundance are comparable. In 1995, WG-FSA concluded that there had been a significant increase in fish density between the 1994 and 1995 surveys (SC-CAMLR-XIV, Annex 5, paragraph 5.93). The survey carried out in 1996 showed a further substantial increase in the biomass of *C. gunnari*.

4.160 Further, they considered that the Russian acoustic survey showed that the biomass estimate of *C. gunnari* is not less than 43 000 tonnes, but in reality this may be an underestimate because a midwater trawl was used for species identification and calculation of mean weight. It is noted that both the Argentinian trawl survey and Russian acoustic survey show a strong 1994 year class.

4.161 Drs Gasiukov, Gerasimchuk and Gubanov concluded that these results show that the *C. gunnari* stock has recovered to the point at which it is possible to open a commercial fishery. Management advice can be formulated by comparing the biomass estimates from the trawl surveys with the catches made in the same year as the survey (SC-CAMLR-X, Annex 6, paragraph 7.26).

Table 18: Reported catches (tonnes) and summary of biomass estimates (tonnes) in Subarea 48.3 (extraction from SC-CAMLR-X, Annex 6, Table 3).

Season	Catch	South Georgia Biomass	CV (%)	Shag Rocks Biomass	CV (%)	Source
1984/85	14144	15821	101			SC-CAMLR-IX/BG/11
1984/85		17232				SC-CAMLR-IX
1986/87	71151	151293	95	62867	87	Balguerías,1989
1986/87		50414	18	10023	55	SC-CAMLR-XI/BG/12
1986/87		47312	-			Sosinski and Skora, 1987
1987/88	34620	15086	21	1447	78	SC-CAMLR-XII/BG/23
1987/88		15716		506		SC-CAMLR-IX
1987/88		17913	-			Sosinski, unpublished
1988/89	21356	21069	50			WG-FSA-89/6
1988/89		22328				SC-CAMLR-IX
1988/89		31686	45			Parkes, unpublished
1989/90		95404	63	27900	83	SC-CAMLR-IX, Annex 5

4.162 It can be seen from this table that the catches of *C. gunnari* sometimes exceed the biomass estimates from trawl surveys. Furthermore, the catches did not result in a decrease in the biomass estimates in the following year. For example, following the 1988/89 catch of 21 000 tonnes, the total biomass estimate in 1989/90 from the UK trawl survey around South Georgia was 95 000 tonnes.

4.163 Taking into account:

(i) the results of a comparison of biomass estimates and corresponding catches in the same year;

(ii) the successive increase in relative abundance in recent Argentinian surveys; and

(iii) the estimate of total biomass of around 43 000 tonnes by the Russian acoustic survey;

Drs Gasiukov, Gerasimchuk and Gubanov recommended that, bearing in mind the precautionary approach, the fishery for *C. gunnari* should be opened with a TAC of 13 000 tonnes. This value is the lower 95% confidence interval of the 1994 UK survey trawl survey biomass estimate.

4.164 The rest of the participants of the Working Group considered that they were unable to provide advice on an appropriate long-term management strategy or TAC at the present time and that the situation regarding the assessment of *C. gunnari* remained substantially the same as at last year's meeting.

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

4.165 Estimates of biomass and size composition were available from the Argentinian bottom trawl survey and Russian acoustic survey around South Georgia (WG-FSA-96/27 and 96/49). For similar reasons to those outlined above for *C. gunnari* (paragraph 4.135), no assessment of these stocks has been attempted.

Management Advice

4.166 The Working Group reiterated its advice from previous years concerning these species. In the absence of any new assessment of these species the Working Group recommended that

Conservation Measures 2/III, 3/IV and 95/XIV remain in force and that Conservation Measure 76/XIII be extended to the 1996/97 season.

Electrona carlsbergi (Subarea 48.3)

4.167 No new data were available.

Management Advice

4.168 The Working Group reiterated its advice from 1995 concerning this species (SC-CAMLR-XIV, Annex 5, paragraphs 5.116 and 5.117). In the absence of any new information on this species, the Working Group recommended that Conservation Measure 96/XIV be carried forward for the 1996/97 season.

Crabs (*Paralomis spinosissima* and *P. formosa*) (Subarea 48.3)

General Information about the Fishery

4.169 On 4 November 1995 (immediately following the Fourteenth Meeting of the Commission), the US fishing vessel, *American Champion*, began its second season of participation in the exploratory crab fishery and initiated Phase 2 of Conservation Measure 90/XIV (the provisions of Phase 2 require vessels to concentrate fishing effort in three squares, each measuring approximately 26 n miles^2). The vessel continued to target *P. spinosissima* with *P. formosa* being returned to the sea.

4.170 The *American Champion* completed Phase 2 of the experimental harvest regime on 20 November 1995 and continued standard commercial operations until 29 January 1996, when it stopped participating in the fishery.

4.171 In accordance with the 10-day Catch and Effort Reporting System set forth in Conservation Measure 61/XII, data for the last two 10-day periods of the 1994/95 crab fishing season (the periods beginning 11 October and 21 October 1995) have been submitted to CCAMLR. Data from the entire 1995/96 crab fishing season have also been submitted in accordance with Conservation Measure 61/XII. Summary catch and effort information from the 1994/95 and 1995/96 crab fishing seasons is provided in Table 19.

4.172 By-catch of *D. eleginoides* during the 1995/96 crab fishing season was lower than by-catch during the 1994/95 season. Information on the by-catch of *D. eleginoides* during these two fishing seasons is given in Table 20.

Table 19: Catch of *P. spinosissima* (KCV) during the 1994/95 and 1995/96 crab fishing seasons.

Start of 10-day Period	Catch KCV (numbers)	Catch KCV (kg)	Pots Fished	Hours Fished	CPUE (numbers/pot)
1994/95 season:					
1 September	3198	2677	847	84	3.78
11 September	2827	2541	960	125	2.94
21 September	36398	32125	2220	240	16.40
1 October	50114	41985	2040	240	24.57
11 October	49218	39429	1600	168	30.76
21 October	23068	18046	948	120	24.33
Totals 1994/95	164823	136803	8615	977	19.13
1995/96 season:					
1 November	30558	23960	1528	168	20.00
11 November	87767	72709	2608	218	33.65
21 November	58210	49572	2620	231	22.22
1 December	17883	14860	711	49	25.15
11 December	58283	47102	2723	240	21.40
21 December	66376	57555	3099	264	21.42
1 January	17482	14861	952	78	18.36
11 January	45921	39093	1462	131	31.41
21 January	46263	40101	1758	205	26.32
Totals 1995/96	428743	359813	17461	1583	24.55
Grand Totals	593566	496616	26076	2560	22.76

Table 20: By-catch of *D. eleginoides* (TOP) during the 1994/95 and 1995/96 crab fishing seasons.

Start of 10-day Period	Catch TOP (numbers)	Catch TOP (kg)	Numbers of TOP/pot	Catch TOP/pot (kg)	kg TOP/ kg KCS
1994/95 season:					
1 September	77	196	0.09	0.23	0.07
11 September	133	418	0.14	0.44	0.16
21 September	1039	4291	0.47	1.93	0.13
1 October	460	2090	0.23	1.02	0.05
11 October	188	933	0.12	0.58	0.02
21 October	0	0	0.00	0.00	0.00
Totals 1994/95	1897	7928	0.22	0.92	0.06

Table 20 (continued)

Start of 10-day Period	Catch TOP (numbers)	Catch TOP (kg)	Numbers of TOP/pot	Catch TOP/pot (kg)	kg TOP/ kg KCS
1995/96 season:					
1 November	152	631	0.10	0.41	0.03
11 November	65	259	0.02	0.10	0.004
21 November	0	0	0.00	0.00	0.00
1 December	0	0	0.00	0.00	0.00
11 December	0	0	0.00	0.00	0.00
21 December	0	0	0.00	0.00	0.00
1 January	0	0	0.00	0.00	0.00
11 January	0	0	0.00	0.00	0.00
21 January	0	0	0.00	0.00	0.00
Totals 1995/96	217	890	0.01	0.05	0.002
Grand Totals	2114	8818	0.08	0.34	0.02

4.173 The *American Champion* has surrendered its US-issued permit to fish for crabs in Subarea 48.3. American Seafoods South America (the company which manages *American Champion*) does not currently consider this fishery to be economically viable, and the US is not aware of any other vessels intending future participation in the Antarctic crab fishery.

Information Collected from the Experimental Harvest Regime and Implications for Stock Assessment

4.174 Analyses of data collected during Phase 1 of the experimental harvest regime are presented in WG-FSA-96/34. GLMs fitted to haul-by-haul catch and effort data show that fishable concentrations of male *P. spinosissima* are highest off the northern coast of South Georgia, between depths of about 180 and 550 m.

4.175 With regard to stock assessment, the analyses conducted on data collected during Phase 1 indicate that local estimates of crab abundance should not be extrapolated to the whole of Subarea 48.3 solely on the basis of depth-specific seabed area; extrapolations must consider area-specific differences in crab density.

4.176 Analyses of data collected during Phase 2 of the experimental harvest regime are also presented in WG-FSA-96/34. Simple linear models fitted to CPUE and cumulative catch data from the three depletion experiments did not have significant, negative slopes. Depletion events were probably not realised/recognised because there was a significant amount of interhaul variability in CPUE and mark-recapture data illustrated that the depletion experiments were probably not closed to immigration since individual crabs are capable of moving over large distances.

4.177 Results from Phase 2 of the experimental harvest regime suggest that there is not much scope for using depletion estimators to estimate local abundances of *P. spinosissima*.

4.178 At its last meeting, the Working Group requested that data be collected for estimating the size at sexual maturity of *P. formosa* (SC-CAMLR-XIV, Annex 5, paragraph 11.2). These data were collected during the 1995/96 crab fishing season and an analysis is presented in WG-FSA-96/35. The document describes a new method for estimating size at maturity from claw and body size data on male crabs; the method uses smoothing splines. Using the new method, the estimated size at maturity for *P. formosa* is 80 mm carapace length. Since the dataset contained a large number of crabs with regenerating claws, there was considerable uncertainty in the estimated size at maturity.

4.179 Given the uncertainty in the estimated size at maturity and the lack of information on growth rates for *P. formosa*, a wide range of minimum size limits are likely to be feasible options for managing this species. The Working Group noted the conclusion in WG-FSA-96/35 and agreed that there is not a sufficiently strong biological reason to revise the current size limit on *P. formosa* (90 mm carapace width) set forth in Conservation Measure 91/XIV.

Assessment

4.180 Noting that the Antarctic crab fishery does not currently appear to be commercially viable and that there is no indication that new vessels are planning to enter this fishery, the Working Group determined that it was not necessary to conduct an assessment of the crab stocks in Subarea 48.3.

General Comments on the Experimental Harvest Regime

4.181 The Working Group agreed that the experimental harvest regime set forth in Conservation Measure 90/XIV had provided valuable information. In particular, the wide geographic distribution of fishing effort required by Phase 1 was useful for learning about the distribution of *P. spinosissima* around South Georgia and determining where the areas of high crab abundance are located. The Working Group further noted that the experimental harvest regime was successful in providing information about whether the crab fishery was likely to be economically viable.

4.182 The Working Group noted that the purpose of Phase 2 was to determine whether local depletion estimators could be used in an assessment of the crab stock (SC-CAMLR-XIV, Annex 5, paragraph 5.124) and agreed that the implementation of this phase during the 1995/96 fishing season had successfully shown that such estimators would not be appropriate for estimating the abundance of *P. spinosissima*. If, in the future, it is necessary to make an assessment of the crab stock in Subarea 48.3, the Working Group agreed that it would be necessary to consider other methods of estimating abundance.

4.183 The Working Group recognised that if new vessels enter the Antarctic crab fishery it would not be useful for these vessels to conduct depletion experiments during Phase 2 of the experimental harvest regime. In this regard, the Working Group agreed that it might be useful to redraft Phase 2 of the regime and require each vessel to repeat Phase 1 or to conduct a tagging study during its second season of participation in the crab fishery.

4.184 The Working Group recognised the successes of Phase 1 of the experimental harvest regime and recommended that the Commission consider methods of distributing fishing effort over a wide geographic area when deliberating on appropriate management methods for other new and exploratory fisheries in the Convention Area (see also paragraph 4.20).

Management Advice

4.185 The Working Group recalled the Commission's view that exploratory fisheries should provide information that is useful for developing an assessment of the target species and recognised that the experimental harvest regime set forth in Conservation Measure 90/XIV has already provided such information. The Working Group recommended that Conservation Measure 90/XIV should remain in force, but, if new vessels enter the fishery, the Commission may wish to revise Phase 2 in light of the comments made in paragraph 4.183.

4.186 Since the crab stock was not assessed, the Working Group recognised that a conservative management scheme is still appropriate for this fishery. In particular, the Working Group noted that the fishery should continue to be controlled by direct limitations on catch and effort, as well as by limitation on the size and sex of individual crabs which may be retained in the catch. The Working Group noted that Conservation Measure 91/XIV contains such limitations and recommended that this measure should continue to be applied to the crab fishery in Subarea 48.3.

Martialia hyadesi (Subarea 48.3)

4.187 A research survey using a Korean squid jigger was carried out in Subarea 48.3 (WG-FSA-96/21) (see paragraphs 3.56 and 3.57). An assessment of *M. hyadesi*, based on predator food consumption rates, was presented in WG-FSA-96/20.

4.188 A notification of the intent to conduct a new fishery for *M. hyadesi* in Subarea 48.3 during the 1996/97 season has been lodged jointly by the Republic of Korea and the UK. Management advice is given in paragraph 4.14.

South Sandwich Islands (Subarea 48.4)

4.189 Although a small fishery for *D. eleginoides* was open in this area, no catches were reported.

Management Advice

4.190 In the absence of any new information on this species, the Working Group recommended that Conservation Measure 92/XIV be carried forward for the 1996/97 season.

Bouvet Island (Subarea 48.6)

4.191 No information was available to make any assessment of this area.

4.192 Notifications of the intention to conduct new fisheries for *D. eleginoides* in Subarea 48.6 during the 1996/97 season have been lodged by Norway and South Africa. Management advice is given in paragraphs 4.20 to 4.30.

Statistical Area 58

4.193 Total catches by species and subarea in Statistical Area 58 for the 1996 season are shown in Table 21.

Table 21: Total catches by species and subarea in Statistical Area 58. Species are designated by abbreviations as follows: ANI (*Champsocephalus gunnari*), LIC (*Channichthys rhinoceratus*), TOP (*Dissostichus eleginoides*), NOR (*Notothenia rossii*), NOS (*Lepidonotothen squamifrons*), ANS (*Pleuragramma antarcticum*), MZZ (Unknown), SRX (*Rajiformes spp.*), WIC (*Chaenodraco wilsoni*).

Split-Year	ANI		LIC	WIC	TOP				NOR			NOS			ANS		MZZ			SRX
	58	58.5	58.5	58.4	58	58.4	58.5	58.6	58	58.4	58.5	58	58.4	58.5	58	58.4	58	58.4	58.5	58.5.1
1971	10231				XX				63636			24545					679			
1972	53857				XX				104588			52912					8195			
1973	6512				XX				20361			2368					3444			
1974	7392				XX				20906			19977					1759			
1975	47784				XX				10248			10198					575			
1976	10424				XX			6	6061			12200					548			
1977	10450				XX			-	97			308					11			
1978	72643	250	82		196	-	2	370	46155			31582	6023	98	234		261			
1979				101	3	-	-	-				1307	2096				1218			
1980		1631	8	14		56	138	-			1742		3035	11308				239		
1981		1122	2			16	40	-		217	7924		4865	6239				375	21	
1982		16083				83	121	-		237	9812		1594	4038		50		364	7	
1983		25852				4	128	14			1829		733	1832		229		4	17	1
1984		7127				1	145	-		50	744		1175	3794					611[1]	17
1985		8253		279		8	6677	-		34	1707		570	7394		966		11	7	4
1986		17137		757		8	459	-		-	801		11283	2464		692				3
1987		2625		1099		34	3144	-		2	482		1963	1641		28		22		
1988		159		1816		4	554	491		-	21		5002	41		66				

Split-Year	ANI		WIC	TOP			NOR	NOS		ANS	
	58.5.1	58.5.2	58.4.2	58.4.4	58.5.1	58.6	58.5.1	58.4.4	58.5.1	58.4.2	58.4.4
1989	23628	-	306	35	1630	21	245	4016	1553	30	17
1990	226	-	339	5	1062	-	155	1463	1262	-	-
1991	13283[2]	-	-	-	1944	-	287	1000	98	-	-
1992	44	3	-	-	7492[3]	13	-	-	4	-	-
1993	-	-	-	-	2722	-	2	-	-	-	-
1994	12	3	-	-	5083	56	-	-	-	-	-
1995	3936	-			5534	114					
1996	5	-	-	-	4911	3			15		

1 Mainly *Rajiformes* spp.

2 There are some discrepancies between the French statistics for the Soviet fishery under licence in Division 58.5.1 (12 644 tonnes) and the STATLANT A data provided by the USSR (13 268 tonnes). It may be explained by the inclusion of 826 tonnes of by-catch (mainly Rajiformes) in this total.

3 1 589 tonnes - France; 5 903 tonnes - Ukraine, of which 705 tonnes were caught by longline.

NB: Before 1979/80 catches reported in Statistical Area 58 mainly concern Division 58.5.1 (Kerguelen subarea). Catch reporting was not divided into Divisions 58.5.1 and 58.5.2 until the 1989 season.

Antarctic Coastal Areas (Divisions 58.4.1 and 58.4.2)

4.194 No new information was available to make any assessment of this area.

Banzare Bank (Division 58.4.3)

Dissostichus spp. (Division 58.4.3)

4.195 Notification of the intention to conduct a new fishery for *Dissostichus* spp. in Division 58.4.3 during the 1996/97 season has been lodged by Australia (see paragraph 4.16).

Ob and Lena Banks (Division 58.4.4)

4.196 At CCAMLR-XIII, a conservation measure to allow a commercial catch of 1 150 tonnes of *L. squamifrons* to be taken over a two-year period (Conservation Measure 87/XIII) was approved at the request of Ukraine, provided a biomass survey was undertaken. No fishing took place during the 1994/95 and 1995/96 seasons, and so no new data were available.

4.197 Notification of the intention to conduct a new fishery for *D. eleginoides* in Division 58.4.4 during the 1996/97 season has been lodged by South Africa. Management advice is given in paragraphs 4.20 to 4.30.

Management Advice

4.198 Conservation Measure 87/XIII, allowing a catch of 1 150 tonnes of *L. squamifrons* on the two banks provided an approved biomass survey is undertaken, will lapse at the end of the 1995/96 season. The Working Group noted that Ukraine has again expressed an interest in undertaking a biomass survey of the area in the 1996/97 season. The Working Group recommended that this conservation measure be extended to the 1996/97 season provided that the survey is of the design approved by the Scientific Committee (CCAMLR-XIII, paragraphs 8.52 and 8.53).

Kerguelen Islands (Division 58.5.1)

Dissostichus eleginoides (Division 58.5.1)

4.199 In 1995/96 commercial fishing was carried out by French trawlers in the northern and eastern sectors of the shelf and Ukrainian longliners in the western sector. The total catches are reported in Table 21.

4.200 On the western slope of the shelf, two Ukrainian longliners caught 1 003 tonnes of *D. eleginoides*. The catches were lower than the 1 400-tonne limit recommended in 1993 (SC-CAMLR-XII, Annex 5, paragraph 6.129). The catch level has been voluntarily limited by the French authorities.

4.201 The northern sector catches by French trawlers dropped from 3 164 tonnes in 1995 to 2 574 tonnes in 1996. A 2 800-tonne catch limit had been imposed on the trawlers. The fishing trip of one of the trawlers was short, which explains why the catch limit was not reached. The eastern sector catches increased from 810 tonnes in 1995 to 1 029 tonnes in 1996. The French authorities had imposed a limit of 1 000 tonnes in this sector as a preventative measure to restrict fishing effort.

4.202 A joint scientific exploratory deep-sea longline fishing cruise (Japan/France) was conducted from February to April 1996 off the Kerguelen Shelf. Depths from 300 to 1 500 m were investigated at 145 non-duplicated stations. A total catch of 263 tonnes was recorded.

Standardisation of Catch per Unit Effort

4.203 The Working Group 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 1995 meeting of the Working Group, and details of the methodology are provided in Appendix G of last year's report (SC-CAMLR-XIV, Annex 5). At its last meeting the Working Group also used a GLM to analyse CPUE data from the Ukrainian longline fishery in Division 58.5.1. Additional data were not available to update the analysis of CPUE data from the Ukrainian longline fishery and the analysis at this year's meeting was limited to data from the trawl fishery.

4.204 The GLM was fitted to haul-by-haul data from the French and Ukrainian trawl fisheries operating off the northern and eastern coasts of Kerguelen during the period 1990 to 1996. Kilograms per hour towed was used as the response variable, and vessel, year, month, area and depth were considered as predictor variables. Year was defined as calendar year.

4.205 The Working Group thanked Prof. Duhamel for providing both new and historical data from the Kerguelen trawl fishery (the analysis conducted during the Working Group's last meeting had been restricted to data collected during 1994 and 1995).

4.206 Vessel, year, month, area and depth contributed significant sources of variation to haul-by-haul CPUE from the trawl fishery (Table 22). The vessel effect was the most significant component of variability in CPUE and the year effect was the next most significant.

Table 22: Analysis of deviance tables from GLM fit to catch rate data from the trawl fishery for *D. eleginoides* in Division 58.5.1. Factors/covariates were entered into the models in order from top to bottom.

Factor/Covariate	Residual df	Residual Deviance	p
NULL	4519	3706	
Vessel	4511	3312	< 0.01
Year	4505	3179	< 0.01
Area	4504	3173	0.02
Month	4493	3101	< 0.01
Depth	4492	3094	0.01

4.207 Figure 7 illustrates the effects of year, vessel, area and depth on standardised catch rates from the trawl fishery. In general, standardised CPUE was low during the period 1990 to 1992 and higher during the period 1993 to 1996. There were vessels with high, intermediate, and low catch rates, and the differences between the northern and eastern fishing grounds were minimal. Standardised CPUE decreased with increasing depth.

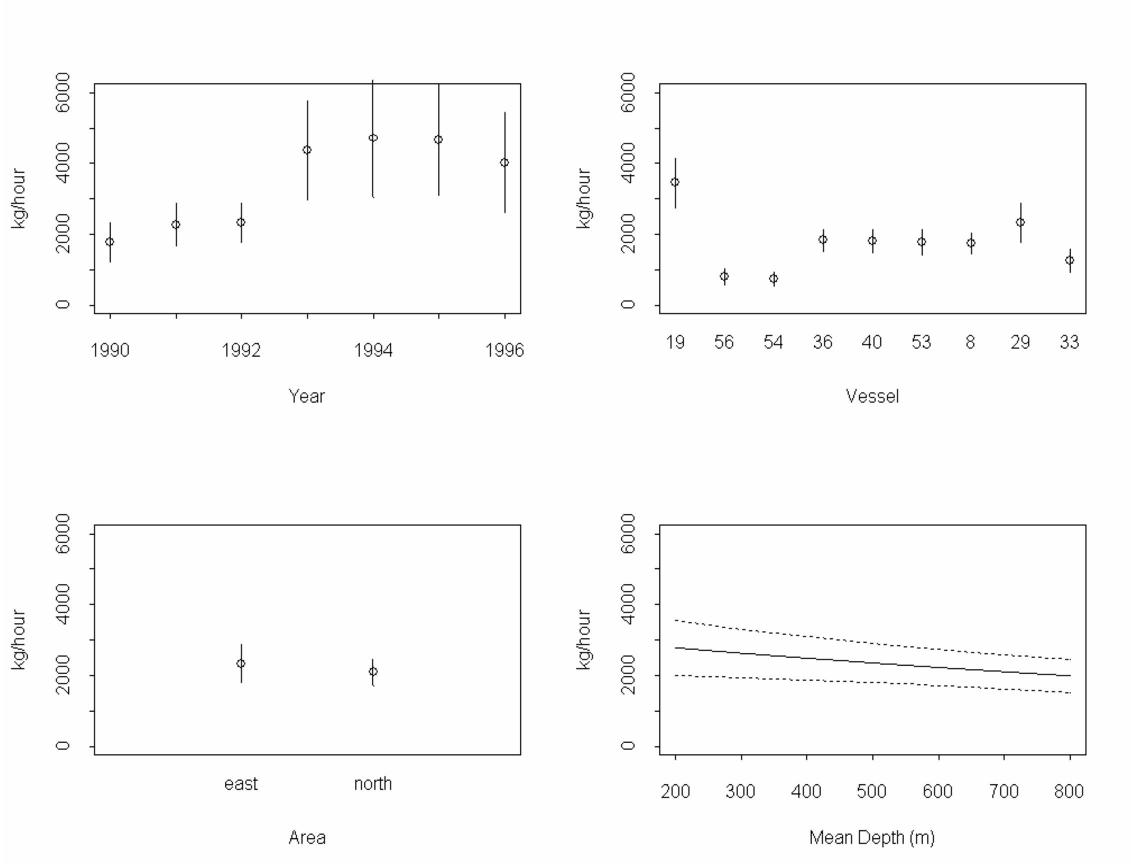

Figure 7: Illustration of the effects of year, vessel, area and depth on standardised catch rates from the trawl fishery.

4.208 Prof. Duhamel noted that the increase in standardised CPUE between 1992 and 1993 (see Figure 7) was probably a result of the fishermen locating the most productive trawling grounds.

4.209 Prof. Duhamel also noted that vessel-specific differences in standardised catch rates were likely to be a result of differences in fishing strategy.

4.210 The Working Group noted that the CPUE-depth relationship illustrated in Figure 7 was consistent with results from the analysis conducted at its last meeting.

4.211 In general, the GLM analysis supported the view that there has not been a decline in trawl catch rates.

Management Advice

4.212 The French authorities have allocated a TAC to the two trawling sectors for the 1996/97 season. A maximum of 2 500 tonnes applies to the northern sector and a 1 000-tonne limit applies in the eastern sector. The longlining catch limit in the western sector has already been established for the end of 1996 (October to December). A TAC of 500 tonnes applies for two vessels only. The level of catch in the first six months of 1997 is not expected to increase and will be in line with the 1993 recommendations of WG-FSA.

4.213 For the western sector longline fishery no further analysis of *D. eleginoides* has been undertaken. However, since there has been no decline in the trends of CPUE in recent years (WG-FSA-93/15 and subsequent data) the Working Group recommended that the value of the long-term sustainable yield estimated at the 1994 meeting of 1 400 tonnes per split-year be continued.

4.214 For the northern sector trawl fishery the GLM analysis has not detected a significant decline in trawl catch rates in recent years. The Working Group therefore recommended that the TAC of 2 500 tonnes set by the French authorities, which is a slight decrease from the 2 800 tonnes set in the previous year, be endorsed.

4.215 For the eastern sector, for which 1995/96 was the second year of fishing, the 1 000-tonne limit, set in 1995/96 by the French authorities was considered appropriate as a precautionary catch limit for 1996/97.

4.216 The Working Group felt 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 acquire haul-by-haul data collected on board Ukrainian longline vessels from the Ukrainian authorities.

Champsocephalus gunnari (Division 58.5.1)

4.217 The Secretariat has verified the accuracy and completeness of the new data reported for the Soviet fishery for *C. gunnari* in Subarea 58.5 between 1970 and 1978 (SC-CAMLR-XIV, Annex 5, Table 20). Fine-scale data for these fisheries are not yet available (WG-FSA-96/7).

4.218 The 1991 year class has not been fished as its biomass is thought to be low following fishing activities in 1994/95. In order to obtain information on the new cohort, it was requested that a trawler carry out a number of hauls in the area in which aggregations have traditionally been found. Six hauls (at the end of March 1996) were carried out by bottom trawl at depths of 200 to 280 m (codend mesh size: 30 mm). Fish aged 4+ from the 1991 year class were still present ($\overline{L}$ = 36.4 cm, n = 414), but fish aged 1+ from the 1994 year class, a large number of which were found to be caught in the mesh, predominated in all areas ($\overline{L}$ = 16.6 cm, n = 882). The largest haul gave a yield of 4 tonnes per hour (5 tonnes caught). It should be noted that the 1992 year class ($\overline{L}$ = 29 cm, n = 175) was observed at the edge of the shelf during the southeastern survey for *L. squamifrons*, however its abundance is very low.

4.219 Most of the fish are currently below the legal size limit of 25 cm and so this will restrict the landings from the fisheries during 1996/97.

4.220 In order to assess pre-recruit biomass (year class 1994), a trawl survey has been scheduled for the 1996/97 summer season. A week of trawling is planned, with a total of between 40 and 50 hauls to be carried out. A random trawl survey will be conducted, with stations allocated to strata based on their area. The results may be available for assessment at the next meeting.

Management Advice

4.221 The Working Group reiterated its advice from last year (SC-CAMLR-XIV, Annex 5, paragraphs 5.151 and 5.152) that the fishery for *C. gunnari* in Division 58.5.1 be closed until at least the 1997/98 season, when the cohort born in 1994 will have had an opportunity to spawn. Before this cohort is fished, it is recommended that a pre-recruit biomass survey be conducted in the 1996/97 season to evaluate the strength of the cohort at age 2+. These data should be evaluated at the 1997 meeting of WG-FSA, and an appropriate level of catch recommended.

Notothenia rossii (Division 58.5.1)

4.222 No new data on the stocks of this species are available.

Management Advice

4.223 The Working Group reiterated advice from previous meetings that the fishery for *N. rossii* remain closed until a biomass survey demonstrates that the stock has recovered to a level that will support a fishery (SC-CAMLR-XIII, Annex 4, paragraphs 4.120 to 4.123).

Lepidonotothen squamifrons (Division 58.5.1)

4.224 As indicated last year (SC-CAMLR-XIV, Annex 5, paragraph 5.138), two French trawlers carried out exploratory fishing in the areas in which concentrations of *L. squamifrons* have traditionally been found (southeastern sector of the area) in order to obtain CPUE and length frequency data. The vessels carried out their operations during two different periods:

(i) end of October 1995:

  (a) 12 hauls were carried out between the eastern and southern parts of the shelf;

  (b) three hauls were made on West (Zapadnaya) Bank; and

  (c) five hauls were carried out on the northern part of Pike (Shchuchya) Bank.

  No aggregations were encountered. The length frequency data obtained were only for immature fish (less than 33 cm in length).

(ii) beginning of March 1996:

  (a) 21 hauls were carried out in the southeastern and one in the southern area of the shelf;

  (b) three hauls on West (Zapadnaya) Bank; and

(c) two hauls on the northern part of Pike (Shchuchya) Bank.

L. squamifrons was not encountered on the two banks but one aggregation was detected in the southeastern area of the shelf (south of 50°S at depths of 300 to 330 m). The total catch from this aggregation was 16 tonnes, with an average CPUE of 1.25 tonnes per hour (±0.71, n = 6). The length of fish ranged from 25 to 43 cm ($\bar{L}$ = 33.0 cm, n = 2 090).

4.225 These results confirm that the distribution of the stock and its areas of aggregation remain unchanged, but are extremely dependent on the time at which the survey is undertaken.

4.226 A specific survey will, however, be required in order to obtain an estimation of the biomass and of the potential fishable resources.

Management Advice

4.227 In the absence of a new assessment, the Working Group recommended that the Kerguelen shelf fishery for *L. squamifrons* should remain closed.

Heard and McDonald Islands (Division 58.5.2)

Dissostichus eleginoides (Division 58.5.2)

4.228 In 1994 and 1995, the Working Group assessed potential yields of *D. eleginoides* in Division 58.5.2 in a manner similar to assessments of krill yield. This was because the only information available consisted of two estimates of biomass from trawl surveys in previous years. In these assessments, a proportion of the estimated biomass is determined that satisfies the two decision rules used by the Commission (see SC-CAMLR-XIII, paragraphs 5.18 to 5.26 for a discussion on the application of these rules). The 1995 assessment was undertaken using estimates of population parameters from Subarea 48.3, which were applied in this case because of the absence of estimates from the local stock. The Working Group noted at last year's meeting that improved techniques developed in 1995, such as that for estimating recruitment in Subarea 48.3, should be used in future assessments of the stock in Division 58.5.2. At this year's meeting, the Working Group undertook a new assessment of yield for this stock, applying the improved method of estimating recruitment (described in WG-FSA-96/38) and the refined version of the generalised yield model (paragraphs 3.65 to 3.69). It was expected that these changes would provide substantially different results from last year's assessment.

4.229 The generalised yield model was applied this year with estimates of recruitment derived from two trawl surveys, taken from WG-FSA-96/38, employing the same method used for *D. eleginoides* in Subarea 48.3 (paragraphs 4.67 and 4.68). These new recruitment estimates demonstrated that the majority of the biomass comprised young fish aged 3 to 5 years, with only the age classes up to about year 10 represented (Tables 1 and 2 in WG-FSA-96/38).

4.230 The numbers of fish estimated for age class 4 for cohorts born in 1985 to 1991 are given in Table 23.

Table 23: Recruitment to the stock of *D. eleginoides* in Division 58.5.2 as numbers of fish by year-class at age-class 4, estimated from trawl surveys at Heard Island (from WG-FSA-96/38).

Cohort	Number of Fish at Age 4 (millions)
1991	2.120
1990	4.214
1989	1.749
1988	1.773
1987	3.435
1986	1.584
1985	1.635

4.231 The numbers of fish at age 4 in each year of the simulation are drawn from a lognormal distribution. The mean and standard deviation of the distribution are derived by the sample mean and variance of the numbers of fish given in Table 23. The resultant estimates are:

Mean number of recruits at age 4	=	2 359 000
Standard deviation	=	1 041 000
Lognormal mean	=	14.585
Lognormal standard error	=	0.159
Lognormal standard deviation	=	0.422

4.232 Biological parameters required for input into the generalised yield model are unknown for Heard Island. A maturity-at-length ogive is known for fish caught in the trawl fishery in the adjacent Division 58.5.1 around Kerguelen Island. However, this ogive may not be representative of the whole stock because trawl fisheries for *D. eleginoides* take smaller fish. Other biological parameters, such as length at age and natural mortality, are unknown for the region. As a consequence, the biological parameters used in the model were taken from the assessments in Subarea 48.3. The Working Group agreed that, wherever possible, biological parameters used in the analysis should be derived from within one area as the estimates of these parameters are not independent. The application of the maturity ogive from Division 58.5.1 would not be appropriate until larger fish were included in the development of the ogive and a length-at-age model and estimates of M were available for the same area.

4.233 Applying the generalised yield model to *D. eleginoides* in Division 58.5.2 requires an age-specific selectivity function which takes into account the fact that the catches will be taken by trawling. No commercial trawling has taken place for *D. eleginoides* in the division, and so the age distribution of trawl catches from the adjacent Kerguelen fishery was estimated from commercial length frequency data using the age/length key given in SC-CAMLR-XV/BG/14. The estimated age distribution shows the effects of variability in recruitment, both in the age/length key and in the length distribution of the catches. The age distribution averaged over a number of years would be a smooth curve, and so a smooth function, based on a gamma distribution, was fitted to the age distribution. The estimated and fitted age distributions are shown in Figure 8. The age specific selectivity was calculated as the ratio of the numbers at age in catch at age curve to the numbers of fish that would occur in the corresponding age classes, assuming that natural mortality is 0.16 for all ages in the range. The values for age-specific selectivity are shown in Table 24.

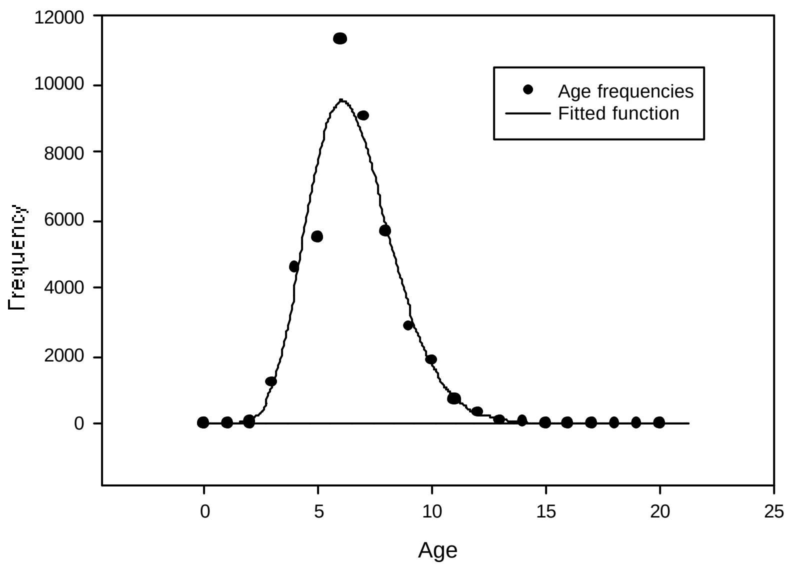

Figure 8: Estimated and fitted age distributions.

Table 24: Age specific selection function for *Dissostichus* trawl fisheries (scaled to unity at age 6).

Age	Selectivity
3	0.070
4	0.311
5	0.699
6	1.000
7	1.038
8	0.849
9	0.579
9	0.341
10	0.179
11	0.085
12	0.037
13	0.015

4.234 The assessment of yield made by the generalised yield model used the same input parameters as the assessment in Subarea 48.3 but with the new recruitment estimate and the selectivity function derived for a trawl fishery. The application of the decision rules to the trawl fishery in Division 58.5.2 is shown in Figures 9(a) and 9(b). The methods used to generate these figures and ways in which they can be interpreted are discussed in the presentation for Subarea 48.3 (paragraphs 4.76 to 4.80). These figures differ from those for Subarea 48.3 because of the differences between areas in the recruitment parameters and fishing selectivity functions.

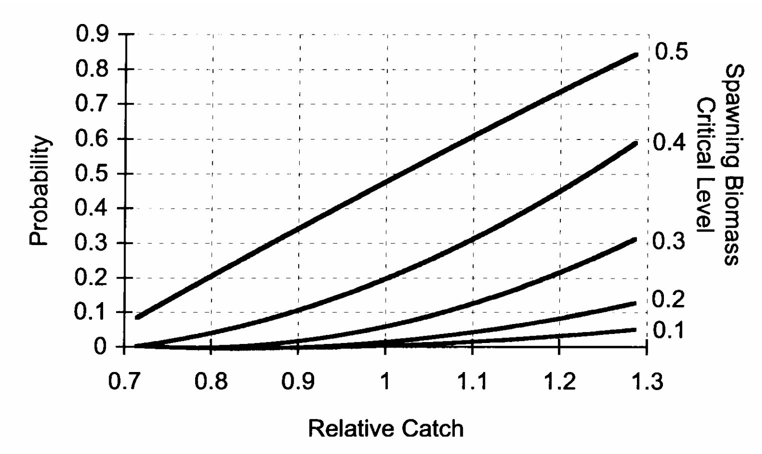

Figure 9(a): *D. eleginoides* in Division 58.5.2: Probabilities of falling below a critical level of spawning biomass relative to the median spawning biomass at Time 0 for a range of catches using parameters from the final run.

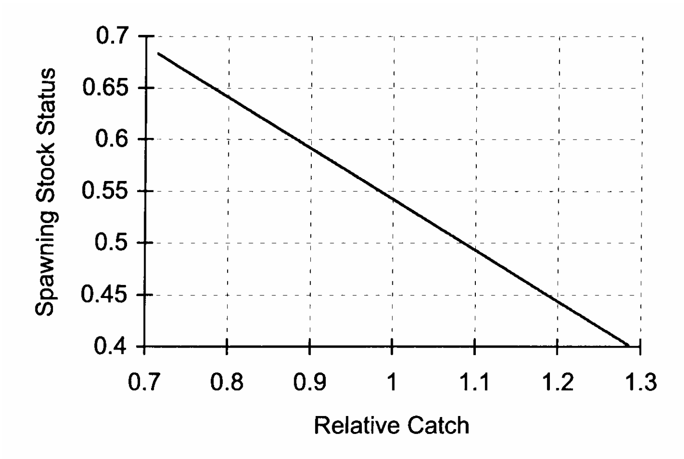

Figure 9(b): *D. eleginoides* in Division 58.5.2: Median status of the spawning biomass at the end of a projection period relative to the median spawning biomass at Time 0 for a range of catches using parameters from the final run.

4.235 The catch that satisfies the decision rules (γ_2 in this case) is 3 800 tonnes. At this catch level the probability of depletion was 0.04, but the ratio of median spawning stock biomass at the end of the projection period to the pre-exploitation level was 0.5. This catch level is substantially different to the figure estimated at last year's meeting (297 tonnes). Two factors are responsible for this increase. The first is the refinement to the generalised yield model since last year (paragraphs 3.65 to 3.69). The second is the use of the new estimate of recruitment, rather than total biomass in the calculations. The assessment of recruitment revealed that the biomass estimates used in 1995 were underestimates of the stock biomass because the trawl surveys had sampled mostly the younger age classes.

Management Advice

4.236 The Working Group welcomed the refinements to the analysis using the generalised yield model made during the intersessional period and at this year's meeting, and noted a number of further refinements which could be undertaken in the future.

4.237 The Working Group noted that the assessment of yield was based on the expectation that future catches will be taken only by trawling. Fishing with other types of gear, such as longlines, would change the age structure of the catch. The Working Group made no assessment of the effects of such catches in this division at this year's meeting. The Working Group therefore recommended that the directed fishery for *D. eleginoides* in Division 58.5.2 be restricted to trawling during the 1996/97 season. Should there be an interest in longlining for *D. eleginoides* in Division 58.5.2 in the future, then the assessment using the generalised yield model could be adjusted to take this into account.

4.238 As requested by the Scientific Committee, the Working Group has provided advice on the relative effects on catch levels of departing from the current γ_1 decision rule (i.e. that the probability that of the spawning stock biomass falling below 20% of its initial level during the projection period, should not exceed 10%). It was noted that in the case of the fishery for *D. eleginoides* in Division 58.5.2, it was the γ_2 decision rule which was limiting on the catch level rather than γ_1 (as in the case of Subarea 48.3). No specific decision rule criteria, other than γ_1 and γ_2, were considered at this year's meeting. The Working Group agreed, however, that more detailed consideration could be given to the critical level of spawning stock biomass at next year's meeting.

4.239 The results of the projections using the generalised yield model indicated that an annual catch of 3 800 tonnes applied over a period of 35 years was consistent with the γ_2 decision rule. At this level of catch the probability of the spawning stock biomass falling below the 20% critical level was 0.04. The Working Group recommended that this should be the basis for setting the catch limit for *D. eleginoides* in Division 58.5.2 during the 1996/97 season.

4.240 The Working Group recognised the importance to the assessment work of biological data and information collected from this area. This information can be collected both by scientific surveys and through a scientific observer program. In view of the urgent need for information, the Working Group recommended that a requirement for 100% observer coverage be applied to this fishery for the 1996/97 season. The Working Group also reiterated the importance of timely submission to the Secretariat of data from observer trips, in the appropriate formats, to enable them to be made available for consideration by the Working Group (paragraph 3.16(vi)).

Champsocephalus gunnari (Division 58.5.2)

4.241 No fishery for this species has been reported in recent times, although Conservation Measure 78/XIV set a precautionary TAC of 311 tonnes for *C. gunnari* on the basis of results from Australian biomass surveys.

Management Advice

4.242 In the light of experience with the fishery for this species in Division 58.5.1 (SC-CAMLR-XIV, Annex 5, paragraphs 5.146 to 5.152), it is recommended that the fishery for *C. gunnari* in Division 58.5.2 also avoid the taking of fish smaller than the size at first spawning (about 28 cm total length).

Crozet and Prince Edward Islands (Subareas 58.6 and 58.7)

4.243 No information was available to make any assessment of these areas.

4.244 Notification of the intention to conduct a new fishery for *D. eleginoides* in Subareas 58.6 and 58.7 during the 1996/97 season has been lodged by South Africa. Management advice is given in paragraphs 4.20 to 4.30.

Pacific Ocean Sector (Area 88)

4.245 No information was available to make any assessment of this area.

4.246 Notification of the intention to conduct a new fishery for *D. eleginoides* in Subareas 88.1 and 88.2 during the 1996/97 season has been lodged by New Zealand (see paragraph 4.17). Management advice is given in paragraphs 4.20 to 4.30.

Resumed/Reopened Fisheries

4.247 The Commission, at last year's meeting, recognised that no clear policies or measures exist to manage fisheries which have been closed but are under consideration for reopening (CCAMLR-XIV, paragraph 8.26). The Commission agreed that this topic should be discussed at the next Scientific Committee meeting. The Working Group considered a proposal outlining the need for procedures to govern the reopening of a closed fishery (SC-CAMLR-XV/BG/11).

4.248 There was considerable debate over the definition of a resumed fishery, under what conditions a fishery might be reopened, and whether the existing conservation measures for new (Conservation Measure 31/X) or exploratory (Conservation Measure 65/XII) fisheries could be used in such instances. It was recognised that fisheries may lapse for a variety of reasons (including both economic and sustainability factors), and may therefore need to be considered on a case-by-case basis.

4.249 The Working Group agreed that information and procedures similar to those required for the initiation of a new fishery (Conservation Measure 31/X) and/or for the execution of an exploratory fishery (Conservation Measure 65/XII) should be required during the resumption of a closed fishery. For example, a Data Collection Plan and a Research and Fishery Operation Plan, which are required for new and exploratory fisheries, should be considered.

4.250 However, the Working Group recognised that the requirement for a survey prior to the resumption of a fishery might best be considered on a case-by-case basis. For example, the Commission requires a survey be completed before closed areas (Subareas 48.1 – Conservation Measure 72/XII and 48.2 – Conservation Measure 73/XII) are reopened for fishing and has required a survey be conducted before directed fishing on a depleted species is resumed (Conservation Measure 97/XIV). However, it does not require a survey before the initiation of a new fishery and may not require a survey before reopening a fishery which had closed for reasons other than suspected stock depletion.

4.251 In all cases, it was considered highly desirable for prior notification of the intention to resume a fishery be provided so that an appropriate assessment of the status of the stock could be made and appropriate management advice given to the Scientific Committee. To this end, the Working Group recommended that the Commission maintain a register of lapsed fisheries.

CONSIDERATIONS OF ECOSYSTEM MANAGEMENT

Interactions with WG-EMM

5.1 Dr Everson (Convener, WG-EMM) outlined those aspects of the ecosystem assessment conducted by WG-EMM at its meeting this year (Annex 4, paragraphs 7.1 to 7.59) that related directly to the work of WG-FSA.

5.2 Throughout Subareas 48.1, 48.2 and 48.3, the abundance of krill was higher in 1995/96 than in previous years. In Division 58.4.1, a survey carried out in 1996 has shown that the abundance of krill was higher in the western part of the division than in the eastern part, but no historical survey data were available for comparison with the results of this survey.

5.3 Ecosystem implications of proposed new fisheries were discussed by WG-EMM. These were considered under Agenda Item 4.2 (see paragraph 4.32).

5.4 Comprehensive sea-surface temperature (SST) data have been acquired by the Secretariat, and WG-EMM recommended that comprehensive bathymetric data should also be acquired. The usefulness of bathymetric data for estimating relative areas of fishable seabed was emphasised during WG-FSA's discussions of proposals for new fisheries for *D. eleginoides* (see paragraph 4.20). It was noted that sea-ice indices may also prove useful for the work of WG-FSA.

5.5 As the primary current focus of WG-EMM is on krill and its dependent species, interactions between WG-EMM and WG-FSA are relatively minor for most of the fish stocks of concern to WG-FSA. However, ecosystem assessments will clearly form a valuable adjunct to studies on the long-term management of *C. gunnari* (see paragraphs 4.149 to 4.151).

5.6 WG-EMM has devoted considerable time to discussions of multifrequency acoustic techniques in surveys, and related topics. WG-FSA agreed that it would be appropriate for WG-EMM to take the lead on acoustic survey methodology and it agreed that it would refer technical questions to WG-EMM as appropriate.

5.7 WG-EMM recommended that more extensive studies of the occurrence of fish in krill catches should be carried out (Annex 4, paragraphs 6.1 to 6.3). In particular, additional studies covering the entire fishing season were needed. The by-catch of fish in krill trawls has also been considered by an intersessional WG-FSA correspondence group. The interim report from this group is in WG-FSA-96/41.

5.8 The WG-FSA correspondence group identified a number of available datasets and several other datasets for which little or no information was available. Of these latter datasets, a complete record of Russian krill survey data for 1967 to 1990 has now been prepared and made available to the Secretariat (WG-FSA-96/17). The remaining data are expected to be acquired by the Secretariat by early 1997.

5.9 It was noted that before the newly-acquired data could be used by the correspondence group, it was necessary that these data be entered into the CCAMLR database. If this were to be done by the Secretariat, then a suitable budget provision would have to be made.

5.10 In addition to the data identified in WG-FSA-96/17 and 96/41, the Working Group noted with appreciation that additional information on fish by-catches in krill trawls was presented in WG-FSA-96/18 and 96/19.

5.11 The Working Group thanked the correspondence group for its work. Provided the data entry can be accomplished, it was agreed that the correspondence group should analyse all the available fish by-catch data and report progress to the next meeting of WG-FSA.

5.12 An alternative and useful way of addressing the problem of fish by-catches in the krill fishery is to look at the distribution of juvenile fish directly. New information on juvenile fish distribution was presented in WG-FSA-96/58 and 96/60.

Ecological Interactions

5.13 A number of papers tabled at this meeting addressed ecological interactions between the fisheries and various by-catch species.

5.14 WG-FSA-96/8 described the distribution of South Georgia albatrosses and their interactions with fisheries. While much of the material in this paper is more directly related to incidental mortality, which is discussed under Agenda Item 7 (see paragraph 7.70), there was new information on foraging grounds and migration routes from band recoveries and satellite tracking. Interactions of seabirds, seals and whales with the squid *M. hyadesi*, for which there is a proposal to initiate a new fishery (see paragraphs 4.8 to 4.14), are discussed in WG-FSA-96/20.

5.15 WG-FSA-96/11 and 96/36 reported information on by-catches from longline fishing around Kerguelen (Division 58.5.1). In WG-FSA-96/11, it was found that the by-catch was low during longline fishing directed at toothfish in 1994/95 and 1995/96 at around 500 m depth. This indicated that longlining is a highly target-specific method of fishing in the toothfish fishery, at least at these depths. However, experimental longline fishing carried out around Kerguelen over a wider range of depths (300 – 1 700 m) in 1996 (WG-FSA-96/36) produced a by-catch of 10 species of fish, of which the numerically dominant species were grenadier and two species of skates. Two species of large sharks were also taken (sleeper shark (*Somniosus microcephalus*) and porbeagle shark (*Lamna nasus*)).

5.16 The Working Group agreed that both rays and large sharks are likely to be more vulnerable to overfishing than the target species for the longline fishery (*D. eleginoides*). Close attention should be paid to by-catches of potentially vulnerable species. Dr de la Mare noted that sleeper sharks had also been taken and released alive in the trawl fishery for *D. eleginoides* around Macquarie Island.

5.17 The Working Group noted that observers already record the biomass of by-catches by species in *D. eleginoides* fisheries. However, it is not always clear whether these by-catches are actually discarded or whether some are retained. As some potential by-catch species are commercially valuable, it was important that records be kept of whether or not by-catches are retained. The observation forms need to be amended to allow this information to be recorded.

5.18 The other primary ecological interactions with the longline fishery involve marine mammals. Two types of interactions occur: fish on longlines can be damaged or removed by marine mammals, and marine mammals can be injured or killed through entanglement in the fishing gear.

5.19 WG-FSA-96/12 discussed the impact of marine mammals on the longline fishery for *D. eleginoides* around Kerguelen in 1995/96. The main impact is due to fur seals, which damage or remove fish directly from the longlines. There were no observations of fur seals being tangled in the longline gear. Sperm whales have been observed in the vicinity of longlines and may be taking fish from the lines.

5.20 The presence of sperm whales, killer whales and fur seals in the vicinity of a Chilean longliner has also been reported in Subarea 48.3 in 1996 (WG-FSA-96/22). Fish loss due to sperm whales was estimated to be low, but fish loss due to killer whales was considerable, with commonly only a few fish being left on the line. Sperm whales became entangled in the line, which subsequently broke.

5.21 WG-FSA-96/52 also reported observations of sperm whales, killer whales, Antarctic fur seals and southern sea elephants in the vicinity of a Russian longliner operating in Subarea 48.3 in 1996. Killer whales, a sperm whale and southern sea elephants were observed to take fish from the longline, with killer whales being the most active. In nine longlines, all or part of the catch was reportedly eaten by killer whales (at least 380 fish). One sperm whale was observed to have been entangled in the main line. The longline was lost when attempts were made to release the whale. Dr Everson advised that there have also been reports of interactions between cetaceans (sperm whales and killer whales) and longline fishing operations around South Georgia.

5.22 The Working Group agreed that interactions between marine mammals and longline fishing operations were a continuing problem for which there is no obvious solution. It is apparent that in some cases, the number of fish taken by marine mammals can be substantial. If so, it may become necessary to take these into account during assessments, as they are not currently counted amongst landings. It was noted that observers are required to make quantitative estimates of the number of fish taken by marine mammals, but it was recognised that this is often very difficult. The other most frequent type of interaction occurred when sperm whales became entangled in longlines.

5.23 WG-EMM-96/31 reported that, on the basis of studies over six years, mainly coastal fish species are found in the diet of blue-eyed shags. *Notothenia coriiceps* and *Harpagifer antarcticus*, the most abundant inshore fish species, formed the bulk of the diet, while *N. rossii* and *G. gibberifrons* comprised a low proportion with no apparent trend over the years. These studies will continue into the future and it may be possible to monitor the abundance of these species using such dietary data. The Working Group looked forward to seeing future analyses of these data.

RESEARCH SURVEYS

Simulation Studies

6.1 At its 1995 meeting, WG-FSA endorsed the use of simulation studies to tackle specific survey design questions and identified a number of other fields in which simulation studies may be applied (SC-CAMLR-XIV, Annex 5, paragraphs 7.1 and 7.2).

6.2 The Working Group noted that little progress has been made, although the Working Group did note that simulations of the properties of sampling methods, such as those described in WG-FSA-96/56, are likely to be useful in evaluating the efficacy of such methods.

6.3 In the light of the above, WG-FSA concluded that in future it will consider developments in various simulation approaches under its deliberations on developments in assessment methods (e.g. under Agenda Item 3).

6.4 WG-FSA-96/56 outlines an approach to obtain representative samples of fish from commercial longline catches (see also paragraph 6.2). The Working Group welcomed this approach and encouraged the authors to develop the scheme so as to provide a working protocol for incorporation into the *Scientific Observers Manual*.

Recent and Proposed Surveys

6.5 Details of recent fish surveys have been addressed where appropriate during other WG-FSA deliberations (see paragraphs 3.20 to 3.22 especially). However, the Working Group noted various matters associated with specific surveys.

6.6 Such matters included:

(i) the termination of the UK survey in Subarea 48.3 during September 1996 for operational reasons;

(ii) the successful completion of a joint Japanese/French deepwater survey in Division 58.5.1 (including the lodging of haul-by-haul data in the CCAMLR database); and

(iii) a survey by Spanish scientists participating in a German cruise on board *Polarstern* (January to March 1996) in Subarea 48.5 (Weddell Sea – Cape Norvegica to Halley Bay areas).

6.7 Dr Gasiukov drew WG-FSA's attention to the results of a recent Russian survey to estimate fish biomass in Subarea 48.3 using both acoustics and trawling during January and February 1996 (WG-FSA-96/59). Further discussions of these results are given in paragraphs 4.129 to 4.135.

6.8 In respect of future surveys, the following developments were noted.

6.9 As part of its AMLR program, Dr Holt indicated that the US is intending to commence fish surveys in Subarea 48.1 (in the vicinity of Elephant Island) from 1997. Such surveys will be undertaken regularly thereafter and the US indicated that it welcomed input from other Members with expertise in fish survey work as well as advice from WG-FSA on aspects of survey design. The Working Group welcomed this development, particularly since the current status of fish stocks in Subarea 48.1 is uncertain and fishing in the area has been closed under Conservation Measure 72/XII.

6.10 Dr Gubanov indicated that Ukraine, while still interested, has not yet been able to undertake a survey of *L. squamifrons* at Lena and Ob Banks (Division 58.4.4) subject to the provisions of Conservation Measure 87/XIII. Further advice on the proposal is given in paragraph 4.196.

6.11 WG-FSA noted with appreciation France's impending survey of *C. gunnari* in Division 58.5.1 during February 1997. Prof. Duhamel's offer to submit the data from this survey to the Working Group's next meeting was welcomed.

6.12 Dr K.-H. Kock (Chairman, Scientific Committee) informed the Working Group that Germany will be undertaking a demersal fish survey of the Elephant Island area (Subarea 48.1) during November/December 1996 on board the *Polarstern*. Results from this survey will be submitted to the 1997 meeting of WG-FSA.

6.13 Lic. Marschoff informed the Working Group that a fish survey will be undertaken on board *Dr Eduardo L. Holmberg* in Subarea 48.3 in the first quarter of 1997. Results of the survey will be submitted to the next meeting of WG-FSA.

INCIDENTAL MORTALITY ARISING FROM LONGLINE FISHING

Intersessional Work

7.1 The program of intersessional work, developed at the end of last year's meeting (WG-FSA-96/32 appendix), was conducted by the Secretariat as described in WG-FSA-96/32.

7.2 Dr Sabourenkov reported that all reports and relevant information from last year's meeting had been circulated to the members of the ad hoc Working Group on Incidental Mortality Arising from Longline Fishing (WG-IMALF) and to other organisations as instructed. He requested that members of WG-IMALF suggest changes to the membership as appropriate. It was recollected that two additional members, J. Molloy and J. Dalziell (New Zealand) had been suggested informally last year. Mr N. Klaer and Dr G. Tuck (Australia) and Dr Kock were recommended as additional members of WG-IMALF.

7.3 The Working Group noted that despite the efforts of the Secretariat to exchange information with a range of international organisations (see SC-CAMLR-XIV, Annex 5, paragraph 8.5), CCAMLR had still received very few positive or informative responses from these organisations (see also SC-CAMLR-XIV, paragraph 3.27).

7.4 Australia, France, New Zealand and the UK had responsed to the request of the Scientific Committee (SC-CAMLR-XIV, paragraph 3.28(i)) for information on steps taken or planned by Members in addressing the topic of incidental mortality of seabirds associated with fisheries, especially longline fishing, in waters under their jurisdiction adjacent to the Convention Area and in other regions where seabirds from the Convention Area might be affected. These responses are discussed in paragraphs 7.56 to 7.65 below.

7.5 The book *Fish the Sea Not the Sky*, aimed at reducing incidental mortality of seabirds and improving efficiency of demersal longline fisheries, was produced during the year (WG-FSA-96/32, paragraphs 9 to 12). The Working Group congratulated the Secretariat and especially the Science Officer on this achievement. It also thanked Mr N. Brothers (Tasmanian Parks and Wildlife, Australia) for his initial work on the project and all those who helped in the final production, especially Mr G. Robertson and other staff at the Australian Antarctic Division. The generosity of Australia in providing additional funds to ensure production in all Commission languages was particularly appreciated.

7.6 It was agreed that well-targeted distribution of this book was very important; the following were seen as priority recipients:

(i) all vessels conducting demersal longlining in the Convention Area;

(ii) all vessels conducting demersal longlining in areas adjacent to the Convention Area;

(iii) the managers of fishing companies operating vessels conducting demersal longlining in either the Convention Area or areas adjacent to it; and

(iv) all CCAMLR scientific observers on board demersal longlining vessels.

7.7 It was envisaged that, as these recipients would need to be identified in the first instance by CCAMLR Members, distribution of these copies would be undertaken by the Members. In undertaking this distribution, Members were asked to take all appropriate steps to encourage a positive attitude amongst fishermen towards modifying their fishing practices in the manner detailed in the book. It was also recommended that the Secretariat provide copies of the book to other international fisheries forums with priority being given to those regulating longlining.

7.8 The Working Group agreed that the message contained in the book *Fish the Sea Not the Sky* was clear and succinct. It advised the Scientific Committee to investigate producing a flyer, poster and/or sticker which could be used to reach a wider audience than the book alone.

7.9 WG-FSA also agreed that the evaluation of the effectiveness of the book should be an integral part of efforts to educate fishermen. Accordingly, it was requested that Members advise the Secretariat of the addresses of recipients.

7.10 Additionally, it was agreed that observers should be asked to comment on whether the book was present on the vessels on which they are deployed, how effective it was in influencing fishing activities and any suggestions for improvements.

7.11 The proposed seabird identification manual (SC-CAMLR-XIV, paragraph 3.28(iii)) had been described in a formal submission by New Zealand to CCAMLR (CCAMLR-XV/13).

7.12 The Working Group endorsed the scope and projected content of the manual and noted that New Zealand was well placed to undertake the task in terms of expert authors and artist. However, the Working Group expressed concern that: (i) the support being sought from CCAMLR (A$24 000) was at a level where it would compete directly with the very highest of CCAMLR's own priorities; and (ii) the proposal did not include provision for editions in languages other than English.

7.13 The Working Group suggested that the Scientific Committee might advise that while the proposal could not at present be amongst the high priorities of the Scientific Committee itself, it could be a very important initiative for the Commission, particularly if, for instance, support for production in French, Spanish and Russian could be achieved without displacing any higher-priority CCAMLR objectives. The Working Group suggested that funding for the basic production might readily be raised via international conservation agencies and/or commercial sponsorship.

7.14 Proposals for banding and genetic studies to help determine the origin of birds caught in longlines (SC-CAMLR-XIV, paragraph 3.28(v) and Annex 5, paragraph 8.34) had been referred to SCAR for advice. The report of the CCAMLR Observer to SCAR (SC-CAMLR-XV/BG/12) indicated that SCAR advised that:

(i) its previous experience in trying to develop and coordinate multinational banding programs (for giant petrels) suggested that it was preferable for those Members currently banding albatrosses to undertake an appropriately intensive banding project by mutual agreement; and

(ii) appropriate genetic studies offered great promise but would require expert advice and facilities and fairly substantial funding. SCAR had referred this request to its newly formed Subcommittee on Evolutionary Biology of Antarctic Organisms (meeting in Brazil in 1997) for specialist advice.

7.15 Following the renewed request (SC-CAMLR-XIV, paragraph 3.28(vi)) for information on existing and proposed monitoring of albatrosses, giant petrels and white-chinned petrels, responses (additional to those from the UK in SC-CAMLR-XIV, Annex 5, paragraph 8.31 and New Zealand in SC-CAMLR-XIV, paragraph 3.44) had been received from South Africa (indicating extension of existing programs on albatrosses at Marion Island for a further five years) and New Zealand.

7.16 Dr M.J. Imber (New Zealand) had indicated in correspondence that relevant work was in various stages of progress in New Zealand on 11 albatross taxa, northern giant petrel and two *Procellaria* petrel species. Work on white-chinned petrels, however, was a low priority in New Zealand because of the apparent rarity of these species in fishery by-catch in the region.

7.17 The Working Group welcomed the reports on these studies. It noted that information had yet to be received on relevant monitoring programs being undertaken by French scientists at Kerguelen and Crozet Islands and by Australian scientists at Macquarie.

7.18 In this context Mr I. Hay (Australia) noted that:

(i) Dr Robertson is about to undertake observations in the toothfish longline fishery conducted around the Falklands/Malvinas Islands, including monitoring the relative effectiveness of different types of bird lines and other incidental mortality mitigation measures;

(ii) censusing and monitoring studies, coordinated by Dr R. Gales (Australia) of wandering albatross, black-browed albatross, grey-headed albatross, light-mantled sooty albatross and southern and northern giant petrels is continuing at Macquarie Island. The studies, which also examine the breeding success of the populations, are expected to continue until 2001; and

(iii) opportunistic monitoring of albatross and petrel populations at Heard Island is expected to be conducted this austral summer during a three-day visit.

7.19 The Scientific Observer Logbook for longline fisheries was developed, published and circulated by the Secretariat during the year (WG-FSA-96/32, paragraphs 15 to 16). Further discussion of logbooks and their use by observers appears in paragraphs 3.10 to 3.19.

7.20 In response to the Scientific Committee's recommendation concerning the collection of specimens from seabirds killed on longlines (SC-CAMLR-XIV, paragraph 3.32(i)), the logbook forms now contain an entry indicating the place of deposition and the scientists responsible for this material. The request to Members to notify CCAMLR of the identity of birds killed and the number of specimens taken was reiterated.

7.21 No responses had been received to the request for research into ways of reducing the by-catch of white-chinned petrels at night (SC-CAMLR-XIV, paragraph 3.32(ii)).

7.22 Responses to the request for information on the use and effectiveness of longline systems for releasing baited lines underwater (SC-CAMLR-XIV, paragraph 3.46) had been received from New Zealand, Norway and the USA.

7.23 In correspondence, Dr Imber reported that two contracts funded by Conservation Services Levies (CSL) were concluded during the 1995/96 fishing year to develop underwater setting devices suitable for use on domestic pelagic longline vessels. The contractors are required to produce a working prototype and a report describing the device. The two contractors have used different approaches in developing the underwater setting devices. One has constructed a slotted chute to 3 m under the surface, down which the baited hook and snood is fed, while the other has built a mechanism which shoots a capsule containing the baited hook up to 10 m underwater – the capsule (which is attached to a cable) springs open upon reaching maximum depth, ejecting the bait; the capsule is then recovered and reloaded. Preliminary sea trials have been undertaken on both devices, and they are now in the final stages of refinement. If either or both of the devices are considered to be worth further investment, an experimental program to test their effectiveness in reducing seabird by-catch will be undertaken during the 1996/97 fishing year. The Working Group commended this work and looked forward to receiving reports on the use of the devices.

7.24 In WG-FSA-96/6, Dr S. Løkkeborg (Norway) described tests in the North Atlantic of a system (produced by Mustad) of setting lines through a funnel that guided the baited line beneath the sea surface. Seabird by-catch was significantly reduced using this method although it was slightly less effective than using conventional line setting with streamer lines to scare birds away. The lower efficiency of the underwater setting system in this comparison was probably due to the length of the funnel being insufficient to counteract propeller wake and turbulence which tended to bring the bait to the surface. Mustad has indicated to the Secretariat that it hopes to introduce modifications to improve performance. The Working Group commended the study and encouraged further trials using improved funnels. It was noted, however, that this system is only feasible for deployment of autoline systems and is not suitable for the Spanish method.

7.25 Dr Watters reported that the *American Champion* attempted use of a device for setting underwater, but this was discontinued after approximately one week due to line tangling problems.

Reports on Incidental Mortality of Seabirds during Longline Fishing

Data from the Convention Area

Observations for 1995

7.26 The plan of intersessional work had provided for further validation and analysis of the 1995 data (see WG-FSA-96/32, appendix and 96/26). However, because the Scientific Observer Data Analyst was not appointed until mid-May and the priority was to develop the scientific observer database (as described briefly in WG-FSA-96/25) and to enter and analyse 1996 data, there had been insufficient time to undertake any re-analysis of 1995 data. Given the amount of 1996 data that would need intersessional analysis, it was unlikely that further work on the 1995 data would be performed in the coming year. However, it was noted that some re-analysis of 1995 data had taken place in revising WG-FSA-95/42 for publication in *CCAMLR Science*.

Observations for 1996

Data Submission

7.27 The Scientific Observer Logbook for longline fisheries was published and distributed by the Secretariat in January 1996. Three completed logbooks from the *D. eleginoides* fishery in Subarea 48.3 were received in time to complete data entry before this meeting. A total of 16 cruises were carried out during 1995/96 in this area, and all were observed. Additional observer cruise data were received by the Secretariat for the remaining cruises just prior to this meeting, but due to the time required for data entry, these data are not currently available in computerised form (see Table 25 for a summary of data submitted to date).

Table 25: Summary of observer data received by the Secretariat for the longline *D. eleginoides* fishery in Subarea 48.3 for the 1995/96 period.

Vessel	Designating State	End of fishing in CCAMLR Area	Received	Entered	Data Type
Antarctic III	Chile	8/3/96	27/9/96	Logbook	logbook, cruise report
Vieirasa Doce	Chile	25/3/96	27/9/96	Logbook	logbook, cruise report, C2
Aquatic Pioneer	Chile	9/3/96	27/9/96		cruise report, C2
Ercilla	Argentina	22/6/96	7/10/96		cruise reports, C2, biological
Faro de Hercules	Argentina	12/5/96	7/10/96		cruise reports, C2, biological
Friosur III	Argentina	30/6/96	7/10/96		cruise report, set information, biological information
Isla Camilla	Argentina	24/6/96	7/10/96		cruise reports, C2, set information, biological information
Isla Sofia	Argentina	22/7/96	7/10/96		cruise report, C2
Maria Tamara	Argentina	13/3/96	7/10/96		cruise report
Antonio Lorenzo	Argentina	18/3/96	7/10/96		cruise report
Magallanes III	Argentina	24/5/96	7/10/96		cruise reports, C2, set information, biological information
Mar del Sur I	Argentina	19/6/96	7/10/96		cruise reports, C2, set information, biological information
Puerto Ballena	Germany	11/5/96	19/8/96	Logbook	logbook, cruise report
Ihn Sung 66	Russia	1/7/96	10/9/96		cruise report
Itkul	Ukraine	17/7/96	7/10/96		cruise report
American Champion	Chile	11/4/96	27/9/96		cruise report, C2

7.28 The data submitted by the Argentinian observers were in several different formats, most of which are not used by CCAMLR. This makes data entry difficult, as the data need to be reorganised in such a way that they are compatible with the current database. It is estimated that it will take at least a further three months to have all of the 1995/96 observer data entered into the database and verified. This time could have been reduced if the data had been submitted using the Scientific

Observer Logbook format. Lic. Marschoff advised that he would investigate this and report back to the Working Group.

7.29 The Working Group commended the three observers who had submitted logbooks in timely fashion and particularly J. Selling (Germany) who provided much additional information enabling valuable supplementary observer reports (WG-FSA-96/22 and 96/31) to be submitted.

7.30 The Working Group expressed concern in respect of the other observer material, noting that:

(i) most reports had arrived much too late for analysis;
(ii) many reports were not in the specified formats; and
(iii) there were considerable potential uncertainties concerning the validity/accuracy of some of the data.

7.31 The Working Group noted that because of this it had been largely unable to evaluate much of the data required for the proper management of the *D. eleginoides* fishery in Subarea 48.3, in respect of its interactions with seabirds.

Demersal Longline Seabird By-catch and By-catch Rates in Subarea 48.3 during 1995/96 – Preliminary Results

7.32 Further details relating to the four sets of observer data used in the main analysis are summarised in Table 26.

7.33 WG-FSA-96/26 provides an analysis of mean seabird catch rates from 4 of 16 vessels known to have fished for *D. eleginoides* in Subarea 48.3 in the 1995/96 fishing period. Both vessel logbooks and observer cruise reports are required to carry out analyses of seabird by-catch rates. Further relevant data have been submitted to the Secretariat, but will not become available until data entry has been completed. The results presented here are to be treated with caution due to the small sample sizes, and should also be regarded as preliminary until all relevant data have been analysed. No estimates of the variance of mean values have been calculated, although methods of doing so are available (e.g. WG-FSA-96/66). To allow comparison of estimates among years or other strata, estimates of variance are required. The implementation of suitable methods for such calculations will be pursued intersessionally.

Table 26: Summary of observation programs on longline fisheries conducted in the 1995/96 season, in accordance with Conservation Measure 80/XIII, by observers designated under the CCAMLR Scheme of International Scientific Observation.

Flag State	Vessel	Fishing Method	Observer	Subarea/ Fishery	Streamer Line	Period of Observation	Report	Data Reported
Chile	*Puerto Ballena*	LLS Spanish	Germany: J. Selling	48.3 *D. eleginoides*	Own design	22/2 - 17/5/96	Observer Cruise Log	Cruise, vessel, catch and IMALF details
Republic of Korea	*Ihn Sung 66*	LLS Spanish	Russia: A. Kozlov	48.3 *D. eleginoides*	CCAMLR and own design	26/2 - 27/7/96	Observer Cruise Report	Cruise, catch and IMALF details
Argentina	*Antarctic III*	LLS Auto	Chile: J. Soto	48.3 *D. eleginoides*	Own design	2/3 - 8/3/96	Observer Cruise Log	Cruise, vessel, catch and IMALF details
Argentina	*Vieirasa Doce*	LLS Spanish	Chile: V. Briones	48.3 *D. eleginoides*	CCAMLR design	5/3 - 25/3/96	Observer Cruise Log	Cruise, and vessel details

Table 27: Observed seabird catches.

Vessel	Obs C2	Obs Log	Obs Hooks	Total Hooks	% N sets	Observed Birds Caught								
						Dead			Alive			Total		
						Night	Day	Total	Night	Day	Total	Night	Day	Total
Antarctic III	Yes	Yes	52.9	73.9	89	2	0	2	0	0	0	2	0	2
Vieirasa Doce	Yes	Yes	204.2	204.2	81			[42]						
Aquatic Pioneer	No	No		23.8										
Ercilla	Yes	No		544.8										
Faro de Hercules	Yes	No		706.5										
Friosur III	Yes	No		1115.5										
Isla Camilla	Yes	No		1114.6										
Isla Sofia	Yes	No		369.0										
Maria Tamara	No	No		11.3										
Antonio Lorenzo	No	No		40.0										
Magallanes III	Yes	No		537.8										
Mar del Sur I	Yes	No		1014.0										
Puerto Ballena	Yes	Yes	233.3	906.4	53	29	111	140	17	10	27	46	121	167
Ihn Sung 66	Yes	No	512.6	1459.1	53	1	7	8	24	15	39	25	22	47
Itkul	No	No		646.3										
American Champion	Yes	No		754.8										
Total			1003.0	9521.9	61	32	118	150	41	25	66	73	143	216

Note: % N sets indicates the proportion of observed sets made at night (between nautical twilights)

7.34 A summary of the data for observed seabird by-catch is given in Table 27. Only 3 cruises of the 16 provide sufficient information for the calculation of mean catches and catch rates. One cruise (*Vieirasa Doce*) provides information on total seabird catches without an indication of whether the catches were made at night or during the day, so those data have been excluded from further examination. For the purposes of this examination, vessels without observer data at this stage will be referred to as 'unobserved'.

7.35 Catch and release of live seabirds appears to be common in this fishery, with 66 of 216 observed seabird captures (31%) resulting in a live release. There is no information presently available on the fate of seabirds released alive, but an unknown proportion of them would probably die. This, in combination with an unknown number of birds which were hooked and killed but lost from the line prior to hauling (an estimate of 27% for tuna longline fisheries is given in WG-IMALF-94/6) suggests that reported numbers of dead birds significantly underestimates the total kill due to fishing activities.

7.36 Conversion of catches of birds given in Table 27 to observed by-catch rates is given in Table 28. For the three cruises examined, catch rates show considerable variability among vessels. This suggests that any measure of variance which may be calculated for the mean values would be high. As also shown in WG-FSA-96/26, mean catch rates of birds not released alive during the day were approximately six times higher than night catch rates. For birds released alive there is little difference between night and day catch rates. Given the small sample size, however, no conclusion should be made on this observation at this time.

7.37 The mean percentage of observed sets carried out at night was 61%. This contravenes Conservation Measure 29/XIV, paragraph 2, which states that longlines shall be set at night. As the catch rate for killed birds has been observed to be much higher during the day, a considerable proportion of the seabird mortality would have been avoided if this conservation measure was followed.

7.38 Estimates of total by-catch of seabirds by all vessels are given in Table 29. Estimates were derived by assuming that the proportion of night sets for vessels without data at this stage was the same as the observed mean. Mean catch rates for all observed vessels given in Table 26 were then used to construct an estimate of the total seabird catch for unobserved vessels.

7.39 Also given in Table 29 are total seabird catches recorded on C2 data forms. There appears to be large discrepancies between these records for observed vessels, indicating misrecording of either observer or vessel records. For the *Ihn Sung 66*, 53% of sets were observed, and 47 seabirds were observed caught for these sets. The C2 vessel statistics for all sets record a total of

41 seabirds caught. For the *Puerto Ballena*, 69% of sets were observed, and 167 seabirds were observed caught for these sets with 140 of these killed. The C2 vessel statistics for all sets record a total of 131 seabirds killed, and no statistics were given for those released alive. Such discrepancies clearly require further investigation.

7.40 Table 29 indicates that all 16 vessels in the *D. eleginoides* fishery in Subarea 48.3 during 1995/96 caught in the order of 2 300 seabirds, of which 1 618 were dead and 682 were released alive. It was expressly noted, however, that these estimates are extrapolated from just 3 (of 16) datasets which may not be fully representative of the overall picture; revised estimates will be provided as soon as intersessional analysis of the remaining data is complete. Nevertheless, the present estimates are the best that can be made with the available data.

7.41 To estimate numbers caught by species, an estimate of the species composition of the catch for the fishery is required. Two sources of this information were investigated: observed catch composition, and vessel-reported C2 catch composition. Composition of observed catch is given in Table 30, and vessel C2 catch composition is given in Table 31. Only five species were reported by observers, compared with nine in the vessel C2 reports. Observed captures gave a total sample size of 169, while the vessel C2 sample size was 787. While there may be reason to give greater weight to observed records due to discrepancies already outlined, the larger sample of the vessel C2 records has been selected for use in this case. As an estimate of percentage catch composition is required, under- or over-reporting is not an issue. Of importance is that the sample is random in relation to the total catch, and that the sampled birds are correctly identified. The accuracy of identification by observers and persons completing vessel details should be investigated.

7.42 Estimates of percentage catch composition by identified species were constructed in Table 31 by proportional distribution of catch identified as ‘birds’ to albatrosses, petrels and shearwaters, and Antarctic terns. Then, catches given as just ‘albatrosses’ or ‘petrels and shearwaters’ were proportionately distributed over individual species within those groups. This resulted in estimates of total catch by identified species, and the percentage species composition given in the table. Estimates of total catch by species for the fishery were then made by multiplying the species composition proportions by the estimated total fishery seabird catch given in Table 29. Results in Table 31 indicate that of the birds captured, 1 498 were albatrosses and 747 were petrels. Of these, it was estimated that 1 055 albatrosses and 527 petrels were killed. Note that these are also extrapolated estimates (see paragraph 7.40).

Table 28: Observed seabird catch rates.

Vessel	Obs C2	Obs Log	Obs Hooks	Total Hooks	% N sets	Observed Catch Rates								
						Dead			Alive			Total		
						Night	Day	Total	Night	Day	Total	Night	Day	Total
Antarctic III	Yes	Yes	52.9	73.9	89	0.042	0.000	0.038	0.000	0.000	0.000	0.042	0.000	0.038
Vieirasa Doce	Yes	Yes	204.2	204.2	81									
Aquatic Pioneer	No	No		23.8										
Ercilla	Yes	No		544.8										
Faro de Hercules	Yes	No		706.5										
Friosur III	Yes	No		1115.5										
Isla Camilla	Yes	No		1114.6										
Isla Sofia	Yes	No		369.0										
Maria Tamara	No	No		11.3										
Antonio Lorenzo	No	No		40.0										
Magallanes III	Yes	No		537.8										
Mar del Sur I	Yes	No		1014.0										
Puerto Ballena	Yes	Yes	233.3	906.4	53	0.235	1.012	0.600	0.137	0.091	0.116	0.372	1.104	0.716
Ihn Sung 66	Yes	No	512.6	1459.1	53	0.004	0.029	0.016	0.088	0.062	0.076	0.092	0.091	0.092
Itkul	No	No		646.3										
American Champion	Yes	No		754.8										
Total						0.053	0.299	0.150	0.067	0.063	0.066	0.120	0.362	0.215

Table 29: Estimated total seabird catch.

Vessel	Obs Hooks	Total Hooks	% N sets	Estimated Total Birds Caught									Totals from C2 Forms		
				Dead			Alive			Total			Dead	Alive	Total
				Night	Day	Total	Night	Day	Total	Night	Day	Total			
Antarctic III	52.9	73.9	89	2.79	0.00	2.79	0.00	0.00	0.00	2.79	0.00	2.79	4	0	4
Vieirasa Doce	204.2	204.2	81	8.71	11.58	20.29	11.16	2.45	13.61	19.87	14.04	33.90	41	0	41
Aquatic Pioneer		23.8	61	0.76	2.79	3.55	0.97	0.59	1.56	1.73	3.39	5.11			
Ercilla		544.8	61	17.38	64.09	81.48	22.27	13.58	35.85	39.65	77.67	117.32			
Faro de Hercules		706.5	61	22.54	83.12	105.66	28.88	17.61	46.49	51.42	100.73	152.15	132	33	165
Friosur III		1115.5	61	35.59	131.23	166.82	45.60	27.80	73.40	81.19	159.04	240.23	48	6	54
Isla Camilla		1114.6	61	35.56	131.12	166.68	45.56	27.78	73.34	81.12	158.91	240.02	35	3	38
Isla Sofia		369.0	61	11.77	43.41	55.18	15.08	9.20	24.28	26.86	52.61	79.47			
Maria Tamara		11.3	61	0.36	1.32	1.68	0.46	0.28	0.74	0.82	1.60	2.42			
Antonio Lorenzo		40.0	61	1.28	4.71	5.98	1.64	1.00	2.63	2.91	5.70	8.61			
Magallanes III		537.8	61	17.16	63.28	80.43	21.99	13.41	35.39	39.14	76.68	115.83			
Mar del Sur I		1014.0	61	32.35	119.30	151.65	41.45	25.27	66.73	73.80	144.57	218.37	197	3	200
Puerto Ballena	233.3	906.4	53	112.67	431.25	543.92	66.05	38.85	104.90	178.72	470.10	648.82	131	0	131
Ihn Sung 66	512.6	1459.1	53	2.85	19.93	22.77	68.32	42.70	111.01	71.16	62.62	133.78	8	33	41
Itkul		646.3	61	20.62	76.04	96.66	26.42	16.11	42.53	47.04	92.14	139.18			
American Champion		754.8	61	24.08	88.80	112.88	30.85	18.81	49.67	54.94	107.61	162.55	113	0	113
Total	1003.0	9521.9	61	346.47	1271.97	1618.44	426.69	255.45	682.13	773.15	1527.42	2300.57	709	78	787

Note: shaded regions indicate extrapolated estimates (derived as indicated in paragraph 7.40).

Table 30: Species catch summaries from observer logbooks and cruise reports.

Species	Code	Dead			Alive			Total		
		Night	Day	Total	Night	Day	Total	Night	Day	Total
Grey-headed albatross	DIC	0	3	3	0	0	0	0	3	3
Black-browed albatross	DIM	7	93	100	9	11	20	16	104	120
Wandering albatross	DIX	0	0	0	0	1	1	0	1	1
Southern giant petrel	MAG	0	0	0	0	5	5	0	5	5
White-chinned petrel	PRO	3	36	39	0	1	1	3	37	40
Total		10	132	142	9	18	27	19	150	169

Table 31: Species catch summary from C2 forms and estimated total catch proportions.

Species	Code	Dead				Alive				Total			
		Recorded	Est	%	Total	Recorded	Est	%	Total	Recorded	Est	%	Total
Birds	BIZ	2				0				2			
Albatrosses	ALZ	89				1				90			
Grey-headed albatross	DIC	19	23.61	3.33	53.90	0	0.00	0.00	0.00	19	23.12	2.94	67.59
Black-browed albatross	DIM	310	385.25	54.34	879.42	45	45.92	58.87	401.57	355	431.99	54.89	1262.80
Royal albatross	DIP	1	1.24	0.18	2.84	0	0.00	0.00	0.00	1	1.22	0.15	3.56
Wandering albatross	DIX	35	43.50	6.13	99.29	4	4.08	5.23	35.70	39	47.46	6.03	138.73
Sooty albatross	PHU	7	8.70	1.23	19.86	0	0.00	0.00	0.00	7	8.52	1.08	24.90
Identified albatrosses		372				49				421			
All albatrosses		461	462.30	65.21	1055.30	50	50.00	64.10	437.27	511	512.30	65.10	1497.57
Petrels and shearwaters	PTZ	119				3				122			
Southern giant petrel	MAG	5	10.39	1.47	23.72	22	25.00	32.05	218.63	27	51.90	6.59	151.71
Northern giant petrel	MAH	2	4.16	0.59	9.49	0	0.00	0.00	0.00	2	3.84	0.49	11.24
White-chinned petrel	PRO	104	216.10	30.48	493.30	0	0.00	0.00	0.00	104	199.91	25.40	584.37
Identified petrels, shearwaters		111				22				133			
All petrels, shearwaters		230	230.65	32.53	526.51	25	25.00	32.05	218.63	255	255.65	32.48	747.32
Antarctic tern	STV	16	16.05	2.26	36.63	3	3.00	3.85	26.24	19	19.05	2.42	55.68
Total		709	708.99	100.00	1618.44	78	78.00	100.00	682.13	787	787.00	100.00	2300.57

Notes: Shaded regions indicate extrapolated estimates (derived as indicated in paragraph 7.42); Est indicates total recorded catch after redistribution to identified species; % is the estimated proportion of the recorded catch which applies to each species; Total is the estimated total catch of each species after multiplying percentage proportions by the total estimated seabird catches given in Table 27.

7.43 No estimates of the effectiveness of mitigation measures such as streamer lines, avoidance of offal discharge or underwater setting were made due to the very small sample sizes in the limited datasets available for analysis at the meeting. As more data become available, such analyses should certainly be carried out.

7.44 Some suggestions for future improvement of analyses of seabird catch and catch rates are as follows:

(i) areas of discrepancy in data supplied should be investigated and rectified;

(ii) an evaluation of the accuracy of species identifications carried out by observers and vessels should be made;

(iii) estimates of the variance of mean catch and catch rate estimates are required to allow cross-year and cross-strata statistical comparisons;

(iv) statistical analysis of the effectiveness of mitigation measures should be carried out as more data becomes available; and

(v) methods for stratification of the data for the calculation of seabird by-catch and by-catch rates should be given more thought in relation to time (seasonal effects, night setting), area (are there areas within the fishery where species abundance varies?), and vessel effects (bird lines, offal discharge, underwater setting, bait thawing, etc.).

7.45 Additional supplementary information from some of the observers' reports is extracted and summarised below.

7.46 The report (WG-FSA-96/31) of the observer on the *Puerto Ballena* includes data showing that:

(i) black-browed albatrosses are particularly susceptible to capture during the day with white-chinned petrels equally susceptible to capture during the day and night;

(ii) the behaviour and abundance of black-browed albatrosses is such as to dominate other seabirds for access to baits. Only white-chinned petrels, which can dive for baits, can readily operate outside the influence of black-browed albatrosses and therefore be commonly caught;

(iii) catch rates of both black-browed albatrosses and white-chinned petrels were substantially reduced after early May (presumably reflecting post-breeding migration/dispersal);

(iv) three-quarters of the birds observed as being caught were taken on 11 (10%) hauls. In at least three of these cases the longline was at an angle or perpendicular to wind/wave direction, which prevented the streamer line covering the area where the baited hooks entered the water;

(v) with three exceptions, all lines with considerable by-catch of birds were set during daylight; and

(vi) of 139 black-browed albatrosses handled, all of which were adults, 5 (4%) were banded at Bird Island. This proportion is much higher than the percentage of banded birds in the overall South Georgia black-browed albatross population (<0.1%). The status of the birds caught is consistent with the observed reduction in survival rates of adult black-browed albatrosses at Bird Island study colonies (SC-CAMLR-XV/BG/7).

7.47 The report (WG-FSA-96/40) of the observer on the *Ihn Sung 66* indicates that:

(i) 47% of sets were made in daylight hours (i.e. outside the times defined in Conservation Measure 29/XIV);

(ii) most of the birds caught were taken during the early part of the March–July fishing season; and

(iii) seven of the eight dead birds were subsequently identified in the Falkland/Malvinas Islands as six adult black-browed albatrosses and one adult wandering albatross (ringed at Bird Island).

7.48 The report (WG-FSA-96/52) of the observer on *Itkul* indicated that:

(i) relatively few birds were caught: 24 in total, comprising 20 white-chinned petrels, 3 black-browed albatrosses and 1 wandering albatross (ringed at Bird Island);

(ii) from late May onwards (to mid-June) no birds were caught, probably due to a reduction in the number of birds in the fishing area;

(iii) a number of difficulties (listed in detail) were experienced with the recording forms (these have largely been rectified in the revision of the logbook); and

(iv) agreements for payment of observers have not been honoured; the observer suggests that CCAMLR might be able to act as the fund holder for payment of observers.

7.49 A report by Ukrainian observers (WG-FSA-96/50) provides summary information on mitigation methods in use in Division 58.5.1 in 1995/96 which, except for the discharge of offal during the set (designed to distract birds), were consistent with Conservation Measure 29/XIV.

7.50 WG-FSA-96/47 is a preliminary report which indicates that only one bird was caught by the *American Champion* in 35 days of fishing near the Prince Edward Islands in August/September 1996. A more comprehensive report from this cruise will be submitted by South Africa in due course; although obtained from outside the Convention Area, the results will be of interest to CCAMLR because fishing was carried out close to the boundary of the Convention Area.

7.51 The Working Group made the following comments on the analyses undertaken and the reports received.

(i) It expressed concern that all logbook data so far analysed and all detailed observer reports received to date indicated failure to comply with the provisions of Conservation Measure 29/XIV, especially in respect of daytime setting, but also with respect to discharge of offal on the same side as the haul. There is a need to re-emphasise that both these practices lead to increased bird-bait or bird-fish interactions and inevitably reduce fishing efficiency. It is essential that vessels conform strictly to the provisions of Conservation Measure 29/XIV.

(ii) Daytime setting undoubtedly is the major contributor to the relatively high overall catch rates of birds reported in 1995/96.

(iii) The number of black-browed albatrosses being caught – and to a lesser extent that of wandering and grey-headed albatrosses and white-chinned petrels – is a matter of serious concern.

(iv) There is increasing evidence that after early May interactions with albatrosses, especially black-browed albatrosses, and white-chinned petrels decrease greatly.

7.52 The Working Group commended the Scientific Observer Data Analyst for his work in developing the database and undertaking initial data analysis. The Working Group noted that this work had greatly enhanced its ability to analyse data in an effective and comprehensive way. The small amount of analysis undertaken this year had been due simply to the absence or lateness of submitted data and its submission in inappropriate formats. Arising from this, there was a requirement for very substantial intersessional data analysis of information provided by scientific observers. The Working Group recommended that the Scientific Observer Data Analyst post should be funded throughout the intersessional period to enable this work to be undertaken as a matter of high priority.

Demersal Longline Seabird By-catch in Division 58.5.1

7.53 WG-FSA-96/10 reports on catch rates of seabirds around Kerguelen from 1993/94 to 1995/96 and the efficacy of mitigating measures in use. The longline system was a Mustad autoliner used both during the day and at night. Offal was discharged on the opposite side to the haul to attract birds away from setting/hauling operations; to scare birds away from the baited line during setting, a line as specified in Conservation Measure 29/XIV was used (this was used only during the day and in part of the 1995/96 season). A total of 529 birds (86% white-chinned petrels, 6% black-browed albatrosses, 5% grey-headed albatrosses, 2% wandering albatrosses) were caught during 291 sets (655 000 hooks) at a mean rate of 0.81 birds/1 000 hooks (with the maximum value for a single set of 10.4 birds/1 000 hooks when the streamer line became entangled with the fishing line). The number of birds caught varied significantly between years (very high in 1995/96) and month (high in October/November, low in December/January increasing to high levels from February to March). The number of birds caught at night was lower, but not significantly so, than during the day, although differences may be masked because white-chinned petrels (active both during the day and at night) formed the bulk of the seabird catch. The presence of offal produced significantly lower by-catch rates in two of the three years. However, in WG-FSA-96/10 the continuing use of offal to distract birds is not recommended because although it may confer a short-term advantage, in the longer term it probably attracts more birds to boats, thereby increasing both catch rates and bait loss. The streamer line design was not as effective as expected because of the relevant rapid adaptation to its presence by birds and the heavy sea conditions in the Kerguelen area which reduce its positive effects.

7.54 The Working Group thanked Mr D. Capdeville (France) for his thorough study which reinforced a number of important points which had been incorporated into the existing conservation measure. The Working Group endorsed the comments relating to offal discharge. It reiterated the need to continue to assess the effectiveness of the CCAMLR streamer line in further seasons.

Data from Outside the Convention Area

7.55 New Zealand, UK, Australia and France responded to requests for information relating to measures used to mitigate by-catch outside the Convention Area (see paragraph 7.4). Some of these responses also contained information on levels of seabird by-catch.

7.56 Dr Imber reported by correspondence that, regarding measures to mitigate by-catch in the New Zealand region in September 1993 the Fisheries (Commercial Fishing) Regulations 1986 Amendment 6 came into effect to standardise requirements for Japanese and domestic longliners. This requires all tuna longliners to deploy bird-scaring devices at all times, as a minimum standard. The CCAMLR streamer-line design was adopted. New Zealand fisheries legislation has been amended to provide funding for a range of projects designed to assess and mitigate impacts of domestic commercial fishing on protected species of marine wildlife. This allows the Crown to recover its costs from the Fishing Industry in respect of the provision of these conservation services (CSL). A project funded through CSL for the fishing year 1995/96 provided for the supply of an approved design for streamer lines to domestic fishermen (the intention was to supply all boats but a few were unavoidably missed) and advice on various methods for avoiding seabird by-catch. CSL also provided for the collection by fisheries observers of good statistical data on by-catch, processing and analysis of that data, recovery of seabird carcasses, some population monitoring, and the development of a population management plan for wandering albatrosses. In the 1995/96 fishing year only domestic fishermen operated in the tuna fishery in the New Zealand EEZ.

7.57 Dr Croxall summarised information received from the Fisheries Department of the Falkland Islands Government. Commercial longlining for *D. eleginoides*, commenced in 1994, is still regarded as being exploratory with no more than two vessels being licensed to fish at any given period. Although no legislation to mitigate seabird mortality has yet been introduced, license conditions are imposed to mitigate seabird mortality which require the use of CCAMLR-type measures, such as setting lines at night, the use of streamer lines, avoidance of dumping offal during hauling and setting operations and the use of heavily weighted lines. In addition, the company currently licensed to fish (Consolidated Fisheries Limited) and Australia funded the observation in 1995 by Mr Brothers resulting in WG-FSA-95/58, which reviewed the Spanish system of longlining from the perspective of mitigating seabird mortality. Incidental mortality of seabirds is recorded in the catch logbooks. In 1994 and 1995 the overall seabird catch rates were 3.07 birds per 4.58 million hooks (0.067 birds/1 000 hooks) and 1.39 birds per 2.75 million hooks (0.051 birds/1 000 hooks) respectively. Maximum rates reached 4.79 and 5.00 birds/1 000 hooks, but the problems that caused these (chiefly insufficient weighting of the line and too much tension during setting) have since been corrected. The species caught were predominantly black-browed albatrosses (87%), grey-headed albatrosses (7%) and white-chinned petrels (4%).

7.58 Australia tabled a suite of papers (WG-FSA-96/62 to 96/66) summarising various aspects of its recent work on interactions between longline fisheries and seabirds. Mr Hay reported that from November 1995 the use of streamer lines has been mandatory within the Australian Fishing Zone (AFZ) for all tuna longlines during setting operations when fishing south of 30°S.

7.59 WG-FSA-96/65 describes effort trends in the tuna longline fisheries of the Southern Ocean, and also factors that may affect catch rates. The paper focuses on the Japanese southern bluefin tuna fishery, historically the dominant and best-documented fishery south of 30°S. However, this fishery is not the only longline fleet operating in the Southern Ocean, and in 1992 it constituted only about 44% of the estimated tuna longline effort below 30°S. It is clear that seabird by-catch is a significant problem for the Japanese longline fishery and more data need to be collected and analysed to gain further insights into the problem. The paper's main conclusions are:

(i) there has been a recent reduction in Japanese effort (effort 1994 ~48% of 1986);

(ii) fishing occurs predominantly in quarters 2 and 3 (April–September);

(iii) the fishery has contracted and shifted areas of operation;

(iv) the use of mitigation devices by Japanese vessels has increased within the Australian and the New Zealand EEZs;

(v) the use of monofilament mainlines has increased with possible increases in seabird by-catch; and

(vi) there have been recent and large increases in effort by other fleets (especially Taiwan).

7.60 WG-FSA-96/64 presents summary tables of seabird by-catch observations on Australian tuna longline vessels. Its main findings are:

(i) no birds were caught in the Cairns area from 20 598 observed hooks (50 sets);

(ii) two birds were caught (1.09 birds/1 000 hooks) from 1 830 observed hooks (4 sets) off New South Wales; and

(iii) eight birds were caught (0.29 birds/1 000 hooks) from 27 682 observed hooks (27 sets) off Tasmania.

WG-FSA-96/63 provides more detailed information on the data from 12 observer cruises summarised in WG-FSA-96/64.

7.61 WG-FSA-96/62 summarises data available from five Real Time Monitoring Program (RTMP) observer cruises by Australian observers in 1995. There is little information on seabird by-catch on the high seas. Information from the high seas is important, due to differences in abundance, species composition by region and distance from land. The RTMP was set up in 1991 to provide timely and reliable information on catch and effort, verification and collection of additional data (e.g. biological samples). In 1995 it was agreed that information on ecologically-related species (including seabirds) should also be collected (e.g. data on by-catch, mitigation measures). The main findings and conclusions of the paper are:

(i) 182 sets were observed, 72% in the southeastern Indian Ocean, 28% off South Africa;

(ii) all observed vessels had streamer lines and these were used except for one set (3.9 birds/1 000 hooks for that set);

(iii) catch rates varied from 0 to 0.37 birds/1 000 hooks by cruise;

(iv) the catch rate on one vessel decreased dramatically after reconfiguration of the streamer line;

(v) there is a need for adequate observer coverage in order to obtain reliable estimates of by-catch rates (e.g. here only three vessels covered, variation within/among vessels); and

(vi) the presence of observers contributes to reducing by-catch.

7.62 WG-FSA-96/66 presents the methodological approach to, and results of, estimating total seabird catch and catch rates (with associated variances) by season and area. The methods are applied to observer data from the AFZ. Estimates of by-catch by species are also produced. Results suggest that the total seabird by-catch by Japanese longliners operating in Australian waters was 2 981 (CV 17%) in 1992, 3 590 (CV 15%) in 1993 and 2 817 (CV 19%) in 1994.

7.63 The Working Group welcomed these detailed and useful reports. It noted that the reports:

(i) confirmed that by-catch of albatross species breeding within the Convention Area (especially wandering albatross, black-browed albatross, grey-headed albatross) is prevalent in waters outside the Convention Area;

(ii) supported (and often provided greater detail based on the use of more data) the conclusions of CCAMLR with respect to mitigating methods (e.g. the efficacy of streamer lines in reducing by-catch); and

(iii) include details of methods (especially WG-FSA-96/66) that would be very applicable to the analysis of full sets of CCAMLR data (see also paragraph 7.51).

7.64 The Working Group also understood that Australian conservation agencies were conducting complementary research into aspects of seabird/longline fishery interactions and encouraged Australia to submit reports of this work to CCAMLR.

7.65 WG-FSA-96/9 reports the results of a joint investigation by French and Australian scientists relating population change in wandering and Amsterdam albatrosses at Crozet, Kerguelen and Amsterdam Islands to changes in the location and intensity of longline fishing (principally for southern bluefin tuna outside the Convention Area but also for *D. eleginoides* inside the Convention Area) in the Indian Ocean. The main conclusions of the paper are:

(i) that wandering albatross populations at Crozet and Kerguelen Islands have declined markedly, but have shown slow recovery since 1986;

(ii) the population of the endangered Amsterdam albatross appears to have similarly recovered since 1985, but remains close to extinction;

(iii) demographic study of the Crozet population indicates that the earlier decline was mainly the result of increased adult mortality, and secondarily of low recruitment;

(iv) satellite tracking studies of breeding birds and band recoveries of non-breeding birds indicate that during and outside the breeding season these populations are in contact with longline fisheries, mainly the pelagic Japanese southern bluefin tuna fishery and, to a lesser extent, the very limited *D. eleginoides* fishery operating on the Kerguelen shelf;

(v) decreased fishing effort and concentration outside the central Indian Ocean by the Japanese fishery during recent years has probably resulted in the slow recovery of these albatross populations as a result of improved adult survival and recruitment; and

(vi) longline fisheries still represent a major threat to great albatross populations, most of which are still declining in the Southern Ocean.

7.66 Information on tuna-seabird interactions of interest to CCAMLR is also presented in the report of the Ecologically Related Species (ERS) Working Group of the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). This report sets out the terms of reference of ERS and its response to a set of questions posed to it.

7.67 The Working Group was pleased to note the establishment of the ERS by CCSBT and:

(i) noted that the responses to many of the seabird-related questions were very consistent with the conclusions CCAMLR had reached at previous meetings in relation to the nature, magnitude and significance of interactions between seabirds and longline fisheries. That is, that significant declines have been observed for a number of albatross and other seabird populations; that significant levels of seabird by-catches are associated with longline fisheries; that the magnitude of the by-catch is sufficient to be the primary cause of the observed declines and that the population biology and demography of many albatross species suggests that the current by-catch levels are not sustainable;

(ii) noted that the references cited included many derived from research within the CCAMLR Convention Area;

(iii) recommended that CCAMLR should encourage the ERS Working Group, in the interests of promoting efficient fishing practice and reducing by-catch of seabirds (especially albatrosses), to consider moving rapidly to implement provisions, similar to those of CCAMLR, designed to reduce seabird mortality, especially in those regions adjacent to the Convention Area;

(iv) recommended that CCAMLR should seek to promote closer liaison between relevant work of its WG-FSA and CCSBT-ERS by requesting that it provide for the attendance of a CCAMLR observer at ERS meetings;

(v) recommended that CCAMLR should request that the reports of the ERS meetings and the supporting papers should be submitted to CCAMLR; and

(vi) suggested that CCAMLR and CCSBT should plan to hold a joint meeting of CCSBT-ERS and CCAMLR ad hoc WG-IMALF.

7.68 The Working Group expressed the hope that other conventions regulating longline fishing would follow the lead of CCSBT in establishing groups to tackle the problem of seabird-longline fishery interactions; from the CCAMLR perspective there were particular priorities in doing this for the Indian Ocean (via the incipient IOTC) and the Atlantic Ocean (ICCAT).

Information Relevant to Fisheries Management

7.69 Dr Croxall recollected that last year WG-FSA-95/43 (Croxall and Prince, 1996) identified the period March to mid-May (the brooding period) as the time when there was greatest overlap (and thereby higher potential for interaction) between at-sea distribution of wandering albatrosses foraging from breeding colonies at South Georgia and the longline fishery for *D. eleginoides*.

7.70 WG-FSA-96/8 briefly recapitulates this, and by summarising the at-sea distribution of black-browed and grey-headed albatrosses breeding at South Georgia, provides a preliminary assessment of overlap between these species and the longline fishery. In particular, grey-headed albatrosses feed in waters of the Antarctic Polar Frontal Zone (see also WG-FSA-96/20) and have limited potential for (and there have been few direct observations of) interactions with longline fishing vessels, except in transit to and from their breeding colonies. In contrast, black-browed albatrosses are most commonly associated with shelf slope areas around South Georgia, where their feeding areas are coextensive with the longline fishery. WG-FSA-96/8 also contains data on the post-breeding migrations of black-browed albatrosses – confirming their rapid movement in April/May to South African waters (and their consequent vulnerability to longline fisheries in this region). Post-breeding dispersal of grey-headed albatrosses is poorly known but now includes Pacific Ocean as well as Indian Ocean/ Australasian areas.

7.71 The Working Group agreed that because of the:

(i) extensive overlap between black-browed albatross feeding and longline fishing areas;

(ii) ready association of black-browed albatrosses with fishing vessels and their dominant behaviour in attempting to feed on bait;

(iii) large numbers of birds (especially adults and individuals known to breed at South Georgia) currently being caught around South Georgia;

(iv) continuing failure to implement the full range of mitigating measures (as specified in Conservation Measure 29/XIV) to give maximum potential reduction in incidental mortality of seabirds;

(v) observed significant declines in monitored black-browed albatross populations at South Georgia (SC-CAMLR-XV/BG/7);

(vi) observed decreases in adult survival rates of black-browed albatrosses at South Georgia since longline fishing started in the area (SC-CAMLR-XV/BG/7); and

(vii) reduction in catch rates of black-browed albatrosses after late April to early May (see e.g. paragraphs 7.46 and 7.48);

it would be highly desirable, in order to minimise the incidental mortality of seabirds, especially albatrosses, to delay the start of longline fishing in Subarea 48.3 until at least the beginning of May. This would also afford protection to wandering albatrosses at the time of year when they are most vulnerable and provide similar protection for grey-headed albatrosses throughout most of their chick-rearing period.

7.72 The Convener reminded participants that last year the Scientific Committee recommended to the Commission (SC-CAMLR-XIV, paragraphs 4.57 and 4.58) that, given that there would be full compliance with Conservation Measure 29/XIV, the fishing season of 1 March to 31 August be retained for 1995/96. It also requested Members to collect and/or provide data for assessing the consequences of delaying the start of the fishing season for *D. eleginoides* until 1 May.

7.73 It was clear from the observer reports that there had been less than full compliance with Conservation Measure 29/XIV in the *Dissostichus* fishery in Subarea 48.3.

7.74 Last year the concern was raised that delaying the start of fishing for *D. eleginoides* in Subarea 48.3 might cause increased fishing during the *D. eleginoides* spawning season (SC-CAMLR-XIV, Annex 5, paragraph 8.71). Data presented this year (WG-FSA-96/44) indicate that the spawning season starts in May and extends into August.

7.75 However, it was noted that unless fishing was delayed until after the end of the spawning season there would be little difference, in terms of consequence for fish stocks, between starting fishing in May and earlier in the year. Analysis of catch rates for fishing undertaken during the spawning season would be a useful element of future work.

7.76 No information had been provided by Members to WG-FSA on the consequences of delaying the start of the *D. eleginoides* fishing season in Subarea 48.3 until 1 May. It was recognised, however, that delaying opening this fishery until May might require a closure of the fishery later than the current date of 31 August (a date chosen to allow adequate time to meet the data reporting requirements in advance of a meeting of WG-FSA in mid-October). This would result in fishing during the period of worst weather conditions at sea in Subarea 48.3 and would make it much more difficult for vessels to restrict cost-effective fishing to night-time setting operations.

7.77 The Working Group agreed on the importance of drawing these issues to the attention of the Scientific Committee and Commission for consideration in the formulation of the appropriate conservation measures for this fishery.

Conservation Measure 29/XIV

7.78 No specific recommendations for modification of this conservation measure had been received or suggested.

Advice to the Scientific Committee

7.79 The Working Group commended the efforts of the many people who contributed to the production of *Fish the Sea Not the Sky*. The Scientific Committee should ask the Commission to request Members to undertake well-targeted distribution of this book to the priority recipients listed in paragraph 7.6 and to undertake further distribution and evaluation as indicated in paragraphs 7.7 to 7.10.

7.80 The Scheme of International Scientific Observation has continued to develop in a useful manner. Despite some problems associated with meeting appropriate reporting standards and submitting data in a timely manner (hopefully to be resolved with revised procedures), the reports provide much useful data. Unfortunately, because only 3 out of 16 observer logbooks were received at the time of the meeting, it was not possible to conduct the same level of analyses as last year. With further analyses and validation of some data, to be tackled intersessionally, a more comprehensive analysis of incidental mortality of seabirds in the Convention Area in 1996 should be possible.

7.81 The CCAMLR Scheme of International Scientific Observation is a crucial element in tackling the problem of seabird mortality arising from longline fishing. There is a particular need to:

(i) improve the flow of information to and from observers. It was considered that the appointment of a technical coordinator, by each Member which provides CCAMLR observers, would be the most effective means of resolving difficulties in this area (e.g. receipt and distribution of observer instructions, dispatch of observer reports, resolution of queries from the Secretariat concerning observer reports, training of observers, etc.);

(ii) facilitate more timely processing and provision of data by the Secretariat. Scientific Observer Logbooks and cruise reports should be submitted no later than one month after the end of the observed cruise and in the correct format;

(iii) revise the content and format of the *Scientific Observers Manual* (to include instructions and procedures contained in the current manual and logbooks, adoption of a loose-leaf format and inclusion of completed examples of data recording forms);

(iv) publish the *Scientific Observers Manual* in all four CCAMLR languages to reduce erroneous data due to misinterpretation of instructions; and

(v) prioritise the list of major data collection tasks for observers working on longline vessels (see Table 2, paragraph 3.18). A single observer must complete all high and medium priority tasks and should complete those tasks given low priority as far as possible.

7.82 Comprehensive observer coverage is essential to the aquisition of the appropriate data with which to manage longline fisheries. 100% observer coverage should be maintained as a matter of priority; Members able to make provision for two observers are strongly encouraged to do so.

7.83 The results of the analyses performed at the Working Group meeting, although preliminary in nature due to the small size of the datasets, indicate that:

(i) seabird mortality, especially of albatrosses, from longlining in the Convention Area is a serious problem with relatively high overall catch rates reported in 1995/96;

(ii) black-browed albatrosses are especially susceptible to capture during the day. Catch rates of black-browed albatrosses and white-chinned petrels were substantially reduced after early May (probably reflecting post-breeding migration/dispersal) indicating that appropriate restrictions on the timing of the fishery have the potential to reduce seabird mortality substantially; and

(iii) daylight setting and the incorrect or ineffective use of streamer lines were major causes of high levels of seabird mortality.

7.84 The available reports clearly indicate that daytime setting, in contravention of Conservation Measure 29/XIV, is occurring frequently (in approximately one-third of all sets for which data were available in the database). This is of serious concern as daytime setting is clearly linked to high levels of seabird mortality. The Scientific Committee should ask the Commission to request Members to take all appropriate steps to ensure compliance with all aspects of the conservation measure, thereby achieving substantial reduction in seabird by-catch and more cost-effective fishing.

7.85 Conservation Measure 29/XIV should be retained in its present form.

7.86 Members were encouraged to continue work to assess and improve the effectiveness of the streamer line as currently specified in Conservation Measure 29/XIV.

7.87 Useful progress has now been made in developing techniques to allow underwater setting of longlines. The Scientific Committee should give the strongest encouragement to further work to improve existing devices and to test new methods, especially those that could be used with the Spanish method of longline fishing.

7.88 Furthermore, the Scientific Committee should re-emphasise that research on the effectiveness of such measures should not only be undertaken in a manner consistent with the spirit of Conservation Measure 64/XII, but also that when underwater setting devices are being tested it is still a requirement to adhere to the provisions of Conservation Measure 29/XIV.

7.89 The Working Group commended the work of the Scientific Observer Data Analyst in developing the database and undertaking initial analysis; this has substantially enhanced the Working Group's ability to analyse data effectively. In view of the substantial amount of intersessional work planned, arising in part from the small number of data reports submitted on time, the Working Group asked the Scientific Committee to continue to fund, as a matter of high priority, the position of Scientific Observer Data Analyst throughout the intersessional period.

7.90 The volume of work involved within this agenda item makes it essential to commence work at the start of the WG-FSA meeting. Effective progress this year was largely due to the preliminary input of the Scientific Observer Data Analyst and to the presence of and input by staff from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Division of Fisheries, Hobart).

7.91 The Working Group received much useful data from outside the Convention Area. The establishment of a Working Group to consider seabird-tuna fishing interactions by CCSBT was also a welcome development. However, CCAMLR should encourage CCSBT to implement seabird mortality mitigation measures, based at least in part on CCAMLR Conservation Measure 29/XIV, and seek to improve liaison as suggested in paragraph 7.67.

7.92 The Scientific Committee should encourage the Commission to continue to develop links with other international fisheries forums, especially those dealing with longline fisheries in the Indian and Atlantic Oceans, with a view to encouraging greater efforts to tackle the problem of seabird-longline fishery interactions (paragraph 7.68).

OTHER INCIDENTAL MORTALITY

8.1 The Working Group reviewed the information available on incidental mortality of marine mammals and seabirds arising from fishing gear other than longlines, and incidental mortality of species other than birds caused by longlines.

8.2 Prof. Duhamel informed the Working Group that the use of net monitor cables in the trawl fishery around Kerguelen Islands has been prohibited. Since the inception of the prohibition, no incidental mortality caused by the trawl fishery has been observed.

8.3 Mr G. Benavides (Chile) reported that Chilean observers have recorded entanglement of marine mammals with longlines, resulting in the death of one Weddell seal and one fur seal in the fishery for *D. eleginoides* in Subarea 48.3.

8.4 Further information on interactions of marine mammals with fishing gear is given in paragraphs 5.14 to 5.22.

8.5 Instances of birds in breeding colonies impaled on or regurgitating hooks have been reported to CCAMLR in recent years (e.g. SC-CAMLR-XIV/BG/9, SC-CAMLR-XV/BG/4). WG-FSA-96/57 attempts to quantify hook loss in longline fisheries in Subarea 48.3 in recent years. In the last three years 320 000 hooks (6.4% of those set) have been lost; there is, however, considerable variation between years (even for the same vessel) and between vessels. As WG-FSA-96/57 notes, loose hooks lost overboard pose few environmental problems but loss of sections of line and hooks remaining in fish heads subsequently thrown overboard do pose threats to marine life (especially seabirds, but also *D. eleginoides*).

8.6 Hooks and hooks with snoods are also lost overboard, attached to the discarded heads of *D. eleginoides*. Hooks have been found in the stomachs of *D. eleginoides*, suggesting that discarded heads have been scavenged. Such discards also represent a danger for birds feeding on discharged offal. Another potential problem is the loss of sections of longline with hooks attached. Although the frequency of such loss is unclear, it is more likely in autoliners of the 'Mustad' type than in gear rigged using the Spanish system.

Hook Loss

8.7 The Working Group endorsed the conclusion of WG-FSA-96/57 that observers should be requested to record hook loss and the loss of sections of line. Provision for this has now been made in the current revision to the logbook.

FUTURE WORK

9.1 The Working Group noted that the high priority tasks set out below and the requirement to process data from the rapidly expanding fisheries for *Dissostichus* spp. will add substantially to the already considerable workload of the CCAMLR Secretariat. This may have additional financial implications.

Data Requirements

9.2 The Working Group requested the Secretariat to correspond with appropriate scientists and authorities in Member countries in order to acquire the following:

D. eleginoides Subarea 48.3	Haul-by-haul data which are required to complete datasets, particularly with respect to positional information and other items specified in Table 16.
	Haul-by-haul length frequency data from earlier bottom trawl surveys to be used for analyses of recruitment abundance (paragraphs 4.72 and 4.113).

Catch data from areas adjacent to the Convention Area (paragraph 4.44).

C. gunnari Subarea 48.3	Haul-by-haul, catch and age data from earlier commercial fisheries (paragraph 4.138).
	Information on surveys as set out in paragraph 4.142.
D. eleginoides Division 58.5.1	Haul-by-haul data from the Ukrainian fishery (paragraph 4.216).

9.3 The Working Group noted that the CCAMLR database should be reviewed in order to determine which datasets are still incomplete and which data are missing. This information would also be used to identify which particular data from the datasets mentioned in paragraph 9.2 above need to be requested from Members.

Other Intersessional Activities

9.4 The Working Group identified the following tasks as high priority in the Data Management work of the Secretariat:

(i) Preparation of an inventory of, and users' guides for, the CCAMLR database.

(ii) Development and application of methods for validation of data entries into the database.

(iii) Preparation of data files for length-density analyses of *D. eleginoides* from trawl surveys (paragraph 4.113).

(iv) Completion and validation of the entry of data from the 1995/96 observer programs (paragraph 4.84).

(v) Request information on fisheries activities by non-Members (paragraph 3.26);

(vi) Production of tables of areas of seabed within depth strata (similar to those produced by Everson and Campbell (1990)).

(vii) Revision (in consultation with Dr Rodhouse) of catch and effort and biological data forms for the 1995/96 squid jigging fishery in Subarea 48.3 (paragraph 4.14).

9.5 The Working Group also identified the following intersessional activities which should be carried out by WG-FSA participants, the Convener or the Secretariat:

(i)	Development of multispecies models for *C. gunnari* as described in paragraph 4.153:	WG-FSA participants.
(ii)	A correspondence group should address aspects of acoustic survey conducted by Russia in Subarea 48.3 in 1995/96 (paragraphs 4.131 to 4.133):	Convener, Dr Everson, Dr Gasiukov.
(iii)	Analyses of surveys using standard methods (paragraph 4.142):	WG-FSA participants.
(iv)	Review of biological reference points for decision criteria (paragraphs 4.75 and 4.95):	
	(a) include the subject in the agenda of the next meeting:	Convener;
	(b) prepare a review of available literature:	Science Officer.
(v)	Enhance generalised yield model to include sexes separately (paragraph 4.86):	Convener, Dr Constable.
(vi)	Submission of information on mesh/hook selectivity (paragraph 3.22):	WG-FSA participants.
(vii)	Consider methods of validating predictions of generalised yield model (paragraphs 3.69 and 4.109):	WG-FSA participants.

9.6 Other tasks for the Secretariat identified by the Working Group for the 1996/97 intersessional period include:

(i) Distribution of *Fish the Sea Not the Sky* as set out in paragraph 7.6.

(ii) Revision of the *Scientific Observers Manual* to include forms and instructions from the Scientific Observers Logbook for longline and trawl fisheries as set out in paragraph 3.16.

9.7 As was the practice in the past, a plan of work on the incidental mortality of marine animals in fisheries (discussed under Agenda Item 7) will be considered during CCAMLR-XV by members of the IMALF Coordinating Group. The Secretiariat will report on the work of the Coordinating Group to the next meeting of WG-FSA.

OTHER BUSINESS

License for Fishing Operations

10.1 Lic. Marshcoff noted that a CCAMLR observer (WG-FSA-96/52) mentioned the existence on board the vessel of a license for fishing operations in the area which was not required under CCAMLR regulations. He noted that this issue will be further considered at the coming meeting of the Commission.

10.2 The Working Group noted that this topic was not appropriate for consideration at its meeting.

Experts for the Editorial Board

10.3 WG-FSA noted that the Editorial Board of *CCAMLR Science* requires input from a small number of experts in each of the Working Groups to provide advice on which papers should be sent out for peer review.

10.4 It was agreed that in future, the identification of experts should be formalised as an early item on the Working Group's agenda.

10.5 Further, the Scientific Committee's attention was drawn to the fact that the editorial policy of *CCAMLR Science* has been subject to a variety of interpretations during the paper selection process. Clarification of the application of the editorial policy was therefore sought.

ADOPTION OF THE REPORT

11.1 The report of the meeting was adopted.

CLOSE OF THE MEETING

12.1 The Convener thanked all participants for their hard work during a busy meeting and expressed his appreciation to the conveners of the subgroups and to the rappoteurs for their considerable efforts. He also thanked the Secretariat for its sterling support, particularly as they were short-staffed due to the absence of a Data Manager.

12.2 On behalf of the Working Group, Dr Miller thanked the Convener for his guidance and calming influence.

12.3 The Convener then closed the meeting.

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AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 7 to 16 October 1996)

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 1995
   - 3.2 Fisheries Information
     - (a) Catch, Effort, Length and Age Data
     - (b) Scientific Observer Information
     - (c) Research Surveys
     - (d) Mesh/Hook Selectivity and Related Experiments Affecting Catchability
     - (e) Unreported Catches
   - 3.3 Fish and Crab Biology/Demography/Ecology
   - 3.4 Developments in Assessment Methods

4. Assessments and Management Advice
   - 4.1 Definition of Fishing Grounds
   - 4.2 New Fisheries
   - 4.3 Antarctic Peninsula (Subarea 48.1)
   - 4.4 South Orkney Islands (Subarea 48.2)
   - 4.5 South Georgia (Subarea 48.3) – Finfish
   - 4.6 South Georgia (Subarea 48.3) – Crabs
   - 4.7 South Sandwich Islands (Subarea 48.4)
   - 4.8 Antarctic Coastal Areas (Divisions 58.4.1 and 58.4.2)
   - 4.9 Ob and Lena Banks (Division 58.4.4)
   - 4.10 Kerguelen Islands (Division 58.5.1)
   - 4.11 Heard Island (Division 58.5.2)
   - 4.12 Pacific Ocean Sector (Area 88)
   - 4.13 Reopening Fisheries

5. Considerations of Ecosystem Management
   5.1 Interactions with WG-EMM
   5.2 Ecological Interactions (e.g. multi-species, benthos, etc.)

6. Research Surveys
   6.1 Simulation Studies
   6.2 Recent and Proposed Surveys

7. Incidental Mortality Arising from Longline Fishing

8. Other Incidental Mortality

9. Future Work
   9.1 Data Requirements
   9.2 Software and Analyses to be Prepared or Developed Prior to the Next Meeting

10. Other Business

11. Adoption of the Report

12. Close of the Meeting.

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(Hobart, Australia, 7 to 16 October 1996)

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APPENDIX C

LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 7 to 16 October 1996)

WG-FSA-96/1	PROVISIONAL AGENDA AND ANNOTATION TO THE PROVISIONAL AGENDA FOR THE 1996 MEETING OF THE WORKING GROUP ON FISH STOCK ASSESSMENT (WG-FSA)
WG-FSA-96/2	LIST OF PARTICIPANTS
WG-FSA-96/3	LIST OF DOCUMENTS
WG-FSA-96/4	BRIEF INFORMATION ON FISHING OPERATIONS CONDUCTED BY SRTM *PRIMORETS* INSIDE ECONOMIC ZONE OF KERGUELEN ISLANDS DURING THE PERIOD OF 1994/95 A. Vertunov, V. Frimer and V. Chikov (Ukraine)
WG-FSA-96/5	SUMMARISED DATA ON OPERATION OF RTMS *VOZROZHDENYE* INSIDE ECONOMIC ZONE OF KERGUELEN ISLANDS DURING THE SEASON OF 1994/95 E. Goubanov and Yu. Domashenko (Ukraine)
WG-FSA-96/6	SEABIRD BY-CATCH AND BAIT LOSS IN LONGLINING USING DIFFERENT SETTING METHODS S. Løkkeborg (Norway)
WG-FSA-96/7	UKRAINIAN DATA UPDATE Secretariat
WG-FSA-96/8	THE PELAGIC DISTRIBUTION OF SOUTH GEORGIA ALBATROSSES AND THEIR RELATIONSHIP WITH FISHERIES P.A. Prince, J.P. Croxall, P.N. Trathan and A.G. Wood (United Kingdom)
WG-FSA-96/9	POPULATION DYNAMICS OF WANDERING ALBATROSS *DIOMEDEA EXULANS* AND AMSTERDAM ALBATROSS *D. AMSTERDAMENSIS* IN THE INDIAN OCEAN AND THEIR RELATIONSHIPS WITH LONGLINE FISHERIES: CONSERVATION IMPLICATIONS H. Weimerskirch (France), N. Brothers (Australia) and P. Jouventin (France)

WG-FSA-96/10	INCIDENTAL MORTALITY OF SEABIRDS AROUND KERGUELEN ISLANDS (DIVISION 58.5.1) AND EFFECTIVENESS OF MITIGATION MEASURES: 1993/94 TO 1995/96 CRUISES D. Capdeville (France)
WG-FSA-96/11	BY-CATCH IN THE LONGLINE FISHERY ALONG THE SHELF SLOPE OF KERGUELEN (DIVISION 58.5.1) DURING THE 1994/95 AND 1995/96 CRUISES D. Capdeville and G. Duhamel (France)
WG-FSA-96/12	IMPACT OF MARINE MAMMALS ON LONGLINE FISHERY AROUND KERGUELEN ISLANDS (DIVISION 58.5.1) DURING 1995/96 CRUISE D. Capdeville (France)
WG-FSA-96/13	COMPOSITION AND VERTICAL DISTRIBUTION OF THE BENTHOPELAGIC ICHTHYOFAUNA OF THE SOUTHERN PART OF THE KERGUELEN RIDGE A.S. Piotrovsky (Ukraine)
WG-FSA-96/14	*SQUALUS ACANTHIAS* – A NEW SPECIES IN THE ANTARCTIC ICHTHYOFAUNA (DIVISION 58.5.1) L.K. Pshenichnov (Ukraine)
WG-FSA-96/15	POTENTIALLY COMMERCIAL INVERTEBRATES ON OB BANK: *MOROTEUTHIS INGENS* (OEGOPSIDA) AND *PARALOMIS ACULEATA* (ANOMURA) (DIVISION 58.4.4) L.K. Pshenichnov (Ukraine)
WG-FSA-96/16	SOME SPECIFIC CHARACTERISTICS OF *DISSOSTICHUS ELEGINOIDES* BIOLOGY IN THE VICINITY OF THE KERGUELEN ISLANDS (DIVISION 58.5.1) L.K. Pshenichnov (Ukraine)
WG-FSA-96/17	THE BY-CATCH OF JUVENILE FISH IN MIDWATER KRILL TRAWLS IN THE SOUTH GEORGIA AREA FROM 1967 TO 1990 M. Nevinsky and K. Shust (VNIRO, Russia)
WG-FSA-96/18	BY-CATCH OF JUVENILE FISHES – THE ANTARCTIC KRILL FISHERY Carlos A. Moreno (Chile)
WG-FSA-96/19	RESULTS ON BY-CATCH OF FISH DURING UKRAINIAN, POLISH AND JAPANESE KRILL FISHERY IN THE SOUTH ORKNEY ISLANDS, SOUTH GEORGIA AND SHETLAND ISLANDS AREAS T. Iwami (Japan), Z. Cielniaszek (Poland) and E.A. Pakhomov (Ukraine)
WG-FSA-96/20	PRECAUTIONARY MEASURES FOR A NEW FISHERY ON *MARTIALIA HYADESI* (CEPHALOPODA, OMMASTREPHIDAE) IN THE SCOTIA SEA: AN ECOLOGICAL APPROACH P.G. Rodhouse (United Kingdom)

WG-FSA-96/21	RESEARCH FISHERY FOR THE SQUID *MARTIALIA HYADESI* AT SOUTH GEORGIA CONDUCTED BY THE KOREAN REGISTERED VESSEL *IHN SUNG 101* (JUNE 1996): SCIENTIFIC OBSERVER'S REPORT A.F. González and P.G. Rodhouse (UK)
WG-FSA-96/22	REPORT ON SCIENTIFIC OBSERVATIONS ONBOARD THE CHILEAN LONGLINER, '*PUERTO BALLENA*', IN STATISTICAL SUBAREA 48.3 FROM MARCH TO MAY 1996 Karl-Hermann Kock and Jörn Selling (Germany)
WG-FSA-96/23	SUGGESTIONS TO MODIFY THE CCAMLR SCIENTIFIC OBSERVER CRUISE LOG Karl-Herman Kock and Jörn Selling (Germany)
WG-FSA-96/24	THE BIOLOGY AND ECOLOGY OF MACKEREL ICEFISH, *CHAMPSOCEPHALUS GUNNARI* – AN ANTARCTIC FISH SPECIES THAT LACK HAEMOGLOBIN K.-H. Kock (Germany) and I. Everson (UK)
WG-FSA-96/25	SCIENTIFIC OBSERVER DATABASE Secretariat
WG-FSA-96/26	OBSERVER IMALF DATA ANALYSIS Secretariat
WG-FSA-96/27	RESULTS OF *E.L. HOLMBERG* 1996 FISH SURVEY IN SUBAREA 48.3 E. Marschoff, B. Gonzalez, J. Calcagno, G. Shandikov, F. López, A. Madirolas and R. Reta (Argentina)
WG-FSA-96/28 Rev. 1	DIET COMPOSITION AND OBSERVATIONS ON REPRODUCTION OF *CHAMPSOCEPHALUS GUNNARI* IN SUBAREA 48.3 IN MARCH/APRIL 1996, *DR EDUARDO HOLMBERG* SURVEY E. Barrera-Oro, R. Casaux and E. Marschoff (Argentina)
WG-FSA-96/29	DIET COMPOSITION OF *DISSOSTICHUS ELEGINOIDES* IN SUBAREA 48.3, *DR EDUARDO HOLMBERG* SURVEY MARCH/APRIL 1996 E. Barrera-Oro, R. Casaux and E. Marschoff (Argentina)
WG-FSA-96/30	SPATIAL DISTRIBUTION OF *CHAMPSOCEPHALUS GUNNARI* IN SUBAREA 48.3. SOME IMPLICATIONS FOR PARAMETER ESTIMATION. E. Marschoff, B. Gonzalez and J. Calcagno (Argentina)
WG-FSA-96/31	INCIDENTAL MORTALITY OF SEABIRDS ASSOCIATED WITH LONGLINE FISHING IN SUBAREA 48.3 – PRELIMINARY RESULTS OF SCIENTIFIC OBSERVATIONS ONBOARD THE CHILEAN LONGLINER, *PUERTO BALLENA*, FROM MARCH TO MAY 1996 Karl-Hermann Kock and Jörn Selling (Germany)

WG-FSA-96/32	INTERSESSIONAL WORK ON THE INCIDENTAL MORTALITY OF SEABIRDS IN LONGLINE FISHERIES Secretariat
WG-FSA-96/33	PREVALENCES OF PARASITIZED AND HYPERPARASITIZED CRABS NEAR SOUTH GEORGIA: SUMMARY OF A MANUSCRIPT SUBMITTED TO THE '*JOURNAL OF ANIMAL ECOLOGY*' George Watters (USA)
WG-FSA-96/34	PRELIMINARY ANALYSES OF DATA COLLECTED DURING EXPERIMENTAL PHASES OF THE 1994/95 AND 1995/96 ANTARCTIC CRAB FISHING SEASONS George Watters (USA)
WG-FSA-96/35	ESTIMATION OF SIZE AT MATURITY AND CALCULATION OF AN APPROPRIATE SIZE LIMIT FOR MALE *PARALOMIS FORMOSA* George Watters (USA)
WG-FSA-96/36	CAPTURES ACCESSOIRES DE POISSONS LORS D'UNE CAMPAGNE EXPERIMENTALE PROFONDE A LA PALANGRE AU LARGE DES ILES KERGUELEN (DIVISION 58.5.1) EN 1995/96 G. Duhamel and P. Pruvost (France)
WG-FSA-96/37	DATA AVAILABILITY FOR WG-FSA/96 Secretariat
WG-FSA-96/38	ESTIMATES OF ABSOLUTE RECRUITMENT FOR PATAGONIAN TOOTHFISH (*D. ELEGINOIDES*) AROUND HEARD ISLAND W. de la Mare (Australia)
WG-FSA-96/39	ABUNDANCE OF PATAGONIAN TOOTHFISH (*D. ELEGINOIDES*) AT MACQUARIE ISLAND ESTIMATED FROM TAGGING STUDIES DURING 1995/96 FISHING SEASON W. de la Mare and R. Williams (Australia)
WG-FSA-96/40	EXTRACT FROM RUSSIAN OBSERVER'S REPORT ON KOREAN VESSEL, *IHN SUNG 66* A.N. Kozlov (Russia)
WG-FSA-96/41	INTERIM REPORT OF ACTIVITIES OF THE WG-FSA CORRESPONDENCE GROUP ON FISH BY-CATCH IN KRILL FISHERIES Secretariat
WG-FSA-96/42	COMPARISON BETWEEN AGE READINGS FROM SCALES AND OTOLITHS OF THE TOOTHFISH (*D. ELEGINOIDES*) FROM SOUTH GEORGIA M.C. Cassia (Argentina)

WG-FSA-96/43	COMPARATIVE FEEDING ECOLOGY OF *DISSOSTICHUS ELEGINOIDES* IN ARGENTINE CONTINENTAL SHELF AND SOUTH GEORGIA (STATISTICAL SUBAREA 48.3) S.B. García de la Rosa, F. Sánchez and D. Figueroa (Argentina)
WG-FSA-96/44	SEXUAL RATIO OF *DISSOSTICHUS ELEGINOIDES* FROM LONGLINES SAMPLES: A PARTIAL INDICATOR OF REPRODUCTIVE MIGRATION IN SUBAREA 48.3 C.A. Moreno, J. Guerra and A. Zuleta (Chile)
WG-FSA-96/45	VACANT
WG-FSA-96/46	REFINEMENTS TO THE GENERAL YIELD MODEL FOR USE AT WG-FSA-96 A.J. Constable (Australia)
WG-FSA-96/47	SHORT REPORT ON TRIP 9604, *AMERICAN CHAMPION*, AUG/SEP 1996 Delegation of South Africa
WG-FSA-96/48	DEPENDENCE OF CATCHES OF *D. ELEGINOIDES* ON ENVIRONMENT FACTORS INSIDE STATISTICAL AREA 58.5.1 (KERGUELEN ISLAND) – (CONSERVATION MEASURE 29/XIV) A.S. Petrenko (Ukraine)
WG-FSA-96/49	REPORT ON OPERATION OF THE UKRAINIAN FLEET INSIDE THE DIVISION 58.5.1 (KERGUELEN ISLAND) DURING THE PERIOD 1991–1996 E.P. Goubanov, A.S. Petrenko and V.V. Krakatitsa (Ukraine)
WG-FSA-96/50	REPORT ON ESTIMATES AND AVOIDING SIDE MORTALITY OF MARINE RESOURCES OF ANTARCTIC REGION INSIDE THE DIVISION 58.5.1 (KERGUELEN ISLAND) – (CONSERVATION MEASURE 29/XIV) E.P. Goubanov and A.S. Petrenko (Ukraine)
WG-FSA-96/51	OBSERVER LOGBOOKS (TRAWL FISHERIES) Secretariat
WG-FSA-96/52	EXTRACT FROM REPORT ON SCIENTIFIC OBSERVATION DURING PATAGONIAN TOOTHFISH, *DISSOSTICHUS ELEGINOIDES*, FISHERY ON BOARD SRTM '*ITKUL*' IN SUBAREA 48.3 IN THE PERIOD OF 17 MARCH TO 17 JULY 1996 A.K. Zaitsev (Ukraine)
WG-FSA-96/53	A METHOD TO ESTIMATE FISH GROWTH PARAMETERS USING HARD STRUCTURE WITHOUT BACK CALCULATION A. Aubone and D.R. Hernández (Argentina)

WG-FSA-96/54	A SHORE-BASED RANDOMISED SAMPLING DESIGN USED IN THE ARTISANAL LONGLINE FISHERY FOR *DISSOSTICHUS ELEGINOIDES* OFF CENTRAL CHILE J. Ashford (UK), P. Rubilar (Chile) and C. Jones (USA)
WG-FSA-96/55	DETERMINATION OF STOCK STRUCTURE AND MOVEMENT-AT-AGE IN PATAGONIAN TOOTHFISH (*DISSOSTICHUS ELEGINOIDES*) THROUGH LASER-BASED ANALYSIS OF OTOLITHS – A REPORT ON PROGRESS J. Ashford and I. Everson (UK) and C. Jones (USA)
WG-FSA-96/56	A RANDOMISED SAMPLING DESIGN USED IN THE LONGLINE FISHERY FOR *DISSOSTICHUS ELEGINOIDES* IN THE SOUTHERN INDIAN OCEAN J. Ashford (UK) and G. Duhamel (France)
WG-FSA-96/57	LOSS OF HOOKS DURING LONGLINE FISHING IN SUBAREA 48.3 G. Parkes and J. Jones (UK)
WG-FSA-96/58	DATA ON JUVENILE FISH SURVEYS WITHIN SOUTH GEORGIA Z.A. Frolkina (Russia)
WG-FSA-96/59	EXPERIMENTAL ACOUSTIC ESTIMATION OF BATHYPELAGIC FISHES BIOMASSES FROM THE SOUTH GEORGIA AND SHAG ROCK SHELF AREAS WITH TRAWL SAMPLING (RV *ATLANTIDA*, FEBRUARY 1996) V.M. Yorobyov, P.A. Bukatin, V.A. Severin, G.A. Frolkina, V. Yu. Sunkovich, M.I. Polischuk, V.N. Shnar and A.M. Abramov (Russia)
WG-FSA-96/60	DISTRIBUTION OF YOUNG ICEFISHES IN THE SOUTH GEORGIA SHELF AREA ON THE BASIS OF JUVENILE SURVEYS DATA Zh. A. Frolkina and I.A. Trunov (Russia)
WG-FSA-96/61 Rev. 1	REPORT OF THE FIRST MEETING OF THE CCSBT'S ECOLOGICALLY RELATED SPECIES WORKING GROUP Wellington, New Zealand, 18 to 20 December 1995
WG-FSA-96/62	RECENT INFORMATION RELATED TO SEABIRD BY-CATCH ON THE HIGH SEAS T. Polacheck and A. Betlehem (Australia)
WG-FSA-96/63	SOME OBSERVATIONS ON SEABIRD BY-CATCH FROM AUSTRALIAN LONGLINE FISHING VESSELS W. Whitelaw (Australia)
WG-FSA-96/64	SUMMARY TABLES OF AVAILABLE INFORMATION ON SEABIRD BY-CATCH BY AUSTRALIAN TUNA LONGLINE VESSELS T. Polacheck (Australia)

WG-FSA-96/65	TRENDS IN TUNA LONGLINE FISHERIES IN THE SOUTHERN OCEANS AND IMPLICATIONS FOR SEA BIRD BY-CATCH T. Polacheck and G. Tuck (Australia)
WG-FSA-96/66	BY-CATCH OF ALBATROSSES AND OTHER SEABIRDS BY JAPANESE LONGLINE FISHING VESSELS IN THE AUSTRALIAN FISHING ZONE FROM APRIL 1992 TO MARCH 1995 N. Klaer and T. Polacheck (Australia)

OTHER DOCUMENTS

CCAMLR-XV/7	NOTIFICATION OF THE INTENTION OF THE REPUBLIC OF KOREA AND THE UNITED KINGDOM TO INITIATE A NEW FISHERY Delegations of the Republic of Korea and the United Kingdom
CCAMLR-XV/8 Rev. 1	NOTIFICATION OF NEW ZEALAND'S INTENTION TO INITIATE A NEW FISHERY Delegation of New Zealand
CCAMLR-XV/9	NOTIFICATION OF AUSTRALIA'S INTENTION TO INITIATE A NEW FISHERY Delegation of Australia
CCAMLR-XV/10 Rev. 1	NOTIFICATION OF NORWAY'S INTENTION TO INITIATE A NEW FISHERY Delegation of Norway
CCAMLR-XV/11	NOTIFICATION OF SOUTH AFRICA'S INTENTION TO INITIATE NEW FISHERIES Delegation of South Africa
CCAMLR-XV/13	A PROPOSAL FOR PUBLICATION OF A SEABIRD IDENTIFICATION MANUAL Delegation of New Zealand
CCAMLR-XV/BG/10	DRAFT IUCN RESOLUTION ON SEABIRD BY-CATCH IN LONGLINE FISHERIES Secretariat
SC-CAMLR-XV/BG/1 Rev. 1	CATCHES IN THE CONVENTION AREA 1995/96 Secretariat
SC-CAMLR-XV/BG/7	POPULATION CHANGES IN ALBATROSSES AT SOUTH GEORGIA Delegation of United Kingdom

SC-CAMLR-XV/BG/11	NEED FOR PROCEDURES TO GOVERN THE RESUMPTION OF FISHERIES TARGETING SPECIES NOT PRESENTLY HARVESTED BUT FOR WHICH A FISHERY PREVIOUSLY EXISTED Delegation of USA
SC-CAMLR-XV/BG/14	TRENDS OF THE *DISSOSTICHUS ELEGINOIDES* STOCK USING THE SEQUENTIAL POPULATION ANALYSIS (SPA) MODEL IN SUBAREA 48.3: 1992 TO 1996 Delegation of Chile (Submitted in English and Spanish)
WG-EMM-96/31	FISH IN THE DIET OF THE BLUE-EYED SHAG *PHALACROCORAX ATRICEPS* AT THE SOUTH SHETLAND ISLANDS: SIX YEARS OF MONITORING STUDIES R. Casaux and E. Barrera-Oro (Argentina)
WG-EMM-96/43	INTER-ANNUAL VARIATION IN CONDITION INDEX OF THE MACKEREL ICEFISH *CHAMPSOCEPHALUS GUNNARI* I. Everson (United Kingdom), K.-H. Kock (Germany) and G. Parkes (United Kingdom)
WG-EMM-96/52	PRELIMINARY RESULTS ON BY-CATCH OF FISHES CAUGHT BY THE FISHERY VESSEL *CHIYO MARU NO. 3* TO THE NORTH OF THE SOUTH SHETLAND ISLANDS (FEBRUARY TO MARCH, 1996) S. Kawaguchi, T. Ichii and M. Naganobu (Japan) (abstract only)
ADDENDUM TO WG-FSA-96/37	DATA SUBMISSIONS

APPENDIX D

1996 ASSESSMENT SUMMARIES

Assessment Summary: *Dissostichus eleginoides*, Subarea 48.3

Source of Information: This report

Year:	1991	1992	1993	1994	1995	1996	Max[2]	Min[2]
Recommended TAC					-	4000		
Agreed TAC	2500[4]	3500	3350	1300	2800	4000		
Landings	3843	3703	2990	604	6171[5]	3871[6]		
Survey Biomass	335[+a]	19315*	3353*		14923[*a]		2012[*b]	
	3020[+b]	885[+]	2460[+]		4831[+a]		67259[+b]	
Surveyed by	UK	UK		UK[a] Arg[b]				
Stock Biomass[3]			11000-17000					
Recruitment (age...)								
Mean F (.....)[1]								

Weights in tonnes

1 ... weighted mean over ages (...)
2 Over period 1982 to 1992
3 Estimated from cohort projections
4 TAC from 1 November 1990 to 2 November 1991
5 Estimated by WS-MAD from various sources
6 For the period 1 March 1996 to 24 July 1996

* Shag Rocks
\+ South Georgia

Conservation Measures in Force: 92/XIV, 93/XIV and 94/XIV

Catches: Reported catches 1995/96 split-year = 4 362 tonnes, 1995/96 season (1 March to 24 July 1996) = 3 871 tonnes.

Data and Assessment: Revision of stock projections made at the 1995 meeting using the refined generalised yield model with revised input parameters. Standardisation of CPUE using generalised linear model did not show any trends in the status of the stock.

Fishing Mortality:

Recruitment: Estimated from trawl survey data using the same method as last year with four additional surveys (length-density analysis). Mean recruits at age 4 = 2.8 million.

State of Stock: Total removals of 5 000 tonnes per annum for 35 years consistent with γ_1 decision rule in generalised yield model. Ratio of spawning stock biomass at the end of the projection period to the pre-exploitation level was 53%.

Forecast for 1996/97: Recommended TAC of 5 000 tonnes and other conservation measures to remain in force.

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.1

Source of Information: This report

Year:	1991	1992	1993	1994	1995	1996	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings	1848	7492	2722	5083	5534	4869	7492	121	
Survey Biomass									
Surveyed by									
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

1 ... weighted mean over ages (...)

2 Over period 1982 to 1994

3 From VPA using (..........)

Conservation Measures in Force: None. Recommendation not to exceed 1 400 tonnes in western fishing grounds (CCAMLR-XII, paragraph 4.21).

Catches: Northern sector, French trawlers = 2 574 tonnes. Eastern sector, French trawlers = 1 029 tonnes. Western sector, Ukrainian longliners = 1 003 tonnes. Scientific exploratory deep-sea longline fishing cruise (Japan/France) = 263 tonnes.

Data and Assessment: New data for recent and historical fishing submitted for the trawl fishery. Standardisation of CPUE using a generalised linear model did not show any decline in catch rates.

Fishing Mortality:

Recruitment:

State of Stock: No declining trends apparent in CPUE.

Forecast for 1996/97: TACs set by the French authorities: northern sector trawl fishery = 2 500 tonnes, eastern sector trawl fishery = 1 000 tonnes, western sector longline fishery = 1 400 tonnes.

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.2

Source of Information: This report

Year:	1991	1992	1993	1994	1995	1996	Max[2]	Min[2]	Mean[2]
Recommended TAC				297	297	297			
Agreed TAC						297			
Landings	0	0	0	0	0	0			
Survey Biomass	17714	3179		11880					
Surveyed by	Australia								
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 (..........)

Conservation Measures in Force: 78/XIV - TAC 297 tonnes.

Catches: None.

Data and Assessment: Revision of stock projections made at the 1995 meeting using the refined generalised yield model with revised input parameters (from Subarea 48.3) and a new recruitment function based on trawl survey data from 1990 and 1993.

Fishing Mortality:

Recruitment: Estimated from trawl suvey data using the length-density method. Mean recruits at age 4 = 2.4 million.

State of Stock: Total removal of 3 800 tonnes per annum for 35 years consistent with γ_2 decision rule in generalised yield model. Probability of spawning stock biomass falling below 0.2 of its initial level during the projection period = 0.04.

Forecast for 1996/97: Recommended TAC = 3 800 tonnes with scientific observers on all vessels operating in the fishery.

GLOSSARY OF ACRONYMS AND ABBREVIATIONS USED IN CCAMLR REPORTS

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ACC	Antarctic Circumpolar Current
ADCP	Acoustic Doppler current profiler
AFZ	Australian Fishing Zone
AMD	Antarctic Master Directory
AMLR	Antarctic Marine Living Resources
APIS	Antarctic Pack-Ice Seals Program (SCAR-GSS)
ASMA	Antarctic Specially Managed Area
ASPA	Antarctic Specially Protected Area
ASOC	Antarctic and Southern Ocean Coalition
ATCM	Antarctic Treaty Consultative Meeting
ATCP	Antarctic Treaty Consultative Party
ATSCM	Antarctic Treaty Special Consultative Meeting
AVHRR	Advanced very high resolution radiometry
BAS	British Antarctic Survey
BIOMASS	Biological Investigations of Marine Antarctic Systems and Stocks (SCAR/SCOR)
BPUE	Birds per unit effort
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 ERS	CCSBT Ecosystem and Related Species
CDW	Circumpolar Deep Water
CEMP	CCAMLR Ecosystem Monitoring Program

CEP	Committee for Environmental Protection
COMNAP	Council of Managers of National Antarctic Programs (SCAR)
COFI	Committee on Fisheries (FAO)
CPD	Critical period-distance
CPUE	Catch per unit effort
CITES	Convention on International Trade in Endangered Species
CS-EASIZ	Coastal Shelf Sector of the Ecology of the Antarctic Sea-Ice Zone (SCAR)
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
CTD	Conductivity temperature depth probe
CV	Coefficient of variation
CWP	Coordinating Working Party on Fishery Statistics (FAO)
EASIZ	Ecology of the Antarctic Sea-Ice Zone
EEC	Commission of the European Communities
EEZ	Exclusive Economic Zone
EPOS	European *Polarstern* Study
EU	Commission of the European Union
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
GIS	Geographic Information System
GLM	Generalised Linear Model

GLOBEC	Global Ocean Ecosystems Dynamics Research (US Global Change Research Program)
GLOCHANT	Global Change in the Antarctic (SCAR)
GMT	Greenwich mean time
GOOS	Global Ocean Observing System (SCOR)
GOSEAC	Group of Specialists on Environmental Affairs and Conservation (SCAR)
GOSSOE	Group of Specialist on Southern Ocean Ecology (SCAR/SCOR)
GPS	Global Positioning System
GRT	Gross registered tonnage
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
IKMT	Isaacs-Kidd midwater trawl
IMO	International Maritime Organisation
IOC	Intergovernmental Oceanographic Commission

IOCSOC	IOC Regional Committee for the Southern Ocean
IOFC	Indian Ocean Fisheries Commission
IOTC	Indian Ocean Tuna Commission
IRCS	International radio call sign
ISCU	International Council of Scientific Unions
ISO	International Organisation of Standardisation
ISR	Integrated Study Region
IUCN	International Union for the Conservation of Nature and Natural Resources - the World Conservation Union
IWC	International Whaling Commission
IWC-IDCR	IWC International Decade of Cetacean Research
JGOFS	Joint Global Ocean Flux Studies (SCOR/IGBP)
LMR	Living Marine Resources Module (GOOS)
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)

NOAA	National Oceanic and Atmospheric Administration (USA)
NRT	Net registered tonnage
NSF	National Science Foundation (USA)
NSIDC	National Snow and Ice Data Center (USA)
PTT	Platform Transmitter Terminals
OECD	Organisation for Economic Cooperation and Development
RMT	Research midwater trawl
ROV	Remotely-operated vehicle
RTMP	Real-time monitoring program
RV	Research vessel
SCAF	CCAMLR Standing Committee on Administration and Finance
SCAR	Scientific Committee on Antarctic Research
SCAR-ASPECT	Antarctic Sea-Ice Processes, Ecosystems and Climate (SCAR Program)
SCAR-BBS	Bird Biology Subcommittee (SCAR)
SCAR-EASIZ	Ecology of the Antarctic Sea-Ice Zone (SCAR Program)
SCAR-COMNAP	SCAR Council of Managers of National Antarctic Programs
SCAR-GOSEAC	SCAR Group of Specialists on Environmental Affairs and Conservation
SCAR-GSS	SCAR Group of Specialists on Seals
SCAR/SCOR-GOSSOE	SCAR/SCOR Group of Specialists on Southern Ocean Ecology
SC-CAMLR	Scientific Committee for CCAMLR
SC-IWC	Scientific Committee for IWC
SCOI	CCAMLR Standing Committee on Observation and Inspection
SCOR	Scientific Committee on Oceanic Research
SD	Standard deviation

SIBEX	Second International BIOMASS Experiment
SO-GLOBEC	Southern Ocean GLOBEC
SO-JGOFS	Southern Ocean JGOFS
SPA	Sequential population analysis
SSSI	Site of special scientific interest
SST	Sea-surface temperature
TAC	Total allowable catch
TDR	Time depth recorder
TEWG	Transitional Environmental Working Group
TIRIS	Texas Instruments Radio Identification System
TS	Target strength
TVG	Time varied gain
UN	United Nations
UNCED	UN Conference on Enviroment and Development
UNEP	UN Enviromental Program
UNCLOS	UN Convention on the Law of the Sea
US AMLR	United States Antarctic Marine Living Resources
US LTER	United States Long-term Ecological Research
UV	Ultra-violet
VMS	Vessel Monitoring System
VPA	Virtual population analysis
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
WG-CEMP	CCAMLR Working Group for the CCAMLR Ecosystem Monitoring Program
WMO	World Meteorological Organisation
WOCE	World Ocean Circulation Experiment
WSC	Weddell-Scotia Confluence
WS-MAD	CCAMLR Workshop on Methods for the Assessment of *D. eleginoides*
WWD	West Wind Drift
WWW	World Wide Web
XBT	Expendable bathythermograph