SC-CAMLR-XI

SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

REPORT OF THE ELEVENTH MEETING OF THE SCIENTIFIC COMMITTEE

HOBART, AUSTRALIA
26 - 30 OCTOBER 1992

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Abstract

This document presents the adopted record of the Eleventh Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 26 to 30 October 1992. Major topics discussed at this meeting include: krill resources, fish resources, other resources, ecosystem monitoring and management, marine mammal and bird populations, assessment of incidental mortality, CCAMLR Scheme of International Scientific Observation, cooperation with other organisations and publication of scientific papers. Reports of meetings and intersessional activities of subsidiary bodies of the Scientific Committee, including the Working Groups on Krill, on Fish Stock Assessment and for the CCAMLR Ecosystem Monitoring Program, are appended.

TABLE OF CONTENTS

ANNEX 1: List of Participants

ANNEX 2: List of Documents

ANNEX 3: Agenda for the Eleventh Meeting of the Scientific Committee

ANNEX 4: Report of the Fourth Meeting of the Working Group on Krill

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

ANNEX 6: Paragraphs extracted from CCAMLR-V and CCAMLR-VIII

ANNEX 7: Report of the Working Group for the CCAMLR Ecosystem Monitoring Program

ANNEX 8: Joint Meeting of the Working Group on Krill and the Working Group for the CCAMLR Ecosystem Monitoring Program

ANNEX 9: Status and Trends of Antarctic and Sub-Antarctic Seabirds

ANNEX 10: Abundance and Trends of Antarctic Pinniped Populations

ANNEX 11: Scientific Committee Budget for 1993 and Forecast Budget for 1994

ANNEX 12: CCAMLR Glossary of Terms

REPORT OF THE ELEVENTH MEETING
OF THE SCIENTIFIC COMMITTEE

(Hobart, Australia, 26 to 30 October 1992)

OPENING OF THE MEETING

1.1* The Scientific Committee for the Conservation of Antarctic Marine Living Resources met under the Chairmanship of Mr O. Østvedt (Norway) from 26 to 30 October 1992 at the Wrest Point Hotel, Hobart, Australia.

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

1.3 The Chairman welcomed observers from Bulgaria, Finland, Greece, Ukraine, Uruguay, the Scientific Committee on Antarctic Research (SCAR), the International Whaling Commission (IWC) and the World Conservation Union (IUCN) to the meeting and encouraged them to participate in the meeting as appropriate.

1.4 An observer from the Antarctic and Southern Ocean Coalition (ASOC) had been invited to attend the proceedings of the Scientific Committee by the Executive Secretary in accordance with rules of procedure for the attendance of observers to meetings of the Scientific Committee. The Japanese Delegation stated that it understood that the observer was attending under the conditions laid out in SC-CAMLR-X, paragraph 1.9. Amendments based on these conditions were endorsed by the Commission at its last meeting and are given in Appendix 4 of SC-CAMLR-X.

1.5 The Chairman commemorated Mr Wieslaw Slosarczyk, from the Sea Fisheries Institute in Gdynia, Poland, who died on 3 March 1992 after a long illness. Wieslaw made great individual contributions to the work of the Scientific Committee and the Working Group on Fish Stock Assessment, attending meetings from 1984 to 1989. As a measure of the high regard in which he was held by his colleagues, he was elected a Vice Chairman of the Scientific Committee at SC-CAMLR-IV for a two-year term. Although only 41 when he died, he had an outstanding career in Antarctic research.

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* The first part of the number relates to the appropriate item of the Agenda (Annex 3).

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

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

- Dr M. Basson (UK), Krill Resources;
- Dr W. de la Mare (Australia), Fish Resources;
- Dr R. Holt (USA), Other Resources;
- Dr J. Croxall (UK), Ecosystem Monitoring and Management;
- Dr J. Bengtson (USA), Marine Mammal and Bird Populations and Assessment of Incidental Mortality;
- Mr D. Miller (South Africa), CCAMLR Scheme of International Scientific Observation and Scientific Exemption Provisions;
- Dr D. Agnew (Secretariat), all other matters.

ADOPTION OF THE AGENDA

1.8 The Provisional Agenda had been circulated prior to the meeting. The Agenda was adopted with one amendment, the raising of Agenda item 5(ii), "Report of the Joint Meeting of the Working Groups on Krill and CEMP" to a full agenda item as Item 6 (Annex 3).

REPORT OF THE CHAIRMAN

1.9 During the intersessional period Members had participated in a number of meetings. The Chairman expressed his thanks to Chile and Germany for hosting these meetings, and to Conveners, Members, Rapporteurs and the Secretariat for ensuring their success.

1.10 The Working Group on Krill (WG-Krill) met from 27 July to 3 August 1992 in Punta Arenas, Chile and was chaired by the Convener, Mr Miller. The Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) met in Viña del Mar, Chile from 7 to 12 August 1992, and was chaired by the Convener, Dr Bengtson. A joint meeting of these two Working Groups from 5 to 6 August 1992 was also held in Viña del Mar, and was chaired by the Chairman of the Scientific Committee, Mr Østvedt.

1.11 A Workshop on the Design of Bottom Trawl Surveys was held from 16 to 19 September 1992 in Hamburg, Germany, chaired by the Convener, Dr K.-H. Kock (Germany).

1.12 The Working Group on Fish Stock Assessment (WG-FSA) met in Hobart, Australia, from 13 to 21 October 1992. Dr I. Everson (UK), the Convener, was unable to attend the meeting and the Chairman expressed his thanks to Dr Kock for chairing the meeting in Dr Everson's absence.

1.13 The report of WG-Krill is attached as Annex 4, that of the joint meeting as Annex 8, that of WG-CEMP as Annex 7, and that of WG-FSA as Annex 5. The report of the Workshop on the Design of Bottom Trawl Surveys is appended to the report of WG-FSA as Appendix H.

1.14 The Scientific Committee had been represented as an observer at a number of international meetings during the intersessional period. As appointed at last year's meeting (S-CAMLR-X, paragraph 11.15) Mr E. Balguerías (Spain) had been an observer for the Scientific Committee at the 80th Statutory Meeting of ICES, Dr de la Mare at the meeting of the IWC Scientific Committee and Dr Croxall at SCAR meetings. Although the Chairman of the Scientific Committee had been nominated to represent CCAMLR at the FAO Technical Consultation on High Seas Fishing, held at FAO headquarters from 7 to 15 September 1992, he had been unable to attend and Mr S. Olsen (Norway) had agreed to act as observer in his place.

KRILL RESOURCES

FISHERY STATUS AND TRENDS

2.1 The krill catch for the 1991/92 season was 19% less than in 1990/91 and totalled 288 546 tonnes (Table 2.1).

Table 2.1: National krill landings (in tonnes) since 1984/85 based on STATLANT returns.

Member	Split-Year*							
	1985	1986	1987	1988	1989	1990	1991	1992
Chile	2598	3264	4063	5938	5329	4501	3679	6066
Germany	50	0	0	0	0	396	0	0
Japan	38274	61074	78360	73112	78928	62187	67582	74325
Republic of Korea	0	0	1527	1525	1779	4040	1211	519
Poland	0	2065	1726	5215	6997	1275	9571	8607
Spain	0	0	379	0	0	0	0	0
USSR**	150538	379270	290401	284873	301498	302376	275495	0
Russia								137310
Ukraine								61719
Total	191460	445673	376456	370663	394531	374775	357538	288546

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

2.2 The total krill catch by subarea and country for 1990/91 and 1991/92 is given in Table 2.2.

Table 2.2: Total krill catch in 1991/92 by area and country. The catch for 1990/91 is indicated in brackets.

Subarea /Area	Chile		Japan		Republic of Korea		Poland		Russia	Ukraine	(USSR)	Total	
48.1	6066	(3679)	61598	(54720)	519	(1211)	641	(310)	8975		(4721)	77799	(64641)
48.2			272	(1924)			2742	(6020)	80142	20333	(159313)	103489	(163979)
48.3			12405	(9606)			5224	(3241)	48163	41386	(110715)	107178	(123562)
48.4													
48.5									30		(0)	30	(0)
58.4			0									0	(1329)
88			50								(746)	50	(3)
Total	6066	(3679)	74325	(67582)	519	(1211)	8607	(9571)	137310	61719	(275495)	288546	(353514)

2.3 Catches contained in reports of Members' Activities were noted to be different from some of those submitted in STATLANT returns and included in Tables 2.1 and 2.2. The Scientific Committee sought clarification from the Members concerned on the discrepancies.

2.4 An analysis of the 1991/92 catches indicate that Chile and Japan have increased their catch levels between the 1990 and 1991 seasons whereas Korea, Poland and the combined fleets of Russia and Ukraine have decreased their catch levels.

2.5 The Scientific Committee noted with concern that the Secretariat could not prepare the summary tables of total krill catches prior to the meeting because of a lack of compliance with Conservation Measure 32/X and the fact that not all STATLANT data had been received by the official submission date of 30 September. This matter is further discussed in paragraphs 3.12 and 3.13.

2.6 Dr K. Shust (Russia) confirmed that catches of krill reported by Russia and Ukraine for the 1991/92 fishing season did not include any catches taken by vessels from the Baltic states. Dr Shust also indicated that since the Baltic states do not have a large scale krill fishery, catch levels are likely to be relatively low.

2.7 Dr V. Yakovlev (Ukraine observer) confirmed that fishing was conducted during March to August with scientific observers on board the vessels.

2.8 Dr I.-Y. Ahn (Korea) reported that Korean vessels fished between 14 January and 2 February 1992 and took a total krill catch of 519 tonnes to the north of Elephant and Livingston Islands. These data were submitted to the Secretariat at the Scientific Committee meeting.

2.9 The utility of reviewing Members' intended commercial krill fishing activities for the forthcoming season was again noted (SC-CAMLR-IX, paragraph 2.11 and SC-CAMLR-X, paragraph 3.13). Delegates from Chile, Japan and Russia reported that it was very difficult to predict the number of vessels that would be involved in the forthcoming season since this was primarily driven by economic factors.

2.10 Dr Yakovlev indicated that vessels from Ukraine will be fishing in Statistical Area 48 in the 1992/93 season and that information on the number of vessels and catching capacities of the vessel could be submitted.

REPORT OF THE WORKING GROUP ON KRILL

2.11 The Fourth Meeting of the Working Group on Krill (WG-Krill) was held in Punta Arenas, Chile from 27 July to 3 August 1992. This meeting was attended by 27 participants from 11 Member countries. The objectives of the meeting are outlined in SC-CAMLR-X, paragraphs 3.23, 3.48, 3.52, 3.53, 3.82, 3.89, 3.91 to 3.94, 3.105, 6.30, 6.36 and Annex 4, paragraphs 2.1 to 2.3)

2.12 The Convener of WG-Krill, Mr Miller presented the report of the meeting. He thanked the rapporteurs, participants and Secretariat for their support.

2.13 The Working Group's report is attached at Annex 4.

2.14 In reviewing the report, the Scientific Committee thanked the Convener and participants for their input. Some 39 working and background papers were tabled at WG-Krill's meeting. A list of these documents is given in Annex 4, Appendix C.

2.15 The Scientific Committee endorsed WG-Krill's report and made use of its deliberations as a basis for discussion. In the interests of brevity and to avoid unnecessary duplication, only a brief summary of the report is presented here. Wherever paragraphs of the Working Group report were accepted with little or only minor revision, the reader is referred to the relevant paragraphs of Annex 4. Consequently, the following summary should be read in conjunction with this Annex.

Review of Fisheries Activities (Annex 4, paragraphs 3.1 to 3.23)

2.16 The Scientific Committee shared WG-Krill's concern about the lack of compliance with Conservation Measure 32/X which calls for monthly reports of krill catches. It was noted that more data had been submitted since the meeting of WG-Krill in July and it was anticipated that compliance will improve in the future (Annex 4, paragraph 3.9).

2.17 The Scientific Committee noted that it might be possible to derive a composite index of CPUE, as first defined by WG-Krill in 1989 (SC-CAMLR-VIII, Annex 4, Appendix 7), from haul-by-haul fishery data in combination with acoustic data collected on a similar scale (Annex 4, paragraph 3.12). The Scientific Committee encouraged Chile and the USA to establish cooperative research programs to work on this problem.

2.18 The Scientific Committee again noted the value of haul-by-haul data from the Russian and Chilean krill fisheries and the important role played by scientific observers aboard fishing vessels in the collection of such data. It was agreed that the collection of biological and other data from commercial krill fishing vessels remains a top priority in WG-Krill's work.

2.19 WG-Krill indicated that it is still not possible to assess the full effect of the by-catch of larval and juvenile fish in the krill fishery. This is despite past concerns and several requests for information on this problem (SC-CAMLR-X, paragraph 3.22). The Scientific Committee urged both WG-Krill and WG-FSA to keep the matter under review.

2.20 The Scientific Committee noted WG-Krill's deliberations on the problem of assessing the mortality of krill not retained in krill trawls and endorsed the comments made by the Working Group (Annex 4, paragraph 3.22).

Estimation of Krill Yield (Annex 4, paragraphs 4.1 to 4.88)

Krill Flux in Statistical Area 48 (Annex 4, paragraphs 4.1 to 4.33)

2.21 The importance of krill movement with respect to krill distribution and the estimation of potential yield was again emphasised at the WG-Krill meeting (Annex 4, paragraph 4.1). The Working Group had provided a summary of current knowledge on water flow rates in and between subareas in Statistical Area 48 (Annex 4, Table 1).

2.22 The Scientific Committee noted that new information on water flow rates in Statistical Area 48 had only been presented for Subarea 48.1. There is still not much information available for Subarea 48.2 and no new information had been provided for Subarea 48.3 (Annex 4, paragraph 4.27). It was agreed that submissions should be encouraged for Subareas 48.2 and 48.3, as well as other statistical areas.

2.23 The Scientific Committee supported WG-Krill's view on the value of historic fine-scale fisheries data from Statistical Area 48 in the identification of areas of high krill density and the relative persistence of krill concentrations (Annex 4, paragraph 4.30). The Scientific Committee therefore urged Members to submit historical fine-scale data where possible.

2.24 Dr Shust noted that accessing the historic data from the Russian krill fishery and preparing the data for submission to CCAMLR is possible but would represent a major data processing effort. Because of the potentially large amount of historic catch data and the substantial investment of personnel time that would be required to transform the data into a format useful to CCAMLR (e.g., extracting logbook data and recording it onto computer files or standard reporting sheets), it might be difficult to reconstruct all historical fine-scale data. However, if sufficient resources can be allocated to undertake such a project, it would probably be possible to assemble and submit historic catch data for at least some areas of particular interest.

2.25 The Scientific Committee agreed that Members holding previously unreported historic data on krill catches should be encouraged, as a matter of priority, to evaluate the current accessibility of such data. Following the completion of an initial data inventory, the feasibility of processing these data into standard formats and submitting the data to the CCAMLR Data Centre should be investigated. The historic data should be reported to CCAMLR in as fine a scale as possible.

2.26 There seem to be few difficulties in collecting fine-scale data and the Scientific Committee therefore endorsed the recommendation that fine-scale data be submitted for all Statistical areas in the Convention Area. This would imply an extension of the current requirements for Subareas 48.1, 48.2 and 48.3 to Subareas 48.4, 48.5 and 48.6, as well as, Statistical Areas 58 and 88.

2.27 WG-Krill had indicated that, for reason of convenience, the boundaries between subareas within Statistical Area 48 were used to assess the flow of water masses between subareas (Annex 4, paragraph 4.10). The Scientific Committee agreed that it will be necessary to consider whether these boundaries are indeed appropriate with respect to krill movement. If the boundaries need to be re-defined, the information necessary to do so should also be identified.

2.28 The Scientific Committee agreed that there was a need for more oceanographic models and encouraged the establishment of links between research groups and institutes working on krill population dynamics and those working on oceanographic models. It was noted that there were many oceanographic studies focusing on very different spatial and temporal scales. The Scientific Committee encouraged WG-Krill to develop outlines indicating the ranges of spatial and temporal scales (for oceanographic models) that would be most relevant to the work of WG-Krill.

2.29 The Scientific Committee's attention was drawn to publications by Prof. Hofman and colleagues on the integration of models of oceanographic factors and of krill biology. Members were requested to provide information on similar studies to the Convener of WG-Krill before the next meeting of this Working Group.

2.30 The Scientific Committee recommended that the Secretariat develop a bibliography with respect to oceanographic matters relevant to the WG-Krill. The Scientific Committee, however, also requested WG-Krill to provide outlines that would define the subjects within oceanography that are of greatest relevance to the Working Group in order to assist the Secretariat in their task. The attention of the Secretariat was drawn to the SO-GLOBEC program (CCAMLR-XI/BG/9 Rev. 1).

Estimation of Biomass (Annex 4, paragraph 4.34 to 4.71)

2.31 WG-Krill reviewed various submissions on estimating krill biomass using acoustic data. The Scientific Committee endorsed without comment, WG-Krill's call for further work regarding acoustic methods (Annex 4, paragraphs 4.40, 4.41 and 4.44).

2.32 The Scientific Committee noted that Russia had tabled a paper (SC-CAMLR-XI/BG/13) setting out an outline proposal for a project to model krill aggregation (KRAM) in relation to acoustic surveys to estimate the species abundance. While the Scientific Committee recognised that there may be some merit in the proposal, it felt that the matter should be referred to WG-Krill's next meeting. The Working Group should then evaluate the proposal in the light of its other priorities and advise the Scientific Committee accordingly.

2.33 The precautionary limit set in 1991 for krill in Statistical Area 48 (Conservation Measure 32/X) was based, in part, on calculations undertaken by WG-Krill in 1991 using estimates of krill biomass from FIBEX. The Scientific Committee had requested that the FIBEX data be re-analysed (SC-CAMLR-X, paragraph 3.78) to obtain estimates of biomass by subarea using the new acoustic target strength (TS) values adopted by the Scientific Committee (SC-CAMLR-X, paragraph 3.34). A group of scientists from several Member nations undertook this analysis and the results were reported to WG-Krill (Annex 4, paragraphs 4.47 to 4.59 and Table 2).

2.34 It was noted that the densities obtained from the new target strength relationship (see paragraph 2.32) were approximately four-times those obtained from the original target strength relationship (*BIOMASS Rept. Ser. No. 40*, 1986). There were, however, some problems with the results from one vessel (*Walther Herwig)* which used 50 kHz as its survey frequency. In Subarea 48.2 the density from the *Walther Herwig* was similar to that from other vessels, whereas in Subarea 48.1 the density from this vessel appeared very high for a survey covering such a large area of deep water. The Working Group discussed possible reasons but could not satisfactorily explain the difference.

2.35 The Scientific Committee's attention was drawn to this problem and it agreed with WG-Krill's recommendation that further evaluation of the FIBEX acoustic data for *Walther Herwig* together with net-haul data should be undertaken (Annex 4, paragraph 4.58).

2.36 In discussion it was also noted that a superswarm had been detected north of Elephant Island during the time of the FIBEX survey. Mr Miller informed the Working Group that some transects of the *Walther Herwig* cruise did cross the area where the superswarm had been detected and that the analysis presented to WG-Krill had not correctly weighted the data from these transects. He reported that re-analysis of these data have been performed since that meeting.

2.37 Mr Balguerías informed the Scientific Committee of the establishment of a new ICES Study Group on Target Strength Methodology and suggested that the Scientific Committee follow the work of that Study Group in order to benefit from its expertise.

2.38 The Scientific Committee's attention was drawn to results of acoustic surveys, presenting estimates of krill biomass in the Ross Sea, Prydz Bay and around Elephant Island (Annex 4, paragraphs 4.59, 4.60 and 4.63 to 4.70).

Refining Calculations of Potential Yield (Annex 5, paragraphs 4.72 to 4.80)

2.39 The Scientific Committee noted that various refinements to the process used to calculate potential yield of krill were carried out during the intersessional period and presented to WG-Krill (Annex 4, paragraphs 4.73 to 4.77 and WG-Krill-92/4 and 28).

2.40 It was also noted that direct account was taken of uncertainties, particularly with respect to recruitment, mortality and the initial biomass. This approach implied that there was no further need for a discount factor as previously used (SC-CAMLR-X, paragraph 3.67).

2.41 At the WG-Krill meeting, two papers were presented containing estimates of potential yield using calculations that were very similar, though not identical (WG-Krill-92/4 and 28). Results were, however, quite different and the Working Group recommended that the calculations contained in these papers should be independently checked.

2.42 In this regard, the Scientific Committee endorsed WG-Krill's call for the establishment of a procedure whereby the Secretariat would verify the methodology, calculations and computer software used in models or assessments, particularly in situations where results from such models are used in providing management advice.

2.43 The Scientific Committee noted that estimates of potential yield obtained from the refined model developed by WG-Krill (Annex 4, paragraph 4.72 to 4.80) are sensitive to the assumption about the variability in recruitment and endorsed the Working Group's recommendation that further work, along the lines set out in Appendix D of Annex 4, be conducted to try and estimate recruitment variability from length frequency data.

Refinement of Precautionary Catch Limit Estimates (Annex 4, paragraphs 4.83 to 4.88)

2.44 In arriving at suggestions for an overall precautionary catch limit for Subareas 48.1, 48.2 and 48.3, WG-Krill had considered four estimates based on the re-analysed FIBEX data (Annex 4, paragraph 4.84). Two biomass estimates were used, one including and the other excluding the

Walther Herwig data, because of the problems encountered with results from this vessel (see paragraph 2.34) and the fact that the Working Group had not found a satisfactory explanation for this discrepancy.

2.45 Two methods of calculation were used, one based on the model used in 1990/91 (SC-CAMLR-X, Annex 5, paragraphs 4.32 and 6.42 to 6.55) and the other based on the refined model presented in WG-Krill-92/4, because of the problems regarding validation of the calculations (see paragraphs 2.41 and 2.42).

2.46 Dr Shust was of the opinion that the *Walther Herwig* results should be included because, although estimated densities were very high for Subarea 48.1, estimates for Subarea 48.2 are very similar to those from other vessels (paragraph 2.34).

2.47 The Working Group had suggested that the estimates of biomass used in these calculations were likely to be underestimates. The Scientific Committee, however, suggested that the estimates could also be positively biased, if recruitment had been above average in the period prior to the survey.

2.48 Seven alternative methods for allocating the precautionary limit to subareas within Statistical Area 48 were considered by WG-Krill (Annex 4, paragraph 4.87 and Table 5). The methods could be grouped into those that could be implemented immediately and those that would need more information before they could be implemented.

2.49 Prof. J. Beddington (UK) expressed his doubts about the feasibility of the method based on predator demands since it was not clear whether a positive or negative relationship between predator demands and precautionary catch level in a subarea should be applied. For example, should a high level of predator demand imply a relatively high or low catch level?

2.50 Dr Bengtson, the Convener of WG-CEMP, indicated that WG-Krill had requested WG-CEMP to consider the feasibility of this method and WG-CEMP had concluded that the method was not feasible (Annex 7, paragraph 8.7).

2.51 It was, however, noted that the possible problem of local depletion of krill and any corresponding need for supplementary management measures to ensure that not all catches were taken in the critical period and location for predators still remained (Annex 4, paragraph 4.88).

2.52 Further problems with some of the other methods were highlighted. Dividing the catch limit evenly between areas was thought to be unrealistic since biomass and productivity would tend to differ between subareas.

2.53 By contrast, the information needed to implement the method using local biomass adjusted for movement of krill is so great that once it has been obtained, a more detailed and appropriate management strategy for each subarea rather than a simple division of catches, could be developed.

Ecological Implications of Krill Fishing (Annex 4, paragraphs 5.1 to 5.53)

Location and Timing of Fishery (Annex 4, paragraphs 5.3 to 5.26)

2.54 The Scientific Committee had posed some questions regarding the ecological implications of krill fishing to WG-Krill at its 1991 meeting (SC-CAMLR-X, paragraph 6.36). WG-Krill had an extensive and valuable discussion on this topic and noted that the dialogue between scientists and those with practical experience of the fisheries had led to a better appreciation of what measures would be considered as reasonable when considering management options.

2.55 In summary, the main factors affecting the timing and location of the fishery are ice, the type of krill (e.g., feeding or non-feeding) and operational requirements (Annex 4, Table 1). The Scientific Committee endorsed the comments made by WG-Krill in this regard (Annex 4, paragraphs 5.5 to 5.8).

2.56 WG-Krill noted that in Subarea 48.1 fishing is concentrated in the months and locations that are critical to land-based predators. In Subarea 48.2 much less fishing occurs during the critical months and locations and in Subarea 48.3 the bulk of the catches are taken in the winter months (paragraph 5.29).

2.57 In considering the relation of fishing to krill predators WG-Krill focussed on two spatial scales: the Southern Ocean scale and a scale relating to localised krill/predator interactions.

2.58 Prof. Beddington suggested that there would be merit in considering a spatial scale in the middle of the range (for example, at the scale of subareas) since management decisions are currently based on the subarea scale.

Effects of Management Measures on Krill Fishing
(Annex 4, paragraphs 5.46 to 5.51)

2.59 Various management measures for controlling fishing in specific areas were discussed at WG-Krill's meeting. The Scientific Committee noted that there were advantages and disadvantages associated with all the methods.

2.60 Prof. Beddington disagreed with WG-Krill's assertion that a combination of closed areas and closed seasons was not easy to enforce. The Scientific Committee agreed that questions regarding the enforcibility of management measures was a matter for the Commission and not a problem the Working Group needs to consider.

2.61 Dr Shust suggested that although the combination of closed areas and closed seasons seems most appropriate, it would be very difficult to define appropriate areas because the predator-prey interactions are so dynamic.

2.62 Dr de la Mare noted that, with respect to land-based predators, the problem of defining appropriate 'management areas' that could be used in the closed areas management measure, is quite tractable. Biological characteristics such as foraging range could be used to define such areas. With respect to pelagic predators, the problem is far less tractable.

2.63 Further discussion on this topic is given in paragraphs 5.41 to 5.43.

Liaison with WG-CEMP (Annex 4, paragraphs 5.52 and 5.53)

2.64 The close liaison between WG-Krill and WG-CEMP was endorsed.

Advice on Krill Fisheries Management (Annex 4, paragraphs 6.1 to 6.30)

Precautionary Limits on Krill Catches (Annex 4, paragraphs 6.1 to 6.5)

2.65 The Scientific Committee took note of the calculations carried out by WG-Krill to estimate precautionary limits using the re-analysed FIBEX data and the refined model (Annex 4, paragraph 4.84), in response to a request from the 1991 meeting (SC-CAMLR-X, paragraph 3.78). The Scientific Committee endorsed the comments made by WG-Krill regarding the reservations and caveats associated with these calculations (Annex 4, paragraph 6.2).

2.66 The Scientific Committee endorsed the Working Group's recommendation that the precautionary catch limit for krill in Statistical Area 48 should remain at 1.5 million tonnes noting, however, that this level is only exceeded by one of the revised estimates.

2.67 With some reservations being made by certain Members about the revised methodology, the Scientific Committee agreed that the estimates of yield calculated by WG-Krill for Division 58.4.2 (Annex 4, paragraphs 6.1 and 6.3) could be used as a basis for setting a precautionary catch limit for this subarea and endorsed WG-Krill's recommendation (Annex 4, paragraph 6.4).

2.68 Dr M. Naganobu (Japan) stated that he endorsed the view expressed by Dr H. Hatanaka (Japan) in WG-Krill (Annex 4, paragraph 6.4). In his opinion advice could not be based on the lower figure (0.25 million tonnes) which was obtained from the revised model because of the problems associated with validation (see paragraphs 2.40 and 2.41). The higher figure (0.39 million tonnes), based on the model used at the 1991 meeting, could however, be used as a basis for setting a precautionary catch level in Division 58.4.2.

2.69 The Scientific Committee took note of WG-Krill's advice that if the validity of the FIBEX results remains in doubt, consideration would need to be given in the near future to the institution of a near-synoptic survey for krill in Statistical Area 48 as a whole. This matter is further discussed in paragraphs 2.116 to 2.118 of this report.

2.70 With respect to future refinements of these calculations, the Scientific Committee noted that the focus had been on the estimate of initial (or unexploited) biomass. The variance associated with the estimate of biomass had not really been considered and should receive more attention. The variance of recruitment assumed in the model calculations also affects results and further work to try and estimate the level of variance from data (for example, as outlined in Appendix E of Annex 4) is encouraged.

2.71 Dr D. Robertson (New Zealand) drew Members' attention to the implicit assumption that the biomass estimate from the FIBEX survey conducted in 1981 is appropriate for use as an estimate of unexploited biomass in the calculation of potential yield.

2.72 WG-Krill considered several options as the basis for allocating precautionary catch limits to subareas within Statistical Area 48 (Annex 4, paragraphs 6.6 to 6.10) and considered that, ideally, the total krill biomass in a subarea, corrected for predator demands and krill movements should be used. Some members of WG-Krill felt that an approach based on considerations of the movement of krill between subareas within the season would be most appropriate.

2.73 The Scientific Committee endorsed the view of the Working Group that since the catch in the most recent season had been well below the trigger level of 620 000 tonnes (stipulated in Conservation Measure 32/X), it would be unlikely that the implementation of an allocation scheme would become necessary in the near future. An interim approach was therefore recommended (Annex 4, paragraph 6.9).

2.74 The interim approach was based on taking the average of three percentages for each subarea:

(i) the percentage of the total biomass, estimated from the FIBEX survey including the *Walther Herwig* data, in that subarea:

(ii) the percentage of the total biomass, estimated from the FIBEX survey excluding the *Walther Herwig* data, in that subarea; and

(ii) the percentage of the historical total average catch in each subarea;

The reason why the historical catch was taken into account in these calculations was because the proportion of biomass estimated in Subarea 48.3 seemed unrealistically low relative to the proportion of the catch taken in that subarea. This may have been due to the fact that only part of Subarea 48.3 was covered during the FIBEX survey (Annex 4, paragraph 4.54).

2.75 The Scientific Committee noted that there are problems with an approach based on krill biomass with an adjustment for predator demands. Firstly, krill biomass may fluctuate greatly between subareas and between years. Secondly, as indicated by CEMP (Annex 7, paragraph 7.6), it is currently impossible to estimate total consumption for all krill predators in the subareas.

2.76 The Scientific Committee also took note of the view that krill movement (or flux) should be taken into account when allocating catch limits to subareas, but agreed that much more information on oceanographic factors and krill biomass fluctuations was needed before such an approach could be implemented.

2.77 The Scientific Committee agreed that, at this stage, the most practical approach would be that recommended by WG-Krill (Annex 4, paragraph 6.10). The Scientific Committee drew the Commission's attention to the fact that this approach implies that the sum of the percentages for all subareas is greater than 100%. Implications of this recommendation, in terms of catch limits by subarea based on a total precautionary catch of 1.5 million tonnes, are set out below (in tonnes):

Antarctic Peninsula	48.1	28%	420 000
South Orkney Islands	48.2	49%	735 000
South Georgia	48.3	24%	360 000
South Sandwich Islands	48.4	5%	75 000
Weddell Sea	48.5	5%	75 000
Bouvet Island region	48.6	20%	300 000

2.78 WG-Krill again discussed the possible need for additional management measures to ensure that not all catches are concentrated within the critical times and locations for krill predators (Annex 4, paragraphs 6.11 to 6.15). The discussion in the Scientific Committee with respect to this matter is given in paragraphs 5.39 to 5.43.

2.79 The Scientific Committee endorsed the recommendation by WG-Krill that there may be a need for the definition of management regions for krill that are more appropriate than statistical subareas (Annex 4, paragraphs 6.16 and 6.17).

Refining Operational Definitions (Annex 4, paragraphs 6.18 and 6.19)

2.80 The Scientific Committee noted that the Working Group had made definite progress at its last meeting, with respect to the development of operational definitions within the context of a particular management procedure. WG-Krill had started with relatively simple models, taking uncertainty into account and using relatively arbitrary levels of probability in the calculations of potential yield. The Scientific Committee supported further work in WG-Krill to move to a more realistic set of models and biological targets.

2.81 The Scientific Committee endorsed WG-Krill's comment that advice from the Commission on policy matters may be needed in future as management procedures are developed (Annex 4, paragraph 6.19). An example of such a policy matter would be the question of how frequently and by how much catch levels can alter.

Other Possible Approaches and their Development (Annex 4, paragraphs 6.20 to 6.23)

2.82 WG-Krill highlighted the fact that essentially three types of information would be available for the development of a feedback management procedure: information from the fisheries, information independent of the fisheries (e.g., surveys) and information on krill predators. The

Scientific Committee noted the advantages and disadvantages associated with the three types of information.

2.83 The studies on CPUE by Drs Mangel and Butterworth[1] which had been endorsed by the Scientific Committee (SC-CAMLR-VIII, paragraphs 2.13 to 2.21) indicated that haul-by-haul data are essential if any changes in CPUE were to be detected. The information obtained from surveys have not yet been subjected to such rigorous examination. It would therefore be appropriate now to move on to consider the information content of data from different types of survey and the information content of data on predator responses. The latter is a more difficult exercise than the former and the functional relationships between predators and prey should first be investigated.

2.84 The Scientific Committee commended WG-Krill and WG-CEMP for taking up this task, as outlined in the report of the Joint Meeting (Annex 8).

2.85 The Japanese Delegation indicated that due to the constraints of domestic law it would be impossible for them to submit haul-by-haul data. Dr Naganobu, however, confirmed that it would be possible for Japan to report combined krill catches on a scale of 10 x 10 n miles (Annex 7, paragraph 5.29; and 5.13 of this report).

2.86 Dr Shust pointed out that although surveys are expensive, fisheries data are not collected without costs and collecting fine-scale data is also expensive. He suggested that a small fund should be created from Members' contributions to assist in covering the costs of the collection and collation of fisheries data.

2.87 Several Members also noted that more studies of the interactions between krill and the fishing fleets are needed.

Data Requirements (Annex 4, paragraphs 6.24 to 6.26)

2.88 The Scientific Committee endorsed the comments made by WG-Krill in this regard.

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[1] BUTTERWORTH, D.S. 1989. A simulation study of krill fishing by an individual Japanese trawler. In: *Selected Scientific Papers. 1989 (SC-CAMLR-SSP/5).* CCAMLR, Hobart, Australia: 1-108. BUTTERWORTH, D.S. 1989. Some aspects of the relation between Antarctic krill abundance and CPUE measures in the Japanese krill fishery. In: *Selected Scientific Papers. 1989 (SC-CAMLR-SSP/5).* CCAMLR, Hobart, Australia: 109-126. MANGEL, M. 1989. Analysis and modelling of the Soviet Southern Ocean krill fleet. In: *Selected Scientific Papers. 1989 (SC-CAMLR-SSP/5).* CCAMLR, Hobart, Australia: 127-236.

Scientific Observer Scheme (Annex 4, paragraphs 6.27 to 6.29)

2.89 The Scientific Committee endorsed the recommendation by WG-Krill for the trial use of the draft scientific observer manual developed by the Secretariat during the forthcoming fishing season.

2.90 The Scientific Committee also endorsed the Working Group's views expressed in paragraphs 7.2 to 7.13 regarding editorial matters. For further discussion on SC-CAMLR's publications policy see paragraphs 11.1 to 11.5.

DATA REQUIREMENTS

2.91 The Scientific Committee was pleased to note that a considerable number of papers had been tabled at WG-Krill and that these contained information relevant to the data requirements identified at the Working Group's 1991 meeting (SC-CAMLR-X, Annex 4, Table 8). In this connection, the Scientific Committee endorsed WG-Krill's updated table of information requirements (Annex 4, Table 5). The following requirements were highlighted in particular:

- the Secretariat should contact FAO and other relevant organisations to determine whether data on catches from FAO Statistical Area 41 are available, and can be added to the CCAMLR Database;

- the requirement to submit fine-scale catch and effort data from Subareas 48.1, 48.2 and 48.3 and the CEMP Integrated Study Regions (ISRs) should be expanded to apply to any catches of krill in the Convention Area. Historical fine-scale catch data should also be submitted for Statistical Area 58;

- the ongoing requirement to submit length frequency data from commercial vessels, haul-by-haul data (irrespective of proximity to CEMP sites) and information on the number/capacity of fishing vessels should remain.

2.92 With respect to the requirement to submit both catch and effort data, Japan restated that it had difficulties with the submission of fine-scale effort data. Japan indicated, however, that Japanese effort data would be, and had been, included in analyses undertaken by Japanese scientists, e.g. SC-CAMLR-XI/BG/14.

2.93 Other requirements include - reporting of monthly catches in accordance with Conservation Measure 32/X, presentation of data on krill flux in Subareas 48.2 and 48.3 as well as other areas, examination of the precision of estimates of krill length-weight relationships and reports of experiments of krill passing through trawls during fishing.

2.94 The Scientific Committee agreed that it would still be of value if fishing Members could indicate the number of vessels that plan to fish for krill in the forthcoming season together with their catching capacities. Reservations were, however, expressed by many Members of their ability to do this.

2.95 The value of qualitative information from the fisheries was emphasised and future submissions of such information is encouraged.

FUTURE WORK OF WG-KRILL

2.96 The Scientific Committee noted that WG-Krill made significant progress in its work. In particular, the refinement of procedures to calculate potential yield, the development of alternative procedures whereby the allocation of precautionary limits to subareas in Statistical Area 48 may be achieved, and consideration of various approaches to take explicit account of predator requirements in the management of the krill fishery were seen as being noteworthy achievements.

2.97 The Scientific Committee endorsed the following topics as having the highest priority for WG-Krill in the forthcoming year:

- the continued investigation of oceanographic flux in Statistical Area 48 and other areas;
- the further estimation of total effective biomass in Statistical Area 48 and other areas;
- the further estimation, refinement and validation of methods to calculate potential yield and precautionary limits in various statistical areas and subareas, including refinements of the underlying model used to estimate yield as well as its input parameters;
- further work, in association with WG-CEMP, on models to describe functional relationships between krill, its principal predators and the fishery. Such work would include the need to take account of predator requirements in the development of management procedures for the krill fishery; and
- further work on the possible extent of krill mortality during fishing operations.

2.98 In addition the Working Group should continue to address issues associated with survey design, acoustic assessment of krill biomass, development of approaches to management and continue liaison with WG-CEMP on matters of common concern.

2.99 In order to address these issues, which are fundamental to the development of advice on krill, the Scientific Committee recommended that WG-Krill should meet during the intersessional period for approximately one week during 1993.

ADVICE TO THE COMMISSION

General Advice

2.100 WG-Krill should hold an intersessional meeting during 1993 in order to continue work on topics set out in paragraphs 2.97 and 2.98.

2.101 The Commission's attention was drawn to the fact that, because of non-compliance with the data reporting element of Conservation Measure 32/X, the Secretariat was unable to complete the tables of krill catch statistics before the Scientific Committee meeting.

2.102 Submissions are encouraged on the dynamics of krill fluxes in Subareas 48.2 and 48.3 in particular, as well as in other statistical areas (paragraph 2.22).

2.103 Consideration should be given to whether the use of CCAMLR statistical subareas is appropriate with respect to krill movement and the definition of water mass boundaries. In particular, the information necessary to define water mass boundaries should be identified (paragraph 2.27).

2.104 Fine-scale fisheries data should be submitted for all statistical areas (including Areas 58, 88 and subareas in Area 48 for which fine-scale data have not been required in the past). Such data from past seasons should also be submitted (paragraph 2.23).

2.105 Krill recruitment variability should be estimated using length distribution data from research surveys as outlined by WG-Krill (Annex 4, Appendix D) (paragraph 2.43).

2.106 Submissions to WG-Krill's next meeting on additional management measures to supplement precautionary catch limit allocations are encouraged (paragraph 2.78).

2.107 The *Walther Herwig* FIBEX data should be validated further. Should the validity of the FIBEX data remain in doubt then consideration needs to be given in the near future to the institution of a near-synoptic krill survey in Statistical Area 48 as a whole (paragraph 2.69).

2.108 A flexible scheme for designating specific management areas, fishing grounds or areas of specific ecological interest is required. As a first step such a scheme could be based on aggregates of fine-scale catch reporting units (0.5° latitude by 1° longitude) (paragraphs 2.61 and 2.62).

2.109 WG-Krill and WG-CEMP should continue their close liaison on the development of a feedback management procedure to take account of information on interactions among krill, krill predators, the fishery and the environment (paragraph 2.82).

2.110 The specific data requirements listed in paragraph 2.91 should be addressed as a matter of priority.

Specific Advice on the Status of Krill Stocks

2.111 The Scientific Committee recommended that Conservation Measure 32/X should not be amended at this time.

2.112 The average of FIBEX-based biomass estimates and historical catch levels plus 5% currently offers the most practical interim allocation procedure for apportioning the precautionary catch limit to subareas within Statistical Area 48 (paragraph 2.74).

2.113 A range of 0.25 to 0.39 million tonnes represents the best scientific advice on a precautionary catch limits for Division 58.4.2 which can be given at this time (paragraph 2.67). It was agreed that a precautionary catch limit of 0.39 million tonnes should be applied to Division 58.4.2 at this time.

2.114 As a principle, the Secretariat should be charged with checking specific calculations, particularly when these are used as a basis for management measures (paragraph 2.42).

2.115 When developing a comprehensive management procedure for krill (paragraph 2.82) it is necessary to know the magnitude and frequency by which krill catch levels may be adjusted. The Commission's guidance is sought on this matter.

2.116 The Commission's attention is drawn to the possible need for a large-scale near-synoptic survey in Statistical Area 48 (paragraph 2.69). Such a survey would involve considerable effort in coordination and involve significant costs. The Commission's guidance on the feasibility of such an exercise is sought .

2.117 The Commission's attention is drawn to the fact that the development of management procedures for krill is critically linked to the reliability and quality of information that would be used in such a procedure.

2.118 This implies, for example, that if WG-Krill could not rely on obtaining the necessary detailed data from the commercial fishery, management procedures that rely on such data would not be possible. In this circumstance, alternatives such as regular comprehensive surveys might be necessary.

FISH RESOURCES

FISHERY STATUS AND TRENDS

3.1 In the Atlantic sector commercial fishing for finfish was prohibited in Subareas 48.1 and 48.2 (Conservation Measures 41/X and 42/X).

3.2 In Subarea 48.3 (South Georgia) the total catch of all species in 1991/92 was 50 678 tonnes, which compares to 82 423 tonnes in 1990/91, the difference being largely due to a drop in myctophid landings. However, all expected catch returns have not yet been received.

3.3 The fishery for *Champsocephalus gunnari* was closed for the 1991/92 season (Conservation Measure 33/X). The fishing season for *Dissostichus eleginoides* was shorter than in previous seasons, mainly because of entry into the fishery of the Chilean fleet. This fishery was subject to a TAC of 3 500 tonnes (Conservation Measure 35/X). The total catch reported for this species was 3 703 tonnes, including 133 tonnes taken in research catches. The total catch of *Electrona carlsbergi* was 46 960 tonnes, well below the TAC of 245 000 tonnes (Conservation Measure 38/X). Directed fisheries on *Notothenia rossii, Patagonotothen guntheri, Notothenia gibberifrons, Chaenocephalus aceratus, Pseudochaenichthys georgianus* and *Notothenia squamifrons* were prohibited in 1991/92 under Conservation Measures 3/IV and 34/X. A summary of catches of all species from 1970 onwards is presented in Table 3 of Annex 5.

3.4 In the Indian Ocean sector, the only commercial fishing reported was from Division 58.5.1 (Kerguelen). The total catch consisted of 44 tonnes of *C. gunnari* and 7 492 tonnes of *D. eleginoides*. Fishing for *N. squamifrons* in Division 58.4.4 (Ob and Lena Banks) was prohibited under Conservation Measure 43/X.

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

3.5 The acting chairman of the Working Group on Fish Stock Assessment (WG-FSA), Dr Kock presented the report of the meeting which had been held at the CCAMLR Secretariat Offices in Hobart from 13 to 22 October, 1992.

3.6 The Report of the Working Group is attached in Annex 5.

3.7 WG-FSA reported there were no scientists present at the meeting who were familiar with the contents of some of the papers which presented assessments. WG-FSA attempted to take these papers fully into account in its work, but in some cases, the Working Group was unable to evaluate them because some technical details of the analyses were insufficiently reported. In these cases, WG-FSA has referred the papers back to the authors for clarification and re-submission to a future meeting.

3.8 In reviewing the report, the Scientific Committee thanked WG-FSA for the considerable work which had gone into the report. The Committee particularly thanked the acting chairman for running the Working Group meeting when the Convener (Dr Everson) was unfortunately unable to attend.

CCAMLR Scheme of International Scientific Observation
(Annex 5, paragraphs 4.1 to 4.5)

3.9 The Scientific Committee endorsed the comments of WG-FSA. The Scientific Committee agreed that all vessels conducting any form of fishing should be covered under the Scientific Observation Scheme, but the highest priority for the placement of Scientific Observers was on commercial fishing vessels.

Review of Draft CCAMLR Scientific Observers Manual
(Annex 5, paragraphs 4.6 to 4.9)

3.10 The Scientific Committee endorsed the comments made by WG-FSA. The Scientific Committee expressed its appreciation for the considerable effort put into producing the manual by the Secretariat, and to many Members of the Scientific Committee and Working Groups for their contributions.

Data Requirements Endorsed by the Commission in 1991
(Annex 5, paragraphs 5.1 and 5.2)

3.11 Requests for various data from WG-FSA in 1991 (SC-CAMLR-X, Annex 6, Appendix E) were endorsed by the Scientific Committee and Commission. Data submitted to the Secretariat in response to this request are listed in Annex 5, Appendix D. Although some of the data requested by the Working Group had been submitted, there is a substantial amount of data still required (Annex 5, Appendix D).

Catch and Effort Statistics (Annex 5, paragraphs 5.3 to 5.7)

3.12 The Scientific Committee noted that STATLANT A and B data are still not being submitted to the Secretariat by the due date (September 30), and many of these data were still not submitted in time for the meeting of WG-FSA. This year, the necessary data could be compiled from the returns under the reporting requirements adopted under the various conservation measures in force. However, the STATLANT data cover any fisheries not subject to specific reporting requirements, and so their timely submission is essential. The Data Manager suggested that moving the due date for submission forward to 31 August would allow the Secretariat to determine which data are missing well ahead of the meeting of WG-FSA. Given this extra time the Secretariat would be able to seek these data from Members so that they would be available in time for WG-FSA.

3.13 The Scientific Committee requested the Data Manager to consult with Members in the intersessional period to determine if such a scheme could be arranged, and to report the results and recommendations from this review to the next meeting of WG-FSA for further consideration.

General Advice on the Management of Fish Stocks
(Annex 5, paragraphs 6.237 to 6.245)

3.14 WG-FSA discussed the potential utility of effort controls as a means of controlling fishing mortality. These were seen as likely to be useful in controlling the rate of expansion of fishing effort on stocks for which new fisheries have recently begun and for which insufficient information was available for setting a TAC.

3.15 Effort controls may be particularly valuable in ensuring that the fishing season does not become excessively foreshortened. Some of the estimation methods in use by WG-FSA may become unreliable if the fishing season is very short. In such cases increasing effort will lead to increasing uncertainty about the status of the stocks.

3.16 The Scientific Committee endorsed these comments, but also noted WG-FSA's comments that the implementation of effort controls has a number of practical difficulties which will require consideration by the Commission.

Considerations of Ecosystem Management

Interactions with WG-Krill (Annex 5, paragraphs 7.1 to 7.7)

3.17 The Scientific Committee endorsed the comments of WG-FSA. The Scientific Committee reiterated the conclusion of WG-Krill-91/25 that there is still an urgent requirement for more detailed monitoring of the krill fishery to properly assess the magnitude of the fish by-catch problem, and to determine the locations and times of year when young fish are at greatest risk. The Scientific Committee also emphasised the need to ensure that future information should be submitted in accordance with the formats set out in the Draft Scientific Observers Manual along with full details of the sampling procedures employed according to the agreed guidelines (see SC-CAMLR-IX, Annex 5, Appendix F).

3.18 It was suggested that the Commission may need to consider measures which reduce the by-catch of fish in krill trawls.

Interactions with WG-CEMP (Annex 5, paragraphs 7.8 to 7.15)

3.19 The Scientific Committee endorsed the comments of WG-FSA on these matters.

Research Surveys

Workshop on the Design of Bottom Trawl Surveys

3.20 The Report of the Workshop on the Design of Bottom Trawl surveys is given in Annex 5, Appendix H. The Scientific Committee endorsed the comments and recommendations of WG-FSA, and thanked the Bundesforschungsanstalt für Fischerei (Federal Research Centre for Fisheries), Germany, for hosting the Workshop. The Scientific Committee agreed that the 'Draft Manual for Bottom Trawl Surveys' should be circulated by the Secretariat to all Members in the intersessional period for comment. A new draft will be prepared for final approval next year.

Recent and Proposed Surveys

3.21 The Scientific Committee noted that a Russian survey on *D. eleginoides* was carried out in the Shag Rocks/South Georgia area from May to July 1992 using two commercial longliners. The catch taken during the survey made up approximately 6% of the TAC set by the Commission for the 1991/92 season which had been exhausted in March 1992. It was noted that no provisions have been made to take these catches into account when considering a TAC for 1992/93.

3.22 A plan detailing the survey design and the objectives of this research cruise was not submitted to CCAMLR six months in advance as requested by the Commission in 1986 (CCAMLR-V, paragraph 60). As a result the research plan was not subject to scrutiny by the Scientific Committee and the Working Group. WG-FSA was unable to assess if the research plan set out in COMM CIRC 92/23 was directed to specific questions and gaps in knowledge addressed by the Working Group at its last meeting.

3.23 Fine-scale haul-by-haul data and length composition data from the research cruise were submitted to CCAMLR. Preliminary analyses of biological characteristics (age, reproduction) were provided in WG-FSA-92/13, 14 and 15. However, the Scientific Committee noted that the submission of biological data did not follow the guidelines and standards set out by WG-FSA earlier (SC-CAMLR-IX, Annex 5, paragraphs 249 to 254). It was noted that biological sample size was small compared with the approximate 20 000 fish taken.

3.24 The Scientific Committee noted the conclusion of WG-FSA that the information provided so far from these surveys contributed little to improve the assessments carried out by the Working Group during this year's meeting. The Scientific Committee reiterates earlier statements and the Commission's decision from 1986 that research plans should be submitted six months in advance to allow careful review of research proposals to ascertain that they address specific requests by the Scientific Committee and Working Groups (see also Scientific Research Exemption section following).

3.25 A bottom trawl survey was undertaken by the *Falklands Protector* in January 1992 with scientists from the UK, Germany and Poland participating.

DATA REQUIREMENTS

3.26 The Scientific Committee endorsed the list of data requirements specified by WG-FSA set out in Annex 5, Appendix D.

SCIENTIFIC RESEARCH EXEMPTION

3.27 The Scientific Committee noted the concerns expressed by various Members (CCAMLR-XI/9) in connection with the Russian research cruise on *D. eleginoides* in Subarea 48.3 during 1992.

3.28 This particular cruise commenced after closure of the fishery in accordance with Conservation Measure 35/X; the TAC of 3 500 tonnes set by this measure was exceeded as a consequence of catches during the cruise. The catch comprised approximately 6% of the TAC and had not been taken into account in the formulation of the TAC (Annex 5, paragraph 8.17).

3.29 While re-endorsing the need for research exemption provisions (CCAMLR-V, paragraphs 59 and 60), the Scientific Committee noted that there is still some uncertainty attached to their effective implementation.

3.30 The Scientific Committee consequently agreed that in the interest of reducing such confusion, some attempt should be made to clarify the scientific research exemption provisions as they currently stand.

3.31 As a first step, the Scientific Committee recommended that the status of scientific research exemption provisions as set out in CCAMLR-V, paragraph 60 should be such that they are formalised either as a Commission resolution or as a full conservation measure.

3.32 The Scientific Committee reiterates its concern that many vessels (including research vessels) are capable of taking large catches which may have a detrimental impact on the objective function of specific conservation measures (SC-CAMLR-VIII, paragraph 3.10).

3.33 The Scientific Committee drew the Commission's attention to apparent inconsistencies in interpretation of the exemption provisions as applied to research vessels and commercial or fishery support vessels engaged in scientific research (CCAMLR-V, paragraph 60(c); CCAMLR-VIII, paragraph 51 - see Annex 6). Definition of the latter is further confused by the stipulated requirement to register permanent research vessels that may engage in fishing for research purposes (CCAMLR-V, paragraph 60(a) and (b)), and by the fact that it is unclear whether it is only these vessels to which the additional requirements are to be applied.

3.34 For the reasons stipulated in paragraph 3.32 above, the Scientific Committee recommended that the scientific exemption review procedure described below should be applied to all vessels planning to undertake research on species, or in areas, subject to conservation measures. This application procedure shall only be invoked when research catch levels are anticipated to be substantial. "Substantial" should be viewed as equivalent to the lowest commercial catch level of the species taken in any year in the area or subarea concerned, or 100 tonnes, whichever is the least. This qualification is necessary to ensure that research activities likely to result in inconsequential catches are not included in the exemption review process set out in the following paragraphs.

3.35 In the context of applying research exemption provisions to all vessels, the Scientific Committee sought further clarification by the Commission on the definition of "research vessels" as applied in the Registry of Permanent Research Vessels (CCAMLR-V, paragraph 60(a) and (b) - reproduced in Annex 6 of this report). The Scientific Committee emphasised the desirability of obtaining the details of all vessels subject to the scientific research exemption provisions as set out in subpragraph 60(b) of CCAMLR-V (Annex 6).

3.36 The Scientific Committee recommended that any Member intending to undertake research at the fishing level stipulated above and in accordance with subparagraph (c) of CCAMLR-V, paragraph 60 should submit a research plan to the Secretariat. Such plans should then be reviewed by the appropriate Working Group and advice on their scientific merits be provided to the Scientific Committee. To allow this process sufficient time to occur, submission of plans should be submitted to the Secretariat at least 30 days in advance of the appropriate Working Group's planned next meeting or three months in advance of the annual Scientific Committee meeting whichever is the earlier.

3.37 It was felt, however, that the current statement and level of detail for submitted research plans (CCAMLR-V, paragraph 60(d)) should be viewed as little more than interim requirements. The Scientific Committee therefore tasked its Working Groups to develop guidelines and standardised formats for such plans. The standardisation of formats will provide for comparable review and evaluation of submitted research plans.

3.38 Having evaluated the submitted research plans, the Scientific Committee will formulate advice to the Commission on their scientific merits. Due account will be taken of the advice offered by the appropriate Working Groups in this regard.

3.39 The Scientific Committee again endorses the principle (CCAMLR-VIII, paragraph 51) that catches of all species taken during scientific research as outlined above should be considered as part of any prevailing TACs.

3.40 During the review, evaluation and acceptance of research plans, a catch reporting procedure equivalent to the finest-scale reporting provisions for commercial fisheries on the same species or in the same area, should be instituted. The implementation of catch reporting procedures should occur when the appropriate Working Group or Scientific Committee are of the opinion that catches will comprise a discernible proportion of any prevailing TAC on the species, or in the area, concerned.

3.41 Submission of catch data in accordance with the above should reach the Secretariat within 180 days of the completion of the research.

3.42 Failure to submit required catch data should be viewed as a failure to fulfil the research exemption provisions.

NEW FISHERIES

3.43 Two notifications of new fisheries in Subarea 48.4 were received by CCAMLR; one from the USA (CCAMLR-XI/5) and one from Chile (CCAMLR-XI/7). Dr Holt reported that the US intention was to take *D. eleginoides* in fish pots which are used to capture bait for the crab fishery. However, during the initial trip of the US crab vessel in Subarea 48.3, few fish were captured and use of fish pots was discontinued (WG-FSA-92/29). It is believed unlikely that further attempts to catch *D. eleginoides* using fish pots will be made by this vessel in Subarea 48.4.

3.44 Dr C. Moreno (Chile) presented plans of a Chilean fishing company to conduct exploratory fishing operations for *D. eleginoides* using longlines in waters off the South Sandwich Islands (Subarea 48.4) during the 1992/93 fishing season (CCAMLR-XI/7). The proposed fishing activity will be undertaken during a 40-day period aboard the Chilean vessel *Friosur V*. The vessel will take a maximum of 240 tonnes of *D. eleginoides*. Dr Moreno extended an invitation for one scientist to participate as an invited observer on board the vessel.

3.45 The Scientific Committee supported the application to conduct the exploratory fishery, noting that the minimum effort possible was being applied (i.e., use of one vessel conducting only one trip of 40 days) and a maximum of 240 tonnes would be taken. The Scientific Committee agreed that the list of data to be collected should include information on the amount and composition of by-catch in the fishery. It was agreed that the participation of scientific observers aboard the vessel was essential.

EXPLORATORY FISHERIES

3.46 The Scientific Committee noted that the exploratory crab fishery had provided a useful example of the sequence of the steps that should be taken in association with a new fishery. It was felt that the advance notification of the start of the fishery, the provision of information about fishing operations and catches, and the plans to convene a workshop had been helpful in the Scientific Committee's evaluation of this exploratory fishery.

3.47 It was recalled that the provisions of Conservation Measure 31/X requiring notification of entry into a fishery and provision of information about the fishery ceased to apply at the conclusion of the Commission's annual meeting following initial notification from at least one Member. Members agreed that although there was an expectation that the provision of this type of information would continue once the fishery entered into an exploratory phase, a formal requirement no longer applied.

3.48 Some Members suggested that it would be desirable to formalise this process to ensure that any future new fisheries that may occur undergo similar assessments during their exploratory phase. Other Members believed that the need for such formal measures was less apparent.

3.49 The Scientific Committee agreed that as a general principle, the orderly development of new and exploratory fisheries was fundamental. Commercial catches should not be allowed to expand faster than the Scientific Committee is able to consider the implications of such expansion.

3.50 WG-FSA had discussed the various types of precautionary measures that could be implemented to promote the orderly development of new and exploratory fisheries (Annex 5, paragraphs 6.237 to 6.245). In this regard, it had recommended that when insufficient data were available with which to calculate a TAC, consideration should be given to imposing limits on fishing effort .

3.51 The Scientific Committee agreed that the topic of exploratory fisheries was one which merited further discussion at the 1993 meetings of the Scientific Committee and its Working Groups. Members were encouraged to develop and submit papers outlining possible approaches to this issue for consideration during the forthcoming year.

3.52 It was noted that the issues outlined above highlight the question of what management measures and research requirements are most appropriate when a fishery is operating under substantial uncertainty concerning the types and availability of data required for undertaking the desired single- or multi-species assessments.

3.53 It is the Scientific Committee's view that a precautionary approach is especially appropriate under circumstances of uncertainty, and the guidance of the Commission is solicited in advising the Scientific Committee of the types of analyses and management options that would be most useful to the Commission.

ASSESSMENTS AND MANAGEMENT ADVICE

3.54 Assessment summaries for the various fish stocks assessed by WG-FSA are presented in Appendix I of Annex 5.

Statistical Area 48 (South Atlantic)

Subarea 48.3 (South Georgia)

Notothenia rossii, Patagonotothen guntheri
and *Notothenia squamifrons* (Subarea 48.3)
(Annex 5, paragraphs 6.32 to 6.34, 6.83 to 6.88 and 6.89 to 6.91)

3.55 The Scientific Committee endorsed the advice of WG-FSA and recommended that all conservation measures for these species should remain in force.

Champsocephalus gunnari (Subarea 48.3)
(Annex 5, paragraphs 6.36 to 6.82)

3.56 The Scientific Committee endorsed the comments of WG-FSA. The Scientific Committee noted that a new survey carried out in 1992 by the UK confirmed that a dramatic drop in biomass in this stock occurred between 1989/90 and 1990/91. In view of this, the Scientific Committee agreed that the conservative management adopted by the Commission in 1991/92 was the most appropriate. Fish in 1990/91 were found to be in poor condition, with a lower than usual proportion in prespawning condition, which was probably the result of poor feeding due to a low abundance of krill in the area.

3.57 The 1992 survey indicates that there was a modest increase in the abundance of the stock, and that the fish have improved in condition.

3.58 The Scientific Committee agreed that the results from VPA analyses and stock projections from the VPA were unreliable and should not be used for assessing the current status of the stock.

3.59 WG-FSA used the age distributions and abundance estimates from the recent survey to calculate stock projections and a range of possible TACs. The Scientific Committee noted that these projections assumed that future recruitment to the stock would be similar to those estimated to occur before the recent decline in biomass. However, the observations of fish in poor condition which may have led to increased mortality and poor spawning performance means that this assumption may not be justified. The Scientific Committee considered that TACs calculated from these projections should be treated with caution. The lower 95% confidence interval of the projected catch using $\mathbf{F_{0.1}}$ indicates a TAC of 15 200 tonnes.

3.60 The Scientific Committee noted that re-opening the fishery for *C. gunnari* would lead to a by-catch of other species, and that only limited data (from Polish catches) on the by-catch in earlier fishing on *C. gunnari* were available. These data indicate that with bottom trawling, the catch of *C. gunnari* would need to be limited by the by-catch consideration, to six-times the MSY calculated for *N. gibberifrons*. This results in a TAC of 8 800 tonnes.

3.61 Analyses undertaken in 1990 showed that the by-catch of *N. gibberifrons* in pelagic trawls for *C. gunnari* is potentially of the order of 3 to 16%. This leads to a range for a possible TAC for *C. gunnari* of 9 200 to 15 200 tonnes, if MSY for *N. gibberifrons* is not to be exceeded.

Management Advice

3.62 In light of the uncertainty surrounding the current status of the stock the Scientific Committee recommended that a conservative approach to management is appropriate in the immediate future.

3.63 Some Members, taking into account the uncertainty about current levels of recruitment, the modest increase in abundance even after two years with negligible catches, and the likelihood that a fishery this coming season would rely heavily on two year old fish, considered that the current conservation measure prohibiting directed fishing on *C. gunnari* in Subarea 48.3 should be continued for at least one more year. Further monitoring of the stock should be carried out to observe its rate of recovery.

3.64 Other Members considered that re-opening the fishery with a low TAC would be possible.

3.65 Dr Shust considered that a TAC of 12 000 tonnes, which is at the middle of the range given above, would be appropriate.

3.66 Some Members considered that a TAC of this magnitude could result in the by-catch of one or more of *N. gibberifrons* or *C. aceratus* or *P. georgianus* exceeding the MSY for these species, even if the fishery was to be restricted to pelagic trawls (Annex 5, paragraph 6.72). It was emphasised that *P. georgianus* may be particularly vulnerable to pelagic trawls because it is believed to undertake vertical migrations within the water column.

3.67 Dr Shust said that a higher by-catch of *N. gibberifrons* could be acceptable because of the likely continued improvement in the stock (Annex 5, paragraph 6.95).

3.68 If the fishery is re-opened, the Scientific Committee recommended that the following measures be applied:

(i) bottom trawling to be prohibited;

(ii) a TAC set at 9 200 tonnes;

(iii) an effort and biological reporting system similar to that specified in Conservation Measure 37/X be instituted which should also include information on the proportion of by-catch species;

(iv) the fishing season to be closed from 1 April to the end of the following Commission meeting to protect the spawning stock; and

(v) the mesh regulations to be maintained (Conservation Measure 19/IX).

Notothenia gibberifrons, Chaenocephalus aceratus and *Pseudochaenichthys georgianus* (Subarea 48.3) (Annex 5, paragraphs 6.92 to 6.101)

3.69 The Scientific Committee endorsed the recommendations of WG-FSA.

Management Advice

3.70 Stocks of *N. gibberifrons* and *C. aceratus* have apparently recovered to a high proportion of their initial levels. *P. georgianus* may not have recovered to the same extent. A re-opening of the fishery on these species might be considered. However, all three species have been taken in quantity only by bottom trawling in the commercial fishery. None of these species can be taken without a significant by-catch of other species.

3.71 The Scientific Committee recommended that a directed fishery on these three species should remain prohibited because the potential yields could be entirely taken as by-catch in the *C. gunnari* fishery.

Electrona carlsbergi (Subarea 48.3) (Annex 5, paragraphs 6.102 to 6.107)

3.72 The Scientific Committee endorsed the advice from WG-FSA on this species.

Management Advice

3.73 The Scientific Committee has difficulty in providing advice based on data and assessments which are no longer current. The fishery in 1991/92 was subject to Conservation Measure 38/X.

3.74 On the basis of the known biological characteristics of the stock, the current level of fishing on *E. carlsbergi* in Subarea 48.3 may be sustainable. However, the fishery is now based on a stock for which the age structure and biomass are unknown. Substantial by-catches of other myctophids are also taken, for which few biological data are available. Thus, the Scientific Committee was unable to advise on an appropriate TAC for the current fishery. The Scientific Committee reiterated the need for further surveys to estimate current biomass (SC-CAMLR-X, Annex 6, paragraph 7.149).

Dissostichus eleginoides (Subarea 48.3)
(Annex 5, paragraphs 6.108 to 6.176)

3.75 The Scientific Committee endorsed the advice and recommendations of WG-FSA for this stock.

3.76 WG-FSA undertook a substantial review of the state of biological knowledge of this species as part of the assessment. This review is summarised in Annex 5, paragraphs 6.118 to 6.140. and Annex 5, Appendix G.

3.77 The Scientific Committee endorsed the list of data requirements and future research needs given in Annex 5, paragraph 6.176.

3.78 The Scientific Committee noted with appreciation the submission of haul-by-haul data from the fishery. This detailed data has allowed considerable refinement of the estimates of stock abundance using a range of methods. Last year, the range of estimates of stock abundance was 8 000 to 610 000 tonnes. The improvements in data has allowed this range to be refined to 8 000 to 160 000 tonnes. Further fine-scale data collection should allow a steady improvement in assessments, particularly if experiments on hook selection factors could be carried out by ensuring that different hook types were fished on the same grounds at the same time.

Management Advice

3.79 In spite of the improvements in estimates of abundance, considerable uncertainty still remains about the size of this stock and its sustainable yield. Given the wide range of possible TACs the Scientific Committee considered that a conservative approach should be taken in setting a TAC. The Scientific Committee considered that a stock biomass in excess of 45 000 tonnes is unlikely. Accordingly, the Scientific Committee recommended a TAC in the range 750 to 5370 tonnes. Given that the most recent TAC is near the middle of this range, the Scientific Committee agreed that a TAC similar to that set in 1991/92, under Conservation Measure 35/X, would be appropriate. It was also agreed that it is desirable to avoid large year to year variations in TAC when possible. The

Scientific Committee recommended that Conservation Measure 35/X, with an appropriate alteration dependent on the setting of a new TAC, should be retained for the 1992/93 season.

3.80 The Scientific Committee noted that the TAC in 1991 was reached after four months. It was agreed that further expansion of the number of vessels taking part in the fishery would not be appropriate, as this would lead to even earlier closure of the fishing season, which could introduce extra complications into the CPUE and other fine-scale data, with consequent deleterious effects on assessments.

Subarea 48.2 (South Orkney Islands)

Champsocephalus gunnari (Subarea 48.2) (Annex 5, paragraphs 6.181 to 6.199)

3.81 Dr Shust queried the assumption used in one set of biomass projections, carried out for this stock by WG-FSA, that the recruitment to the stock was assumed to be zero for a number of years. He considered that the validity of this assumption was doubtful and use of it would lead to a substantial underestimate of current stock abundance and to a TAC which would be too low.

3.82 The acting chairman of WG-FSA explained that the samples collected during research surveys contained very few young fish. He further explained that WG-FSA had used three different scenarios relating to recruitment in order to evaluate the likely range for the current status of the stock. Mr Balguerías concurred, noting that data from both the former USSR fishery and the results of trawl surveys carried out by Spain indicate that one strong cohort supported the fishery over a number of years.

3.83 With this clarification, the Scientific Committee endorsed the advice and recommendations of WG-FSA on this species.

Management Advice

3.84 The Scientific Committee noted the large number of assumptions and uncertainties associated with both the projections and the maximum yield calculations for this stock. The Scientific Committee agreed that a conservative approach would be appropriate for managing this stock. The Scientific Committee recommended that the fishery for *C. gunnari* in Subarea 48.2 remains closed until a survey is conducted and a more accurate estimate of the status of the stock has been obtained.

Notothenia gibberifrons, Chaenocephalus aceratus, Pseudochaenichthys georgianus, Chionodraco rastrospinosus and *Notothenia kempi* (Subarea 48.2) (Annex 5, 6.200 to 6.202)

3.85 The Scientific Committee endorsed the advice from WG-FSA on these species. In light of the Scientific Committee's recommendation for continued closure of the *C. gunnari* fishery, the re-opening of a mixed species fishery in Subarea 48.2 was not considered.

Subarea 48.1 (Antarctic Peninsula) (Annex 5, paragraphs 6.203 to 6.206)

3.86 The finfish fishery in the Antarctic Peninsula subarea has been closed during the 1991/92 season (Conservation Measure 41/X). The Scientific Committee expressed concern about the reported catch of 50 tonnes of *E. carlsbergi* taken in Subarea 48.1. The Scientific Committee endorsed the comments of WG-FSA on this subarea.

Management Advice

3.87 Pending further information on the fish stocks in the area, the Scientific Committee recommended that conservation measures in force should be maintained (Conservation Measure 41/X) until a research survey is carried out to enable the status of the fish stocks in Subarea 48.1 to be re-assessed.

Statistical Area 58 (Indian Ocean)

Division 58.5.1 (Kerguelen)

Dissostichus eleginoides (Division 58.5.1) (Annex 5, paragraphs 6.208 to 6.214)

3.88 The catch in 1991/92 of this species increased markedly over previous years to 7 492 tonnes. This is the highest catch of this species ever recorded in this area. The average annual catch between 1984/85 and 1990/91 was 2 210 tonnes, and the previous largest catch was 6 677 tonnes in 1984/85 when the trawling grounds on the western shelf area were first exploited. 6 787 tonnes of the 1991/92 catch was taken mostly on the trawling grounds in the northern part of the plateau, which were discovered in the 1990/91 season. The exploratory longline fishery was conducted in the western part of the plateau (at 400 to 600 m) by two vessels to assess the effects of this type of fishery on *D. eleginoides*, the efficiency of the regulations imposed and the measures to minimise incidental mortality of seabirds. 705 tonnes of fish were caught by this method.

3.89 Dr G. Duhamel (France) agreed with the conclusions reached by WG-FSA with respect to its analyses and recommendation for the trawling grounds for *D. eleginoides* to the west of Kerguelen. However, he considered that more careful analysis of the CPUE data was required, particularly to take into account catch location. He considered that it was not valid to extrapolate the advice from the western trawling ground to the new trawling ground to the north of Kerguelen.

Management Advice

3.90 The Scientific Committee is concerned at the rapid expansion of the fishery for *D. eleginoides* in Division 58.5.1. The Scientific Committee recommended a catch at a similar level to 1991/92 (1 100 tonnes) should be set for the western trawling grounds. The Scientific Committee also recommended that a catch level be established for the northern trawling grounds substantially below the catch taken in the 1991/92 season.

Notothenia rossii (Division 58.5.1)
(Annex 5, paragraphs 6.215 to 6.216)

3.91 The Scientific Committee endorsed the recommendations of WG-FSA. The Scientific Committee recommended that existing measures prohibiting directed fishing should be retained.

Notothenia squamifrons (Division 58.5.1)
(Annex 5 paragraphs 6.217 and 6.218)

3.92 The Scientific Committee endorsed the recommendations of WG-FSA.

Champsocephalus gunnari (Division 58.5.1)
(Annex 5 paragraphs 6.219 and 6.220)

3.93 The Scientific Committee endorsed the advice of WG-FSA without comment.

Division 58.4.4 (Ob and Lena Banks)

Notothenia squamifrons (Division 58.4.4)
(Annex 5, paragraphs 6.222 to 231)

3.94 The Scientific Committee endorsed the recommendations of WG-FSA.

3.95 Dr Yakovlev stated that Ukraine was intending to conduct surveys to estimate the biomass of the stocks on these banks in the coming year. An *ad hoc* group was set up to review the Ukrainian cruise design before the end of this Commission meeting.

Management Advice

3.96 The results calculated by WG-FSA indicate a stock in 1990 of about 6 000 tonnes on Lena Bank and 3 500 tonnes on Ob Bank. As the species is relatively slow growing, the stock size is likely to have changed little since 1990. Although it appears that the stock could sustain a fishery of a few hundred tonnes, the Scientific Committee recommended that a survey to determine age structure and stock size at both Ob and Lena Banks should be undertaken, and a revised assessment carried out before considering re-opening the fishery.

Pleuragramma antarcticum (Division 58.4.2)
(Annex 5, paragraphs 6.232 to 6.236)

3.97 The Scientific Committee endorsed the comments of WG-FSA on this species. The Scientific Committee recommended that no fishery should be undertaken on *P. antarcticum* in the CEMP Integrated Study Regions (ISRs).

OTHER RESOURCES

SQUID

4.1 No Members reported fishing for squid within the Convention Area during the past year. In addition, no field program on cephalopod biology was reported by Members.

4.2 The UK reported research on the diet of *Martialia hyadesi* that was conducted during this last year (SC-CAMLR-XI/BG/10 and 11). Samples of deep frozen squid, collected aboard two

Japanese squid jigging vessels carrying out commercial fishing trials at the Antarctic Polar Frontal Zone, north Scotia Sea in February 1989 were examined. The prevalence of copepod-feeding myctophids in the diet of squid, which is itself a major prey item of some higher predators in the Scotia Sea, suggests that they fed in two food chains, the copepod-myctophid food chain and the *E. superba* food chain.

4.3 An international symposium on Southern Ocean Cephalopods: Life Cycles and Population, on behalf of the Cephalopod International Advisory Council and sponsored by the British Antarctic Survey and the Malacological Society of London will be held at King's College, Cambridge from the 4 to 10 July, 1993.

CRABS

4.4 It was noted that the Scientific Committee at the last meeting had initially assigned the task of assessing the status of crab stocks to WG-FSA. It was agreed that this was the appropriate venue for this work and that future assessment of crab stocks should be completed by WG-FSA.

4.5 The Scientific Committee commended the US for the way it had conducted the early developmental stages of the new crab fishery and that this should serve as a guide for the development of other new fisheries.

4.6 Beginning in early July 1992 and continuing until the present, the US vessel FV *Pro Surveyor* has been conducting fishing operations for Antarctic crabs in waters around South Georgia and Shag Rocks (Subarea 48.3). Two species are being caught: *Paralomis spinosissima* and *P. formosa*. Using data collected during the first 22-day trip of the vessel, "commercial" crabs to be retained as catch were defined as males of *P. spinosissima* that exceed 102 mm in carapace width. Only about 500 male *P. formosa*, which exceeded 90 mm, were retained and all other crabs were returned to the sea (Annex 5 and WG-FSA-92/29).

4.7 During the first trip, approximately 7 280 pots were lifted (fished), and on average, each pot contained approximately seven crabs which averaged about 1.1 kg each.

4.8 Mr P. Duffy, owner of the US crab fishing vessel conducting operations in Antarctic waters, was invited by the Scientific Committee to provide details of the fishing operation. He provided answers to several questions concerning the specific operation of the fishery, his future plans to fish in Antarctic waters, survival of released crabs, incidence of parasites in the crabs, etc.

4.9 The Scientific Committe noted WG-FSA's view that growth rates of Antarctic crabs are unknown and apparently high initial catches may reflect an accumulated biomass and lead to an overestimate of sustainable yield. In addition, the Scientific Committee agreed that reliable estimates of sustainable yield of Antarctic crabs could not be calculated from the limited data available (Annex 5, paragraphs 6.8 and 6.9).

4.10 WG-FSA investigated two methods which might provide guidance in setting conservative levels of catch to be applied in the early stages of the fishery while the data necessary for more precise estimates are being acquired and analytical methods are being developed.

4.11 The first method, described in Annex 5, paragraph 6.10, is based on the fact that catch rates and the depths at which crabs are taken in Antarctic waters are similar to those in the Aleutian Islands (Bering Sea) fishery for golden king crab (*Lithodes aequispinum*). This method indicated that Subarea 48.3 might have an annual potential yield of 2 210 tonnes between 200 and 1 000 m (strata fished during the first trip).

4.12 In the second method (Annex 5, paragraph 6.11), a rough calculation of the standing stock of commercially sized male *P. spinosissima* was made by determining the vessel's average catch per n mile^2 and multiplying this value by the total fishable area (200 to 1 000 m) in Subarea 48.3. This method indicated that the standing stock might be roughly 155 000 tonnes.

4.13 However, the Scientific Committee agreed with the view of WG-FSA that this method contained a number of potential biases (Annex 5, paragraphs 6.16 and 6.17). Therefore, a conservative approach was to reduce the standing stock calculation by 50% and by 70%. This reduced the calculated stock estimate to 78 000 and 48 000 tonnes, respectively.

4.14 A catch of 2 210 tonnes, based on calculations of the potential yield from the Aleutian Island fishery, would correspond to less than 5% of exploitable standing stock estimates in the second method.

Management Advice

4.15 The Scientific Committee agreed that given the large uncertainties associated with estimating standing stock, a conservative management strategy should be followed. This would include WG-FSA's suggestion that immediate application of precautionary measures and the simultaneous commencement of work on the development of a longterm management plan for the fishery should be adopted.

4.16 The Scientific Committee recognised that the first stage in the development of a longterm management plan is the convening of a workshop during the intersessional period to specify the data needed and the actions required to acquire the data from the exploratory crab fishery that will allow the development of assessment methods and the estimation of appropriate harvest levels. The Workshop should be held in late April or early May, 1993.

4.17 The terms of reference for the Workshop are:

(i) to design an approach to management of this fishery that will enable WG-FSA to measure;

(a) the productivity and abundance of the stock; and
(b) the effect of different harvest strategies;

(ii) to establish the types and scale of data necessary to implement the above approach to management; and

(iii) to establish reporting requirements for the fishery.

4.18 Pending the development of a longterm management plan for the crab fishery in Statistical Area 48 by the Workshop and its subsequent review by WG-FSA and the Scientific Committee and its endorsement by the Commission, the following measures should be applied:

(i) the fishery should be closed until the end of the Workshop (planned for April or May, 1993);
(ii) the exploratory crab fishery should be limited to a few vessels (i.e., one to three vessels); however, if more than three vessels register with the Secretariat to fish for Antarctic crabs, a catch limit (see paragraphs 4.19 and 4.20) should be applied for the period from the start of the fishery until the next meeting of the Commission;

(iii) a condition to enter this fishery should be that each Member participating, or intending to participate, in the exploratory crab fishery register with the Secretariat (at least three months in advance of starting fishing annually) the name, type, size, registration number, and radio call sign and fishing plan of each vessel that the Member has authorised to participate in the exploratory crab fishery;

(iv) the following data should be reported to CCAMLR by 30 September 1993 for crabs caught prior to 30 July 1993;

  (a) the location, date, depth, fishing effort (number and spacing of pots) and catch (numbers and weight) of commercially sized crabs (reported on as fine a scale as possible, but no coarser than 1° longitude by 0.5° latitude) for each 10-day period;

  (b) the species, size, and sex of a representative subsample of crabs caught in traps;

  (c) other relevant data, as possible, according to the logbook formats already being used in the exploratory crab fishery (Annex 5, Appendix F);

(v) data identified by the Workshop that are required to determine the appropriate harvest levels should be collected during the 1993 season by all vessels fishing for Antarctic crabs. These data should be reported to CCAMLR in the form specified by the Workshop;

(vi) crab fishing gear should be limited to the use of crab pots (traps). The use of all other methods of catching crabs (e.g., bottom trawls) should be prohibited;

(vii) the crab fishery should be limited to sexually mature male crabs that have had, on average, at least one opportunity to breed - all female and undersized male crabs caught should be released unharmed. In the case of *P. spinosissima* and *P. formos*a, males with a minimum carapace width of 102 mm and 90 mm, respectively, may be retained in the catch; and

(viii) crab processed at sea should be frozen as crab sections (minimum size of crabs can be determined using crab sections).

4.19 Some Members believed that if more than three vessels register to enter the fishery for Antarctic crabs (see paragraph 4.18 above) a reasonable catch limit would be 2 200 tonnes.

4.20 Other Members believed that if more than three vessels register to participate in the crab fishery a reasonable catch limit would be 1 000 tonnes.

4.21 The Scientific Committee welcomed the offer of the US to host the CCAMLR Crab Workshop at the Southwest Fisheries Science Center, La Jolla, California.

ECOSYSTEM MONITORING AND MANAGEMENT

5.1 Dr Bengtson, Convener, presented the report of the Sixth Meeting of the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP), held at Viña del Mar, Chile, 7 to 12 August 1992 (Annex 7).

5.2 The Scientific Committee thanked the Working Group for its work during the intersessional period and at the recent meeting. The text below reports the endorsement of specific initiatives and the discussion of these and other points during the Scientific Committee's review of the report. The remainder of the WG-CEMP report, which was endorsed generally by the Scientific Committee, should be consulted for specific details.

5.3 Seventeen scientists from nine Members had attended the meeting. The absence of scientists at WG-CEMP from Brazil, France, Germany, New Zealand, Sweden and South Africa, all of whom have active programs of considerable relevance to WG-CEMP, was greatly regretted. The Scientific Committee endorsed the initiative of WG-CEMP in attempting to enhance participation (Annex 7, paragraph 3.10) and encouraged Members to do whatever possible to help. The action of Argentina in producing a video to increase awareness of CEMP operations was particularly commended.

5.4 The Convener drew attention to the substantial amount of CEMP activity being undertaken by Members. Annual data collection in support of CEMP is underway at several field sites (see Annex 7, Table 1), and many papers describing results and analyses from these studies had been tabled for the Working Group's consideration.

MONITORING PROCEDURES

5.5 The Scientific Committee endorsed the establishment of *ad hoc* subgroups within WG-CEMP for reviewing existing and future proposals relating to:

(i) designation and protection of monitoring sites and review of management plans;

(ii) practical aspects of standard monitoring methods and proposals for new methods; and

(iii) statistical aspects of monitoring and methods.

Member's attention was drawn to the requirement to submit any proposals on these topics in writing three months in advance of WG-CEMP meetings. Proposals concerning protection of CEMP sites should be submitted to the Secretariat; all others should be sent initially to the Convener.

5.6 The production by the Secretariat of a document describing in detail the procedures for calculating indices from each of the parameters being monitored by standard methods, was noted. This document marks an important step in the development of appropriate standardised analytical methods. Future refinements will undoubtedly be desirable but it was agreed that the document in its present form should be published in CCAMLR *Selected Scientific Papers* and included in the next edition of the *CEMP Standard Methods for Monitoring*.

5.7 Although no proposals for new standard field methods had been received, the Scientific Committee noted that the use of implanted passive transponder tags was an important development with significant implications for automated monitoring of several parameters in the future.

5.8 It was noted that WG-CEMP had indicated that it was not intending to schedule in 1993 a workshop to develop standard methods for monitoring at-sea behaviour of penguins and pinnipeds. Scientists who had attended the workshop on analysis of data from time-depth recorders used on pinnipeds at the University of Alaska in September 1992 and those who will attend sessions and/or symposia on this topic at the forthcoming meeting of the Society for Marine Mammalogy (Galveston, Texas, October 1993) are urged to ensure that WG-CEMP receives full and detailed feedback on relevant aspects of these meetings. Pending review of the outcome of these meetings, WG-CEMP will consider whether CCAMLR should consider holding a workshop on this topic in the future.

5.9 The Scientific Committee commended progress in investigating the feasibility of acquiring satellite imagery permitting routine monitoring of sea-ice distribution within CEMP Integrated Study Regions (ISRs). It thanked the Secretariat for its considerable effort in this regard. It endorsed the recommendations of WG-CEMP concerning acquisition of JIC data that would be incorporated into the CCAMLR Database for the three ISRs and for Subareas 48.1, 48.2 and 48.3 (Annex 7, paragraphs 4.30 and 4.31). SC-CAMLR-XI/10 provided the requested (Annex 7, paragraph 4.29) estimates for this undertaking. These were approved by the Scientific Committee and it was agreed that they be incorporated into the budget request of the Scientific Committee for the current and succeeding financial years.

5.10 The Scientific Committee endorsed the recommendation of WG-CEMP, based on a detailed evaluation by the Secretariat, that future editions of the *Standard Methods for Monitoring* volume should be produced in loose leaf ring binder format. It was recommended that a new edition be produced as soon as possible.

MONITORING RESULTS

5.11 The Scientific Committee noted that there had been an extensive review of the full set of data resulting from monitoring of predators (Annex 7, paragraphs 5.1 to 5.18). Members were encouraged to complete the process of checking the accuracy of their submitted data and of the indices derived therefrom.

5.12 Prey data from both fishery and fishery-independent activities had been reviewed by WG-CEMP. This included fine-scale krill catch data (Annex 7, paragraphs 5.20 to 5.22) and additional valuable information on the operations of the Russian and Chilean fisheries, including the provision of haul-by-haul and CPUE data from the latter (Annex 7, paragraphs 5.23 to 5.26).

5.13 The value of fine-scale data had again been emphasised by WG-CEMP, and the Scientific Committee noted the importance of the request to Japan to provide data on combined hauls at a scale of 10 x 10 n miles.

5.14 Dr Naganobu indicated that Japan could report future krill catches on a scale of 10 x 10 n miles. He noted, however, that because of the need to develop appropriate analytical software and domestic reporting mechanisms, initiating this reporting scheme may be delayed for 6 to 12 months. The Scientific Committee thanked Japan for their positive response and encouraged them to provide the required information as rapidly as circumstances permit.

5.15 Korea will continue scientific surveys on krill distribution and abundance. However, future plans for krill fishing are not available at the present time.

5.16 The Scientific Committee noted the request from WG-CEMP to WG-Krill for the provision of estimates of krill biomass within the complete area of all three ISRs whenever the data become available.

5.17 The Scientific Committee welcomed the continuation of the fine-scale hydroacoustic surveys of krill in the vicinity of the Seal Island CEMP site by the USA. These are currently the only surveys for krill being conducted in accordance with the standard methodology developed by WG-Krill; other Members were urged to commence similar surveys as soon as possible. The importance of reporting the variance associated with estimates of krill biomass was emphasised.

ECOSYSTEM ASSESSMENT

5.18 The 1992 meeting of WG-CEMP provided the first opportunity to review and assess all the data being collected under CEMP in relation to available information on the biological and physical environment (including fishery data) in the manner previously endorsed by the Scientific Committee and Commission (see Annex 7, paragraphs 6.1).

5.19 This assessment and its synthesis in Annex 7, Table 4 was warmly welcomed by the Scientific Committee. Although WG-CEMP had noted that the present synthesis was a rather coarse and preliminary treatment, the Scientific Committee felt that even at this level it showed clearly the importance and utility of the approach. Some interesting patterns had emerged, particularly for 1991, apparently a year of poor availability of krill to predators across all three subareas of Statistical Area 48; there were numerous additional features of interest.

5.20 WG-CEMP was strongly encouraged to expand and refine these assessments at future meetings, especially by considering the magnitude and significance of changes and by incorporating future years' data as these become available.

5.21 It was recognised that these assessments would be greatly improved by more comprehensive data on krill availability both from the fishery and from research surveys. In this regard, WG-CEMP had suggested that obtaining some subjective assessments might be a helpful complement to other sources of data (Annex 7, paragraph 6.35).

5.22 However, Dr V. Marín (Chile) was doubtful that requesting subjective assessments, including general impressions from fishing captains (Annex 7, paragraph 6.35) would be useful. He much preferred reliance on CPUE indices, such as Chile was able to provide from its fishery. Mr Miller agreed and noted that the Composite Index which had been developed by WG-Krill (SC-CAMLR-VIII, paragraph 2.15) was directly relevant to this assessment of availability of krill to the fishery.

5.23 WG-Krill was encouraged to develop these indices as far as possible and to provide annual summaries of the current availability of such indices to WG-CEMP in advance of the latter's meeting.

POTENTIAL IMPACT OF LOCALISED KRILL CATCHES

5.24 Last year in response to the analyses showing the considerable geographical overlap between the krill harvest and the foraging ranges of krill-dependent predators during their breeding season in three successive years in Subareas 48.1 and 48.2, the Scientific Committee stated that "a situation, whereby a substantial krill fishery consistently operates within the foraging range of krill-dependent predators at a critical time of year (when the predators have dependent offspring), had long been identified as a most serious concern and one where close and urgent attention needs to be given to appropriate management action" (SC-CAMLR-X, paragraph 6.29).

5.25 The Scientific Committee also noted last year that an appropriate precautionary management measure to provide protection for land-based predator populations at the critical time of year when they are breeding would be to prevent fishing within the foraging range of these predators (up to 50 km for penguins, 80 to 100 km for fur seals) at the time of year that they are rearing offspring (from December through February) (SC-CAMLR-X, paragraph 6.34).

5.26 In consequence, the Scientific Committee initiated an investigation of the implications and consequences of such potential conservation measures with Members conducting fishing in these areas (see paragraph 5.35 below).

5.27 Notwithstanding these initiatives the Scientific Committee also made a clear statement recognising the potentially serious situation of substantial krill fisheries consistently located near seal and seabird colonies, (SC-CAMLR-X, paragraphs 6.28 and 6.31), the current lack of data adequate for any precise assessment of the magnitude and consequences of these problems (SC-CAMLR-X, paragraphs 6.30(i) and (ii), paragraph 6.26) and the advice on precautionary management procedures available to mitigate these problems (SC-CAMLR-X, paragraph 6.34). Most Members felt that it was highly desirable to implement now a conservation measure to provide adequate protection for predators in appropriate parts of Subareas 48.1 and 48.2 until sufficient data are available to assess the situation more precisely (SC-CAMLR-X, paragraph 6.75).

5.28 Dr Naganobu indicated the lack of evidence that the fishery is having any marked effect on seal and penguin colonies.

5.29 This year the analyses by the Secretariat of the fine-scale catch data had reinforced the findings of previous years. The overall picture for Subarea 48.1 was still remarkably consistent in all four years (1988 to 1991) for which data are available, with 96 to 98% of the krill catch from December to March in the subarea being taken within the critical period-distance for foraging activity of breeding penguins and fur seals. For Subarea 48.2, the 1991 data showed 81% of the catch taken within the critical period-distance, similar to 1987 (83%) and 1988 (96%) and very different from 1989 (5%) and 1990 (17%) (Annex 7, paragraph 6.39).

5.30 WG-CEMP had agreed that it was entirely proper for WG-Krill and WG-CEMP to give serious and urgent consideration to the circumstances whereby substantial krill catches are taken annually from within a very restricted area at a time of year when krill eating predators, trying to rear offspring, are restricted to the same area - that it would be difficult to imagine a situation of greater potential concern to WG-CEMP (Annex 7, paragraph 6.49) and, that it is essential to consider appropriate precautionary management measures, including, but not confined to, catch limits (Annex 7, paragraph 6.50). WG-CEMP had re-emphasised that the object of developing precautionary measures in this context is to try to identify management measures to afford adequate protection for krill-dependent predators in specific areas at critical times of year without this protection causing unnecessary or unacceptable restrictions for the krill fishery.

5.31 Dr Naganobu had disagreed with this view, for the reasons set out in Annex 7, paragraphs 6.46 and 6.47, which had been rebutted by other Members (Annex 7, paragraphs 6.50 to 6.52), who drew attention to the possible incompatibility of some of the former views in relation to the established policies of the Scientific Committee and Commission.

5.32 The Scientific Committee then considered a proposal (SC-CAMLR-XI/BG/15) tabled by Dr Holt concerning allocation of krill precautionary catches within the foraging ranges of land-based predators in Statistical Area 48. This was essentially an elaboration of the proposal noted in the report of WG-Krill (Annex 4, paragraph 6.11).

5.33 With regard to this proposal for allocating a precautionary catch limit for the krill fishery near land-based predator colonies, the Chilean Delegation considered that because of the prevailing low catch levels of krill and their decreasing trend, there is no basis for immediate action to be taken by the Scientific Committee. Nevertheless, Chile proposed that this matter should be given further consideration by WG-Krill and WG-CEMP during the intersessional period.

5.34 Japan, Korea and Poland endorsed the statement by Chile.

5.35 In addition, Japan stated that it believed the catch limit for Subarea 48.1 to be recommended to the Commission this year is sufficient to safely manage the krill resources and local ecosystem. Japan does not consider, however, that there is any biological need to further restrict krill catch in the waters around the islands in Subarea 48.1. According to monitoring surveys on penguins and seal populations thus far conducted, there are no signs to suspect that populations of predator animals are adversely affected by the present krill fishery. This is corroborated by the following findings:

(i) according to the Japanese surveys, 80% of the krill resource in Subarea 48.1 is located in the waters around the islands;

(ii) according to surveys by both Japan and USA, the biomass of krill in the waters around islands fluctuates between 1 and 2 million metric tonnes.

(iii) Agnew (1992)[1] estimates that the present catch level in Subarea 48.1 is less than one-third of the MSY and this applies principally to the waters around the islands (see (i) above);

(iv) the nature of the Butterworth model used in setting precautionary catch limits, is, as pointed out by Dr Hatanaka, sufficiently conservative and precludes the need to install further restriction in the area.

5.36 Most Members disagreed with these views and interpretations.

- First, the topic at issue is the provision of protection to populations of krill-dependent predators which are constrained to forage at critical times of year in restricted areas in which substantial krill fishing also occurs. WG-CEMP and the Scientific Committee have consistently recognised that setting precautionary catch limits at area or subarea scales is inadequate to provide protection in such cases (SC-CAMLR-X, paragraphs 3.80 to 3.84, Annex 5, paragraphs 5.13 and 6.16).

- Second, at least with respect to such predators breeding in areas adjacent to the main fishing grounds in Subarea 48.1, there are neither adequate data on status and trends of populations nor monitoring data and so no basis for coming to any conclusion on whether these populations are adversely affected by krill fishing or not. In any case, WG-CEMP and the Scientific Committee have noted the difficulty of detecting causal relations between changes in predator performance and fishing activities (e.g., SC-CAMLR-VIII, Annex 7, paragraph 104) and most Members have recognised that precautionary management approaches will need to be adopted in these kinds of circumstances, based on the best available data.

- Third, the statements in paragraph 5.35(i) and (ii) provide no logical corroboration of any of the preceding statements in the paragraph in view of the restricted nature of the surveys, the mobility of krill, the lack of information on relationships between krill biomass and availability to predators (and fishery) and the fact that estimates of krill

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1 AGNEW, D. 1992. Distribution of krill (*Euphausia superba* Dana) catches in the South Shetlands and South Orkneys. Document *WG-KRILL-92/19*. CCAMLR, Hobart, Australia.

requirements of penguins and fur seals represent minimum estimates for the whole of the local krill-dependent predator community.

- Fourth, the calculation in Agnew (1992) that the ratio between the catch and the estimated predator consumption in Subarea 48.1 is less than one-third does not imply that the catch is less that one-third of the MSY because, as indicated by Beddington and Cooke (1983)[1], the MSY usually occurs at levels of fishing mortality that are lower than natural mortality.

- Fifth, the model referred to in paragraph 5.35(iv) had not been used in the setting of the precautionary catch limits. The model is currently being validated, taking account of Dr Hatanaka's reservation, as requested by the Scientific Committee. Consequently, it is premature to comment on the characteristics of this model at this time and in this context.

5.37 After pursuing counter-comments as described in paragraph 5.36, Japan did not find any scientific reason to alter its position as described in paragraph 5.35. Specifically,

- The point is whether there is any urgent need to introduce further protection measures for foraging animals for particular areas within Subarea 48.1 in addition to the precautionary catch limit to be installed for the entire Subarea 48.1, in view of the available scientific evidence and the historical fishing pattern in the area. Japan stated that there is no such urgency as would not allow awaiting the outcome of the planned study on this issue.

- Further, Japan considers it appropriate to clarify its view in relation to some of the arguments raised in paragraph 5.36. First, Japan does not see any logic in the accusation that 5.35(i) and (ii) provide no logical corroboration. Japan's explanation was terse, pointing to the existence of some 1 to 2 million tonnes of krill in the waters around islands throughout the critical period from January through March, which is far in excess of the demand of the krill predators.

- Japan referred to Agnew (1992) and his use of the Gulland model that indicated the present catch level being less than one-third of the MSY level.

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1 BEDDINGTON, J.R. and J.G. COOKE. 1983. The potential yield of fish stocks. *FAO Fish. Techn. Pap. 242*: 47 pp.

- With respect to the Butterworth model (1991) used in calculating a precautionary catch limit, Japan had two thoughts in advancing its view. One concerns the basic assumption employed in the model; Japan considered that that assumption is far too conservative to be realistic. The second point is the discounting factor employed in the model in arriving at the final catch limit figures.

- In conclusion, Japan does not see any urgent need to introduce such conservative measures as those contemplated in paragraph 5.36 without awaiting the outcome of the planned research into this question.

5.38 The Scientific Committee then addressed the topic of potential management measures relating to closed seasons and areas.

5.39 Responses to last year's questions from the Scientific Committee to Members engaged in fishing in the relevant areas (Annex 4, paragraphs 5.1 to 5.35) had been most helpful. However, it was noted that the general tenor of the replies indicated that moving part of the harvest away from the areas currently targetted during December through February would probably entail some reduction in fishing efficiency.

5.40 The importance of continuing this dialogue was recognised. Several Members indicated that asking questions as general as those outlined in Annex 7, paragraph 6.57 might not be very helpful. However, other Members felt that it would still be useful to invite Members currently engaged in fishing for krill to consider and report on what potential measures, or combinations of measures, would be acceptable to them for application within Subareas 48.1 and 48.2 in order to address the specific problem of providing some precautionary protection for land-based krill predators foraging within 100 km of breeding colonies between December and March inclusive.

5.41 The Scientific Committee decided that in the context of developing precautionary measures to afford adequate protection for krill-dependent predators in specific areas at critical times of year, without this protection causing unnecessary or unacceptable restrictions for the krill fishery, it would be helpful to conduct a simulation study to explore more fully the potential and consequences of different extents and locations of closed areas. The study would use the fine-scale data for the krill fishery in Subarea 48.1 within the period December through February in the last five years.

5.42 The Secretariat was asked to undertake this simulation analysis intersessionally. The Scientific Committee advised that the model would require the subdivision of Subarea 48.1 into several "longitudinal" subdivisions taking into account especially the timing and location of fishing, and the consideration of various zonal limits (e.g., 50 km, 60 km, 100 km from breeding colonies of land-based predators).

5.43 The simulation analysis should examine the consequences of closing one or more subdivisions simultaneously, and in rotation, and taking account also of the need to ensure that in areas around some existing or potential CEMP sites, fishing should remain unrestricted.

5.44 The Secretariat should table the results of these analyses at the next meetings of WG-CEMP and WG-Krill. It is intended that these results would stimulate a further dialogue on the feasibility of implementing some combination of closed areas and closed seasons to protect some predators at a particularly critical time of year.

5.45 Japan, although not intending to deny the merit of such simulation studies, stated that it was opposed to any proposition which might pre-determine the necessity of closed area or closed season measures, in light of the current historical low catch level in the region concerned.

5.46 In response to the Japanese statement, other Members expressed the following opinions. In several recent meetings of WG-CEMP and the Scientific Committee of CCAMLR there had been unanimous or near unanimous concern over circumstances of persistent geographical overlap between significant krill fishing and the foraging ranges of krill-dependent predators at critical times of year; this concern was irrespective of the overall magnitude of the krill fishery and of any assertions regarding future levels of this fishery.

5.47 The Scientific Committee had agreed unanimously that there was a need to give close and urgent attention to appropriate management action in these circumstances (SC-CAMLR-X, paragraph 6.29). It had been indicated at the present meeting that the imposition of precautionary TACs over particular zones within subareas was unlikely, on its own, to be the most appropriate or most effective management measure. Various Members were agreed that some combination of catch limits, closed seasons and closed areas would offer a good prospect of mitigating potential problems for predators without imposing unacceptable changes to fishing practice and also offered a reasonable prospect of monitoring compliance.

5.48 Most Members recognised that it was unreasonable to try to establish measures for closed seasons and closed areas without dialogue with Members conducting fishing and without assessment of the potential consequences of various types and combinations of such measures. Detailed (and very helpful) diaologue commenced last year and the simulation study referred to above is both a logical development and an appropriate scientific way of approaching the issue. There was widespread agreement in the Scientific Committee that this research is appropriate and useful. Members would welcome constructive suggestions from Japan for the development of precautionary management measures for the situation outlined above.

5.49 Dr Shust noted that assessment of overlap between fishery and predators in appropriate parts of Subarea 48.1 depended significantly on the location of the fishing fleet and rates of krill flux (Annex 7, paragraph 6.42).

5.50 All Members recognised that work is needed to investigate more precisely the overlap between predators and the commercial fishery and to assess more accurately the magnitude of potential competition between predators and fishery.

5.51 To undertake this it will be necessary to have accurate data on the size and distribution of the breeding colonies of the major krill predators and of their krill requirements, at least during the time of year when the fishery is operating. It is also important to have fishery data on as fine a scale as possible, to have accurate data on krill biomass (and availability to predators) and to take account of different potential rates of movement of krill through the areas under investigation.

5.52 WG-CEMP and WG-Krill were encouraged to prepare for such work as a matter of some priority and it was agreed that Subarea 48.1 should be the first target of this work.

5.53 The Scientific Committee also endorsed the need to enhance CEMP activities, especially expanded monitoring operations in Subarea 48.2 and as a particularly high priority conducting monitoring at one or more additional sites on the north coast of the main islands in the South Shetland Island group.

PREY REQUIREMENTS FOR KRILL PREDATORS

5.54 Considerable progress had been made intersessionally in accumulating data to estimate prey requirements of krill predators in the ISRs (Annex 7, paragraphs 7.3 to 7.5, 7.8 and 7.9). These data are required to help assess the significance of overlap between the krill fishery and krill-dependent predators and are also potentially relevant to other Scientific Committee initiatives, including assessment of escapement levels and estimates of potential yield of krill (see SC-CAMLR-X, Annex 6, paragraph 6.1).

5.55 However, there had been insufficient time during the intersessional period for WG-CEMP to provide interim estimates even for selected predator species for the ISRs.

5.56 The Joint Meeting of WG-Krill and WG-CEMP had emphasised that even with revised estimates of krill requirements of predators for all or part of the ISRs, assessment of the significance of overlap between fishery and predators would require a knowledge of functional relationships between krill availability and predator performance.

5.57 Consequently, WG-CEMP had accorded greater priority to improving understanding of these relationships, rather than to estimating predator consumption in the ISRs. It was noted that WG-CEMP intended to continue its efforts to develop estimates of the prey requirements of krill predators.

5.58 Several Members indicated their considerable interest in estimates of krill consumption by selected predators (especially penguins and fur seals) for Subareas 48.1 and 48.2. They urged WG-CEMP to try to complete the task of estimating krill consumption by at least these predators in the ISRs as soon as possible.

KRILL ESCAPEMENT

5.59 Last year WG-CEMP noted that the prospects of estimating desired levels of krill escapement on the basis of estimates of krill consumption by all natural predators were remote. At the Joint Meeting of WG-Krill and WG-CEMP, attention was focussed instead on the need to consider critical levels of predator performance in relation to escapement of krill from the fishery. Approaches for doing this were developed in some detail in Annex 8, paragraph 2 and Appendix 1.

5.60 WG-CEMP had chosen representative species (Adélie penguin, crabeater seal, and black-browed albatross) and had allocated responsibility for providing the required data. The Scientific Committee encouraged the prompt provision of these data. It was agreed that as soon as data were received at the Secretariat, they should be circulated to Members who were encouraged to undertake the modelling described in Annex 8, Appendix 1 as soon as possible and to report the results to the next meetings of WG-Krill and WG-CEMP.

LIAISON WITH WG-FSA

5.61 The acting chairman of WG-FSA noted that there had been insufficient time at its recent meeting for consideration of the WG-CEMP ecosystem assessment in the light of relevant fish data. However, WG-FSA intended to carry out this task in future.

5.62 He drew the attention of WG-CEMP to the fact that data on *P. antarcticum* (a target species for CEMP) had been received by the CCAMLR Data Centre.

FUTURE WORK

5.63 The Scientific Committee endorsed WG-CEMP's plan of future work (Annex 7, paragraph 10.1).

MANAGEMENT PLANS FOR CEMP SITES

5.64 Last year the Commission adopted Resolution 8/X according protection to the Seal Islands CEMP site in response to a proposal submitted by the US. In accordance with Conservation Measure 18/IX, the Secretariat sought comments on the proposal from SCAR and from the Antarctic Treaty Consultative Parties.

5.65 Within SCAR the management plan was considered by the Group of Specialists on Environmental Affairs and Conservation (GOSEAC), the Working Group on Biology and the Working Group on Geology (CCAMLR-XI/BG/9 Rev. 1). GOSEAC commented that it "found the management plan acceptable in its present form in terms of environmental care, but noted some written views from USA [geologists] concerning the wording of specific sections"; the Working Group on Biology recommended endorsement by SCAR and the Working Group on Geology found the proposal acceptable. On this basis it was formally endorsed by XXII SCAR.

5.66 Subsequently, however, the Secretary of the Working Group on Geology had requested the CCAMLR observer to SCAR to include some comments on the management plan in his report (CCAMLR-XI/BG/9 Rev. 1, Annex 1). These comments indicate concern due to:

(i) inadequate time to consider the document; and
(ii) potentially restrictive conditions for access to a geologically anomalous area.

5.67 Dr Bengtson noted that the management plan did not intend to exclude geologists or others from conducting research at the Seal Islands that does not disturb the local wildlife, their habitat, or the CEMP studies being undertaken. The US Delegation suggested a modification to the management plan's wording to rectify any such misunderstanding.

5.68 Accordingly, the Scientific Committee recommended that the Commission revise the Seal Islands CEMP Site Management Plan by incorporating the following text as appropriate under section D.1.b. and in the third paragraph of Annex A:

D.1.b. **Throughout the site at all times of year:** Any non-CEMP activities are not permitted which result in:

(i) killing, injuring, or disturbing pinnipeds or seabirds;

(ii) damaging or destroying pinniped or seabird breeding areas; or

(iii) damaging or destroying the access of pinnipeds or seabirds to their breeding areas.

Annex A (paragraph 3)

Geological and other studies which can be done inside of the pinniped and seabird breeding seasons in such a way as they do not damage or destroy pinniped or seabird breeding areas, or access to those areas, would be permitted as long as they would not adversely affect the planned assessment and monitoring studies. Likewise, the planned assessment and monitoring studies would not be affected adversely by periodic biological surveys or studies of other species which do not result in killing, injuring, or disturbing pinnipeds or seabirds, or damage or destroy pinnipeds or seabird breeding areas or access to those areas.

5.69 No adverse responses had been received from Antarctic Treaty Consultative Parties.

5.70 Consequently, the Scientific Committee noted that, with the amendments suggested above, the way was now clear for the Commission to adopt Resolution 8/X as a conservation measure and to attach the Management Plan for the Seal Islands CEMP Site as Annex B to Conservation Measure 18/XI.

5.71 The Scientific Committee noted that draft management plans for the CEMP sites at Magnetic Island (Australia) and Cape Shirreff (Chile) had been reviewed by WG-CEMP and would be reconsidered next year after revision.

ADVICE TO THE COMMISSION

5.72 The Scientific Committee recommended that the Secretariat begin the acquisition of current and historical data on sea-ice distribution around CEMP sites as described by WG-CEMP (Annex 7, paragraphs 4.28, 4.30, 4.31 and 4.33) and according to the schedule and budget elaborated in SC-CAMLR-XI/10.

5.73 The Scientific Committee recommended the publication of a new edition of the *Standard Methods for Monitoring*, in loose leaf format as soon as possible.

5.74 The Scientific Committee recommended that CCAMLR support the proposed SCAR workshop to plan a coordinated multinational research initiative on Antarctic ice-breeding seals.

5.75 The Scientific Committee recommended that a meeting of WG-CEMP be held during 1993.

REPORT OF THE JOINT MEETING OF THE WORKING GROUPS ON KRILL AND CEMP

6.1 This meeting was held in Viña del Mar, Chile, 5 to 6 August 1992 and was chaired by Mr Østvedt (Chairman, Scientific Committee) with the Conveners of WG-CEMP and WG-Krill acting as rapporteurs.

6.2 The summary report was introduced by Mr Østvedt, who noted the success of the interactive initiative and highlighted some of the main achievements and proposed actions. The review of the report by the Scientific Committee concentrated on these areas.

KRILL ESCAPEMENT

6.3 The detailed definition and explanation of escapement was welcomed. For ease of reference it was agreed to repeat this definition in the report of the Scientific Committee and to include it in the CCAMLR Glossary of Scientific Terms (Annex 12). It was noted that care must be taken in translation to distinguish escapement in the present context from fishing escapement loss, meaning animals which pass through the meshes of nets. The definition of escapement in the present context is as follows:

> In a fisheries management context, escapement is the average level of biomass of the exploited stock for a given level of fishing. Proportional escapement is the ratio of this exploited biomass to the average biomass of the stock before the start of the fishery (pristine biomass).

KRILL/PREDATOR FUNCTIONAL RELATIONSHIPS

6.4 This approach was developed further by WG-CEMP and the Scientific Committee comments can be found at paragraphs 5.56 and 5.57. Possible experimental approaches to evaluate these relationships were also discussed by the joint meeting of WG-Krill and WG-CEMP. The Scientific Committee endorsed the comments of the joint meeting on the longterm nature and careful experimental design required of such studies.

KRILL BIOMASS VERSUS AVAILABILITY TO PREDATORS

6.5 The need to investigate this relationship was recognised.

USE OF PREDATOR DEMAND IN SUBAREA ALLOCATION OF CATCH LIMITS FOR KRILL

6.6 The comments of WG-CEMP that such an approach is not advised at present (Annex 7, paragraph 8.7) were noted and endorsed.

TIMING AND LOCATION OF FISHING

6.7 The value of fine-scale, and especially haul-by-haul data in this context has been consistently endorsed by the Scientific Committee.

OPERATIONAL CHARACTERISTICS OF KRILL FISHING

6.8 It was agreed that the dialogue between fishing operators and scientists has been a most valuable one and should be maintained, particularly in the discussion of approaches to management.

KRILL SURPLUS

6.9 The conclusion of the meeting, that work on this concept should be of low priority was endorsed.

EXPERIMENTAL HARVESTING REGIMES

6.10 The Scientific Committee endorsed the advice that the development of models to evaluate the statistical performance and cost-effectiveness of possible experimental harvesting regimes designed to distinguish between natural variation in predator performance and effects due to fishing is desirable. Members are encouraged to develop appropriate proposals.

INCORPORATION OF CEMP INFORMATION IN MANAGEMENT ADVICE

6.11 This is a crucial element in the development of CEMP. It requires modelling a number of management scenarios using current and historical data. One facet of this could be the investigation of the feasibility of dynamic allocation of krill catch limits in response to changes in measures of predator performance. Members were strongly encouraged to undertake studies of this kind.

PRECAUTIONARY MANAGEMENT MEASURES

6.12 Extensive discussion on this topic is included in the discussion of the WG-CEMP report (Annex 7, paragraphs 6.45 to 6.57).

INFORMATION REQUIRED FROM WG-KRILL

6.13 The Scientific Committee endorsed the recommendations of the Joint Meeting to encourage:

(i) submission of haul-by-haul data;
(ii) deployment of scientific observers aboard fishing vessels; and
(iii) fine-scale reporting of fisheries data from statistical areas other than Area 48.

6.14 The need for updated estimates of krill abundance, for krill abundance surveys covering complete ISRs, for more predator prey surveys using recommended procedures (SC-CAMLR-X, paragraphs 6.13 and 6.14) and for data on rates of krill movement were also endorsed.

COORDINATION

6.15 There was unanimous agreement on the need to continue to coordinate the work of, and particularly the formulation of management measures by, WG-Krill and WG-CEMP through joint meetings. In view of the likely impossibility of holding such a meeting in 1993, it is particularly important to try to arrange a joint meeting for 1994. Regular meetings of the Conveners of all the Working Groups of the Scientific Committee were also highly desirable.

MARINE MAMMALS AND BIRDS

STATUS AND TRENDS OF POPULATIONS

7.1 In response to a request from the Scientific Committee, the SCAR Group of Specialists on Seals and the SCAR Bird Biology Subcommittee had reported in 1988 on the abundance and trends of Antarctic pinniped and seabird populations (SC-CAMLR-VII/9 and SC-CAMLR-VII/12). The Scientific Committee had requested that SCAR continue to review available information and to update its report on status and trends every five years.

7.2 The relevant SCAR groups met in Bariloche, Argentina, from 8 to 12 June 1992, at which time their reports for CCAMLR were finalised.

7.3 In responding to the Scientific Committee's request, both SCAR groups had considered the most effective procedure for providing information on status and trends. Although the Secretariat had prepared and distributed standardised forms for reporting abundance data to CCAMLR, the SCAR scientists agreed that it would be difficult to enter in a database all of the relevant background information and judgements necessary to estimate population trends.

7.4 Because census data for some sites are incomplete, survey methods vary among sites, and assumptions or conditions peculiar to individual censuses directly affect the estimated populations, some of the descriptions of increasing or decreasing trends are based on professional judgements arising from combined technical expertise.

7.5 The Scientific Committee agreed with the view of the relevant SCAR groups that the Scientific Committee would be assisted most effectively in considering marine mammal and bird population trends by SCAR providing it with analyses, interpreted judgements, and summaries of available population data.

7.6 The Scientific Committee thanked the SCAR Group of Specialists on Seals and the SCAR Bird Biology Subcommittee for their assistance in providing the updated summaries of marine mammal and bird populations. Given the value of information synthesised in the reports from SCAR, it was agreed that both reports should be appended to the Scientific Committee's report (Annexes 9 and 10).

7.7 It requested that SCAR provide an update of available information for the Scientific Committee's review in 1997. Recognising that the reviews provided by SCAR in 1992 had been quite comprehensive, it was noted that because over the next five years sufficient additional data may not become available on some populations, a full assessment for all species may not be possible. Therefore, it was agreed that SCAR through its Group of Specialists on Seals and the Bird Biology Subcommittee, be requested to provide, prior to the 1997 meeting of WG-CEMP, information on those species or populations for which there is evidence of change in population status.

PINNIPED POPULATIONS

7.8 The report from the SCAR Group of Specialists on Seals concerning the status and trend of pinniped populations was introduced by Dr Bengtson (Annex 10). Tables 2, 3, 4, and 5 of that report summarised the most recent population information for Antarctic pinnipeds.

7.9 Antarctic fur seal (*Arctocephalus gazella*) populations continue to increase in most areas. Fur seal abundance at South Georgia and in the South Shetland, Macquarie, Heard, and Marion Islands appears to be increasing, while the breeding population in the South Orkney Islands has been relatively stable since about 1973.

7.10 Sub-Antarctic fur seal (*A. tropicalis*) populations are increasing rapidly, and a small population appears to be establishing itself at Macquarie Island together with Antarctic fur seals and New Zealand fur seals (*A. forsteri*).

7.11 The status and trends of southern elephant seal (*Mirounga leonina*) populations had been reviewed in detail at the SCAR Southern Elephant Seal Workshop held in 1991 and sponsored by CCAMLR (SC-CAMLR-X/BG/3). It was noted that in response to some of the recommendations from that workshop, the Group of Specialists on Seals in 1992 established a coordinated study to estimate and monitor the weaning mass of pups. It was felt that this cooperative effort would facilitate comparing data from various localities within the three stocks of southern elephant seals.

7.12 In general, southern elephant seal populations are declining in the Indian and Pacific Ocean sectors of the Antarctic, while the status of the South Georgia stock is uncertain. This uncertainty is mainly due to the long period between censuses and their limited number. However, there is no indication that the South Georgia population has experienced either a large decline or a large increase in recent years.

7.13 Although declines in the numbers of southern elephant seals are continuing at some localities, on the basis of stocks in all regions, there is a suggestion that the decline is slowing.

7.14 In contrast to the land-breeding Antarctic pinnipeds, there are relatively few data available for estimating the size or trends of ice-breeding seal populations. Because the SCAR Group of Specialists on Seals felt that it was unable to make meaningful assessments of potential trends in population abundance based on these limited data, the importance of acquiring additional census data for the pack-ice seals was once again emphasised.

SCAR RESEARCH INITIATIVE ON SEALS IN THE ANTARCTIC SEA-ICE ZONE

7.15 Recognising the pressing need for obtaining more information about ice-breeding Antarctic seals, the SCAR Group of Specialists on Seals is developing an international program of research on pack-ice seals (SC-CAMLR-XI/13). The aim of such a project would be to carry out studies of the behaviour, abundance, and distribution of Antarctic pack-ice seals in relation to food and the pack-ice.

7.16 A planning workshop to develop a full description and plan of the program is provisionally scheduled for May or June, 1993.

7.17 The Scientific Committee welcomed the SCAR research initiative, and agreed that the information expected to be forthcoming from such an initiative would provide valuable information of relevance not only to CCAMLR's interest in the status and trends of Antarctic pinniped populations, but also to the work of WG-CEMP.

7.18 Therefore, the Scientific Committee agreed that the SCAR research initiative on ice seal research be supported. Specifically, the Scientific Committee recommended that the following steps be taken:

(i) Members are encouraged to accord a high priority to having their scientists participate in the SCAR research initiative;

(ii) Members are encouraged to allocate sufficient financial and logistic support to enable the ice seal initiative to succeed;

(iii) Members are encouraged to provide funds for their relevant scientists to participate in the planning workshop to be held in 1993; and

(iv) the Commission should be requested to provide financial assistance to SCAR to facilitate the 1993 planning workshop.

CETACEAN POPULATIONS

7.19 No additional information on the status and trends of Antarctic whales was considered by the Scientific Committee. It was noted, however, that the IWC Scientific Committee is undertaking a Comprehensive Assessment of baleen whales in the Southern Hemisphere, to be completed in 1993.

SEABIRD POPULATIONS

7.20 Dr Croxall introduced the report of the SCAR Bird Biology Subcommittee regarding the status and trends of Antarctic and sub-Antarctic seabirds (Annex 9). The main data reviewed by the Subcommittee are summarised in detail, by species and site or area, in Table 1 and Annex 3 of their report.

7.21 It was emphasised that most available population data, even from exactly the same site, derive from a few counts widely separated in time. Given the substantial natural fluctuations in most, if not all, seabird populations, "changes" indicated in the tabulations should not necessarily be interpreted as evidence of systematic population change. Furthermore some apparent population increases, especially relating to petrels, simply reflect improvements in census techniques.

7.22 For many species of Antarctic and sub-Antarctic seabirds, data are generally inadequate to make any accurate assessment of population trends at any site in the region. For most other species, adequate data exist for only one or two sites. Only commitments of continuous longterm studies will remedy this situation.

7.23 Of species for which adequate data exist for at least one site, most are currently fluctuating appreciably but without any discernable trend, or increasing slightly.

7.24 The king penguin is the only species for which significant population increases are currently taking place at most, if not all, breeding localities. These increases are likely to reflect changes in the species' biological environment, presumably involving their main prey, myctophid fish.

7.25 Adélie penguins have increased steadily in the Ross Sea since 1982. Populations are generally stable elsewhere including at sites where significant population increases occurred between the 1950s and 1970s.

7.26 Chinstrap, and possibly macaroni, penguins, which showed substantial local or regional population increases in the 1950s through 1970s are now stable or, at most, slightly increasing.

7.27 There is less evidence than previously that species are continuing to increase in numbers because of increased availability of refuse in the vicinity of stations. Treatment of human refuse, although much improved, still needs attention, especially when the potential main beneficiaries are predatory species whose population increases will be to the likely detriment of other birds.

7.28 The southern giant petrel and nearly all albatrosses for which adequate data are available are decreasing at most or all sub-Antarctic islands. The southern giant petrel has decreased significantly at all breeding sites on the Antarctic continent but the situation in the Antarctic Peninsula area is more complex. The declines are most likely related to incidental mortality associated with longline fisheries but better data, especially for grey-headed albatrosses and giant petrels, are urgently needed.

7.29 There is less evidence than previously that species are continuing to decrease because of human disturbance though better data are needed on populations in the vicinity of bases.

7.30 Burrowing seabirds at most sub-Antarctic islands continue to be seriously affected by introduced animals; the example of South Africa in probably having eradicated cats from Marion Island needs to be emulated as widely and as rapidly as possible.

7.31 There is still only circumstantial evidence that decreases in any seabird population can be attributed to decreases in food availability at sea. There is no evidence that any population decline reflects effects of commercial fishing except for those species referred to above in paragraph 7.28.

7.32 There is increasing evidence of the importance of the physical environment (e.g., ice, climate, oceanographic variables) in influencing reproductive performance and even population dynamics of Antarctic seabirds, especially species of high latitudes. It is crucial that all seabird monitoring studies should record physical variables as an integral part of the CEMP program.

7.33 Despite numerous examples of changes in abundance of seabird populations that correlate with previous or simultaneous changes in characteristics of the biological or physical environment, we have only a very poor knowledge of how such environmental factors operate and interact, or of how seabird populations are regulated. These remain vital fields for enhanced research.

ASSESSMENT OF INCIDENTAL MORTALITY

INCIDENTAL MORTALITY IN LONGLINE FISHERIES

8.1 The problem of seabird mortality associated with the longline fishery for *D. eleginoides* had been discussed in detail at the previous two meetings of the Scientific Committee (SC-CAMLR-IX, paragraphs 7.3 to 7.14; SC-CAMLR-X, paragraphs 8.1 to 8.26).

8.2 These discussions led to the Commission adopting Conservation Measures 26/IX and 29/X, which pertained, respectively, to reporting of seabird entanglement and mortality and the implementation of procedures to minimise incidental seabird mortality.

8.3 WG-FSA had reviewed the extent to which the actions specified in Conservation Measure 29/X had been effective (Annex 5, paragraphs 7.20 and 7.21). The deployment of a tori pole apparently had been effective in minimising incidental mortality of birds during Russian longline fishing operations during the past year (CCAMLR-XI/BG/5).

8.4 However, WG-FSA noted that there had apparently been some mis-interpretation of Conservation Measure 29/X (Annex 5, paragraph 7.21). Certain fishing operators had interpreted this measure to mean that a streamer line is not required if longlines were set at night. The Working Group emphasised that streamer lines should be deployed during all daylight operations, including "nautical twilight". If this definition is used, "daylight" conditions would be present for 20 hours or more in many of the areas where longline operations are undertaken in the Convention Area.

8.5 Accordingly, the Scientific Committee recommended that the Commission consider redrafting Conservation Measure 29/X so that the use of streamer lines is requested in all deployments of longlines regardless of whether these are during daylight or darkness.

8.6 Dr T. Øritsland (Norway) noted that there have been successful experiments on reducing the incidental mortality of seabirds in association with longline fisheries in the North Atlantic Ocean. A report on reducing bait loss had been previously submitted to ICES, and will be made available to CCAMLR. A second report specifically focussed on reducing the incidental catch of seabirds will be brought forward and tabled at the 1993 meeting of WG-FSA.

8.7 The Scientific Committee agreed that it should take appropriate steps to ensure that it has access to as much relevant information as possible on this topic. In particular, papers describing the experience of longline fisheries and the results of research investigations by New Zealand and Australia, as well as those in the North Atlantic, should be brought forward for consideration by the Scientific Committee and its Working Groups.

8.8 The Scientific Committee therefore requested that:

(i) the Secretariat write to relevant sources of information requesting that this information be made available to CCAMLR; and

(ii) Members bring forward information on this topic for review at next year's meetings of the Scientific Committee and Working Groups.

8.9 Dr Robertson noted that New Zealand intended to submit a document for the Scientific Committee's consideration in 1993 which described the successful use of tori poles in the New Zealand longline fishery. Deployment of tori poles decreased the overall incidental mortality of seabirds; when night-time sets were utilised, incidental mortality decreased even further.

8.10 The Scientific Committee reviewed the information available on incidental seabird mortality from longline fisheries operating within the Convention Area during the 1991/92 fishing season.

8.11 A report concerning the Chilean fishery (SC-CAMLR-XI/BG/3) indicated that one black-browed albatross was taken during the 1991/92 fishing season. Apparently tori poles, streamers or other apparatus to discourage birds from diving on baits were not deployed in fishing operations.

8.12 Russian longline fishing operations employed a variety of methods to minimise incidental mortality (SC-CAMLR-XI/BG/17). Research was also conducted to investigate ways to minimise lure attraction for birds and to determine effective methods for reducing incidental mortality. Squid was found to be a bait that was less attractive to birds than fish. The most effective method found for deterring birds from diving on baits was towing a brightly-coloured buoy behind the fishing vessel on a 200 m line.

8.13 A report from the United States (CCAMLR-XI/BG/7) described observations of four cases of giant fulmars (*Macronectes giganteus*) entangled in longline hooks and nylon line. This is the first time that this type of entanglement had been reported in the Palmer Station area, and suggests that a longline fishery is now operating within the foraging range of this population. For example, it was noted that longline fishing operations had, in 1991, moved from Chilean coastal areas to pelagic zones in the southeast Pacific Ocean (but outside of the Convention Area).

8.14 Dr Croxall noted that a small number of albatrosses of several species with longline hooks impaled in their beaks had been observed annually at Bird Island, South Georgia. Examination of these hooks revealed that they are of the type used in *D. eleginoides* longline fisheries.

8.15 An attempted inspection of a Russian longlining vessel (CCAMLR-XI/BG/5) resulted in no evidence that birds were being killed during fishing operations. A device (referred to as a "shori" or "blinker") to deter birds from taking baits had been deployed and appeared to be effective. The shori devices had been used as an alternative to tori poles or streamers because the Russian fishing captains had felt that the latter posed a risk to safe navigation.

8.16 The Scientific Committee welcomed the report on the Russian research on minimising incidental mortality in longline fishing. It was recalled that this report had been submitted in response to a request from the Scientific Committee at its 1991 meeting (SC-CAMLR-X, paragraphs 8.10 to 8.13). The Scientific Committee noted that it looked forward to receiving a more detailed written report on the studies described in paragraph 8.15 at its next meeting.

8.17 Dr Duhamel provided an update of his 1991 report on incidental mortality (SC-CAMLR-X, paragraphs 8.4 to 8.6). Although recommended measures for reducing incidental mortality have been implemented around Kerguelen, data had not yet been received on the effectiveness of these measures. It was expected that this information would be forthcoming and reported to the Scientific Committee in 1993.

8.18 The Scientific Committee noted the evidence presented, that the use of tori poles can be very effective in reducing incidental bird mortality in longline fisheries. However, because albatrosses range very widely (including to areas outside of the Convention Area), steps should be taken to ensure an effective liaison and information exchange between CCAMLR with nations and international organisations that are active outside of the Convention Area.

8.19 It was noted that there is a major international campaign underway to reduce seabird mortality from longline fisheries. The Scientific Committee agreed that it would be desirable for CCAMLR to provide relevant organisations interested in this issue with information arising from CCAMLR's efforts within the Convention Area.

8.20 The Scientific Committee encouraged Members to advise their scientists to be on the lookout for birds that may have been entangled in line or hooks from longline fisheries. Such occurrences may go generally unnoticed unless a special effort is made to watch for such evidence.

Advice to the Commission

8.21 The Scientific Committee recommended that the Commission consider redrafting Conservation Measure 29/X so that the use of streamer lines is requested in all deployments of longlines regardless of whether these are during daylight or darkness.

8.22 At its 1991 meeting, the Commission noted that the adoption of Conservation Measure 29/X was only one of two options identified by the Scientific Committee that could be effective in minimising incidental mortality in the longline fishery (SC-CAMLR-X, paragraph 8.26). The Commission had requested that the Scientific Committee be prepared to investigate further the other option of restricting the operation of the fishery through some combination of catch and/or effort limitation should the need arise (CCAMLR-X, paragraph 5.9).

8.23 Over the past several years, the situation concerning incidental mortality of seabirds in longline fisheries has improved substantially, due in large part to the conservation measures adopted by the Commission. Reports on this topic have been received from some Members, and additional reports are expected to be tabled for the Scientific Committee's consideration in the future. In particular, reports from the major longlining countries concerning the current status of incidental mortality are expected to provide valuable information.

8.24 The Scientific Committee agreed, however, that if the anticipated reports are not forthcoming as expected, it may be desirable to recommend that the Commission consider adopting additional measures that would allow an effective assessment of incidental mortality and further actions that might be needed to minimise such mortality.

8.25 Steps should be taken to ensure an effective liaison between CCAMLR and nations and international organisations that are active outside the Convention Area, to alert these parties to the incidental mortality of albatrosses from longline operations.

INCIDENTAL MORTALITY IN TRAWL FISHERIES

8.26 At its previous two meetings, the Scientific Committee had discussed the incidental catch of seabirds in trawl fisheries using net monitor cables (SC-CAMLR-X, paragraphs 8.27 to 8.34). In 1991 the Commission adopted Conservation Measure 30/X, which prohibited the use of net monitor cables in the Convention Area starting with the 1994/95 fishing season.

8.27 No reports on the use of net monitor cables in the trawl fishery during 1991/92 had been received by the Secretariat. It was understood that Members have already started to discontinue the use of these devices in the Convention Area.

8.28 Reports from Japan (SC-CAMLR-XI/BG11) and Korea (SC-CAMLR-XI/BG/15) stated that no incidental mortality had been observed in these Members' trawl fisheries during the 1991/92 fishing season.

8.29 Dr Ahn noted that Korea has been conducting studies on reducing incidental mortality in trawl fisheries, and that there were plans to extend these studies into the Convention Area in the future through the use of scientific observers. The Scientific Committee welcomed the plans of Korea to undertake these investigations.

MARINE DEBRIS

8.30 Members' reports on the assessment and avoidance of incidental mortality and impacts of marine debris on biota in the Convention Area had been received from Australia (CCAMLR-XI/BG/8), Chile (SC-CAMLR-XI/BG/7), Japan (CCAMLR-XI/BG/11), Korea (CCAMLR-XI/BG/15), United Kingdom (CCAMLR-XI/BG/14 and SC-CAMLR-XI/BG/9), and the United States (CCAMLR-XI/BG/7).

8.31 Dr Moreno introduced a paper describing the types and quantities of marine debris present on the beaches of Cape Shirreff, Livingston Island (SC-CAMLR-XI/BG/7). Antarctic fur seals at this site have been observed entangled in plastic packing bands, and man-made debris has been found in the nests of Dominican gulls (*Larus dominicanus*) and chinstrap penguins (*Pygoscelis antarctica*).

8.32 Results of on-going surveys of the incidence of Antarctic fur seals entangled in man-made marine debris at Bird Island, South Georgia, were summarised by Dr Croxall (SC-CAMLR-XI/BG/9). Over the past two years, the incidence of fur seal entanglement in marine debris has declined. The types of entangling debris most commonly observed (polypropylene packing straps and fishing net fragments) has remained unchanged. There are plans to continue these surveys annually.

8.33 Dr Bengtson noted that annual surveys of Antarctic fur seals at Seal Island, South Shetland Islands, continue to reveal individuals entangled in marine debris (SC-CAMLR-XI/BG/7). During the 1991/92 austral summer, four fur seals entangled or previously entangled in marine debris were observed at Seal Island. This number is similar to the number of entangled fur seals observed in the previous several seasons.

8.34 Dr K. Kerry (Australia) reported that no sightings of Antarctic wildlife entangled in marine debris had been reported by Australian scientists for the 1991/92 austral summer (CCAMLR-XI/BG/8). He noted, however, that a survey of Antarctic fur seals on Heard Island will be carried out during 1992/93 and that any observed entanglements will be reported to CCAMLR.

8.35 Mr M. Donoghue (New Zealand) drew the attention of the Scientific Committee to a newly developed bait box that does not use plastic packing bands. The "BIO bait box" is designed to disintegrate harmlessly if discarded or lost at sea, thereby reducing the amount of persistent plastics that are added to the ocean. Information on the specifications and benefits of this product was made available to the Scientific Committee.

CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

9.1 At its last meeting, the Scientific Committee had provided advice to the Commission on the operation of a scheme of international scientific observation (SC-CAMLR-X, paragraphs 10.1 to 10.8). It had also agreed that such a scheme would improve the flow of information necessary for the Scientific Committee's work and a draft set of provisions had been submitted to the Commission for consideration. The Commission was unable to reach agreement on certain details of the proposed scheme (CCAMLR-X, paragraphs 7.5 and 7.9) and the matter had been held over to the current meeting.

9.2 In preparation for the eventual introduction of the scheme, the Scientific Committee noted with appreciation that the Secretariat in consultation with the various Working Groups and interested Members had made significant progress in the development of a draft scientific observer manual. This manual was tabled as SC-CAMLR-XI/BG/5.

9.3 The Scientific Committee agreed that on implementation of the scientific observer scheme, this manual should be tested in the field as soon as possible and reviewed or updated whenever necessary.

9.4 During the course of its meeting, the Scientific Committee appreciated that the Standing Committee on Observation and Inspection was in the process of elaborating the functions and tasks of international scientific observers. It was noted that a number of changes had been made by SCOI to the list of tasks for observers forwarded by the Scientific Committee to the Commission last year.

9.5 In considering the SCOI draft, the Scientific Committee took the "detail of trawls" to be provided by observers to be consistent with the information requirements set out in Format 1A of the Draft Scientific Observer manual.

COOPERATION WITH OTHER ORGANISATIONS

ACQUISITION OF BIOMASS DATABASE

10.1 With the conclusion of the BIOMASS program in 1991, SCAR had offered to make the data in the BIOMASS database available to CCAMLR free of charge (SC-CAMLR-X, paragraphs 11.8 to 11.10). The Scientific Committee requested that the Secretariat consult with the manager of the Biomass Data Centre (BDC) to determine the most efficient and cost-effective way of acquiring the BDC data. The Data Manager's report was presented as SC-CAMLR-XI/BG/3.

10.2 The report recommended that since these data have been of use to WG-Krill and the Scientific Committee recently (Annex 4, paragraphs 4.47 to 4.62; SC-CAMLR-X, paragraph 3.78; this report paragraph 2.33), CCAMLR should not only acquire these data but also load them into an active database for the use of CCAMLR Members. The cost of this operation, detailed in SC-CAMLR-XI/BG/3 was estimated as A$3 000.

10.3 The Scientific Committee agreed with this proposal. The Committee expressed its thanks to SCAR and BIOMASS for maintaining these data for the duration of the BIOMASS program and for offering to supply them free of charge to CCAMLR. The Scientific Committee also extended its thanks to Australian Antarctic Division, for agreeing to make computer facilities available for this project to CCAMLR free of charge.

10.4 It was agreed that the Data Manager would contact the manager of the BDC to ensure that a full record of all transformations that have been made to the data in constructing the BIOMASS database will be lodged with the CCAMLR Secretariat for consultation by users of the database.

REQUEST OF THE SCIENTIFIC COMMITTEE
OF THE INTERNATIONAL WHALING COMMISSION

10.5 The Scientific Committee considered the request of the International Whaling Commission (IWC) to comment on the scientific matters raised in a proposal by the Government of France that the IWC designate all waters south of 40°S as a whale sanctuary (SC-CAMLR-XI/12). It was also aware of an IWC resolution on the need for research on the environment and whale stocks in the Antarctic region, which calls for exchange of information between the IWC and CCAMLR (SC-CAMLR-XI/14).

10.6 The Scientific Committee recognised that the IWC is the global international organisation with authority for the management of whales. Accordingly, the Scientific Committee agreed that it should confine its discussion to scientific aspects of the proposal. There was a range of views on the scientific basis of the proposal and its relationship to the IWC's Revised Management Procedure, but no advice could be offered that had not already been reflected in the discussions of this topic by the Scientific Committee of IWC. However, the CCAMLR Scientific Committee welcomed further cooperation with the IWC Scientific Committee in investigating the role of whales in the Southern Ocean ecosystem.

10.7 The Scientific Committee noted that the minke whale was one of the original indicator species proposed under CEMP and that the results of substantial directed research into potential monitoring parameters had been reported to WG-CEMP. The minke whale no longer appeared on the list of indicator species simply because no specific proposals, including methods, for monitoring had been received. The Scientific Committee considered that it was desirable for any IWC program of research and monitoring on minke whales to include the development of methods addressing parameters of relevance to CEMP. The Scientific Committee would be happy to assist in these endeavours.

REPORTS OF OBSERVERS

10.8 Dr Croxall, the observer to SCAR, presented a report on SCAR activities of relevance to CCAMLR (CCAMLR-XI/BG/9), particularly relating to meetings associated with XXII SCAR in Argentina in June 1992. Most of the documents and reports referred to below can be obtained from the SCAR Secretariat.

10.9 The second part of SCAR's proposal for coordinated Antarctic research on the International Geosphere - Biosphere Programme, entitled "The Role of Antarctica in Global Change;

Part 2 - An International Plan for a Regional Research Programme" will be published late in 1992. This major research program which will contain research on the effects of increased UV-B radiation on Antarctic biota, as well as the major initiatives in marine research described below, will be coordinated by a new group of specialists to which SCAR national committees have been invited to nominate corresponding members. Members of CCAMLR may be interested in maintaining liaison with their nominated representatives to this SCAR group.

10.10 SCAR, together with COMNAP has also submitted a paper on environmental monitoring in Antarctica to the Group of Experts on Environmental Monitoring at Buenos Aires, June 1992. The paper covered areas complementary to those covered by CCAMLR, and the meeting recommended that environmental monitoring should be closely coordinated with activities of CCAMLR.

10.11 The management plan for the Seal Islands was approved by SCAR as reported in paragraphs 5.64 to 5.70.

10.12 SCAR and COMNAP have jointly established an *ad hoc* planning group on Antarctic Data Management. The aim of this group is to investigate data coordination in the setting up of an Antarctic data base, and ultimately a data network of Antarctic data holdings. This is envisaged to proceed via the solicitation of information on current data holdings by national and international organisations. The Scientific Committee asked the Data Manager to write to SCAR expressing CCAMLR's interest in participating in the discussions of the planning group.

10.13 The activities of the SCAR Bird Biology Subcommittee and Group of Specialists on Seals are discussed in paragraphs 7.1 to 7.7.

10.14 As part of its IGBP Program SCAR is developing a new coordinated multinational initiative for marine research in the Antarctic sea-ice zone, currently comprising three separate programs. SCAR and SCOR have agreed co-sponsorship of the Southern Ocean Joint Global Ocean Flux Study (SO-JGOFS) and the Southern Ocean Global Ocean Ecosystems Dynamics Programme (SO-GLOBEC). The latter which will investigate relationships within zooplankton and at higher trophic levels is therefore of particular interest to CCAMLR. The most recent initiative is the coordination of work, especially involving longterm studies, at shore-based sites, particularly in the Antarctic Peninsula, Ross Sea and parts of the Antarctic continent in the Indian Ocean sector.

10.15 Recommendations from SCAR to CCAMLR concern support for rapid implementation of the program of scientific observation on fishing vessels and another recommendation of relevance to CCAMLR concerns coordination of scientific research at King George Island. In the latter respect it was noted that the Programa Antártico of the Universidad de Chile proposes to devote a session of the forthcoming seminar, held in conjunction with the Division of Polar Programs, National Science Foundation, USA, on "Science in Antarctica" (Santiago, 12 to 14 May 1993).

10.16 The next major biological meeting of SCAR will be the biology symposium in Venice, Italy in late May to early June 1994. This symposium should contain the results of much research of relevance to CCAMLR and will also offer opportunities for the presentation of the results of research conducted within CCAMLR.

10.17 Mr Balguerías, CCAMLR observer to ICES, presented his report of the 80th Statutory Meeting. Of the 95 current working groups of ICES, 70 held meetings during the 1991/92 season, approximately 45 dealing with the assessment stocks of commercial interest.

10.18 A large number of groups established for the assessment of stocks of single species have been replaced by others based on geographical criteria, and the consideration of multispecies approaches and the environmental relationships of commercial species has become more prevalent in their work. A new approach has been adopted by the Advisory Committee on Fishery Management; it has been accepted that the establishment of fisheries management objectives is the responsibility of management bodies, and the role of ICES should be limited to providing scientific advice to managers. ACFM now presents a range of options of ways of achieving agreed management aims, and their implications, rather than providing specific recommendations for TACs.

10.19 A workshop held at Woods Hole on the analysis of data from assessment cruises was of special relevance to CCAMLR, especially considering CCAMLR's own workshop to address this problem (Annex 5, Appendix H). The report from this workshop will be sent to CCAMLR when it is available.

10.20 Information on forthcoming ICES sponsored meetings was also given in SC-CAMLR-XI/BG/8, including workshops on sampling strategies for age and maturity data (February 1994, Copenhagen), the distribution and sources of pathogens in marine mammals (22 to 26 March 1993, Cambridge), and a symposium on computers in fisheries research to be held prior to the next Statutory Meeting in Dublin (Ireland), September 1993.

10.21 The observer to the Scientific Committee of the IWC, Dr de la Mare, presented his report (SC-CAMLR-XI/BG/6) and drew attention to the recently adopted Revised Management Procedure (RMP) for calculating catch limits. Much of the procedure and the science that has contributed to the development of the RMP should be of interest to CCAMLR.

10.22 In response to a letter from the Convener of WG-CEMP enquiring about sources of data available for investigating the krill requirements of baleen whales, the Scientific Committee of IWC noted that many of the studies it was undertaking as part of the Comprehensive Assessment of Southern Hemisphere baleen whales should provide much of the required information, and would be available in one to two years now that the priority of the Scientific Committee to develop the RMP had been realised.

10.23 The Chairman introduced CCAMLR-XI/BG/12, concerning the recent FAO technical consultation on high seas fishing (paragraph 1.14). There were many references to the CCAMLR Convention Area in the context of high seas management in this document, without apparent consultation of CCAMLR. The Scientific Committee recommended that the Commission consider this development carefully.

10.24 The following were nominated as observers for the meetings taking place in 1993:

- 81st Statutory meeting of ICES (September 1993, Dublin, Ireland):
  Mr Balguerías; and Secretariat representation: Data Manager;

- 1993 meeting of IWC (May 1993, Kyoto): Dr de la Mare;

- SCAR planning workshop for a program of research on pack-ice seals (see paragraph 7.18): Dr Bengtson.

PUBLICATION OF SCIENTIFIC PAPERS

11.1 The Secretariat had prepared a review of publications policy of the Scientific Committee (SC-CAMLR-XI/3). The primary objectives of publishing scientific papers submitted to CCAMLR meetings were identified as:

(i) to provide a complete record of and to facilitate access to documents that have been used in discussions leading to management decisions;

(ii) to foster a high standard of scientific work on which CCAMLR activities are based;

(iii) to promote scientific work on CCAMLR objectives through the worldwide distribution of original research papers of high scientific value; and

(iv) to provide in one readily identifiable volume, a record of the best scientific work undertaken in pursuit of the CCAMLR objectives.

11.2 The Scientific Committee endorsed the conclusions of the paper that some of these objectives were not being met by the present publication of the *Selected Scientific Papers (SSP)*. It therefore recommended that:

(i) a new publication, *CCAMLR Scientific Abstracts* be introduced. This publication will consist of abstracts of all scientific papers submitted to CCAMLR;

(ii) CCAMLR work towards lifting the standard of publication of *SSP* to that of an internationally recognised scientific journal;

(iii) as the first steps in working towards this objective, the current publication procedure for *SSP* be upgraded to include the review of papers before publication by reviewers nominated by the Editorial Board.

11.3 The Scientific Committee recognised that raising the standard of the *SSP* in this way would help to ensure that CCAMLR was seen to be performing high quality science which is of major benefit to CCAMLR.

11.4 The estimated cost of (i) above was recognised to be about A$8 700.

11.5 Several technical points were made about both publications. These were referred to a special meeting of the Editorial Board to be held after the Scientific Committee meeting which would consider ways of implementing the developments outlined in paragraph 11.2.

REVIEW AND PLANNING OF THE PROGRAM OF WORK FOR THE SCIENTIFIC COMMITTEE

12.1 The Scientific Committee agreed that all three Working Groups should meet during the intersessional period.

12.2 An offer was made by Japan to host the meeting of WG-Krill and by the Republic of Korea to host the meeting of WG-CEMP. The Scientific Committee expressed its thanks to Japan and Korea and accepted these offers.

WG-Krill will meet from 4 to 12 August, 1993 in Tokyo, Japan
WG-CEMP will meet from 16 to 23 August, 1993 in Seoul, Republic of Korea
WG-FSA will meet from 12 to 21 October, 1993 in Hobart, Australia

12.3 Additionally, a Workshop on the Design of Approaches to Managing the *P. spinosissima* Fishery in Statistical Area 48 will be held in 1993. The USA offered to host this Workshop in La Jolla, California, in April or May. This offer was gratefully accepted.

12.4 Concerning the meeting of the Conveners of the Working Groups, originally scheduled for 25 October 1992 (SC-CAMLR-X, paragraph 12.4) the Scientific Committee agreed that this should take place within the week of the Commission meeting, and that it should aim to ensure that the Working Groups adopt a common approach to matters of common interest. As an example, the protocols for submission of papers to the meetings should be common (Annex 4, paragraphs 7.3 to 7.7; Annex 5, paragraph 10.3).

12.5 The Secretariat has been asked to maintain and annually distribute a summary of national research plans, according to procedures adopted at SC-CAMLR-IX. Only two Members had submitted reports in the agreed standard format (New Zealand and Norway). Other Members provided a brief description of their plans in their Members' Activities reports to the Commission. The complete information available to the Secretariat did not enable the compilation of the required summary.

12.6 The Scientific Committee agreed that since few Members were submitting reports in the agreed format, and since most Working Groups now considered a review of research plans in their agenda, there was no further need for the reporting of national research plans and their collation by the Secretariat.

12.7 In the absence of a compilation, Norway reported that it is starting up a monitoring program on seabirds and seals in the Antarctic scheduled for the NARE-1992/93 expedition. The activities will be limited to helicopter transects for estimating distribution and abundance of crabeater seals and preliminary performance of Antarctic petrels. A more comprehensive program is under preparation and will include CEMP monitoring of fur seals, chinstrap and macaroni penguins on Bouvet Island.

12.8 Japan reported that it would continue to census Adélie penguins at and around Syowa Station, Antarctica to provide estimates of breeding success and penguin densities.

BUDGET FOR 1993 AND FORECAST BUDGET FOR 1994

13.1 The draft budget given in Annex 9 includes provision for three Working Group meetings and one Workshop on Approaches to Managing the *P. spinosissima* fishery. The budget item for the Workshop includes an amount for attendance of the Data Manager and translation of the report of the meeting.

13.2 A provision is made for activating the BIOMASS database (see paragraph 10.3) and for supporting a SCAR planning workshop for research on pack-ice seals (paragraph 7.18).

13.3 The Secretariat had been asked by WG-CEMP to produce a plan for the acquisition and analysis of satellite data on sea-ice distribution, obtained from Joint Ice Centre ice charts at specified intervals throughout the year (Annex 7, paragraphs 4.28). This plan (SC-CAMLR-XI/10) was endorsed by the Scientific Committee (paragraph 5.9) and a two year provision for the acquisition of these data is included in the budget. The Scientific Committee agreed that collection of these data by the Secretariat constituted the most practical way to ensure that they were available to all Members in conjunction with data currently being submitted on monitoring of predator parameters.

13.4 It was noted that the budget used the remaining part of the Norwegian Special Fund. The Scientific Committee expressed its thanks to Norway for providing this fund to assist its work.

13.5 Dr Kock suggested that, as regards the 1994 forecast budget, the Science Officer should represent CCAMLR at the SCAR symposium in Venice.

ELECTION OF CHAIRMAN

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

14.2 Dr Kock was unanimously elected Chairman of the Scientific Committee, having been nominated by Dr Marín and seconded by Mr Balguerías. Dr Kock has been active in the work of the Scientific Committee for many years, being Convener of WG-FSA from 1987 to 1991.

NEXT MEETING

15.1 The Scientific Committee agreed that its next meeting should be held from 25 to 29 October 1993 in Hobart, Australia.

OTHER BUSINESS

ACCESS TO CCAMLR DATA CENTRE DATA

16.1 The topic of the rules and procedures relating to access to data in the CCAMLR Data Centre was raised in several Working Groups, most specifically in WG-CEMP (Annex 7, paragraphs 9.1 to 9.2) and the Scientific Committee had been asked to consider this matter (Annex 7, paragraph 9.3).

16.2 The main concerns were that at present:

(i) data requested for work relating to CCAMLR meetings was supplied by the Secretariat without the owners/originators of the data having any indication of the reason for the request. This had the potential to create difficulties if the requester later proposed to publish outside of CCAMLR the results of his work; and

(ii) that the Secretariat could be faced with requests for data from individuals who had no previous connections with CCAMLR. It therefore seemed desirable to ensure that such individuals were proceeding with the knowledge and approval of the appropriate Member's representative and in compliance with CCAMLR's policy of data access and use.

16.3 Accordingly the following additions (in bold face) to the existing rules of access to CCAMLR data (CCAMLR-VIII, paragraph 64) were proposed.

(a) All data submitted to the CCAMLR Data Centre should be freely available to Members for analysis and preparation of papers for use within the CCAMLR Commission, Scientific Committee and their subsidiary bodies.

(b) The originators/owners of the data should retain control over any use of their unpublished data outside of CCAMLR.

(c) **Requests to the Secretariat by individual scientists of a Member for access to data in the CCAMLR Data Centre will only be considered if the request has been approved in writing by the Representative to the Scientific Committee (or his nominated deputy) of that Member.**

The Representative is responsible for informing the individual scientist requesting the data, of the rules governing access to CCAMLR data and for obtaining the requester's agreement to comply with these rules.

(d) When Members request access to data for the purpose of undertaking analyses or preparing papers to be considered by future meetings of CCAMLR bodies, **they should indicate the reason for the request and the nature of envisaged data analysis**. The Secretariat should supply the data and inform the originators/owners of the data **of this action, together with the details of the original request**. When data are requested for purposes **other than consideration by future meetings of CCAMLR bodies**, the Secretariat will, in response to a detailed request, supply the data only after permission has been given by the originators/owners of the data.

(e) Data contained in papers prepared for meetings of the Commission, Scientific Committee, and their subsidiary bodies should not be cited or used in the preparation of papers to be published outside of CCAMLR without the permission of the originators/owners of the data. Furthermore, because inclusion of papers in the *Selected Scientific Papers* series or any other of the Commission's or Scientific Committee's publications, constitutes formal publication, written permission to publish papers prepared for meetings of the Commission, Scientific Committee and Working Groups should be obtained from the originators/owners of the data and authors of papers.

(f) The following statements should be placed on the cover page of all unpublished working papers and background documents tabled:

This paper is presented for consideration by CCAMLR and may contain unpublished data, analyses, and/or conclusions subject to change. Data contained in this paper should not be cited or used for purposes other than the work of the CCAMLR Commission, Scientific Committee or their subsidiary bodies without the permission of the originators/owners of the data.

16.4 Dr S. Nicol (Australia) commented on the benefit of dialogue between fishing operators and scientists. This has been possible because of the attendance of some of the former at meetings of the Working Groups. The Scientific Committee agreed that it would be useful to investigate the possibility of organising such dialogue meetings to take place at some time, perhaps adjacent to Working Group meetings, and encouraged Members to consider this matter when organising meetings. These dialogues would also help to determine which fisheries are likely to be the object of fishing activities in the future, and so enable the Scientific Committee to focus its work.

ADOPTION OF THE REPORT

17.1 The Report of the Eleventh Meeting of the Scientific Committee was adopted.

CLOSE OF THE MEETING

18.1 In closing the meeting, Mr Østvedt thanked Members for their hard work and cooperation during his two years as Chairman. He congratulated the Scientific Committee on having always tried to make use of the best scientific advice and not being unduly influenced by non-scientific considerations.

18.2 He also thanked the Secretariat and interpreters for their high standards of professionalism and hard work in making sure the meetings ran smoothly and efficiently.

18.3 Prof. Beddington thanked Mr Østvedt for his guidance over the last two years, and for being a helpful and efficient Chairman to work with.

18.4 Mr Miller extended the very best wishes of the Scientific Committee to Dr Darry Powell and his wife May on the eve of his retirement from the position of Executive Secretary of CCAMLR. He noted especially the high regard in which Dr Powell was held by Members, and the loss they would feel at his departure.

18.5 Finally, Mr Østvedt extended his best wishes to the incoming Chairman of the Scientific Committee, Dr Kock.

18.6 The Chairman then closed the meeting.

ANNEX 1

LIST OF PARTICIPANTS

LIST OF PARTICIPANTS

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	Mr Richard Williams Antarctic Division

	Dr Stephen Nicol Antarctic Division
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	Mr Andrew Jackson Antarctic Division
	Ms Roslyn Simms Department of Foreign Affairs and Trade
	Ms Sharon Moore Antarctic Division
	Mr James Shevlin Antarctic Division
	Ms Janet Dalziell Representative of Non-Governmental Organisations

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DATA MANAGER	Dr David Agnew
ADMINISTRATION/FINANCE OFFICER AND MEETING DOCUMENTS OFFICER	Mr Jim Rossiter
COMPUTER SPECIALIST	Mr Alasdair Blake
PERSONAL ASSISTANT TO THE EXECUTIVE SECRETARY	Mrs Geraldine Mackriell
REPORT SECRETARY	Mrs Genevieve Naylor
ASSISTANT DOCUMENTS OFFICER	Mrs Rosalie Marazas
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	Christina Cordero
	Paulin Djite
	Rozalia Kamene
	Demetrio Padilla
	Ludmilla Stern
	Irene Ulman
	Penny Woods

ANNEX 2

LIST OF DOCUMENTS

LIST OF DOCUMENTS

SC-CAMLR-XI/1	PROVISIONAL AGENDA FOR THE ELEVENTH MEETING OF THE SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES
SC-CAMLR-XI/2	ANNOTATED PROVISIONAL AGENDA FOR THE ELEVENTH MEETING OF THE SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES
SC-CAMLR-XI/3	CCAMLR PUBLICATION POLICY - PUBLICATION OF SCIENTIFIC PAPERS Secretariat
SC-CAMLR-XI/4	REPORT OF THE FOURTH MEETING OF THE WORKING GROUP ON KRILL (Punta Arenas, Chile, 27 July to 3 August, 1992)
SC-CAMLR-XI/5	JOINT MEETING OF THE WORKING GROUP ON KRILL AND THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM (Viña del Mar, 5 to 6 August, 1992) (Convener's and Rapporteur's Summary)
SC-CAMLR-XI/6	REPORT OF THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM (Viña del Mar, Chile, 7 to 12 August, 1992)
SC-CAMLR-XI/7	REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT (Hobart, Australia, 13 to 22 October 1992)
SC-CAMLR-XI/8	STATUS AND TRENDS OF ANTARCTIC AND SUB-ANTARCTIC SEABIRDS Chairman of the Bird Biology Sub-Committee, SCAR
SC-CAMLR-XI/9 Rev. 1	ABUNDANCE AND TRENDS OF ANTARCTIC PINNIPED POPULATIONS Report to the CCAMLR Scientific Committee from the SCAR Group of Specialists on Seals
SC-CAMLR-XI/10	PILOT STUDY ON ACQUISITION OF SATELLITE IMAGERY: REPORT TO THE SCIENTIFIC COMMITTEE Secretariat
SC-CAMLR-XI/11	IOC - SEVENTEENTH SESSION OF THE ASSEMBLY, PARIS, 25 FEBRUARY TO 11 MARCH 1993, INVITATION TO SEND OBSERVER Executive Secretary
SC-CAMLR-XI/12	IWC RESOLUTION ON A SANCTUARY IN THE SOUTHERN HEMISPHERE REQUEST FOR CCAMLR COMMENTS IWC

SC-CAMLR-XI/13 RESEARCH INITIATIVE ON SEALS IN THE ANTARCTIC SEA ICE ZONE
SCAR Group of Specialists on Seals

SC-CAMLR-XI/14 IWC RESOLUTION ON THE NEED FOR RESEARCH ON THE ENVIRONMENT AND WHALE STOCKS IN THE ANTARCTIC REGION

SC-CAMLR-XI/15 VIEW OF THE JAPANESE GOVERNMENT ON THE FRENCH SANCTUARY PROPOSAL
Delegation of Japan

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SC-CAMLR-XI/BG/1 SUMMARY OF FISHERY STATISTICS FOR 1992
Secretariat

SC-CAMLR-XI/BG/2 CCAMLR DATABASES AND DATA AVAILABILITY
Secretariat

SC-CAMLR-XI/BG/3 ACQUISITION OF BIOMASS DATABASE BY CCAMLR
Secretariat

SC-CAMLR-XI/BG/4 COMPARISON OF CCAMLR AND FAO STATLANT DATA
Secretariat

SC-CAMLR-XI/BG/5 SCIENTIFIC OBSERVERS MANUAL FOR OBSERVATIONS ON COMMERCIAL FISHING VESSELS (DRAFT)
Secretariat

SC-CAMLR-XI/BG/6 OBSERVERS REPORT FROM THE 1992 MEETING OF THE SCIENTIFIC COMMITTEE OF THE INTERNATIONAL WHALING COMMISSION
Observer (W.K. de la Mare, Australia)

SC-CAMLR-XI/BG/7 ANALYSIS OF MARINE DEBRIS FOUND AT CAPE SHIRREFF, LIVINGSTON ISLAND, SOUTH SHETLANDS, ANTARCTICA
Delegation of Chile

SC-CAMLR-XI/BG/8 REPORT OF THE CCAMLR OBSERVER TO THE 80TH STATUTORY MEETING OF THE INTERNATIONAL COMMITTEE FOR THE EXPLORATION OF THE SEA (ICES)
CCAMLR Observer (E. Balguerías, Spain)

SC-CAMLR-XI/BG/9 ENTANGLEMENT OF ANTARCTIC FUR SEALS IN MAN-MADE DEBRIS AT BIRD ISLAND, SOUTH GEORGIA
Delegation of United Kingdom

SC-CAMLR-XI/BG/10 CEPHALOPOD RESEARCH IN THE CCAMLR AREA UNDERTAKEN BY THE BRITISH ANTARCTIC SURVEY, 1991-1992
Delegation of United Kingdom

SC-CAMLR-XI/BG/11 TROPHIC RELATIONS OF THE CEPHALOPOD *MARTIALIA HYADESI* (TEUTHOIDEA: OMMASTREPHIDAE) AT THE ANTARCTIC POLAR FRONT, SCOTIA SEA
Delegation of United Kingdom

SC-CAMLR-XI/BG/12 EXTRACT FROM REPORT OF THE 1992 MEETING OF THE IWC SCIENTIFIC COMMITTEE - WHALE SANCTUARIES

SC-CAMLR-XI/BG/13 PROPOSALS ON KRILL AGGREGATION MODEL PROJECT (KRAM PROJECT)
Delegation of Russia

SC-CAMLR-XI/BG/14 CPUES AND BODY LENGTH OF ANTARCTIC KRILL DURING 1990/91 SEASON IN THE FISHING GROUNDS NORTH OF LIVINGSTON ISLAND AND NORTH OF ELEPHANT ISLAND
Delegation of Japan

SC-CAMLR-XI/BG/15 PROPOSAL TO ALLOCATE KRILL PRECAUTIONARY LIMIT WITHIN FORAGING RANGE OF LAND-BASED PREDATORS
Delegation of USA

SC-CAMLR-XI/BG/16 REPORT OF BIOLOGIST-OBSERVER ON THE COMMERCIAL TRAWLER *GRIGORY KOVTUN*, MARCH-AUGUST 1992
Submitted by Ukraine

SC-CAMLR-XI/BG/17 COMMENTS ON SC-CAMLRXI/15: VIEWS OF JAPANESE GOVERNMENT ON ANTARCTIC WHALE SANCTUARY PROPOSAL
Submitted by the Delegations of Australia, France and New Zealand

SC-CAMLR-XI/BG/18 CONSIDERATIONS IN RESPECT OF THE PROPOSAL TO ESTABLISH A WHALE SANCTUARY IN THE SOUTHERN OCEAN
Submitted by the Delegations of France, Australia Sweden and New Zealand

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CCAMLR-XI/1 PROVISIONAL AGENDA FOR THE ELEVENTH MEETING OF THE COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

CCAMLR-XI/2 ANNOTATED PROVISIONAL AGENDA FOR THE ELEVENTH MEETING OF THE COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

CCAMLR-XI/3 EXAMINATION OF THE AUDITED FINANCIAL STATEMENTS FOR 1991 AND APPOINTMENT OF AN EXTERNAL AUDITOR
Executive Secretary

CCAMLR-XI/4	REVIEW OF THE 1992 BUDGET, DRAFT 1993 BUDGET AND FORECAST 1994 BUDGET Executive Secretary
CCAMLR-XI/5	PLAN FOR RESEARCH AND DATA COLLECTION DURING EXPLORATORY FISHING FOR *DISSOSTICHUS ELEGINOIDES* IN CCAMLR SUBAREA 48.4 Delegation of the USA
CCAMLR-XI/6	PROPOSAL FOR A CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION Delegation of EEC
CCAMLR-XI/7	APPLICATION FOR PERMIT TO CARRY OUT EXPLORATION AROUND THE SOUTH SANDWICH ISLANDS IN ORDER TO DETERMINE THE FEASIBILITY OF A NEW FISHERY Delegation of Chile
CCAMLR-XI/8	IMPLEMENTATION OF CONSERVATION MEASURES IN 1991/92 Executive Secretary
CCAMLR-XI/9	RUSSIAN RESEARCH CRUISE 1992 *DISSOSTICHUS ELEGINOIDES* - SUBAREA 48.3 (COPIES OF CORRESPONDENCE) Secretariat
CCAMLR-XI/10	INTEREST ON LATE CONTRIBUTIONS Executive Secretary
CCAMLR-XI/11	COMMENTS ON THE APPLICATION OF CCAMLR CONSERVATION MEASURES 36/X AND 37/X WITH REGARD TO THE *DISSOSTICHUS ELEGINOIDES* FISHERY IN SUBAREA 48.3 Delegation of Chile
CCAMLR-XI/12	REPORT ON THE MEETING OF THE STANDING COMMITTEE ON OBSERVATION AND INSPECTION (SCOI)
CCAMLR-XI/13	THE EXECUTIVE SECRETARY'S REPORT ON THE MEETING OF THE STANDING COMMITTEE ON ADMINISTRATION AND FINANCE (SCAF)

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CCAMLR-XI/BG/1	LIST OF DOCUMENTS
CCAMLR-XI/BG/2	LIST OF PARTICIPANTS
CCAMLR-XI/BG/3	REPORT OF AN INSPECTION CARRIED OUT UNDER THE PROVISIONS OF THE CCAMLR INSPECTION SYSTEM ON THE REGISTERED FISHING VESSEL *MAR DEL SUR III*, 18 JANUARY 1992 Delegation of United Kingdom

CCAMLR-XI/BG/4	CCAMLR REPORT OF INSPECTION Delegation of USA
CCAMLR-XI/BG/5	REPORT OF AN ATTEMPTED INSPECTION, UNDER THE PROVISIONS OF THE CCAMLR INSPECTION SYSTEM, OF THE RUSSIAN LONG-LINE VESSEL *PANTAKOPEI*, 27 JANUARY 1992 Delegation of United Kingdom
CCAMLR-XI/BG/6	REPORT ON THE ASSESSMENT OF INCIDENTAL MORTALITY, PALMER STATION, 1991-1992 Delegation of USA
CCAMLR-XI/BG/7	REPORT ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY IN THE CONVENTION AREA 1991/92 United States of America
CCAMLR-XI/BG/8	REPORT ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY IN THE CONVENTION AREA 1991/92 Australia
CCAMLR-XI/BG/9 Rev. 1	REPORT OF THE CCAMLR OBSERVER TO SCAR Observer (J.P. Croxall, United Kingdom)
CCAMLR-XI/BG/10	CONSERVATION MEASURES - CURRENT STATUS Secretariat
CCAMLR-XI/BG/11	REPORT ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY IN THE CONVENTION AREA 1991/92 Japan
CCAMLR-XI/BG/12	TECHNICAL CONSULTATION ON HIGH SEAS FISHING Ole J. Østvedt, Chairman
CCAMLR-XI/BG/13	REPORT OF THE 44TH ANNUAL MEETING OF THE IWC CCAMLR Observer (USA)
CCAMLR-XI/BG/14	BEACH LITTER SURVEY SIGNY ISLAND, SOUTH ORKNEYS, 1991/92 Delegation of UK
CCAMLR-XI/BG/15	REPORT ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY OF MARINE LIVING RESOURCES IN THE CONVENTION AREA IN 1991/92 Republic of Korea
CCAMLR-XI/BG/16	REPORT OF INSPECTIONS IN THE CCAMLR CONVENTION AREA IN THE 1991/92 SEASON Delegation of the Russian Federation

CCAMLR-XI/BG/17	REPORT ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY IN THE CONVENTION AREA 1991/92 Russian Federation
CCAMLR-XI/BG/18	RESEARCH AND FISHERIES ACTIVITIES OF UKRAINE IN THE CONVENTION AREA (Submitted by Observer from Ukraine) (Available in Russian only)
CCAMLR-XI/BG/19	REPORT ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY IN THE CONVENTION AREA 1991/92 Brazil
CCAMLR-XI/BG/20	THE UNITED NATIONS CONFERENCE ON THE ENVIRONMENT AND DEVELOPMENT (RIO DE JANEIRO, BRAZIL, 3-14 JUNE, 1992) Chairman of the Commission
CCAMLR-XI/BG/21	REPORT OF AN *AD HOC* WORKING GROUP TO REVIEW THE UKRAINE PROPOSAL FOR A BOTTOM TRAWL SURVEY ON OB AND LENA BANKS Submitted by Dr K.-H. Kock, Chairman of the *Ad Hoc* Working Group

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CCAMLR-XI/MA/1	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 South Africa
CCAMLR-XI/MA/2	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 Germany
CCAMLR-XI/MA/3	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 USA
CCAMLR-XI/MA/4	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 Chile
CCAMLR-XI/MA/5	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 Russia
CCAMLR-XI/MA/6	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 France
CCAMLR-XI/MA/7	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 Sweden
CCAMLR-XI/MA/8	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 United Kingdom

CCAMLR-XI/MA/9	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 Australia
CCAMLR-XI/MA/10	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 Poland
CCAMLR-XI/MA/11	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 New Zealand
CCAMLR-XI/MA/12	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 Norway
CCAMLR-XI/MA/13	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 Argentina
CCAMLR-XI/MA/14	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 Spain
CCAMLR-XI/MA/15	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 Japan
CCAMLR-XI/MA/16	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 Republic of Korea
CCAMLR-XI/MA/17	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA 1991/92 Brazil

AGENDA FOR THE ELEVENTH MEETING:
OF THE SCIENTIFIC COMMITTEE

AGENDA FOR THE ELEVENTH MEETING OF THE SCIENTIFIC COMMITTEE

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

2. Krill Resources
   (i) Fishery Status and Trends
   (ii) Report of the Working Group on Krill (WG-Krill)
   (iii) Data Requirements
   (iv) Advice to the Commission

3. Fish Resources
   (i) Fisheries Status and Trends
   (ii) Report of the Working Group on Fish Stock Assessment (WG-FSA)
   (iii) Data Requirements
   (iv) Scientific Research Exemptions
   (v) New Fisheries
   (vi) Advice to the Commission

4. Other Resources
   (i) Review of Activities Related to Squid
   (ii) Review of Activities Related to Crab Species
   (iii) Other Resources
   (iv) Advice to the Commission

5. Ecosystem Monitoring and Management
   (i) Report of the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP)
   (ii) Management Plans for CEMP Sites
   (iii) Advice to the Commission

6. Report of the Joint Meeting of the Working Groups on Krill and CEMP

7. Marine Mammal and Bird Populations

8. Assessment of Incidental Mortality
   (i) Incidental Mortality in Longline Fisheries
   (ii) Incidental Mortality in Trawl Fisheries
   (iii) Marine Debris

9. CCAMLR Scheme of International Scientific Observation

10. Cooperation with Other Organisations
   (i) Acquisition of BIOMASS Data Base
   (ii) Reports of SC-CAMLR Representatives at Meetings of Other International Organisations
   (iii) Nomination of SC-CAMLR Observers to Meetings of Other International Organisations

11. Publication of Scientific Papers

12. Review and Planning of the Program of Work of the Scientific Committee
   (i) Activities in the Intersessional Period
   (ii) Coordination of Field Activities for 1992/93 and 1993/94

13. Budget for 1993 and Forecast Budget for 1994

14. Election of Chairman of the Scientific Committee

15. Next Meeting

16. Other Business

17. Adoption of the Report of the Eleventh Meeting of the Scientific Committee

18. Close of the Meeting.

REPORT OF THE FOURTH MEETING
OF THE WORKING GROUP ON KRILL
(Punta Arenas, Chile, 27 July to 3 August, 1992)

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INTRODUCTION

1.1 The Fourth Meeting of the Working Group on Krill (WG-Krill) was held at the Hotel Cabo de Hornos, Punta Arenas, Chile, from 27 July to 3 August 1992. The meeting was chaired by the Convener, Mr D.G.M. Miller (South Africa).

1.2 Mr Miller welcomed the Working Group to Punta Arenas, commenting that this was the first time the Group had met in the Southern Hemisphere.

REVIEW OF THE MEETING OBJECTIVES AND ADOPTION OF THE AGENDA

2.1 The Convener reviewed the objectives of the meeting. The highest priority topics for consideration by the Working Group had been identified by the Scientific Committee (SC-CAMLR-X, paragraph 3.93) as:

- investigations of flux in Statistical Area 48 and other areas;
- estimation of total effective biomass in Statistical Area 48 and other areas;
- refinement of calculations of potential yield and precautionary limits, including further evaluation of the population models and demographic parameters used in such calculations; and
- further estimation of precautionary limits in various statistical areas and subareas.

2.2 In addition to the activities set out above, the Scientific Committee had endorsed specific additional objectives as:

- further work on by-catch of young fish in the krill fishery (SC-CAMLR-X, paragraph 3.22) and on possible escapement losses of krill not retained during trawling (SC-CAMLR-X, paragraph 3.23);

- additional information on krill demographic parameters should be reviewed (SC-CAMLR-X, paragraph 3.48);

- continued development of operational definitions of Article II in the context of particular management procedures and the associated mechanisms for monitoring the krill resource (SC-CAMLR-X, paragraphs 3.52 to 3.53);

- regions where overlap between fisheries and foraging predators may exist should be further defined in order to facilitate future refinement of precautionary krill limits (SC-CAMLR-X, paragraph 3.82);

- consideration of the costs to fishing nations, likely to be incurred in the collection of length frequency and haul-by-haul data (SC-CAMLR-X, paragraph 3.91).

2.3 The Scientific Committee had posed four questions that would assist the development of exact formulations of future conservation measures in Statistical Area 48:

(i) Within Subareas 48.1 and 48.2, does the consistent concentration of the krill fishery in particular parts of these subareas, reflect that:

(a) these are the only parts of these subareas where economic krill fishing is consistently possible;

and/or

(b) these are consistently the best parts of the subareas for krill fishing?

(ii) What is known about krill concentrations in the parts of these subareas further from land than 100 km?

(iii) How critical is the December through February period to the efficient operation of the krill fisheries in parts of Subareas 48.1 ad 48.2 to which they are currently restricted?

(iv) How does the abundance and distribution of krill in areas currently the focus of the fishery, change throughout the fishing season? In particular, what are the abundance and distribution characteristics immediately prior to and after the breeding seasons of penguins and fur seals (i.e., prior to December and after February).

2.4 A Preliminary Agenda had been circulated prior to the meeting. Two additions were made, 'Techniques' under Item 4(ii), which would cover considerations of target strength estimation and other procedures used for biomass surveys, and 'Editorial Considerations' under Item 7. With these additions the Agenda was adopted.

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

2.6 The report was prepared by Drs D.J. Agnew (Secretariat), R. Hewitt (USA), R. Holt (USA), M. Basson (UK), D. Butterworth (South Africa), J. Watkins (UK), I. Everson (UK) and W. de la Mare (Australia).

REVIEW OF FISHERIES ACTIVITIES

3.1 The following documents were considered during the discussions of the Working Group under this agenda item: CCAMLR COMM CIRC 92/54, WG-Krill-92/6, 9, 13, 21, 29, 32, and 33.

Fisheries Information

Catch Levels

3.2 CCAMLR COMM CIRC 92/54 contained the first summary of monthly krill catch reports required by CCAMLR Conservation Measure 32/X. Conservation Measure 32/X became effective in May 1992, and reports from Member nations were due at the Secretariat by 30 June 1992.

3.3 Poland reported monthly catches from July 1991 through May 1992 totalling 6 887 tonnes; the bulk of these catches were taken in Subarea 48.3. The data reported by Russia including catches by Ukrainian vessels; monthly catches from November 1991 through June 1992 totalled 93 625 tonnes and 89% of the catch was taken in Subarea 48.2. No other Members reported monthly catches.

3.4 Dr M. Naganobu (Japan) reported that six Japanese fishing vessels operated during 1991/92 and that two were currently fishing. The 1991/92 catch was estimated to be similar to the 1990/91 catch (66 250 tonnes total).

3.5 Dr V. Marín (Chile) reported that one Chilean fishing vessel operated in Subarea 48.1 during January through March 1992 and caught 6 086 tonnes (WG-Krill-92/21). These catches had been reported to the Secretariat in haul-by-haul format, separated into two 45-day fishing periods.

3.6 There was no information available regarding catches of krill by other Members in 1991/92.

3.7 Dr K. Shust (Russia) reported that the Murmansk and Black Sea fishing fleets caught 7 014 tonnes of krill in Subarea 48.1, 101 422 tonnes in Subarea 48.2, and 39 305 tonnes in Subarea 48.3 during 1991/92. He also stated that this catch was substantially lower than in previous seasons. However, Russia was unlikely to increase krill catches beyond current levels in the near future.

3.8 From the above, it was concluded that at least 227 000 tonnes of krill were caught in 1991/92, with 30% from Subarea 48.1, 50% from Subarea 48.2, and 20% from Subarea 48.3. Of the total catch, approximately 60% was reported to the Secretariat by month.

3.9 Members noted the lack of compliance by some nations with Conservation Measure 32/X which calls for reports of monthly krill catches. It was also noted that the requirement to report monthly catches had only recently been established, and it is anticipated that compliance with this conservation measure will improve in the future.

Location of the Fishery

3.10 WG-Krill-92/13 described fine-scale catches of krill in Statistical Area 48 reported to CCAMLR for 1990/91. Similar to previous split-years, fishing began at South Georgia, then shifted to South Orkneys, then to the Antarctic Peninsula area, and finally returned to the South Georgia area during the winter of 1991.

3.11 Fine-scale catch data for 1990/91 (WG-Krill-92/13) indicated that krill were caught over shelf areas associated with islands, similar to the fishing patterns reported for 1987/88. During 1988/89 and 1989/90 fishing was less concentrated, particularly in Subarea 48.2. It was noted that CPUE from the Chilean fishery was low during these years. Krill recruitment from spawning in 1988/89 and 1989/90, as implied from length frequency data and reported in WG-Krill-92/15, was also poor.

3.12 The Chilean fishing vessel operated first north of Livingston Island, then north of Elephant Island, and finally back to the area north of Livingston Island; these were similar to the areas fished in 1990/91 (WG-Krill-92/21).

3.13 The distribution of CPUE, provided in WG-Krill-92/21 was very similar to the distribution of krill determined from acoustic surveys conducted during the same period and reported in WG-CEMP-92/15. In this regard, it was noted that an evaluation of the composite CPUE index, defined first by WG-Krill in SC-CAMLR-VIII, Annex 4, Appendix 7, might be made by considering haul-by-haul fishery data in combination with acoustic data collected on a similar scale.

Other Information from the Fishery

3.14 Differences in vertical migration patterns between male and female krill were described from samples collected during Russian krill fishing operations west of Coronation Island (WG-Krill-92/9). It was noted that fishing operations were focused on aggregations of krill that remained in the same area over three months. It was further noted that reports from previous years of fishing operations and research vessel activities described aggregations of krill in the same areas to the west of Coronation Island. The information contained in WG-Krill-92/9 was considered very useful and demonstrates the benefit of having observers aboard fishing vessels.

3.15 Length frequencies of krill sampled from the 1990/91 Chilean fishery indicate that juveniles were taken north of Elephant Island but not north of Livingston Island (WG-Krill-92/21). The length frequency distributions were similar to those reported last year by the US AMLR Program (WG-CEMP-91/11), where juveniles were caught north of Elephant Island but not north of King George Island.

3.16 The problems of catching large numbers of salps or “green” krill were discussed. It was recognised that discarding catches with large numbers of salps may affect observed length frequencies. Dr E. Acuña (Chile) indicated that the Chilean vessel discarded hauls with greater than 40% salps, but that this was a relatively rare event and only ever occurred during short trial hauls at a new location. Dr H. Hatanaka (Japan) commented that some Japanese fishing companies kept the catches including salps. “Green” krill are kept by both fleets but in the case of the Japanese fishery, movement away from regions of “green” krill is necessary to maintain product quality. The Russian fishery on the other hand utilises both “green” and “white” krill.

By-Catch of Young Fish

3.17 WG-Krill-92/32 described the numbers and size distribution of juvenile and adult fish caught during the course of Chilean krill fishing operations. Dr Acuña further explained that approximately

12% of the hauls were examined, and 10% of the total of 419 hauls contained fish as a by-catch. The Working Group noted that the relatively small numbers of large fish reported may still be a cause of concern. In response to a query from Dr Everson, Dr Acuña reported that juvenile fish (*Chionodraco spp.*) were included in the above analyses although there is still an attendant difficulty in separating small fish from krill in the catch and consequently the occurrence of small fish may be under-reported. It was also noted that information on the proportion of fish by-catch by weight would be useful information.

3.18 The abstract of WG-Krill-92/6 reported that there was no fish by-catch during Russian krill fishing operations conducted in Subarea 48.2. Juvenile *Champsocephalus gunnari* were caught, however, during krill fishing operations in Subarea 48.3. Dr Shust indicated that the tables contained in WG-Krill-92/6 would be translated and presented at the meeting of the Working Group on Fish Stock Assessment (WG-FSA) later this year. The Working Group strongly encouraged more reports of this type.

3.19 Attention was drawn to the fact that information on the presence of small fish, particularly the larval stages, is still lacking since they are difficult to observe. It is therefore still not possible to assess fully the possible effect of by-catch on the early life history stages of fish, particularly species subject to conservation measures. The Working Group draws the attention of WG-FSA to the above results in the context of the Scientific Committee's concern expressed in SC-CAMLR-X, paragraph 3.22.

Fishing Escapement Loss/Mortality

3.20 Both the Scientific Committee and Commission have expressed concern as to the lack of information on the mortality of krill which pass through the meshes of nets (see for example, SC-CAMLR-X, paragraph 3.23 and CCAMLR-X, paragraph 6.16).

3.21 In this connection, WG-Krill-92/29 was accompanied by a video of Japanese commercial fishing operations. The objective of showing the video was to suggest that little loss occurred through the codend of the trawl, and that many of the krill retained were still living. It was noted that Japanese fishermen carefully monitor the quantity of krill caught in the net throughout the course of the haul, and that the net is retrieved when an adequate amount of krill is caught. Japanese catches are 10 to 12 tonnes per haul if the krill is to be frozen and 30 tonnes per haul if the krill is to be peeled or reduced to meal. The Russian fishery on the other hand fishes for longer periods of time and catches are often of the order of 15 to 20 tonnes per haul.

3.22 The Working Group encouraged additional experiments to determine the amount and viability of krill passing through the wings, body, and codend of nets used in krill harvesting operations particularly during the towing process. Members with historical information from such experiments were encouraged to submit their results to the next meeting.

Reporting of Catch Data

3.23 Currently data on krill catch and effort are required to be reported by fine-scale rectangles (0.5° latitude x 1° longitude) from Subareas 48.1, 48.2, 48.3 and the Integrated Study Regions (ISRs).

3.24 Members noted that the Chilean fishery occurs in only 3 to 5% of Subarea 48.1. Similarly, total krill catches in Subarea 48.1 have occurred in 15% of the available fine-scale reporting rectangles. It was suggested that subareas, and even the fine-scale reporting blocks, are too large to determine the effects on krill predators of localised fishing. It was further noted, however, that more detailed reporting schemes would be difficult to implement for all catch and effort data, and that the present fine-scale reporting was adequate to define the temporal and spatial distribution of catches (for further discussion see paragraphs 3.11, 3.12, 4.15, 4.30, 4.31 and 6.17). The Working Group emphasised the continued request for reporting of haul-by-haul data within 100 km of CEMP sites (SC-CAMLR-IX, paragraph 2.63; CCAMLR-X, paragraph 4.10(ii)) if possible.

ESTIMATION OF KRILL YIELD

Krill Flux in Statistical Area 48

Immigration and Emigration Rates

4.1 The possible importance of krill movement with respect to the estimation of potential yield was emphasised at both the 1990 and 1991 meetings of WG-Krill and, at the 1991 meeting, the Working Group recommended that submissions on this topic be made.

4.2 Paper WG-Krill-92/25 presented figures and tables containing surface geostrophic flow in Statistical Area 48 and the Atlantic Sector of the Antarctic Ocean, based on oceanographic data accumulated since 1925. Geostrophic velocity and volume transport through specific observation lines were also presented based on oceanographic data collected by cruises of RV *Kaiyo Maru* over the last nine years.

4.3 The geopotential anomaly and vertical distribution of velocity and volume transport, based on data from the second leg of a survey conducted by RV *Kaiyo Maru* in the waters north of the South Shetland Islands (January/February 1991) were presented in WG-Krill-92/24.

4.4 It was pointed out that the picture of flow obtained from four Argos buoys released in the area to the north and north-west of Livingston Island presented in Figure 4 of WG-Krill-92/26, is somewhat different from the picture of geostrophic flows based on geopotential anomalies presented in WG-Krill-92/25.

4.5 The importance of scale and location in this regard was noted. Figure 5 in WG-Krill-92/24, for example, based on geopotential flow, shows a strong flow from the Pacific to the Atlantic Sector with a small counter flow along the shelf. This is not contradictory to the tracks of the Argos buoys, but these flows are defined on a much smaller scale than those in WG-Krill-92/25. Large errors in the estimation of krill migration rates can therefore be made if an inappropriate scale is used to determine the flux or flow of water.

4.6 It was also noted that the tracks of two of the buoys, released on the same date, to the northwest of Livingston Island were very close at one point but one buoy ended up around South Georgia whereas the other became entrained in the waters around Elephant Island. This suggests that it may be very difficult to predict where a body of water (with or without krill) may end up even if the flows are known.

4.7 The Working Group was of the opinion that when considering flow in the deep ocean, between island groups, geostrophic flow on a relatively large scale may be appropriate. Flows on a smaller scale in the area around an island, for example, may be described more realistically using satellite tracking of buoys.

4.8 Dr Naganobu commented that the general direction of the surface geostrophic currents in the northern shelf of the South Shetlands is toward the east, but below 50 m they move in the opposite direction. It is important to consider this current system in relation to the movement of the different life stages of krill in the area.

4.9 One possible disadvantage of using satellite tracking is that a large number of observations needs to be considered in order to obtain an overall picture of the patterns of flow. This is required because the knowledge of integrated mass flows over boundaries, combined with the density of krill in bodies of water, is most important for estimation of the total biomass in a given area.

4.10 At this stage, for convenience, the boundaries used are those that define the CCAMLR Statistical Subareas within Statistical Area 48. It will become necessary to consider whether these boundaries are appropriate and the information that would be necessary to do so should be identified.

4.11 The Working Group's attention was drawn to the WOCE (World Ocean Circulation Experiment) Program which includes the use of tracking buoys put in the open ocean. Members felt that similar studies that concentrate on shelf areas would complement the WOCE study and should provide useful information on krill movement.

4.12 The possible usefulness of models that simulate Southern Ocean circulation, such as FRAM (Fine Resolution Antarctic Model), was noted. Results of this model have been published as FRAM Atlas.

4.13 Dr Everson reported preliminary results of work undertaken with the FRAM at British Antarctic Survey. The study looked at the drift of particles seeded into the model at different locations. When the particles were totally passive and seeded into Drake's Passage, they ended up north of the Antarctic Polar Front (APF). When the particles were allowed to migrate vertically, however, they remained south of the APF. This implies that any model of krill movement should take into account the behaviour of krill, at least in terms of vertical migration.

4.14 Two major problems with the use of FRAM in trying to understand krill movement were identified. Firstly, FRAM only simulates summer conditions and, secondly, its spatial scale is greater than 10s of kilometres so that not much useful information on movement in shelf areas can be obtained.

4.15 Dr Hewitt reported that on one survey around Elephant Island, the geopotential anomalies were found to be complex (many eddy-like structures) and there was a high level of krill density. On another survey, also around Elephant Island, the geopotential anomalies were directed (fewer eddies and a predictable flow pattern) and there were fewer krill. In order to investigate this matter further, it was necessary to look on spatial scales of less than 10 km. There is therefore a need for local circulation models which accommodate much finer spatial resolution.

4.16 In this context, reference was made to the work by Hofman and colleagues (USA) who have developed very fine-scale models linking hydrographic conditions with egg and larval stages of krill.

4.17 Table 1 summarises current knowledge of flow rates in and between subareas in Statistical Area 48.

Residence Times

4.18 The Working Group noted that there were areas where krill concentrations consistently tended to occur year after year, but where local krill concentrations did not necessarily persist. This is particularly evident from data on the location of the fishery. There are also areas where, within a season, there is very little flow and local krill populations may be considered as quasi-stationary.

4.19 It was suggested that Statistical Area 58 may be one where water flow may be less complex and variable in the shelf region and may therefore be a good starting point for studying residence times in a system somewhat simpler than that in Statistical Area 48.

4.20 Dr Everson reported that a krill patch studied during acoustic investigations in the area of Bird Island, persisted for over two weeks (WG-Krill-92/31). Although the length frequency distribution of the krill sampled within the patch was also stable and the density was relatively constant, it was impossible to say whether the same group of animals remained in the area or whether animals were continuously moving into and out of the patch.

4.21 The view was expressed that, with respect to the formation and persistence of aggregations, small-scale flows, eddies and gyres are likely to be more important than large-scale flows. This is because the formation of krill aggregations is likely to be associated with primary production which in turn may depend on localised hydrographic conditions.

4.22 It is likely that krill are able to follow plumes of production and end up in areas of high primary productivity (i.e., food availability). Krill distribution should not therefore be assumed to be entirely passive and dependent on prevailing hydrography.

Influence of Hydrography

4.23 A study of seasonal changes in the oceanic structure of waters around the South Shetland Islands from a survey conducted by RV *Kaiyo Maru* was presented in WG-Krill-92/24. During the first leg of the survey (22 to 29 December 1990) the temperature of the Antarctic Surface Water over the insular shelf was consistently below O°C. On the second leg (18 January to 2 February 1991), however, the temperature in the same waters was consistently above zero.

4.24 The reason for this change in temperature is thought to be caused by the topographic upwelling of the Warm Deep Water and wind-driven coastal upwelling. The distribution patterns of temperature, salinity, density, dissolved oxygen and nutrient salts supported this conclusion.

4.25 One of the authors (Dr Naganobu) added that this upwelling phenomenon is important for primary production and that further analyses are being conducted to investigate this matter.

General Comments

4.26 In the 1991 report of WG-Krill various hypotheses about the movement and degree of mixing of krill between the subareas in Statistical Area 48 were proposed and graphically presented in Figures 2 and 3 in Annex 5 of SC-CAMLR-X. One model is that the populations in each subarea are effectively closed populations. Another model is that there is effectively a conveyer belt moving krill from Subarea 48.1 to 48.2 and on to 48.3. Current information does not exclude either of these possibilities although the general feeling was that a mixed model would probably be most appropriate.

4.27 It was noted that new information has been presented for Subarea 48.1 but that there was not much information available for Subarea 48.2 and no new information for Subarea 48.3. Members agreed that it was also important to consider statistical areas other than Statistical Area 48.

4.28 With respect to Statistical Area 58, it was felt that the system is likely to be simpler than that in Statistical Area 48. Several papers (SC-CAMLR-VI/BG/25 and WG-Krill-90/16) on the characterisation of water masses and the krill distribution as well as on the location of the fishery have been presented in the past. Biological surveys have also been conducted in Statistical Area 58 and, in general, these activities have been concentrated on the shelf area where krill concentrations consistently occur.

4.29 It was also noted that WOCE was focussing on this area.

4.30 The Working Group noted how valuable the fine-scale fisheries data from Statistical Area 48 have been, particularly in identifying areas of high krill density and the duration of these aggregations. These data are essential in the linking of krill distribution with fine-scale oceanographic features.

4.31 There seemed to be few difficulties in collecting these data, and the Working Group therefore recommended that fine-scale data be required for Statistical Areas (58 and 88). These data should be submitted in the same way as those for Statistical Area 48. The submission of fine-scale data for Statistical Areas 58 and 88 from past seasons would also be of great value to the Working Group and should be requested.

4.32 For future work on the influence of hydrography on krill distribution, it was felt that attention should also be given to the use of data on flux and retention times to integrate krill abundance with the flow of water masses in order to estimate overall krill biomass (or standing stock).

4.33 It was pointed out that the effective liaison between biologists, fishermen, fisheries managers and oceanographers has yielded a large amount of information for Subarea 48.1 and that there is a need to extend this cooperative work to the other areas.

Estimation of Biomass

Techniques

4.34 At the 1991 meeting of WG-Krill, recommendations were made regarding the relationship between target strength and length (of the target) that should be used in calculations of biomass, from acoustic surveys conducted at 120 kHz. This recommendation was adopted by the Scientific Committee (SC-CAMLR-X, paragraph 3.34).

4.35 Recommendations for further work regarding the estimation of krill target strength were also made (SC-CAMLR-X, Annex 5, paragraph 4.30). These can be summarised as:

(i) cage and *in situ* measurements of krill aggregations should be made over a range of acoustical frequencies and animal lengths and physiological condition;

(ii) *in situ* measurements of individual krill target strength should be made using dual- or split-beam echosounders;

(iii) the physical conditions of krill should be measured whenever possible;

(iv) the orientation and shape characteristics of krill should be determined whenever possible; and

(v) the above measurements should be used in theoretical models to predict the distribution of individual target strengths that would be expected from a natural aggregation of animals.

4.36 Paper WG-Krill-92/11 presents an overview of empirical values of target strength and theoretical models of target strength. Data from a wide variety of sources are reviewed with the aim of providing a generalised relation between target strength, size and frequency. Various problems are identified and the resulting recommendations are essentially the same as those above.

4.37 Paper WG-Krill-92/31 summarises information, addressing some of the above issues, from three papers submitted for publication by scientists from British Antarctic Survey. The results indicate that:

(i) the near surface bubble layer causes significant backscatter at 38 and 120 kHz but does not cause significant signal attenuation;

(ii) signal strength at 120 kHz was approximately 5 dB higher than at 38 kHz for 55 mm krill in a patch near South Georgia;

(iii) different types of echotraces can be identified from survey records; and

(iv) from target hauls with a Longhurst Hardy Plankton Recorder some of these target types could be identified as individual taxa.

4.38 Target identification, both with single-beam and dual-beam systems, is receiving a lot of attention and improved methods and systems are under development in many countries.

4.39 The estimation of the target strength of salps was discussed in some detail. Salps often occur in areas where krill are found. Although little work has been done on this problem, some members felt that it may be possible to distinguish salps from other taxa because the signals from 200 kHz and 120 kHz for salps appear to be different.

4.40 The Working Group indicated that further work on the effect of the physical condition and orientation of animals on target strength was needed.

4.41 The importance of calibration was emphasised particularly in the estimation of abundance and in situations when dual frequency systems are being used for target identification.

4.42 Paper WG-Krill-92/17 outlines the theory and procedures that have been used for calibrating an echo integration acoustic system with a standard sphere. Results of an extensive calibration of a Simrad EK500 scientific echosounder with a 120 kHz split-beam transducer in a refrigerated 10 m deep tank were presented. Calibration parameters were studied in relation to sphere material, water temperature, transmitted pulse length, target depth and time. Conclusions from this study indicate that the accuracy of the standard sphere as a reference TS value, temperature range and time contribute significant error to the calibration accuracy of an echo integration acoustic system. The Working Group agreed that acoustic calibrations should be undertaken for all the instrument settings used during a survey.

4.43 Paper WG-Krill-92/30 presented a procedure to correct for the effects of acoustic beam width when assessing the biomass of krill aggregations. The problem arises because, as a swarm passes into the beam, it is only fully insonified when a certain distance has been traversed; the distance is a function of the range to the swarm and the angle off-axis at which the swarm is first detected. This off-axis angle should be determined and used in preference to the values supplied by manufacturers. It was pointed out that beam width is infrequently measured although it is a very important parameter in the analysis of acoustic data.

4.44 A further important consideration in acoustic surveys is the choice of threshold levels for echo integration. This should be taken into account when considering results from acoustic surveys.

Statistical Area 48

4.45 In 1991 the Commission set a precautionary limit for krill in Statistical Area 48 (Conservation Measure 32/X), based on calculations undertaken by WG-Krill using estimates of krill biomass established from results of the FIBEX acoustic survey.

4.46 Krill target strength is an important parameter in the estimation of abundance from acoustic survey data. The Working Group agreed at its last meeting that the TS values used during the FIBEX analysis were too high and recommended that a revised TS/length relationship at 120 kHz be used.

4.47 The Scientific Committee had requested that the FIBEX data be re-analysed (SC-CAMLR-X, paragraph 3.78). A group of scientists from some Member nations undertook this task which consisted of:

(i) re-calculation of FIBEX results using the original TS relationship to check the database and programs;

(ii) re-calculation of FIBEX results using the new TS relationship; and

(iii) calculation of biomass estimates for each subarea.

Results are presented in WG-Krill-92/20.

4.48 Thanks were extended to BIOMASS Data Centre and British Antarctic Survey for their cooperation and assistance in this task.

4.49 The TS relationship recommended by the Working Group pertained to a frequency of 120 kHz. Two of the surveys conducted under FIBEX were not at 120 kHz, but at 50 kHz (*Walther Herwig*) and at 200 kHz (*Kaiyo Maru*). The recommended TS relationship had to be adjusted to obtain TS relationships at these other frequencies (Greene *et al.*, 1991*).

4.50 The results using the original TS are, in general, in close agreement with the original BIOMASS results. The ratio of densities obtained by using the original TS and the new TS is approximately 4 in most cases.

4.51 There are some exceptions. First, the Japanese survey was conducted at 200 kHz and the original TS relationship used was very close to the one recommended by WG-Krill, corrected for that frequency. Second, the German survey was conducted at 50 kHz. In this case, the new TS relationship is very different from that originally used; the densities obtained using the new TS relationship were 40.92 times greater than the densities obtained using original FIBEX relationship.

4.52 Biomass estimates from the re-analysed FIBEX data are shown in Table 2. The re-analysed mean density for the Indian Ocean Sector showed an almost two-fold increase over the original. In the West Atlantic Sector the increase was almost 10-fold, due to the fact that the *Walther Herwig* surveyed a relatively large area (see Table 2).

4.53 Some difficulties were encountered in assigning survey tracks used in FIBEX to CCAMLR subareas where transects crossed subarea boundaries. This was particularly true of the *Walther Herwig* survey where many transects crossed subarea boundaries. It was, however, possible to assign parts of survey tracks because of the comprehensive information contained in the dataset for this cruise.

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* GREENE, C.H., T.K. STANTON, P.H. WIEBE and S. MCCLATCHIE. 1991. Acoustic estimates of Antarctic krill. *Nature 349*: 110.

4.54 The authors stressed that the cruise tracks did not cover all of the subareas, particularly in the case of Subarea 48.3, and drew the Working Group's attention to the dangers of extrapolating beyond the area covered by tracks.

4.55 In discussion of the results of the survey the question of coverage was raised. Dr Everson explained that the survey was designed in such a manner that tracks would run in a north-south direction (Anon., 1980*). The tracks extended as far south as possible and, in a northerly direction, until no krill were found. The surveys in Subareas 48.1 and 48.2 are therefore likely to give reasonable estimates of krill biomass at the time.

4.56 In Subarea 48.3, however, technical problems prevented the survey proceeding as intended and only part of the area to the north of South Georgia was surveyed. This resulted in a much smaller area being surveyed in Subarea 48.3.

4.57 In the case of the *Walther Herwig* survey in Subarea 48.1, the mean density appeared very high for a survey covering such a large area of deep water. This meant that the biomass estimate from the *Walther Herwig* survey contributes about 80% to the total estimate of biomass in Subarea 48.1. In Subarea 48.2 the density from the *Walther Herwig* was similar to that from other vessels. It was questioned whether the high density in Subarea 48.1 was representative of a real difference between the area surveyed by *Walther Herwig* and the area surveyed by all the other vessels. The Working Group discussed possible reasons such as inadequate target strength values and threshold effects, but could not satisfactorily explain the difference.

4.58 It was agreed that further analyses of the acoustic data together with the target net-haul data should be done. Such analyses might consider data from other vessels that used similar gear (nets) to that used on the *Walther Herwig* and could try to determine the relationship between density estimates from the acoustic method and those from net-hauls. The same exercise would be done with the *Walther Herwig* data and the results compared. This should allow validation of results from the *Walther Herwig* survey and, if necessary, calibration between results from the *Walther Herwig* and other vessels.

4.59 Results from acoustic surveys conducted in the vicinity of Elephant Island from mid-January to mid-March 1992 were presented in WG-CEMP-92/15. Two large-scale surveys (10s to 100s km) and two smaller scale (1 to 10s km) surveys were done using parallel transects. Distribution maps of krill density show, on the first large-scale survey, a wide band of krill around Elephant Island with the highest density to the north and northeast of the island. On the second large-scale survey the krill

* ANON. 1980. *BIOMASS Report No. 40*.

had dispersed and the density was very low. The smaller scale surveys show that the highest densities are generally along the shelf and shelf break and to the north and northeast of the island.

4.60 Krill abundance decreased approximately two-fold over the two-month period of the survey. This was in marked contrast to the results from surveys conducted in 1990 and 1991 when krill abundance increased from mid-January to mid-March.

4.61 In discussion it was noted that the oceanography in this area is complex and that krill patches do not seem to persist for long periods of time. On a scale of 10s to 100s km krill can consistently be found in this area. No simple relationship has yet been found between krill density and, for example, hydrography or primary production.

4.62 A method for improving biomass estimates was suggested for subareas using the accumulated information from many krill surveys (Appendix D).

Other Estimates

4.63 Paper WG-Krill-92/7 reported results from the Italian Expedition in the Ross Sea (November 1989 to January 1990). Two acoustic surveys for krill estimation were conducted by RV *Cariboo*. The first acoustic survey (30 November 1989 to 5 January 1990) was near the Balleny Islands and in the central part of the Ross Sea. The second survey covered the same area as the first survey, and in addition an area previously covered with pack-ice. Preliminary results from these two surveys indicated that the mean area density of krill in the Ross Sea was similar to that estimated in the Indian Ocean Sector.

4.64 The Working Group noted that this was the first paper on the estimation of krill biomass in the Ross Sea submitted to CCAMLR.

4.65 Members indicated that krill were expected to be found in this area because minke whales are known to feed on krill and to be present in high densities in the area.

4.66 It was pointed out that the FIBEX target-strength relationship had been used. The authors had used this relationship for the purposes of comparison with FIBEX results in other statistical areas. The Working Group suggested that the data be re-analysed using the target-strength relationship recommended by WG-Krill in 1991 (SC-CAMLR-X, Annex 5, paragraph 4.30).

4.67 Reservations were also expressed about the way which the survey was designed and results analysed.

4.68 Paper WG-Krill-92/23 presented results of acoustic surveys in the Prydz Bay region, undertaken by the *Aurora Australis* in January/February 1991 and February/March 1992. The estimated biomass from the 1992 survey was substantially less than that in 1991. There was also a difference in the spatial distribution of krill density. High krill density was observed along the shelf break in 1991 but not in 1992. High krill density was also observed to the west of Prydz Bay in 1991 but not in 1992.

4.69 The paper indicated that the extent of bias in estimates of krill abundance due to the inclusion of biomass of other species, particularly *Euphausia crystallorophias*, cannot be assessed until the target strengths of the other species that occur in the same area as *Euphausia superba* are determined. The Working Group was informed that work was in progress to try and resolve this problem using a multi-beam system.

4.70 Some members questioned why the noise margin and threshold were changed between the surveys in 1991 and 1992. The authors were requested to clarify how this had been taken into account in the analysis.

Refinement of Yield Estimate Calculations

Evaluation of Population Models

4.71 At the previous meeting of the Working Group, estimates of potential yield had been based primarily on the formula $Y = d\lambda MB_0$. In this formula, $\mathbf{B_0}$ is an estimate of the biomass prior to the onset of exploitation, **M** is the natural mortality, and l is a factor calculated so that the probability that the spawning biomass drops below 20% of its average pristine level over a 20-year period under a constant annual catch is 10%. The discount factor **d** was introduced to allow for uncertainty in estimates of parameter values, and the fact that a precautionary limit should be less than a possible ultimate catch level. Calculations made at that meeting had assumed d = 0.67; for recruitment variability $\sigma_R = 0.4$, the values of the product $\mathbf{d}lM$ had been calculated to be 0.093 for M = 0.6 yr $^{-1}$ and 0.14 for M = 1.0 yr $^{-1}$.

4.72 The previous meeting had also specified various refinements to the process used to calculate l, to change the model into a more realistic representation of the krill fishery (SC-CAMLR-X, Annex 5, Appendix E). In particular, to take direct account of the uncertainty in estimates for various parameter values (instead of the *ad hoc* approach of applying a discount factor **d**), prior distributions had been specified for these values, with the refined calculations of l to incorporate integration over these distributions. Thus, for example, results were to be integrated over uniform distributions for **M** and $s_{\mathbf{R}}$ over the ranges [0.4, 1.0 yr^{-1}] and [0.4, 0.6] respectively.

4.73 Refined calculations requested by the Commission were carried out and reported in WG-Krill-92/4. For a fishing season over the whole year, the value of the factor $\lambda M = \gamma$ corresponding to a 10% probability of the spawning biomass falling below 20% of its average pristine level over a 20-year period of constant-catch harvesting had been evaluated to be 0.063.

4.74 Paper WG-Krill-92/28 contained results of calculations similar to those reported in WG-Krill-92/4, using a simplified version of the model. In the light of the results obtained, the author of WG-Krill-92/28 suggested that the values of g listed in WG-Krill-92/4 were too low.

4.75 The Working Group agreed that when complex calculations of this nature, which may form the basis for subsequent management recommendations, are carried out, it is desirable as a matter of principle that they should be independently checked before being finally adopted. Accordingly, it recommended that the Secretariat be requested to check the calculations reported in WG-Krill-92/4 and 28, with particular regard to explaining the apparent differences in results.

4.76 During the course of discussions, further refinements to the model used in WG-Krill-92/4 were suggested. These are detailed in Appendix E which also specifies certain further sensitivity tests and output statistics which were requested.

4.77 The Working Group noted that the model in question is intended to assist with the development of broad <u>initial</u> advice on an appropriate precautionary catch limit, which is based on the results of a single biomass survey only. As such, it would be inappropriate to extend this particular model further to consider either:

(i) feedback-control management options (i.e., adjustment of the catch level during the harvesting period on the basis of additional surveys or other observations);

and

(ii) spatial effects, related (for example) to localised predator aggregations.

Rather, separate models should be developed to address these concerns specifically.

4.78 Dr Hatanaka stated that he considered it unrealistic that harvesting a proportion of the estimated krill biomass as small as 6.3% could deplete spawning biomass to as large an extent as indicated by the results reported in WG-Krill-92/4. He wished to stress his view that it would be premature to base management recommendations on that result.

4.79 At the time of the adoption of the report, Dr Shust indicated his agreement with this point of view.

Evaluation of Demographic Parameters

4.80 The results of yield estimate calculations using the model of WG-Krill-92/4 are particularly sensitive to the value of the recruitment variability parameter $s_{\mathbf{R}}$. It is clearly desirable that the values used in calculations should be based upon analyses of observations of the krill resource, rather than upon analogy with the values for other small pelagic fish species as in the case at present. Appendix E sets out a basis by which $s_{\mathbf{R}}$ might be estimated directly from length distribution results obtained on research surveys.

4.81 Paper WG-Krill-92/8 reported estimates of krill mortality ranging from 0.75 to 1.17 yr^{-1}. It was noted that these were compatible with results obtained previously by Siegel (1991[*]) .

4.82 Paper WG-Krill-92/15 reviewed length-weight relationships for krill, with particular attention to seasonal variation, to aid (*inter alia*) in biomass assessment from acoustic surveys. It was suggested that the precision of the results reported should be investigated by means of the methods similar to those applied by Morris *et al*. (1988[**]).

Refinement of Precautionary Catch Limit Estimates

4.83 At the previous meeting, the formula $Y=d\lambda MB_0$ had been used to provide an indication of an appropriate precautionary catch limit in Statistical Area 48. The value of 15.1 million tonnes used for $\mathbf{B_0}$ was based on the estimate (at that time) from the FIBEX survey in Subareas 48.1, 48.2 and 48.3, because of its near synopticity. The two values for $\mathbf{d}l\mathbf{M}$ indicated in paragraph 4.72 above had then indicated values of 1.40 and 2.11 million tonnes for **Y**; it had been noted that these two

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* SIEGEL, V. 1991. Estimation of krill (*Euphausia superba*) mortality and production rate in the Antarctic Peninsula region. Document *WG-Krill-91/15*. CCAMLR, Hobart, Australia.

** MORRIS, D.J., J.L. WATKINS, C. RICKETTS, F. BUCHOLZ and J. PRIDDLE. 1988. An assessment of the merits of length and weight measurements of Antarctic krill *Euphausia superba*. *Brit. Ant. Surv. Bull. 79*: 37-50.

estimates were negatively biased because no account had been taken of flux factors and incomplete coverage of the total area by FIBEX. Two alternative methods had suggested precautionary limits of 1.5 million tonnes and between 1 and 2 million tonnes. Taking all these results into account, the Working Group had recommended a precautionary catch limit of 1.5 million tonnes (which corresponds to a value of 0.10 for the factor $\mathbf{d}\lambda\mathbf{M}$).

4.84 Based on this previous value for $\mathbf{d}\lambda\mathbf{M}$, and the value of $\gamma = 0.063$ from WG-Krill-92/4, together with the updated results for $\mathbf{B_o}$ from FIBEX as discussed in paragraphs 4.47 to 4.63 above (see also Table 2), precautionary catch limit estimates (**Y**) calculated in a manner and under assumptions similar to those of the previous year would be as follows (all units are million tonnes):

Subarea/Division		$\mathbf{B_o}$	**Y** = ($d\lambda M = 0.10$)	**Y**($\gamma = 0.063$)
48.1, 48.2, 48.3	(including *Walther Herwig*)	21.43	2.14	1.35
	(excluding *Walther Herwig*)	11.00	1.10	0.69
48.6		4.63	0.46	0.29
58.4.2		3.93	0.39	0.25

4.85 Values for Subareas 48.1, 48.2 and 48.3 in the table above have been reported for $\mathbf{B_o}$ estimates both including and excluding data from the *Walther Herwig*, for reasons discussed in paragraphs 4.58 and 4.59 above.

4.86 Conservation Measure 32/X adopted by CCAMLR in November 1991 required the Scientific Committee to provide advice on how the precautionary limit for Statistical Area 48 should be divided between subareas or bcal areas, once the total catch in Subareas 48.1, 48.2 and 48.3 exceeds 620 000 tonnes in any fishing season. Paper WG-Krill-92/16 sets out a number of options in this regard, which formed the basis for the Working Group's discussion of this issue.

4.87 In the light of these discussions, the Working Group developed seven alternative methods for allocating the precautionary limit to subareas. An allocation might be based on any one or a combination of these methods. These seven methods are as follows.

(i) FIBEX estimates of krill biomass including data from *Walther Herwig*
The most recent analyses of the FIBEX data set reported in WG-Krill-92/20 are used to allocate catch among subareas. Allocation is proportional to the biomass of krill estimated for each subarea. No allocation of krill is possible for Subareas 48.5 and 48.6, because no survey took place in these subareas during FIBEX.

(ii) FIBEX estimates of krill biomass excluding data from *Walther Herwig*

This alternative is similar to (i), except that the survey data from the *Walther Herwig* are excluded.

(iii) Historical catch

Allocation to subareas is in proportion to historical catches. The highest catch reported for each subarea, regardless of year, is used. These values are then totalled, and the result is used as the divisor in calculating the percentage allocation for each subarea.

(iv) Even division

Catches are allocated evenly to all six subareas.

(v) Linear extent of shelf break

This allocation is based upon the rationale that fishable concentrations of krill are found most frequently along the shelf break around islands, and that the linear length of the shelf break of each subarea may be proportional to the amount of krill resident at any one time in the subarea. Allocations for each subarea should then be proportional to the linear length of the shelf break (as defined by the 500 m isobath) in the respective subareas. Although this calculation could not be made during the Working Group's meeting, sufficient data are available for it to be performed.

(vi) Predator demand

Allocations to subareas are related to estimates of the amount of krill consumed in each subarea by pelagic and land-based predators. Estimates of predator consumption should include that by pinnipeds, seabirds, cetaceans and fish. Although this calculation could not be made during the Working Group's meeting, sufficient data are available for it to be performed. The exact form of the relationship between the allocations and the consumption estimates should be considered in the context of the estimates once available. The Working Group requested the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) to undertake this calculation as a matter of priority.

(vii) Local biomass adjusted for movement of krill

Allocations to subareas are proportional to some measure of local krill biomass, adjusted for krill movement. The mechanics of this scheme have yet to be specified, but would be intended to account for differences in the residence time of krill in the various subareas.

4.88 The Working Group also recognised the advice to the Commission from the Scientific Committee (CCAMLR-X, paragraph 6.16) that it may be necessary to supplement the allocation of the precautionary catch limit with other management measures to ensure that the catch was not entirely concentrated in the foraging range of vulnerable land-breeding predators.

ECOLOGICAL IMPLICATIONS OF KRILL FISHING

5.1 The ecological implications of krill harvesting have been identified as topics of major concern for the Scientific Committee. The Working Group discussed this item with respect to the location and timing of the fishery, the effects of management measures on krill fishing and CEMP studies. Some discussion of this topic had occurred under Agenda Item 3.

5.2 The Working Group had an extensive and valuable discussion on this topic and it was felt that the dialogue between scientists and those with practical experience with fisheries had led to a better appreciation of what measures would be considered as reasonable when considering management options.

Location and Timing of the Fishery

5.3 Specific questions, posed by the Scientific Committee (SC-CAMLR-X, paragraph 6.36), were considered.

5.4 Responses to questions (i) and (ii), summarised as: 'Why is fishing concentrated at certain times and locations?' and 'What is known of krill concentrations more than 100 km from land?' are set out below.

General Points

5.5 Currently fishing fleets prefer to operate close to islands because concentrations of krill tend to occur in predictable locations there. Such situations are found in summer north of the South Shetlands, west of the South Orkneys in summer and in winter around South Georgia.

5.6 Fleets have tended to encounter sufficient krill on these traditional grounds without needing to search much farther afield. Steady catch rates on these grounds indicate a ready supply of krill but give no substantial indication of the status of the resource.

5.7 Evidence from historical whale catches suggests that krill concentrations can occur at distances greater than 100 km from land. Krill fishing fleets do not look for such concentrations since much greater searching time is required to find such transient and mobile concentrations. Open ocean concentrations also tend to be smaller.

5.8 Icebergs, because they produce substantial quantities of 'growlers' and 'bergy' bits when grounded in summer, and pack-ice are avoided by the fishing fleets.

Subarea 48.1

5.9 The start of the fishing season is dependent on two factors, the absence of ice and the feeding state of the krill.

5.10 The primary areas of commercial fishing are to the north of Livingston, King George and Elephant Islands. Research sampling and commercial fishing have shown that these areas contain predictably good krill concentrations.

5.11 In most years the area is generally clear of ice by November. At this time krill are feeding on the spring bloom of phytoplankton. Such "green" krill are unsuitable for processing by the Japanese fishery. During the second half of December there are only a few Japanese vessels fishing and these actively search for "white" (non-feeding) krill. As the season progresses fewer "green" krill tend to be present so that by mid-February about half of the krill are green. The peak of the Japanese fishery occurs in February at which time it is easier to find "white" krill. By March nearly all of the krill are "white" and fishing continues until sea-ice encroaches into the area at the start of winter (Figure 1).

5.12 At the start of the season fishing is concentrated in the offshore part of the shelf in order to catch the larger krill. Fishing moves shorewards as the season develops.

5.13 Some fishing vessels move northeastwards along the shelf with the intention of fishing on the same concentration for a period of several days. Other fishing vessels remain more or less in the same location and fish on concentrations as they pass through the area. The coastal movement is more consistent in the Livingston and King George Island regions than around Elephant Island.

5.14 Based on a questionnaire and other studies, WG-Krill-92/21 showed that the Chilean fishery operates in a similar manner to that of the Japanese and generally begins in late January so as to avoid sea-ice and "green" krill; it continues for approximately one and a half months. For safety reasons the master of the fishing vessel is encouraged to fish close to the islands.

5.15 Both the Chilean and Japanese fisheries avoid locations where "green" krill are found. The Chilean fishery avoids gravid females while the Japanese fishery targets them. Operationally this means that a vessel would make a short trial tow at a location and, providing the catch was suitable for processing, would remain at that location making longer tows providing a catch rate of around 10 tonnes per haul. If the trial catch was unsuitable, the vessel would move to a new location, perhaps only a few miles away, and make a further trial haul.

Subarea 48.2

5.16 Russian vessels which can use "green" krill tend to fish on concentrations of krill that are found to the west of Coronation Island. Fishing in this area generally commences in December, as soon as ice conditions permit. Hourly catch rates are much higher in this subarea than in their Subarea 48.1 fishery.

5.17 Although krill concentrations generally occur at the same location in Subarea 48.2, they are less predictable here than on the South Shetlands shelf (Subarea 48.1). Consequently in some years the fleet fishes in other locations, sometimes a large distance from the shelf. Such a situation occurred in 1978, a season when fishing was concentrated around 58°S, 42°W.

5.18 The Russian fishery is aimed at catching krill for two types of product. One of these products requires high quality large krill, the other can accept a large proportion of "green" krill. Vessels fishing for krill to produce the high quality product commence fishing in December in Subarea 48.1 and January in Subarea 48.2.

5.19 Russian regulations on the manning of fishing vessels limit the operational period to a total of 150 days at sea. This restricts individual fishing vessels to around three months on the fishing grounds in any one season.

Subarea 48.3

5.20 Fishing tends to be concentrated on the shelf and at the shelf break at South Georgia. Very few catches have been reported more than 100 km from land.

5.21 The South Georgia fishery is conducted throughout the winter and Russian fishing captains are encouraged not to commence fishing in the area before May.

5.22 The absence of ice around South Georgia means that the fishery can continue throughout the year.

5.23 Large catches have been reported from the summer months but these tend to follow research surveys when high concentrations have been detected (WG-Krill-92/14).

5.24 This season (1991/92) a single Japanese trawler moved to Subarea 48.3 when fishing in the coastal area of Subarea 48.1 was impractical due to ice. Preliminary reports indicate that good economical catch rates have been achieved by this vessel operating close to South Georgia.

Division 58.4.2

5.25 This area is not currently the focus of a fishery but in the past Japanese and Russian vessels have operated in a narrow band close to the shelf break. The timing of the fishery is dependent on the amount of sea-ice present.

5.26 Although fishing has been concentrated in the same general area the precise locations are dependent on the locations of patches along an extensive length of shelf. Open ocean concentrations tend to be less predictable as is the case in similar areas in the Atlantic Sector.

Responses to Questions on Variation in Krill Abundance

5.27 Responses to questions (iii) and (iv) of SC-CAMLR-X, paragraph 6.36, summarised as: 'How critical is the December through February period to the fishery?' and 'How does abundance and distribution vary throughout the fishery season' were considered.

5.28 Dr J. Bengtson (USA), Convener of WG-CEMP, explained that the reason for specifying the critical period from December through February was based on the requirements of land-based predators. Penguins that are rearing chicks have restricted foraging ranges from the end of November until February and lactating fur seals have a restricted foraging range from December through March.

5.29 The Data Manager provided a breakdown of catches by month for Subareas 48.1 and 48.2 (Table 3). Between 1988 and 1991 catches were reported from October through to June. In Subarea 48.1 large catches were usually taken from January through to March or April. In Subarea 48.2, while large catches were also taken from January through to March, in some years equally large catches were taken as early as November or as late as June.

5.30 An analysis of catches with respect to distance from predator colonies (WG-Krill-92/19) indicated that, in Subarea 48.1, virtually all of the catches were taken less than 100 km from the colonies. The peak catches have been occurring in the range 41 to 60 km at the start of the season and in the range 21 to 40 km by January or February.

5.31 A similar analysis of data from Subarea 48.2 indicated no clear cut pattern.

5.32 Recent catches within the critical period from December to March and within 100 km of colonies are summarised below:

Year	Total Annual Catch		Percent in Critical Period	
	Subarea 48.1	Subarea 48.2	Subarea 48.1	Subarea 48.2
1987		19 902		78
1988	78 918	94 659	85	54
1989	105 554	82 406	90	5
1990	42 477	220 518	89	13
1991	64 641	167 257	74	53

5.33 Examination of these tabulated results indicates that in Subarea 48.1 fishing is concentrated in the months and locations that are critical to land-based predators. Fishing at these times and in these locations is presently required to provide catches most suitable for the current market demand.

5.34 In Subarea 48.2 much less fishing occurs during the critical period and within 100 km of land-based predator breeding sites, while in Subarea 48.3 the bulk of the fishing is restricted to the winter months.

5.35 Research undertaken in Subarea 48.1 (Siegel, 1988) has shown that the krill distribution extends to its maximum range beyond the shelf break in the summer and to a minimum during the winter. Krill abundance increases from October to reach a maximum in February and then decreases to a winter minimum.

Relation of Fishing to Krill Predators

5.36 Consideration of the functional relationships between krill, its principal predators and the krill fishery is a central requirement of Article II of the Convention.

5.37 The topic was considered at two spatial scales, the Southern Ocean scale and that related to localised krill/predator interactions.

5.38 At the Southern Ocean scale there are still problems in reconciling the best estimates of krill standing stock, mortality and production with estimates of predator consumption.

5.39 The need for careful thought in considering possible krill/predator/fishery interaction models was emphasised. Consequently, the Working Group agreed that strategic approaches to improve model specification and the selection of basic parameter requirements should be encouraged. The main aims of a model of this kind at this stage might be:

(i) to determine the level of escapement* needed to satisfy predator demands; and
(ii) to determine how krill standing stock responds to changes in fishing mortality.

5.40 In the first instance, it was felt that a simple approach to reconcile estimates of predator consumption with those of available krill biomass and mortality offers an appropriate starting point.

5.41 This accounting exercise was undertaken for Subareas 48.1 and 48.2 (Appendix F). A simple model linking predator consumption, krill biomass and estimated mortality rates (**M**) in Subarea 48.1 indicated that there was general agreement between mortality rates used in the estimation of potential yield (see paragraphs 4.84 and 4.85) and those calculated from preliminary estimates of predator consumption.

5.42 Similar calculations were requested for Subarea 48.2. Results of these calculations are also presented in Appendix F. The Working Group did not have time to review these results and consider their implications.

5.43 On the local scale, particularly in the vicinity of CEMP monitoring sites, there has been considerable progress which should lead to quantifying some of the functional relationships between

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* In a fisheries management context, escapement is meant to refer to the average level of biomass of the exlpoited stock for a given level of fishing. Proportional escapement is the ratio of this exploited biomass to the average biomass of the stock before the start of the fishery (pristine biomass).

krill and its predators. These topics will be included in the discussions of the forthcoming Joint Meeting of WG-Krill and WG-CEMP.

5.44 Additional topics raised in consideration of possible functional relationships included the minimum levels of local krill standing stock and aggregation patterns necessary to support a fishery and some consideration of the effects on predators of a fishery when the krill standing stock or density were low.

5.45 Dr Bengtson noted that WG-CEMP is in the process of refining estimates of the prey requirements of krill predators. It is anticipated that these efforts will lead to the development of interim estimates prior to the 1992 meeting of the Scientific Committee. It is also expected that the interim estimates will be further refined during an interactive workshop, tentatively scheduled for 1993, which would incorporate information on the abundance, distribution, energetics, and prey needs of predators into relevant models being considered by WG-CEMP. Subsequent to that meeting, it is likely that WG-CEMP will request detailed information from WG-Krill on the distribution, abundance and biological characteristics of krill at different temporal and spatial scales.

Effects of Management Measures on Krill Fishing

5.46 The following options for management measures to control fishing in specific areas were discussed:

(i) closed areas;
(ii) closed seasons;
(iii) catch limit based on historical catches;
(iv) realtime feedback to adjust catch level based on krill survey results;
(v) realtime feedback to limit fishing when predator indices are low;
(vi) combination of closed area and closed season; and
(vii) applying one set of measures to areas where CEMP monitoring is in progress and a different set of measures to other areas where similar predator colonies are known to exist.

5.47 The imposition of closed seasons and areas would have the effect of forcing fishing activities away from some traditional fishing grounds, where information was being collected on land-based predators, into areas where other predators might be at as much or even greater risk. It was agreed that the exclusion of fishing from the ISRs was contrary to the requirements of CEMP.

5.48 WG-Krill had discussed precautionary limits based on historical catches at its previous meeting (SC-CAMLR-X, Annex 5, paragraph 6.38 *et seq*.). There was no further discussion of historical catches.

5.49 Realtime feedback approaches have the advantage that they can take account of local changes. They are not easy to implement because they require continual monitoring and rapid response time. Such approaches are also likely to be disruptive to commercial fishing.

5.50 A combination of closed area and closed season such that fishing would be permitted for part of an area for part of a season has the advantage that it can afford protection to predators at certain restricted times and locations. It has the disadvantage that it is not easy to enforce.

5.51 The concept of applying additional restrictions to fishing activity in the vicinity of predator colonies not subject to CEMP monitoring rather than those within the ISRs was seen as offering some advantages. These need to be considered in the context of the krill requirements of pelagic predators and an overall strategy which takes pelagic and shore-based predators into account. WG-CEMP was requested to ensure that this concept was considered when reviewing its strategy to investigate the functional relationships among predators, prey and environmental conditions.

Liaison with WG-CEMP

5.52 The draft agenda for the Joint Meeting with WG-CEMP was discussed. The main aims of the meeting were seen as being the discussion of:

- krill catch rates with respect to current estimates of predator consumption (i.e., the question of krill escapement);
- the overlap of predator foraging ranges with commercial fishing activity; and
- krill fishing activity and predator information that might be needed for management.

5.53 To assist WG-CEMP in its ecosystem assessment efforts, WG-Krill had been requested to provide the most recent estimates of krill biomass (or relative biomass) in each of the ISRs (and other subareas or meso-scale survey areas as estimates become available) (SC-CAMLR-X, Annex 7, paragraph 5.6). The most recent analyses of krill biomass for portions of three ISRs are provided in Table 4. The coverage of these surveys in respect to the area of the ISRs is shown in Figure 2. The

Working Group stressed that these biomass estimates are only applicable to the area covered by the surveys and should not be extrapolated to cover the total areas of the ISRs.

ADVICE ON KRILL FISHERY MANAGEMENT

Precautionary Limits on Krill Catches in Various Areas

6.1 The Working Group considered revised estimates of krill abundance in Statistical Areas 48 and 58 obtained from reanalysis of the FIBEX data carried out in response to a request from the 1991 meeting (SC-CAMLR-X, paragraph 3.78). The Working Group also reviewed the results from the model for the calculation of the potential yield (**Y**), revised in accordance with the specifications set out in SC-CAMLR-X, paragraphs 201 to 203. Potential yield calculations based on the revised method and data are set out in the table below. The table includes biomass estimates obtained using FIBEX acoustic survey data, both including and excluding the data from the vessel which used 50 kHz echo sounding apparatus (discussion on this matter is given in paragraphs 4.58, 4.59 and 4.86).

Subarea/Division		$\mathbf{B_0}$ (10^6 tonnes)	**Y** (10^6 tonnes)
48.1 + 48.2 + 48.3	(including 50 kHz data)	21.43	1.35
	(excluding 50 kHz data)	11.0	0.69
48.6		4.63	0.29
58.4.2		3.93	0.25 - 0.39

6.2 The Working Group noted that it had recommended in paragraphs 4.76, 4.77 and 4.81 that some aspects of potential yield calculations required further consideration. It also noted the problems identified during the reanalysis of the FIBEX data and proposed further investigations to determine the validity of the estimates from 50 kHz data (paragraph 4.59).

6.3 The Working Group noted that the range of the revised potential yield calculations (based on $\gamma = 0.063$) for the whole of Statistical Area 48 of 0.98 to 1.64 million tonnes was within the range calculated by the Working Group in 1991 (SC-CAMLR-X, Annex 5). Although the lower end of the revised range was less than the precautionary catch limit adopted by the Commission in Conservation Measure 32/X, the Working Group noted that the potential yield figures were based on biomass estimates with limited coverage of the areas of krill abundance particularly in Subarea 48.3, and where 50 kHz data are excluded. It was noted that in Subarea 48.3 the estimate of krill biomass was substantially lower than that which would be compatible with estimates of the amount of krill consumed by predators. Accordingly, the Working Group recommends that the precautionary catch limit of 1.5 million tonnes for Statistical Area 48 contained in Conservation Measure 32/X need not be revised at this time.

6.4 The Working Group used the revised FIBEX estimate for Division 58.4.2 to estimate the potential yield of krill in this division. It was agreed to calculate the potential yield using the same model and parameters developed in 1991 and the revised model used at this meeting. The Working Group noted that the model used last year has been refined and that further work, detailed in paragraph 4.77, was pending on the revised model. Accordingly, the Working Group agreed that the figures in the table jointly represented the best scientific advice on a precautionary catch limit for Division 58.4.2 which can be given at this time. Dr Hatanaka, however, reiterated his concern expressed in paragraph 4.78 and his opposition to the use of the revised model.

6.5 The Working Group recommended that an attempt should be made to validate the 50 kHz data from FIBEX, using available information from net haul data and acoustic data at other frequencies. The Working Group emphasised that if the validity of the FIBEX results remained in doubt, consideration would need to be given in the near future to the institution of a near-synoptic survey for krill in Statistical Area 48 as a whole. The primary justification for such a survey would be to improve available estimates of $\mathbf{B_0}$ uncoupled from possible flux effects and to be used in revised calculations of krill potential yield.

Possible Ecological Effects of Catch Limits

Allocation of Limits to Subareas

6.6 The Working Group considered the options described in paragraph 4.87 as the basis for developing advice on how the precautionary catch limit in Statistical Area 48 could be allocated to subareas. The Working Group developed Table 5 as a summary of options which could be applied at this time, or which can be further developed in the near future.

6.7 The Working Group considered that the best approach to this problem in principle was to allocate the catch limits to subareas in proportion to the total krill biomass in each subarea, with adjustments being made to take into account the conservation of dependent species in accordance with the Convention’s objectives. Such an approach would require the combination of methods used in columns 1 and 2 of the table with those proposed for further development in columns 7 and 8.

6.8 Dr Shust indicated that in his view the first two options of subdividing yield into subareas using FIBEX biomass estimates (paragraph 4.87) did not take into account the flux of krill between subareas. For this reason he favoured option (vii) as the most appropriate for subdividing yield because it takes krill flux specifically into account.

6.9 Catches in recent seasons have been well below the trigger level of 620 000 tonnes stipulated in Conservation Measure 32/X to institute an allocation scheme. Therefore, it is unlikely that the implementation of an allocation scheme will be necessary in the immediate future. While this allows time for refinement of the scheme, the Working Group advises that the average of columns 1, 2 and 3 plus 5% (given in column 4) is currently the most practical interim allocation procedure to use.

6.10 The interim approach allocates part of the total catch to each subarea, but with the total allocation exceeding 100%. This would allow limited flexibility in catches in each subarea, provided that the total catch remains within the 1.5 million limit. This approach takes account of the proportion of the total krill biomass in each subarea, while also making *ad hoc* allowance for the likely under-estimation of the biomass in Subarea 48.3 from the FIBEX results.

Additional Management Measures

6.11 Dr Holt introduced a proposal in accordance with a scheme suggested at SC-CAMLR-X for the protection of land breeding dependent species (see SC-CAMLR-X, paragraphs 3.81 to 3.84 and 3.105). He noted that the data available to the Working Group showed that the current fishery in Subarea 48.1 occurred virtually exclusively within the foraging range of land-based predators. Accordingly he suggested that a management zone be established within Subarea 48.1, defined as all areas within 60 n. miles of land, and that a precautionary catch limit be set for the amount of krill which can be taken in any one season within the zone. He suggested that the precautionary limit for the zone could be set at the level of the maximum historic catch in Subarea 48.1 of 106 000 tonnes.

6.12 The Working Group agreed that full consideration of this proposal would require advice from WG-CEMP, and that further discussion would take place at the Joint Meeting of WG-Krill and WG-CEMP in Viña del Mar. The Working Group noted that the relevant information on the amount and distribution of krill fishing, as well as current estimates of krill abundance in Subarea 48.1 were available in this report, and in WG-Krill-92/18.

6.13 Dr Naganobu queried the necessity of such a proposal given the current status of the Japanese fishery. Krill are so abundant that fishing vessels are able to take a sufficient amount of krill for their needs with ease. He suggested that this indicates that the krill stock is large enough to support both predators and the fishery.

6.14 Reservations were expressed about Dr Naganobu's rationale. These were based on the reasons advanced in paragraph 5.6. Operationally, "fleets have tended to encounter sufficient krill on these traditional grounds without needing to search much farther afield. Steady catch rates on these grounds indicate a ready supply of krill but give no substantial indication of the status of the resource." Nevertheless, some members expressed other reservations about the proposal put forward in paragraph 6.11.

6.15 It was suggested that the Joint Meeting should consider the criteria that are necessary to determine whether the proposed catch limit was either more than, or substantially less than, catches compatible with the protection of dependent predators within the proposed zone. It was also suggested that not all foraging areas for land-based predator colonies would necessarily require identical levels of protection against possible effects of krill fishing. For example, it may not be desirable to protect all predator colonies monitored under CEMP because restricting the fishery at too low a level may reduce the ability of CEMP to identify the potentially deleterious effects of fishing over various geographic scales (see paragraph 5.51).

Designation of Management Regions

6.16 Dr S. Nicol (Australia) introduced WG-Krill-92/22 which discussed the problem of the considerable disparity in the size of statistical subareas and divisions in Statistical Area 58. He suggested that such large subareas should be partitioned to take into account both features of the distribution of krill, the distribution of fishing, and other practical management considerations.

6.17 The Working Group noted that statistical areas and subareas were not necessarily appropriate management regions for the krill fishery. It was agreed that a flexible scheme for designating management areas is required. The Working Group considered that these areas could be based on aggregates of fine-scale catch reporting units (0.5° latitude by 1° longitude). Such a scheme could be used to designate fishing grounds, or areas of specific ecological interest (for example, as defined by foraging ranges of land-breeding predators) with respect to management. However, operation of such a scheme would not necessarily lead to the alteration of existing statistical areas, or the designation of smaller statistical divisions.

Refining Operational Definitions of Article II

6.18 The following four concepts (from SC-CAMLR-IX, Annex 4, paragraph 61) have been endorsed by the Scientific Committee and Commission.

"(i) aim to keep the krill biomass at a level higher than might be the case if only single-species harvesting considerations were of concern;

(ii) given that krill dynamics have a stochastic component, focus on the lowest biomass that might occur over a future period, rather than the mean biomass at the end of that period as might be the case in a single-species context;

(iii) ensure that any reduction of food to predators which may arise because of krill harvesting is not such that land-breeding predators with restricted foraging ranges are disproportionately affected in comparison with predators present in pelagic habitats; and

(iv) examine what level of krill escapement would be sufficient to meet the reasonable requirements of krill predators".

6.19 No specific proposals for operational definitions have been developed from these concepts. However, operational definitions depend on the details of particular management procedures. An example of this linkage occurs in the calculation of precautionary catch limits based on potential yield. In this case, the proportion of krill biomass which can be taken depends on an operational definition with a fixed probability that krill biomass might fall below 20% of its average unexploited value. This operational definition has been developed in accordance with concept (ii). However, it will require further refinement as information becomes available about the required escapement of krill in accordance with concept (iv). As progress is made in the development of management procedures, the Working Group will need advice from the Commission on policy matters such as how frequently and by how much catch levels can alter. Such policy matters also have to be expressed as operational definitions for the purposes of developing an overall management procedure.

Other Possible Approaches and their Development

6.20 The Commission has endorsed the concept of feedback management as the approach to be developed for the long-term management of the krill fisheries. A feedback management procedure requires information about the state of the ecosystem, which is compared with operational objectives to determine the amount by which catch levels have to be altered. The Working Group recognised that the first priority in developing a feedback procedure is to determine what information about the abundance of krill stocks is likely to be available on a regular basis. In principle, three types of information can be expected:

(i) information derived from the fisheries, such as CPUE data;
(ii) information collected independently from the fisheries, such as surveys;
(iii) information collected on krill dependent predators by CEMP;

6.21 Some Members of the Scientific Committee have expressed reservations about the usefulness of CPUE in managing krill fisheries.

6.22 The Working Group agreed that surveys carried out independently of the fishery will provide reliable data on which to base feedback management. However, there is a tradeoff between the frequency of surveys and the results achieved by a feedback management procedure, either in terms of risk to the stocks or size of catches. The Working Group will need to investigate what scale and frequency of surveys will be likely to be feasible in the future. Advice from the Scientific Committee in this regard would be helpful. This information can be used to undertake some simulation studies on possible long-term feedback management procedures. It was suggested that consideration be given to a range of survey techniques, such as egg surveys. Alternative methods may provide some independent validation of acoustic surveys.

6.23 Information on the interactions of predators, prey and environmental conditions will become available from CEMP, and methods of using this in a feedback management procedure will need to be developed in consultation with WG-CEMP and others as appropriate.

Data Requirements

6.24 The Working Group was pleased to note that a considerable number of papers had been received which contained information relevant to data requirements set out in the report of its last meeting (SC-CAMLR-X, Annex 5, Table 8). An updated table of information requirements is included here as Table 6.

6.25 The Working Group was informed that some catches of krill and acoustic surveys may have occurred in FAO Statistical Area 41, and perhaps others immediately outside the Convention Area.

The Working Group requested the Secretariat to contact FAO and other relevant organisations to determine whether data from these catches is available, and can be added to the CCAMLR database.

6.26 The requirement to submit fine-scale catch and effort data from Subareas 48.1, 48.2 and 48.3 and the ISRs should be expanded to apply to any catches of krill in the Convention Area (paragraph 4.31).

Scientific Observer Scheme

6.27 The Working Group was pleased to receive a draft manual for scientific observers on fishing vessels prepared by the Secretariat incorporating material provided by Russian Scientists. The Working Group also received a paper providing further guidelines for the preparation and reporting of material collected aboard commercial krill trawlers (WG-Krill-92/10).

6.28 A subgroup consisting of Drs Marín, Naganobu, Nicol and Watkins, was convened by the Science Officer to consider the draft manual. Because the manual is a substantial document, the subgroup was not able to give detailed consideration to it in the time available at the meeting. However, a number of amendments were incorporated. The subgroup agreed that the draft manual was reasonably comprehensive and would prove useful.

6.29 The Working Group agreed that Members should give further consideration to the manual and forward suggested amendments to the Secretariat by 30 September, so that the revised draft can be presented to the Scientific Committee. It was suggested that the draft edition of the manual be made available to Members for trial use during the next fishing season.

Future Work

6.30 Future work defined by WG-Krill is listed in Table 7.

OTHER BUSINESS

Krill Surplus

7.1 The Working Group briefly discussed the matter of krill surplus, the perception that there is a potential for a large sustainable catch of krill following the removal of a large proportion of whale biomass from the Antarctic marine ecosystem (SC-CAMLR-X, Annex 5, paragraph 8.3). The

Scientific Committee had been unable to provide guidance as to how to pursue this matter (SC-CAMLR-X, paragraph 3.86). The Working Group agreed that any further deliberations should more appropriately be addressed by the forthcoming Joint Meeting of WG-Krill and WG-CEMP.

Editorial Considerations

7.2 The Working Group noted that references to working group reports were often made as "Anon., ...", and that other inconsistencies in citations in both papers and reports were frequent. A sheet describing the standard format adopted by the Secretariat for citations of the reports of the Working Groups and Scientific Committee, Working Group documents and papers published in the *Selected Scientific Papers* was circulated (Appendix G). The Working Group strongly recommended that authors conform to the formats described in this paper for all future citations in papers and reports.

7.3 The minimum data requirements for reporting acoustic survey results were discussed. The suggested minimum requirements are given in Appendix H. The Working Group also emphasised the need to report data in standard acoustic units and that these should be defined in the papers. The reporting of basic data (Mean Volume Backscattering Strength, MVBS) is preferable to only reporting derived results (such as t/km^2) alone. Whenever derived results are presented, detailed descriptions of the procedures and calculations underlying their derivation must be provided.

7.4 The current ruling for the submission of papers to working group meetings is that papers submitted more than 30 days before the meeting will be circulated to participants by the Secretariat in advance of the meeting. All other papers must be submitted to the Secretariat by 9 am on the first day of the meeting.

7.5 Concern was expressed that many papers submitted for consideration by the Working Group this year had not been submitted in advance, and were therefore unavailable for review by participants until after the start of the meeting. It was emphasised that the Working Group was required to give advice to the Scientific Committee based on the best available scientific information, and in order to do this, papers should be available in plenty of time to allow all participants to thoroughly evaluate their contents, especially when the papers address substantive issues.

7.6 The Working Group recommended the following additional requirements for paper submission:

- submission of papers prior to the 30 day deadline is strongly encouraged; such papers will be circulated to participants in advance of the meeting;

- papers submitted after the 30 day deadline and before 9 am on the first day of the meeting will be accepted for consideration at that meeting, on the condition that participants provide sufficient copies for distribution to all Working Group members at or before 9 am on the first day. The Secretariat will advise participants of the required number of copies for the meeting at the time of the first circulation of papers; and

- papers will not be accepted for consideration by the Working Group if submitted after 9 am on the first day of the meeting. Such papers could be re-submitted for a future meeting of the Working Group.

7.7 For the purpose of the above, participants wishing to receive papers before the meeting must inform the Secretariat of their intention to participate before the 30 day deadline.

7.8 A number of questions relating to publication policy were raised by members of the Working Group. It was acknowledged that the scientific work of CCAMLR was being increasingly recognised within the scientific community, and that this was very beneficial to the work of the Commission. Dr Everson suggested that CCAMLR should encourage scientists who publish papers in the refereed literature to include references to CCAMLR in abstracts and key-word listings, and also to make a point of highlighting the relevance of the work to CCAMLR where appropriate.

7.9 It was also suggested that reprints of papers with relevance to CCAMLR be lodged with the Secretariat in order to build up a reference library of use to scientists working on CCAMLR related topics.

7.10 It was pointed out that CCAMLR has no in-house peer reviewed journal. Dr Butterworth emphasised the value that such a publication would provide in heightening the scientific profile of CCAMLR and providing a single authoritative source for papers addressing matters of importance.

7.11 The Executive Secretary informed the Working Group that the Secretariat has prepared a paper that addresses future developments in publication policy for consideration by the Scientific Committee. These developments include a proposal for a peer review journal for the publication of papers submitted to meetings of the Scientific Committee and Working Groups.

7.12 The Convener expressed the additional concern that under the present rules for publication of working papers, the originators of data must give their permission for any publication which uses their data. Under these rules it was possible that papers which presented analyses that were used extensively by the Working Group would not be available in the published literature.

7.13 Given these concerns, the Working Group recommended that the Scientific Committee take up the subject of publication policy of scientific papers at its next meeting.

ADOPTION OF THE REPORT

8.1 The Report of the Fourth Meeting of the Working Group on Krill was adopted.

CLOSE OF THE MEETING

9.1 In closing the meeting, the Convener thanked the rapporteurs, the various task group conveners and the Secretariat for their support and hard work during the meeting. He also thanked the participants for their input and good humour throughout the meeting. The prevailing spirit was such that a large and complicated agenda had been thoroughly addressed. Finally, the Convener conveyed the Working Group's and his heartfelt thanks to the local organiser, Dr Marín, the Hotel Cabo de Hornos and the Chilean Government for their hospitality in hosting the meeting.

Table 1: Estimates of flows between subareas (Statistical Area 48).

Subarea	Location	Speed x10 → m s^{-1}	Direction	Reference
48.1	Deep	5.5 - 10.9	East	WG-Krill-92/24
	Deep	3.4 - 5.1	East	WG-Krill-92/25
	Deep	30.0 - 40.0	East	SC-CAMLR-X, Annex 5, Table 1
	Coastal	0.8 - 1.6	East	WG-Krill-92/25
	Coastal	26.0 - 64.0	East	SC-CAMLR-X, Annex 5, Table 1
	Coastal	5.0 - 10.0	East	SC-CAMLR-X, Annex 5, Table 1
	Coastal	19.0	East	SC-CAMLR-X, Annex 5, Table 1
48.2	Deep	5.8 - 12.5	East	WG-Krill-92/25
	Coastal	0.8	East	WG-Krill-92/25
48.3	Deep	1.9 - 2.5	East	WG-Krill-92/25
	Deep	4.7 - 5.8	East	WG-Krill-92/25
	Deep	0.2	West	WG-Krill-92/25

Deep = surface currents over deep water (open ocean)
Coastal = surface currents over the shelf

Table 2: Results of the recalculation of krill biomass from the FIBEX cruises. For Subareas 48.1 and 48.2 the results for the *Walther Herwig* are given separately and in combination with the results from the other cruises.

Area/ Subarea/ Division	Strata Used	Density ($g.m^{-2}$)	Area ('000 km^2)	Coefficient of Variation	Biomass (million tonnes)
41	*Walther Herwig* (NW)	48.9	75	29.6	3.66
48.1	*Professor Siedlecki + Itzumi*	11.0	194	98.3	2.12
	Walther Herwig (SW)	94.2	89	38.0	8.42
	Combined	37.2	283	35.0	10.54
48.2	*Odissey + Eduardo L. Holmberg*	39.7	185	19.3	7.37
	Walther Herwig (E)	35.6	57	40.1	2.01
	Combined	38.8	242	17.6	9.38
48.3	*Odissey*	59.7	25	38.0	1.51
48.6	*Agulhas*	8.0	576	23.0	4.63
58.4.2	*Nella Dan + Marion Dufresne + Kaiyo Maru*	2.3	1 711	32.0	3.93

Table 3: Catch (tonnes) of krill in Subareas 48.1 and 48.2, 1988 to 1991, derived from Statlant B data. The percentage of each nation's catch taken in each month is also given.

		1988 tonnes	1988 %	1989 tonnes	1989 %	1990 tonnes	1990 %	1991 tonnes	1991 %
Subarea 48.1									
Chile	January			57	9	1009	22		
	February	5504	93	2750	52	2858	64	861	23
	March	434	7	2135	40	634	14	2818	77
	April			387	7				
Japan	December	128	0.1	1913	3	1663	4	101	1
	January	17705	25	24626	32	11220	33	11697	21
	February	21314	30	26569	35	9779	30	12127	22
	March	22597	32	14435	19	6737	20	17588	32
	April	10070	13	8369	11	4537	13	13207	24
Korea	December	692	62			504	13		
	January	419	38	196	12	1872	46	917	76
	February			681	42	1664	41	294	24
	March			738	46				
Poland	December			80	5			97	31
	January			407	22			213	69
	February	55	100	638	35				
	March			698	38				
USSR	October							688	15
	November							1587	34
	December							2446	51
	January			9920	48				
	February			4094	20				
	March			6861	32				
Total		78918		105554		42477		64641	
Subarea 48.2									
Japan	December	456	35	11	1			36	100
	January	11	1						
	February								
	March	831	64	2799	92				
	April			206	7			1304	69
	May					1	100	584	31
Korean	December	44	10						
	January	370	90						
	February			164	100				
Poland	December							1	
	January			1137	42			1658	28
	February	421	14	1595	58			1560	26
	March	1332	44					1514	25
	April	1306	42					1287	21
USSR	October			553	2	538	0.2	2405	2
	November	325	0.3	3394	4	9104	4	10252	7
	December	391	0.3	27513	36	27776	13	15362	10
	January	15693	18	20131	26	18591	8	13530	8
	February	14158	16	17668	23	16542	8	25572	16
	March	19296	21	7235	9	25981	12	28978	18
	April	39375	44			43763	20	45381	28
	May	650	0.6			57195	25	17833	11
	June					21027	10		
Total		94659		82406		220518		167257	

Table 4: Most recent biomass estimates from ISRs (see Figure 2).

		Year	Status	Area ('000 km^2)	Density ($g.m^{-2}$)	Biomass (10^6 tonnes)	Reference
South Georgia	Acoustic	1981	recalculated from FIBEX data	25	59.7	1.51	WG-Krill-92/20
Peninsula	Acoustic	1981	recalculated from FIBEX data with *Walther Herwig*	283	37.3	10.54	"
			recalculated from FIBEX data without *Walther Herwig*	196	11.0	2.12	"
Prydz Bay	Acoustic	1992	Australian survey	268	7.4	1.98	WG-Krill-92/23

Table 5: Various options for allocating the precautionary catch limit of 1.5 million tonnes of krill in Statistical Area 48 among the various subareas.

<table>
<tr><th></th><th></th><th>FIBEX Estimate with Walther Herwig</th><th>FIBEX Estimate without Walther Herwig</th><th>Historical Catch</th><th>Average of Columns 1, 2, 3 Plus 5%</th><th>Even Division</th><th>Linear Extent of Shelf Break</th><th>Predator Demands</th><th>Local Biomass Adjusted for Krill Movement</th></tr>
<tr><td colspan="2">Krill-predator interactions considered?</td><td>N</td><td>N</td><td>N</td><td>N</td><td>N</td><td>N</td><td>Y</td><td>N</td></tr>
<tr><td colspan="2">Data availability?</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>Y</td><td>?</td></tr>
<tr><td colspan="2">Provisional allocations:</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Antarctic Peninsula</td><td>48.1</td><td>40%</td><td>12%</td><td>17%</td><td>28%</td><td>17%</td><td rowspan="6">Yet to be calculated</td><td rowspan="6">Yet to be calculated</td><td rowspan="6">Yet to be calculated</td></tr>
<tr><td>South Orkney Islands</td><td>48.2</td><td>36%</td><td>53%</td><td>42%</td><td>49%</td><td>17%</td></tr>
<tr><td>South Georgia</td><td>48.3</td><td>6%</td><td>9%</td><td>41%</td><td>24%</td><td>17%</td></tr>
<tr><td>S. Sandwich Islands</td><td>48.4</td><td>0%</td><td>0%</td><td><0.01%</td><td>5%</td><td>17%</td></tr>
<tr><td>Weddell Sea</td><td>48.5</td><td>0%</td><td>0%</td><td>0%</td><td>5%</td><td>17%</td></tr>
<tr><td>Bouvet Island region</td><td>48.6</td><td>18%</td><td>26%</td><td>0.1%</td><td>20%</td><td>17%</td></tr>
</table>

Table 6: Data requirements. This table lists the requests of WG-Krill-91, and adds additional requests of the Fourth Meeting of the Working Group.

Data Required by WG-Krill-91	Data Submitted at WG-Krill-92	Data Requested by WG-Krill-92
Review of demographic parameters	-	Examination of the precision of estimates of krill weight/length relationships (paragraph 4.83)
Krill movement	WG-Krill-92/24, 25	Work on the influence of hydrography on krill distribution should be encouraged (paragraph 4.33)
Observer reports from commercial fishery	WG-Krill-92/6, 10, 33, 21	
Length frequency data submission	Length frequency data from commercial fishery by USSR, Poland, Korea, 1990 and 1991	Continued requirement
Haul-by-haul data submission, irrespecitve of proximity to CEMP sites	Chile only	Continued requirement (paragraph 3.24)
Number and capacity of fishing vessels (Members' Activities Reports)	-	Continued requirement
Estimates of biomass for ISRs (request of WG-CEMP)	Calculated at Working Group	Continuing (paragraph 5.53)
		Reporting of monthly catches should proceed in compliance with Conservation Measure 32/X (paragraph 3.10).
		Data on the amount and viability of krill passing through a net should be reported (paragraph 3.23).
		New data on krill flux in Subareas 48.2, 48.3 and in other areas (paragraph 4.28).
		Fine-scale data - should be submitted for all catches of krill in the Convention Area, - fine-scale data from historical catches in Statistical Area 58 are requested.
		Secretariat is requested to contact FAO and Members concerning krill catches in Statistical Area 41 (paragraph 6.22).
		Minimum data requirements when reporting acoustic surveys, set out in Appendix H should be adhered to.

Table 7: Future work requirements. This table lists the requests of WG-Krill-91, and adds additional requests of the Fourth Meeting of the Working Group.

Work Required by WG-Krill-91	Data Submitted at WG-Krill-92	Future work Requested by WG-Krill-92
Operational definitions of Article II	-	
Estimation of total effective biomass, including reworking the FIBEX data	WG-Krill-92/20, 23, 26, 27, 25	Further analyses of net haul and acoustic data for the *Walther Herwig* and other FIBEX cruises (paragraphs 4.59 and 6.5).
Suggestions of methods to take account of predator needs	WG-Krill-92/16	Further work is required to improve models of the functional relationship between krill, its principal predator and the krill fishery (paragraph 5.39).
Estimates of potential yield - reworking of $Y = \lambda MB_0$ model	WG-Krill-92/4, 22	- Secretariat asked to validate the potential yield model and calculations described in WG-Krill-92/4 and 28 (paragraph 4.76) - Estimation of $\mathbf{s_R}$ and its correlation with **M** and growth rate (Appendix E) and further refinements to the yield model should be made (paragraph 4.77).
Acoustic target strength	WG-Krill-92/11, 17, 31	Examination of the effect of physical condition and orientation on krill target strength required (paragraph 4.41).
Acoustic survey designs	-	-
Analysis of fine-scale fisheries data	WG-Krill-92/18, 19, 21	Continued requirement
Investigation of sampling regimes for krill	-	-
Biological data - observer forms will be compiled and an observer manual drafted	Completed by the Secretariat	- Members should give further consideration to the Observer Manual and forward suggestions by 30 December (paragraph 6.25).

Table 7 (continued)

Work Required by WG-Krill-91	Data Submitted at WG-Krill-92	Future work Requested by WG-Krill-92
Analysis of acoustic and bridge log data from the commercial fishery	-	Continued requirement Haul-by-haul data should be used to evaluate the Composite CPUE Index (paragraph 3.13). More reports of liaison between fishermen, biologists and managers should be compiled (paragraph 4.34). Investigations of the scale and frequency of surveys applicable to feedback management approaches (paragraph 6.19). Consideration of a near-synoptic survey in Statistical Area 48 (paragraph 6.5). Subdivision of results from existing surveys should be investigated in the light of Appendix D. Clarification of the noise margins and thresholds for Prydz Bay surveys if required (paragraph 4.41). Further modelling is required to evaluate feedback control management options (paragraph 4.77) and spatial effects related to localised predator aggregations. Work is required for completion of the precautionary catch allocation table (paragraph 6.7): shelf break extent, predator demands and biomass adjusted for krill movement (flux and retention times) (paragraph 4.33).

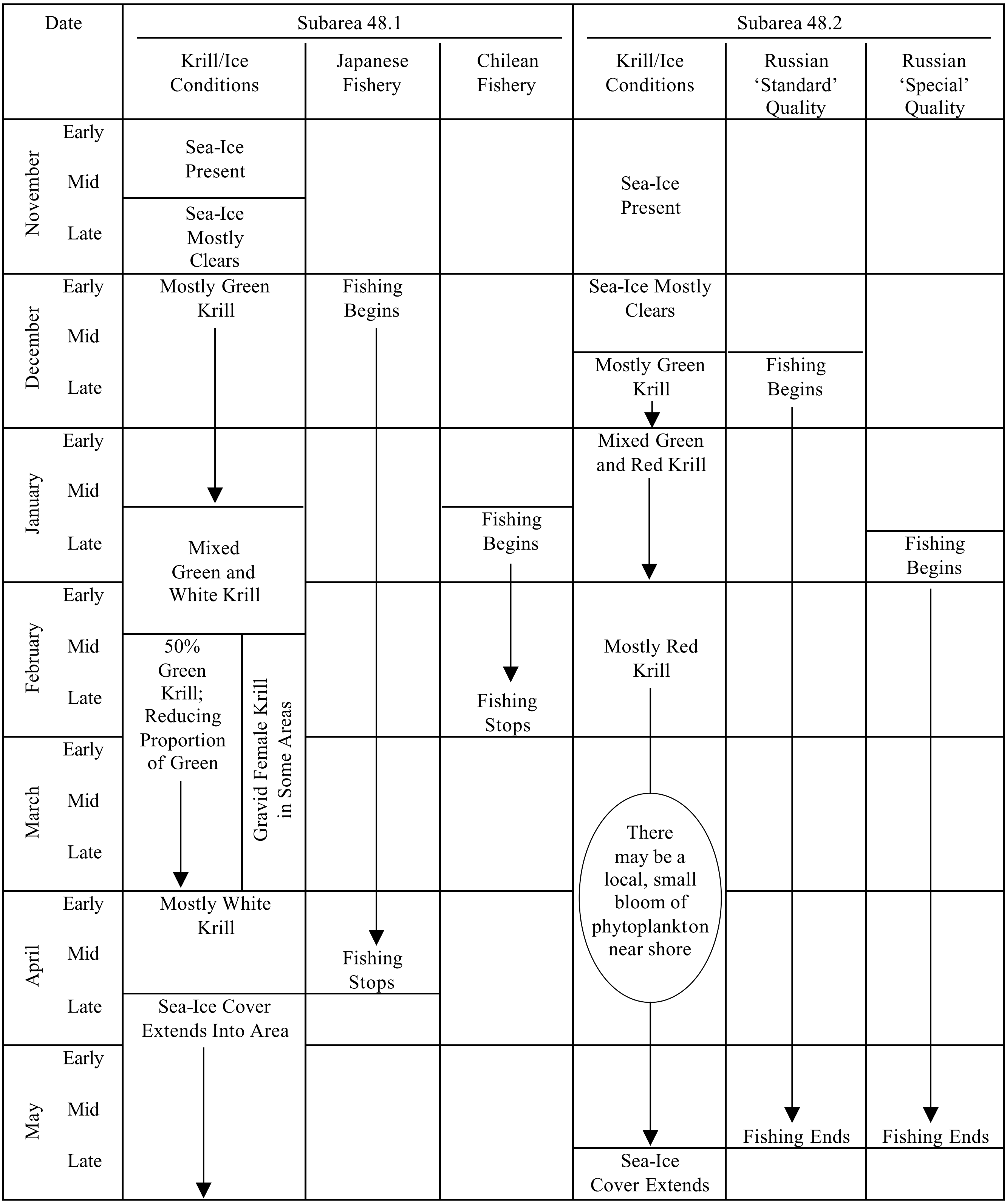

Figure 1: Schematic diagram of the timing of krill fishing in Subareas 48.1 and 48.2 relative to krill and sea-ice conditions. Krill discoloured by full guts are termed 'green', whereas krill without discolouration are termed 'white' (Japanese/Chilean) or 'red' (Russian).

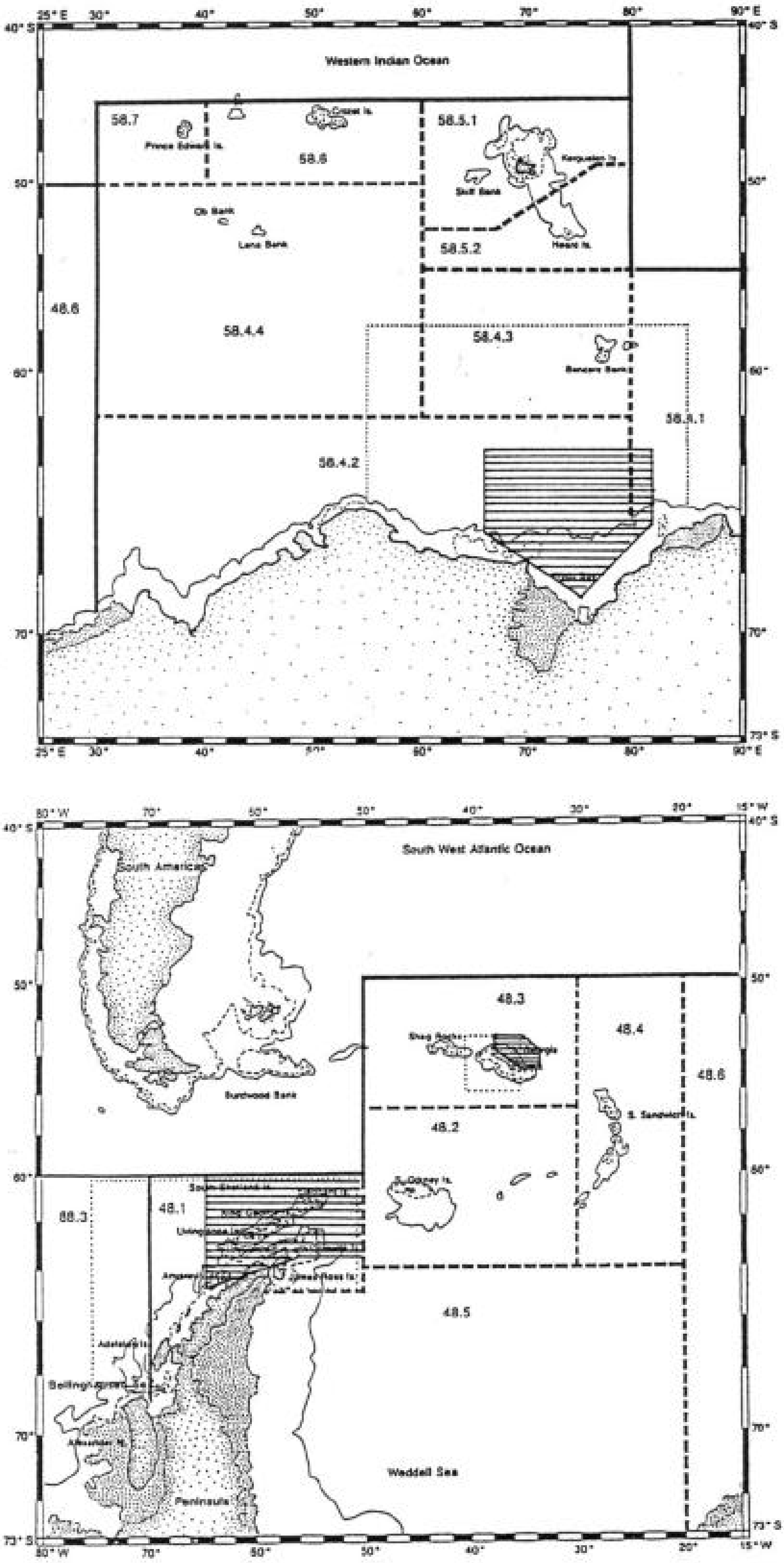

Figure 2: Survey areas in ISRs (see Table 4).

APPENDIX A

AGENDA

Fourth Working Group on Krill
(Punta Arenas, Chile, 27 July to 3 August 1992)

1. Welcome

2. Introduction
   (i) Review of the Meeting Objectives
   (ii) Adoption of the Agenda

3. Review of Fisheries Activities
   (i) Fisheries Information
      (a) Catch Levels
      (b) Location of Catches
      (c) Reports of Observers
         - By-Catch of Young Fish
         - Length Frequency/Haul-by-Haul Data
   (ii) Other Information
      (a) Distribution and Abundance
      (b) Fishing Escapement Loss/Mortality

4. Estimation of Krill Yield
   (i) Krill Flux in Statistical Area 48
      (a) Immigration/Emigration Rates
      (b) Residence Times
      (c) Influence of Hydrography
   (ii) Estimation of Initial Biomass ($\mathbf{B_0}$)
      (a) Techniques
      (b) Statistical Area 48
      (c) Other Areas
   (iii) Refinement of Yield Estimate Calculations
      (a) Evaluation of Population Models
      (b) Evaluation of Demographic Parameters

(iv) Refinement of Precautionary Catch Limit Estimates
  (a) Statistical Area 48
  (b) Other Statistical Areas

5. Ecological Implications of Krill Fishing
  (i) Location and Timing of the Fishery
    (a) Statistical Subareas 48.1 and 48.2
    (b) Other Subareas
    (c) Relation of Fishing to Krill Predators
  (ii) Effects of Management Measures on Krill Fishing
    (a) Location, Timing and Intensity of Fishing
    (b) Krill Management Measures and Krill Predators
  (iii) Liaison with WG-CEMP

6. Advice on Krill Fishery Management
  (i) Precautionary Limits on Krill Catches in Various Areas
    (a) Estimates of Potential Yield
    (b) Possible Ecological Effects of Catch Limits
  (ii) Refining Operational Definitions of Article II
  (iii) Other Possible Approaches and their Development
  (iv) Data Requirements
  (v) Scientific Observer Scheme
  (vi) Future Work of WG-Krill

7. Other Business
  (i) Krill Surplus
  (ii) Editorial Considerations

8. Adoption of the Report

9. Close of the Meeting.

LIST OF PARTICIPANTS

Working Group on Krill
(Punta Arenas, Chile, 27 July to 3 August 1992)

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LIST OF DOCUMENTS

Working Group on Krill
(Punta Arenas, Chile, 27 July to 3 August 1992)

WG-KRILL-92/1	DRAFT AGENDA
WG-KRILL-92/2	LIST OF PARTICIPANTS
WG-KRILL-92/3	LIST OF DOCUMENTS
WG-KRILL-92/4	FURTHER COMPUTATIONS OF THE CONSEQUENCES OF SETTING THE ANNUAL KRILL CATCH LIMIT TO A FIXED FRACTION OF THE ESTIMATE OF KRILL BIOMASS FROM A SURVEY D.S. Butterworth, G.R. Gluckman and S. Chalis (South Africa)
WG-KRILL-92/5	STATE OF THE ANTARCTIC KRILL (*EUPHAUSIA SUPERBA* DANA) RESOURCES IN THE SODRUZHESTVA SEA AREA (STATISTICAL DIVISIONS 58.4.2 AND 58.4.3) IN 1988 TO 1990 V.A. Bibik and V.N. Yakovlev (Russia)
WG-KRILL-92/6	REPORT OF BIOLOGICAL OBSERVATIONS CARRIED OUT ON BOARD THE KRILL FISHING VESSEL *MORE SODRUZHESTVA* IN APRIL TO AUGUST 1991 V.I. Latogursky (Russia)
WG-KRILL-92/7	ACOUSTIC ESTIMATION OF KRILL (*EUPHAUSIA SUPERBA*) BIOMASS AND BEHAVIOUR IN THE ROSS SEA Massimo Azzali (Italy)
WG-KRILL-92/8	POSSIBLE APPROACHES TO THE EVALUATION OF THE ANTARCTIC KRILL MORTALITY L.G. Maklygin and V.I. Latogursky (Russia)

WG-KRILL-92/9	DIURNAL CHANGES OF SOME BIOLOGICAL CHARACTERISTICS OF *EUPHAUSIA SUPERBA* DANA IN SWARMS (WESTWARD OF THE SOUTH ORKNEY ISLANDS, 24 MARCH TO 18 JUNE 1990 - BASED ON DATA REPORTED BY BIOLOGIST-OBSERVER) A.V. Vagin, R.R. Makarov and L.L. Menshenina (Russia)
WG-KRILL-92/10	A GUIDELINE FOR COLLECTION, ANALYSING AND PREPARATION OF REPORT ON MATERIAL COLLECTED BY A BIOLOGIST-OBSERVER ON BOARD A COMMERCIAL TRAWLER (DRAFT) V.I. Latogursky and R.R. Makarov (Russia)
WG-KRILL-92/11	STATUS OF KRILL TARGET STRENGTH Kenneth G. Foote (Norway), Dezhang Chu and Timothy K. Stanton (USA)
WG-KRILL-92/12	VARIABILITY OF KRILL STOCK COMPOSITION AND DISTRIBUTION IN THE VICINITY OF ELEPHANT ISLAND DURING AMLR INVESTIGATIONS 1988-1992 V. Loeb (USA) and V. Siegel (Germany)
WG-KRILL-92/13	FINE-SCALE CATCHES OF KRILL IN AREA 48 REPORTED TO CCAMLR 1990 TO 1991 Secretariat
WG-KRILL-92/14	MANAGING SOUTHERN OCEAN KRILL AND FISH STOCKS IN A CHANGING ENVIRONMENT I. Everson (UK)
WG-KRILL-92/14 Rev. 1	MANAGING SOUTHERN OCEAN KRILL AND FISH STOCKS IN A CHANGING ENVIRONMENT I. Everson (UK)
WG-KRILL-92/15	REVIEW OF LENGTH-WEIGHT RELATIONSHIPS FOR ANTARCTIC KRILL V. Siegel (Germany)
WG-KRILL-92/16	ALTERNATIVE METHODS FOR DETERMINING SUBAREA OR LOCAL AREA CATCH LIMITS FOR KRILL IN STATISTICAL AREA 48 G. Watters and R.P. Hewitt (USA)
WG-KRILL-92/17	CALIBRATION OF AN ACOUSTIC ECHO-INTEGRATION SYSTEM IN A DEEP TANK, WITH SYSTEM GAIN COMPARISONS OVER STANDARD SPHERE MATERIAL, WATER TEMPERATURE AND TIME David A. Demer and Roger P. Hewitt (USA)

WG-KRILL-92/18	KRILL CATCH DISTRIBUTION IN RELATION TO PREDATOR COLONIES, 1987-1991 Secretariat
WG-KRILL-92/19	DISTRIBUTION OF KRILL (*EUPHAUSIA SUPERBA* DANA) CATCHES IN THE SOUTH SHETLANDS AND SOUTH ORKNEYS D.J. Agnew (Secretariat)
WG-KRILL-92/20	KRILL BIOMASS IN AREA 48 AND AREA 58: RECALCULATION OF FIBEX DATA P.N. Trathan (UK), D. Agnew (Secretariat), D.G.M. Miller (South Africa), J.L. Watkins, I. Everson, M.R. Thorley, E. Murphy, A.W.A. Murray and C. Goss (UK)
WG-KRILL-92/21	CHILEAN KRILL FISHING OPERATIONS 1992: ANSWERING SC-CAMLR-X, PARAGRAPH 6.36 Victor H. Marín, Darío Rivas and Antonio Palma (Chile)
WG-KRILL-92/22	MANAGEMENT SUBDIVISIONS WITHIN THE CCAMLR AREA WITH SPECIAL REFERENCE TO AREA 58 Stephen Nicol (Australia)
WG-KRILL-92/23	ESTIMATION OF THE BIOMASS OF KRILL IN PRYDZ BAY DURING JANUARY/FEBRUARY 1991 AND FEBRUARY/MARCH 1992 USING ECHO INTEGRATION I. Higginbottom and T. Pauly (Australia)
WG-KRILL-92/24	CHARACTERSITICS OF OCEANIC STRUCTURE IN THE WATERS AROUND THE SOUTH SHETLAND ISLANDS OF THE ANTARCTIC OCEAN BETWEEN DECEMBER 1990 AND FEBRUARY 1991: OUTSTANDING COASTAL UPWELLING? M. Naganobu, T. Katayama, T. Ichii, H. Ishii and K. Nasu (Japan)
WG-KRILL-92/25	HYDROGRAPHIC FLUX IN THE WHOLE OF STATISTICAL AREA 48 IN THE ANTARCTIC OCEAN M. Naganobu (Japan)
WG-KRILL-92/26	ABUNDANCE, SIZE AND MATURITY OF KRILL (*EUPHAUSIA SUPERBA*) IN THE KRILL FISHING GROUND OF SUBAREA 48.1 DURING 1990/91 AUSTRAL SUMMER T. Ichii, H. Ishii and M. Naganobu (Japan)
WG-KRILL-92/27	DIFFERENCES IN DISTRIBUTION AND POPULATION STRUCTURE OF KRILL (*EUPHAUSIA SUPERBA*) BETWEEN PENGUIN AND FUR SEAL FORAGING AREAS NEAR SEAL ISLAND T. Ichii, H. Ishii (Japan), J.L. Bengtson, P. Boveng, J.K. Jansen (USA) and M. Naganobu (Japan)

WG-KRILL-92/28	COMMENT ON "FURTHER COMPUTATIONS OF THE CONSEQUENCES OF SETTING THE ANNUAL KRILL CATCH LIMIT TO A FIXED FRACTION OF THE ESTIMATE OF KRILL BIOMASS FROM A SURVEY" (WG-KRILL-92/4) H. Hiramatsu (Japan)
WG-KRILL-92/29	AN ARGUMENT AGAINST BIG INCIDENTAL KRILL MORTALITY STATED IN WG-KRILL-91/6 Etuo Sakitani (Japan)
WG-KRILL-92/30	PROCEDURE TO CORRECT FOR ACOUSTIC BEAM WIDTH EFFECTS WHEN ASSESSING THE BIOMASS OF KRILL AGGREGATIONS B. Barange, D.G.M. Miller and I. Hampton (South Africa)
WG-KRILL-92/31	SUMMARY OF SOME RECENT STUDIES COMPARING ECHOLEVELS AT 38 AND 120 KHZ Inigo Everson (UK)
WG-KRILL-92/32	FISHES CAPTURED AS BY-CATCH DURING THE 1991 CHILEAN ANTARCTIC KRILL FISHERY Enzo Acuña S., Armando Mujica R. and Hector Apablaza P. (Chile)
WG-KRILL-92/33	KRILL POPULATION BIOLOGY DURING THE 1991 CHILEAN ANTARCTIC KRILL FISHERY Armando Mujica R., Enzo Acuña S. and Alberto Rivera O. (Chile)

OTHER DOCUMENTS

WG-KRILL/CEMP-92/4	CCAMLR ECOSYSTEM MONITORING AND A FEEDBACK MANAGEMENT PROCEDURE FOR KRILL A. Constable (Australia)
WG-CEMP-92/15	DISTRIBUTION AND ABUNDANCE OF KRILL IN THE VICINITY OF ELEPHANT ISLAND IN THE 1992 AUSTRAL SUMMER Roger P. Hewitt and David A. Demer (USA)
WG-CEMP-92/16	AMLR 1991/92 FIELD SEASON REPORT; OBJECTIVES, ACCOMPLISHMENTS AND TENTATIVE CONCLUSIONS Delegation of the USA
SC-CAMLR-XI/BG/5	SCIENTIFIC OBSERVERS MANUAL FOR OBSERVATIONS ON COMMERCIAL FISHING VESSELS (DRAFT) Secretariat

KRILL SURVEYS - USE OF RESULTANT INFORMATION

Ideally, one would wish to have a time series of comparable estimates of biomass from surveys of the complete extent of each subarea. The resultant information would be used:

(i) in the short term, to improve estimates of $\mathbf{B_o}$; and

(ii) in the longer term, as the basis for management under feedback-control.

2. In practice, problems will arise. Some (many) surveys will not cover the full extent of the subarea concerned. There will be problems concerning comparability, e.g. surveys could take place at different times of year, and use different methodologies (e.g., trawl, hydroacoustic). One would nevertheless like to make use of <u>all</u> the data available. Linear model analysis is an approach which might allow all (or at least most) of the data to be integrated to provide a "single" "best" result. This applies not only to the future, but also to the present where it might be desirable to combine the FIBEX results with the data from other surveys in a methodologically defensible manner.

3. The underlying approach would be to obtain estimates of density for small sectors (e.g., 0.5° latitude by 1° longitude) within each subarea. These density estimates could then be integrated to provide an abundance estimate for the whole subarea. The linear model would need to make allowance for seasonal effects, and could treat trawl survey results as indices of relative density when combining them with the hydroacoustic data. To improve precision, and perhaps allow extrapolation within the subarea, a simple model of spatial factors might be attempted, rather than estimation of independent indices for each small sector.

4. A pre-requisite for attempting such analyses would be the subdivision of existing survey results on whatever small sector grid might be chosen.

5. There may be several problems associated with the practical implementation of this approach in the absence of a satisfactory simple model of spacial factors.

- As mentioned above, with typical transect spacings such as during FIBEX (10 to 50 n miles) it is possible that some longitudinal lines of fine-scale rectangles would not contain any transect.

- Division of transects into 0.5° latitude units may only leave one section of transect per rectangle. Since the density estimator is the transect mean it would be impossible to provide a variance estimator.

- Dividing transects longitudinally may also lead to skewed estimates of variance as a result of possible serial correlation effects that would have to be taken into account in the statistical treatment of the results.

APPENDIX E

FURTHER REFINEMENTS OF THE CALCULATION OF THE FACTOR g RELATING YIELD TO SURVEY BIOMASS ESTIMATES

MODIFICATIONS

1. Stock/Recruit Relationship

Previous calculations have assumed that median recruitment is a constant independent of spawning biomass (except that WG-Krill-92/4 assumed that recruitment became zero if the total recruited biomass was harvested in a particular year). Instead, it will be assumed that median recruitment decreases proportionately to spawning biomass, for spawning biomass below 20% of its average pristine level.

2. Inability to Harvest Specified Fixed Catch

Previous calculations allowed fishing mortality to increase to large values in certain years, in order to attempt to take the specified fixed catch every year, to the extent that on occasions the entire recruited biomass could be harvested. Instead, to place some realistic limit on the proportion of the recruited biomass which could be harvested in any year, an upper bound of 1.5 yr^{-1} will be placed on the fishing mortality **F** for fully selected age-classes (this bound relates to an effective annual fishing mortality; thus, for a three month fishing season for example, the actual upper bound would be 6.0 yr^{-1}). This limitation means that the specified fixed catch will not always be taken in every year during the harvesting period.

3. Prior Distributions for M, s_R and Growth Rate

The previous calculations assumed that estimates of these parameters were uncorrelated; values for M and s_R were drawn independently from their specified distributions, while the krill growth rate was fixed. However, the available length frequency data imply some relationship between these parameters: a higher value of M would correspond to a faster growth rate and a lower value of s_R.

Values for **M** (in yr^{-1}) will be drawn from the uniform distribution [0.4,1.0] as before. A value of s_R will then be generated by the process detailed in Adjunct 1 below. Finally, the growth curve parameter k will be scaled to $\mathbf{M}$. The precise details of this procedure will be finalised by correspondence between Drs Agnew, Basson, Butterworth and de la Mare.

SENSITIVITY TESTS

1. Age Dependence of **M**

Given a value for **M** generated from $\mathbf{U}[0.4, 1.0\text{yr}^{-1}]$, this value will be doubled to obtain the natural mortality for krill of ages 0, 1 and 2 years.

2. Sex Differentiation

To allow for deliberate avoidance of gravid females by the fishery, the model will be sex-disaggregated. During the months of summer fishing (December to February), 20% by number of the mature female numbers present at the start of December will remain unavailable to the fishery.

3. Recruitment Distribution

Censor the lower tail of the log-normal distribution so that recruitment cannot be less than 20% of the median value of the censored distribution. (The 'median value' is that for the appropriate spawning biomass.)

4. Age at First Capture

The original model has a selectivity-at-length profile with a width of 10 mm and a length at 50% vulnerability, $\mathbf{l}_{50}^{\mathbf{r}}$, chosen from $\mathbf{U}$[38,42mm]. Change this to a width of 20mm, with $\mathbf{l}_{50}^{\mathbf{r}}$ selected from $\mathbf{U}$[35,37mm].

ADDITIONAL OUTPUTS

1. Statistics are to be provided for a 10- as well as a 20-year period of harvesting.

2. Statistics (median, 5%- ile and 95%- ile) are to be provided for the average P/B ratio during the harvesting period.

Adjunct 1

Method for estimating and modelling recruitment variability in krill potential yield calculations.

1. Length frequency samples and survey densities will be used to estimate representative length compositions (from research surveys, weighted by density estimates) for selected areas and years (for example, as in Loeb and Siegel, WG-Krill-92/12). This will be done for as many cases as possible; there is no need for there to be a time series for a given area. Single length compositions from disparate areas will be considered as independent, at least at this stage.

2. A size range which represents 2 year old krill will be selected to form an index of recruitment. Possibly the McDonald and Pitcher method will be used to estimate the number of 2 year olds in the sample, perhaps using growth curves to fix the modal length of 2 year olds for cases where there are no clear modes in the length composition. The ratio of 2 year olds to the total 2+ sample size is a Heinke estimate which provides an index of gross recruitment.

3. Parameters characterising the distribution of Heinke estimates will be estimated.

4. For a selected value of $\mathbf{M}$, $s_{\mathbf{R}}$ will be chosen so that the distribution of Heinke indices produced by the model is in accordance with that estimated from the length samples.

ATTEMPTS AT A BASIC ACCOUNTING FOR SUBAREAS 48.1 AND 48.2

D.J. Agnew

I attempt here to relate South Shetland Islands predator consumption, krill biomass in Subarea 48.1, and estimated values of **M**, developing the methodology from that discussed in WG-Krill-92/19.

2. Biomass estimates for Subarea 48.1 from Table 2.1 of WG-Krill-90 (SC-CAMLR-IX, Annex 4), Siegel (WG-Krill-91/15) and the FIBEX estimates excluding the *Walther Herwig* (Table 6 of WG-Krill-92/20) provide estimates of biomass between 0.5 and 2 million tonnes.

3. Siegel (WG-Krill-91/15) estimated production/biomass ratios for the South Shetlands of 0.94 and 0.83 (SC-CAMLR-X , Annex 5, paragraph 4.51) and therefore estimated total effective biomass during the summer months as about 2 million tonnes.

4. WG-Krill-91/15 also estimated residence times of three months in the southern Drake Passage.

5. WG-Krill-92/19 estimates total consumption by penguins in the South Shetlands as 280 thousand tonnes in the period December to February (estimates derived from independent models by Croxall *et al*. and Croll). This does not include fur seals, or pelagic predators; in order to consider these predators in the accounting, we may estimate total consumption = 1.5 x penguin consumption, although there is no empirical evidence for this factor.

6. Estimates of natural mortality **M** were given in Table 6 of WG-Krill-91 (SC-CAMLR-X, Annex 5); WG-Krill-92/4 uses values between 0.4 and 1.0.

7. If we assume that the predation mortality experienced by the part of the krill population resident in the South Shetlands over these three months is $^1/_4$ of the total natural mortality then we can use

$$\text{Consumption} = \text{Biomass} \times (1-\exp(-M/4))$$

to see if biomass, consumption and estimates of **M** are roughly in agreement.

8. Calculating **M** from Biomass and Consumption ('000 tonnes)

	Consumption - December to February	
	280	420
Biomass estimate: 2 000	**M** = 0.6	**M** = 0.94

9. Calculating Biomass from Consumption and **M** (biomass, consumption in '000 tonnes)

	Consumption - December to February	
	280	420
M = 0.4	2 900	4 400
M = 1.0	1 300	1 900

10. Parameter estimates from Subarea 48.2 are:

Biomass	7 m tonnes	(FIBEX, excluding *Walther Herwig*)
Consumption (penguins only)	153 000 tonnes	(December to February; WG-Krill-92/19)

Residence time: probably similar to Subarea 48.1 (see Table 1 of this report)

11. Calculating **M** from Biomass and Consumption ('000 tonnes)

	Consumption	
	153	229
Biomass: 7 000	0.09	0.13

12. Calculating Biomass from Consumption and **M** (biomass, consumption in '000 tonnes)

	Consumption	
	153	229
M = 0.4	1 600	2 400
M = 1.0	690	1 034

13. It is apparent from these calculations that the estimates do not balance well. This implies that either total consumption is underestimated (penguin consumption is a minor part of it) or Biomass and/or **M** are overestimated. For example, calculating Consumption from Biomass and **M**

	M	
	0.4	1.0
Biomass: 7 000	670	1 550

REFERENCES TO CCAMLR PUBLICATIONS AND DOCUMENTS

SC-CAMLR Document:

MILLER, D.G.M. and I. HAMPTON. 1988. Krill aggregation characteristics: Spatial distribution patterns from hydroacoustic observations. Document *SC-CAMLR-VI/BG/13*. CCAMLR, Hobart, Australia: 25 pp.

Working Group Paper:

SHIMADZU, Y. and T. ICHII. 1985. Some considerations on the usefulness of the CPUE data from Japanese krill fishery in the Antarctic. Document *WG-Krill-85/4*. CCAMLR, Hobart, Australia: 16 pp.

Paper published in Selected Scientific Papers:

MILLER, D.G.M. 1989. Commercial krill fisheries in the Antarctic, 1973 to 1988. In: *Selected Scientific Papers, 1989 (SC-CAMLR-SSP/6)*. CCAMLR, Hobart, Australia: 229-281.

Working Group Report:

SC-CAMLR. 1989. Report of the Workshop on the Krill CPUE Simulation Study. In: *Report of the Eighth Meeting of the Scientific Committee*, Annex 4. CCAMLR, Hobart, Australia: 81-137.

Scientific Committee Report:

SC-CAMLR. 1989. *Report of the Eighth Meeting of the Scientific Committee (SC-CAMLR-VIII)*. CCAMLR, Hobart, Australia: 354 pp.

Commission Report:

CCAMLR. 1989. *Report of the Eighth Meeting of the Commission (CCAMLR-VIII)*. CCAMLR, Hobart, Australia: 133 pp.

Standard Methods:

SC-CAMLR. 1991. *CCAMLR Ecosystem Monitoring Program: Standard Methods for Monitoring Studies*. CCAMLR, Hobart, Australia: 131 pp.

Basic Documents:

CCAMLR. 1989. *Basic Documents*. 4th Edition. CCAMLR, Hobart, Australia: 98 pp.

Conservation Measures:

CCAMLR. 1992. *Schedule of Conservation Measures in Force*. CCAMLR, Hobart, Australia: 26 pp.

Statistical Bulletin:

CCAMLR. 1990. *Statistical Bulletin, Vol. 2 (1980-1989)*. CCAMLR, Hobart, Australia: 109 pp.

DETAILS THAT SHOULD BE INCLUDED IN REPORTS OF ACOUSTIC SURVEYS OF KRILL BIOMASS AND/OR DISTRIBUTION

Papers should include, where appropriate, reference to the following topics:

1. SURVEY DETAILS

    Objectives, timing

    Design rationale - random/regular

    Map - including coastlines, bathymetry, acoustic transects, sampling sites.

    Number of transects and transect spacing

    Target trawls - type of net used, aimed or not, number of samples, duration of tows, depth range, time of day

2. ACOUSTIC SYSTEM

    Type and make

    Frequencies used

    Hull mounted or towed body ?

    Split-beam / dual-beam / single beam ?

    Echo integration, echo counting, swarm counting ?

    Integration intervals (vertical)

    Averaging intervals (horizontal)

3. CALIBRATION METHOD

    Methodology, equipment, location, water temperature, results

4. ANALYSIS OF RESULTS

    TS relationships

Length/weight relationships

Biomass variance estimates

Strata definitions

Method of calculation of areal density and volume density

S_a - surface density calculation

Methods used to generate distribution maps and abundance estimates

5. RESULTS

Distribution maps

Biomass estimates and variance estimates

Sizes of krill from target trawls, means and ranges

Any other relevant survey results

Basic data from which derived units arise should be presented

Standard units for reporting acoustic results should be used throughout

REPORT OF THE WORKING GROUP
ON FISH STOCK ASSESSMENT

(Hobart, Australia, 13 to 22 October, 1992)

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT
(Hobart, Australia, 13 to 22 October 1992)

INTRODUCTION

1.1 The meeting of the Working Group on Fish Stock Assessment (WG-FSA) was held at the CCAMLR Headquarters, Hobart, Australia from 13 to 22 October, 1992. The Convener, Dr I. Everson (UK) was unable to attend and Dr K.-H. Kock (Germany) chaired the meeting.

1.2 The Working Group noted with regret that scientists from Russia and France had not been able to attend the meeting. The Working Group also expressed its regret that Dr Everson had been unable to attend the meeting.

1.3 The Chairman informed the Working Group that Mr Wieslaw Slosarczyk of Poland had died during the last year. Wieslaw had participated in WG-FSA between 1984 and 1989. In addition, he had been very active in the BIOMASS program. The Working Group paused for a moment of silence in memory of a dear friend and valued colleague.

GENERAL MATTERS AND ORGANISATION OF THE MEETING

2.1 A List of Participants is given in Appendix A.

2.2 The following were appointed rapporteurs:

Dr R. Holt (USA), Agenda Items 1 to 6.1;
Conveners of Assessment Groups, Agenda Items 6.2 to 6.8;
Mr D. Miller (South Africa), Agenda Item 7;
Dr K.-H. Kock (Germany), Agenda Item 8; and
Dr D. Agnew (Secretariat), Agenda Items 9 to 12.

2.3 The Working Group noted that several papers presenting assessments had been delivered to the Secretariat and no scientists familiar with the contents of these papers were present at the meeting. Concern was expressed that it may not be possible to fully use these papers. The Working Group agreed to take account of the information contained in the papers as far as was possible and, where needed, to refer the papers back to the authors for further clarification. Mr Miller noted that this was the same practice adopted by the Working Group on Krill (WG-Krill).

ADOPTION OF THE AGENDA

3.1 The adopted Agenda is attached as Appendix B, and a List of Documents presented to the meeting is attached as Appendix C.

CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

4.1 The Working Group again emphasised the urgent need for the implementation of a scheme of international scientific observation on commercial fishing vessels. The deployment of observers would improve data collection generally and much of the data which are essential for WG-FSA assessments, could only be collected in this way. It was stressed that data collected under the scheme would not be a substitute for fisheries data requested from Members.

4.2 The Scientific Committee in 1991 endorsed the priorities identified by WG-FSA for allocation of activities under the observation scheme and accepted the Working Group's offer to assist in the preparation of a manual for observers in consultation with the Secretariat (SC-CAMLR-X, paragraphs 10.6 and 10.7).

4.3 Although the Scientific Committee had reviewed the scientific objectives and priorities of a scheme of observation and had reported to the Commission, consensus on the scheme was not reached by the Commission in 1991 and it had been agreed that discussions would continue at the next meeting (CCAMLR-X, paragraphs 7.7 and 7.8). During the intersessional period, the EEC has provided an amended draft text for an observer scheme (CCAMLR-XI/6).

REVIEW OF EEC PROPOSAL

4.4 Members of the Working Group felt it was appropriate to comment only on the data format section (CCAMLR-XI/6, Annex 1). It was noted that the functions and tasks of international scientific observers as defined in Annex 1 have been modified to include observers engaged in scientific research (Annex 1, subtitle). During the meeting of the Scientific Committee in 1991, concern was expressed about observation aboard research vessels. The Scientific Committee clearly identified observation on commercial vessels as the priority and it was pointed out that the research activities of Members already involved some degree of international cooperation (SC-CAMLR-X, paragraph 10.3).

4.5 The Working Group agreed with the general intent of Annex 1, noting that the detailed description of data to be collected and the methods to be used would be specified in an observers manual. The Working Group also suggested that Annex 1, paragraph 2(vii) should be modified to specifically inform the observers as to where the data and biological samples should be deposited, and who will be responsible for subsequent analysis of biological samples. Data and results of each survey should be made available to CCAMLR in the standard data formats for subsequent use by working groups.

REVIEW OF CCAMLR SCIENTIFIC OBSERVERS MANUAL (DRAFT)

4.6 The data collection scheme on commercial vessels should be flexible to enable the changing research priorities identified by the Scientific Committee to be addressed. In addition, the priorities for collection of data would vary according to the vessel and fishery involved (SC-CAMLR-X, paragraph 10.4).

4.7 The Working Group agreed that collection of observer data on the crab fishery was of priority and additions were made to the draft observer manual accordingly.

4.8 Comments were received from Members during the intersessional period and at the Working Group's meeting. Comments made at the meeting included:

(i) Form 1A should be modified to include observations on the incidence and volume of benthos as by-catch in bottom trawls.

(ii) The item 'Weather' on Forms 1A, 1B and 1C should be replaced by 'Sea State'. A table of sea state classifications as defined by the World Meterological Organization (WMO) should be appended to the report.

(iii) The research priorities for *Dissostichus eleginoides* (page 5 of draft manual) should include collection of otoliths and scales.

(iv) Generally total length should be used to record fish lengths. In the case of *Electrona carlsbergi*, standard length should be recorded, as the delicate tail fin rays are often broken.

4.9 The Working Group expressed its appreciation to the Secretariat for preparing the draft manual. It was recognised that considerable effort had been expended to produce the manual in a timely fashion.

REVIEW OF MATERIAL FOR THE MEETING

DATA REQUIREMENTS ENDORSED BY THE COMMISSION IN 1991

5.1 Various data were specifically requested by the Working Group in 1991 (SC-CAMLR-X, Annex 6, Appendix E). Data submitted to the Secretariat in response to this request are listed in Appendix D.

5.2 Some of the data requested by the Working Group had been submitted, however, there is a substantial amount of data still required (Appendix D).

CATCH AND EFFORT STATISTICS

5.3 Complete STATLANT A and B forms had not been received from Russia and Chile at the time of the meeting. However, as Conservation Measures 35/X through 40/X (catch limitations and reporting requirements for *D. eleginoides* and *E. carlsbergi* in Subarea 48.3) had been complied with, the Data Manager was able to construct catch statistics for *D. eleginoides* and *E. carlsbergi* (from fine-scale catches and monthly reported statistics). It was noted that there were some discrepancies between the five-day reported statistics for *D. eleginoides* and the subsequently reported fine-scale catch and effort data; the fine-scale data were considered more accurate and were used to compile the catch statistics.

5.4 Fishing for *D. eleginoides* in Subarea 48.3 commenced on 6 December 1991 and by its closure on 10 March, 3 559 tonnes had been taken by vessels from Chile, Russia and Bulgaria. A further 11 tonnes was taken by Bulgaria before it ceased fishing. Additional data were reported to the Secretariat from Russian and UK research cruises. The Russian cruise reported a total of 191 tonnes (132 tonnes taken between 10 March and 30 June 1992 and 58.8 tonnes taken in July 1992), and the UK cruise reported 1 tonne. All catches were by longline except the UK research cruise. The total catch of *D. eleginoides* in Subarea 48.3 was therefore 3 762 tonnes.

5.5 A fishery targetted at *E. carlsbergi* in Subarea 48.3 from July to November 1991 inclusive took 46 960 tonnes (catches by month: July - 2 515, August - 7 413, September - 22 418, October - 10 981, November - 3 633).

5.6 Catch statistics from Division 58.5.1 (Kerguelen) were incomplete, the Secretariat only having received reports for the whole split-year from France.

5.7 The Working Group draws the attention of the Scientific Committee to the continuing problem of late submission of STATLANT catch data; the deadline is 30 September. However, reporting data by five-day periods and in fine-scale format in accordance with the conservation measures had been successful and proved extremely useful to the Working Group.

MESH/HOOK SELECTIVITY AND RELATED EXPERIMENTS AFFECTING CATCHABILITY

5.8 Although no document was presented that directly investigated this topic, it was noted that some information was available from the Chilean longline fishery (WG-FSA-92/28).

5.9 Dr C. Moreno (Chile) indicated that differences between Chilean and Russian catch rates of *D. eleginoides* may be, in part, because of the use of different types of hooks. Normalised length frequencies of *D. eleginoides* caught by Chilean vessels were substantially different for different shaped and sized hooks (see Table 9 following paragraph 6.116).

5.10 Mr G. Parkes (UK) presented a video made during the UK research trawl survey around South Georgia which showed the retrieval of *D. eleginoides* longlines by Russian and Chilean vessels. Catch rates from Chilean vessels appeared to be higher than from Russian vessels, which was also evident from the reported data.

OTHER DOCUMENTS

5.11 The Working Group welcomed the recent publication of:

Kock, K.-H. 1992. *Antarctic Fish and Fisheries*. Cambridge University Press. 359 pp.

The book gives a comprehensive description of Antarctic fish biology and ecology and presents the history of finfish exploitation and a thorough discussion of the assessment and current state of exploited fish stocks in the Southern Ocean until 1991.

5.12 An update of the Antarctic fish bibliography (Kock, 1989) was made available to the Working Group.

ASSESSMENT WORK AND MANAGEMENT ADVICE

NEW FISHERIES

Crab Fisheries in Subarea 48.3

Description of Fishery

6.1 Dr R. Otto (USA) presented a report of crab fishing by a US vessel in Subarea 48.3 during 1992 (WG-FSA-92/29).

6.2 Fishing operations for Antarctic crabs by the US vessel FV *Pro Surveyor* were conducted in waters around South Georgia and Shag Rocks from 10 July to 1 August, 1992. Operations were conducted in accordance with the Plan for Research and Data Collection During Exploratory Crab Fishing in the Antarctic (SC-CAMLR-X/BG/20). Fishing operations are presently proceeding and only limited data are available from the first 22-day trip.

6.3 Data on fishery operations were recorded using the US crab logbooks (SC-CAMLR-X/BG/20). Copies of the logbooks will be archived at the headquarters of the US AMLR Program in La Jolla, California and at the US NMFS Laboratory at Kodiak (Alaska). Biological data and specimens will be archived at the Kodiak Laboratory until final research projects are completed. Specimens for taxonomic studies will be forwarded to the US National Museum. All data will be made available in accordance with CCAMLR requirements.

6.4 Two species were caught: *Paralomis spinosissima* and *P. formosa*. *P. spinosissima* was the major species targetted by the fishery and few data were recorded for *P. formosa*. Lines of 50 to 60 pots were used for all fishing during the first trips. “Commercial” crabs were male *P. spinosissima* that exceeded 102 mm in carapace width. With the exception of a few (about 500) male *P. formosa*, all other crabs were discarded. Discarded crabs were immediately returned to the sea with apparently minimal mortality.

6.5 Fishing grounds were divided between South Georgia and Shag Rocks at 40°W latitude. Catches taken during the first trip are summarised in Table 1 along with incidental catches of fish. The mean incidental catch rate of all fish was approximately 2.26 individuals per tonne of commercial crab caught. The mean incidental catch rate of *D. eleginoides* was 1.23 individuals per metric tonne of commercial crabs.

Table 1: Estimated total catch of crabs, fish and cephalopods during the first US exploratory crab fishing trip to Subarea 48.3.

Item	South Georgia		Shag Rocks		Grand Total	
	Sampled	Total	Sampled	Total	Sampled	Total
Lines	46	138	7	13	53	151
P. spinosissima						
Commercial	451	51 728	8	758	459	52 486
Discarded	4 519	83 239	908	8 203	5 427	91 442
P. formosa	668	34 768	0	2 152	668	36 920
Total crabs	5 638	169 735	916	11 113	6 554	180 848
Toothfish	22	65	4	8	26	73
Other rock cods	18	46	0	0	18	46
Rays	1	3	0	0	1	3
Flounders	1	3	0	0	1	3
Moray cod	1	3	0	0	1	3
Octopus	1	3	0	0	1	3

6.6 The size at sexual maturity for male *P. spinosissima* was determined using the allometric relationship of chela (claw) height to carapace length. Carapace lengths (CL) were converted to carapace widths (CW) using regression techniques (WG-FSA-92/29). The size at maturity was 75 mm CL at South Georgia and 66 mm CL at Shag Rocks. Assuming that growth per moult is 15% in CL and allowing males at least one opportunity to breed before becoming vulnerable to the fishery, minimum size limits should be 94 mm CW at South Georgia and 84 mm at Shag Rocks. A size limit of 102 mm carapace width was established, based largely on the size of crab desired for processing. This size limit would ensure escapement of a proportion of sexually mature males. Although little information is available, it appears that *P. formosa* matures at smaller sizes than *P. spinosissima*. A size limit of 90 mm CW for *P. formosa* would be likely to be adequate.

6.7 The Working Group noted that the apparently high incidence of rhizocephalan parasites in *P. spinosissima* is likely to limit growth and reproduction in this species. Because only a small area (less than 220 n miles^2) was fished during the first trip, it is not known if the incidence of parasites is widespread or localised to this area.

Estimation of Standing Stock for *Paralomis spinosissima*

6.8 The Working Group noted that growth rates of Antarctic crabs are unknown. Apparently high initial catches may reflect an accumulated biomass and lead to an overestimate of sustainable yield.

6.9 The Working Group agreed that reliable estimates of sustainable yield of Antarctic crabs could not be calculated from the limited data available. Two methods were examined which might provide guidance in setting conservative levels of catch to be applied in the early stages of the fishery while the data necessary for more precise estimates are being acquired and analytical methods are being developed.

6.10 The first method is based on the fact that catch rates and the depths at which crabs are taken in Antarctic waters are similar to those in the Aleutian Islands (Bering Sea) fishery for golden king crab (*Lithodes aequispinum*). Using estimates of annual production of golden king crabs in the Aleutian Islands suggests that Subarea 48.3 might have an annual potential yield of 2 210 tonnes between 200 and 1 000 m (0.243 tonnes of crabs per n mile^2 (WG-FSA-92/29) times 9 096 n miles^2 (Appendix E; Everson and Campbell, 1991[1])).

6.11 In the second method, a rough calculation of the standing stock of commercially sized male *P. spinosissima* was made by determining the vessel's average catch per n mile^2 and multiplying this value by the total fishable area in Subarea 48.3. Results are presented in Table 2 and the method is described below.

1 EVERSON, I. and S. CAMPBELL. 1991. Areas of seabed within selected depth ranges in CCAMLR Subarea 48.3, South Georgia. In: *Selected Scientific Papers, 1990 (SC-CAMLR-SSP/7)*. CCAMLR, Hobart, Australia: 459-466.

Table 2: Calculation of the standing stock of commercially sized male *P. spinosissima* in Subarea 48.3.

	Calculation	Result
Distance between pots		46 m
Effective fishing radius	(45.72)/2	23 m
Effective pot fishing area	$\pi(22.86)^2$	0.00048 n mile^2
Average crabs per pot		7.2
Average crab weight		1.1 kg
Average crab weight per pot	7.21 x 1.13 kg	0.0082 tonnes
Average density	0.00818 tonnes/0.00048 n mile^2	17.1 tonnes/n mile^2
Fishable area		9 096 n miles^2
Standing stock	17.08 tonnes/n mile^2 x 9 096 n miles^2	155 000 tonnes

6.12 The pot lines were rigged so that the crab pots were spaced 46 m (25 fathoms) apart. Assuming that the pot lines were spaced so that adjacent pots did not compete for crab, the effective fishing radius of a single crab pot was assumed to be half the distance between adjacent pots. Therefore, the effective fishing area of a single crab pot was 0.00048 n mile^2.

6.13 During the first trip, 7 282 pot lifts were made, and, on average, each pot contained 7.2 commercially sized *P. spinosissima*. The average weight of commercially sized individuals in the catch was 1.1 kg. Multiplying the average weight of a commercially sized individual by the average number of individuals caught per pot yields an average of 8.2 kg (0.00818 tonnes) of *P. spinosissima* per pot.

6.14 The Working Group assumed that the catchability of a crab pot equals 1.0 (i.e., all crabs within the effective fishing area of a pot are captured) and divided the average catch rate (0.0082 tonnes/pot) by the assumed fishing area of a single pot (0.00048 n mile^2) to obtain an estimate of the average density of *P. spinosissima* around South Georgia and the Shag Rocks. The average density was estimated to be 17.1 tonnes/n mile^2.

6.15 If it is assumed that the total fishable area in Subarea 48.3 is 9 096 n miles^2 and that the average density of *P. spinosissima* of 17.1 tonnes/n mile^2 is representative of the average density of commercially sized crab around all South Georgia and the Shag Rocks, the standing stock was calculated to be approximately 155 000 tonnes.

6.16 The Working Group identified a number of potential biasses with this method of calculating the standing stock. The results depend on:

- the assumed effective fishing radius of each pot;
- the catchability coefficient for pots being 1.0;
- the assumption that the pots randomly sampled local crab density; and
- the local density as calculated being representative of the entire depth stratum.

6.17 The effect of assuming that catchability is 1.0 will be conservative because it is unlikely that a pot will catch all the crabs in its vicinity at one setting. The biasses from the other assumptions could be upwards or downwards, and they may be potentially large. If the effective fishing radius of each pot is less or greater than 23 m the calculations will be biassed upwards and downwards respectively. If pots are placed only in places identified as likely to contain concentrations of crab, the apparent density may be greater than the density of crabs over a wider range. Finally, if a suitable crab habitat is only a proportion of the entire depth stratum of 200 to 1 000 m, the calculations will be biassed upwards. The effect of this last assumption was examined by assuming that the distribution of crabs was restricted to 50% and 30% of the depth stratum. This reduced the calculated stock estimate to 78 000 and 48 000 tonnes respectively.

6.18 A catch of 2 210 tonnes, based on calculations of the Aleutian Island fishery potential yield (paragraph 6.10), would correspond to less than 5% of exploitable standing stock estimates given in paragraphs 6.15 and 6.17.

Management Advice

6.19 Given the large uncertainties associated with estimating standing stock the Working Group recommended that a conservative management strategy should be followed. This would involve the immediate application of precautionary measures and the simultaneous commencement of work on the development of a longterm management plan for the fishery.

6.20 It was recommended that pending the development of a longterm management plan for the crab fishery in Statistical Area 48 the following measures should be applied:

(i) crab fishing gear should be limited to the use of crab pots (traps). The use of all other methods of catching crabs (e.g., bottom trawls) should be prohibited;

(ii) the crab fishery should be limited to sexually mature male crabs - all female crabs caught should be released unharmed. In the case of *P. spinosissima* and *P. formosa*, males with a carapace width of 102 mm and 90 mm, respectively, shall be considered sexually mature and may be retained in the catch;

(iii) crab processed at sea should be frozen as crab sections (minimum size of crabs can be determined using crab sections);

(iv) the exploratory crab fishery should be limited to a few vessels (i.e., one to three vessels);

(v) as far as practical, the following data should be collected and submitted to CCAMLR:

(a) observation on fishing operations;
(b) collection of haul-by-haul catch and effort data;
(c) representative length frequency distributions;
(d) representative sex and maturity stage distributions;
(e) samples of ovaries and eggs;
(f) representative length frequency distributions by sex and maturity stage from both the crab fishery concerned and from bottom trawl surveys.

The format for submission of such data should be in accordance with the provisions of the Draft Scientific Observers Manual (see Appendix F).

(vi) the following data should be reported to CCAMLR by 30 September 1993 for all crabs caught prior to 30 July 1993:

(a) the location, date, depth, fishing effort (number and spacing of pots) and catch of commercially sized crabs (reported on as fine a scale as possible, but no coarser than 1° longitude by 0.5° latitude) for each 10-day period;

(b) the species, size and sex of a representative subsample of all crabs caught in traps;

(c) other relevant data, as possible, according to the logbook formats already being used in the exploratory crab fishery;

(vii) each Member participating, or intending to participate, in the exploratory crab fishery should register with the CCAMLR Secretariat (at least three months in advance of starting fishing annually) the name, type, size, registration number, and radio call sign and fishing plan of each vessel that the Member has authorised to participate in the exploratory crab fishery.

6.21 The first stage in the development of a longterm management plan is the convening of a workshop during the intersessional period to specify the data needed and the actions required to acquire the data from the exploratory crab fishery that will allow the estimation of appropriate harvest levels and methods in accordance with Article II of the Convention. The Working Group envisions that the workshop would produce a plan to implement an experimental/adaptive harvest strategy. It was agreed that results of the workshop should be conveyed to Members so that during the 1992/93 season data could be collected according to guidelines agreed at the workshop.

New Fisheries

6.22 Two notifications of new fisheries in Subarea 48.4 were received by CCAMLR; one from the USA (CCAMLR-XI/5) and one from Chile (CCAMLR-XI/7). Dr Holt reported that the US intention was to take *D. eleginoides* in fish pots which are used to capture bait for the crab fishery. However, during the initial trip of the US crab vessel in Subarea 48.3, few fish were captured and use of fish pots was discontinued (WG-FSA-92/29). It is believed unlikely that further attempts to catch *D. eleginoides* using fish pots will be made by this vessel in Subarea 48.4.

6.23 Dr Moreno presented plans of a Chilean fishing company to conduct exploratory fishing operations for *D. eleginoides* using longlines in waters off the South Sandwich Islands (Subarea 48.4) during the 1992/93 fishing season (CCAMLR-XI/7). The proposed fishing activity will be undertaken during a 40-day period aboard the Chilean vessel *Friosur V*. The vessel will take a maximum of 240 tonnes of *D. eleginoides*. Dr Moreno extended an invitation for one scientist to participate as an invited observer on board the vessel.

6.24 The Working Group supported the application to conduct the exploratory fishery, noting that the minimum effort possible was being applied (i.e., use of one vessel conducting only one trip of 40 days) and a maximum of 240 tonnes would be taken. It was felt that if the standing stock was low, catch rates would be low and less than the planned catch of 240 tonnes would be taken.

6.25 The Working Group agreed that the list of data to be collected should include information on the amount and composition of by-catch in the fishery. It was agreed that the participation of scientific observers aboard the vessel was essential.

6.26 It was noted that levels of abundance and sustainable yield of a species are generally unknown during the initial phases of the development of a new fishery. Two documents that addressed this problem were provided by Dr Moreno (WG-FSA-92/22 and 23).

SOUTH GEORGIA AND SHAG ROCKS (SUBAREA 48.3)

6.27 Summaries of the assessments presented in the following section are given in Appendix I.

Reported Catches

6.28 The catch history of Subarea 48.3 (South Georgia and Shag Rocks) since 1970 is shown in Table 3. This illustrates the collapse of the *Notothenia rossii* fishery following landings in excess of 500 000 tonnes in the first two years of the reported fishery. This was followed by its replacement in the mid-1970s by *Champsocephalus gunnari* as the most important finfish resource on the South Georgia shelf. In recent years the *C. gunnari* catch has declined and is currently overshadowed by the landings of myctophids, notably *Electrona carlsbergi*, from the northern part of Subarea 48.3. The total catch of all species in 1991/92 was 50 678 tonnes, which compares to 82 423 tonnes in 1990/91, the difference being largely due to a drop in myctophid landings.

Table 3: Catches of various finfish species from Subarea 48.3 (South Georgia subarea) by year. Species are designated by abbreviations as follows: SSI (*Chaenocephalus aceratus*), ANI (*Champsocephalus gunnari*), SGI (*Pseudochaenichthys georgianus*) and ELC (*Electrona carlsbergi*), TOP (*Dissostichus eleginoides*), NOG (*Notothenia gibberifrons*), NOR (*Notothenia rossii*), NOS (*Notothenia squamifrons*), NOT (*Patagonotothen guntheri*). "Others" includes Rajiformes, unidentified Channichthyidae, unidentified Nototheniidae and other Osteichthyes.

Split year	SSI	ANI	SGI	ELC[e]	TOP	NOG	NOR	NOS	NOT	OTHERS	TOTAL
1970	0	0	0	0	0	0	399704	0	0	0	399704
1971	0	10701	0	0	0	0	101558	0	0	1424	113713
1972	0	551	0	0	0	0	2738	35	0	27	3351
1973	0	1830	0	0	0	0	0	765	0	0	2595
1974	0	254	0	0	0	0	0	0	0	493	747
1975	0	746	0	0	0	0	0	1900	0	1407	4053
1976	0	12290	0	0	0	4999	10753	500	0	190	28732
1977	293	93400	1608	0	441	3357	7945	2937	0	14630[a]	124611
1978	2066	7557	13015	0	635	11758	2192	0	0	403	37626
1979	464	641	1104	0	70	2540	2137	0	15011	2738[b]	24705
1980	1084	7592	665	505	255	8143	24897	272	7381	5870	56664
1981	1272	29384	1661	0	239	7971	1651	544	36758	12197[c]	9167
1982	676	46311	956	0	324	2605	1100	812	31351	4901	89036
1983	0	128194	0	524	116	0	866	0	5029	11753[d]	146482
1984	161	79997	888	2401	109	3304	3022	0	10586	4274	104742
1985	1042	14148	1097	523	285	2081	1891	1289	11923	4238	38517
1986	504	11107	156	1187	564	1678	70	41	16002	1414	32723
1987	339	71151	120	1102	1199	2844	216	190	8810	1911	87882
1988	313	34620	401	14868	1809	5222	197	1553	13424	1387	73794
1989	1	21359	1	29673	4138	838	152	927	13016	55	70160
1990	2	8027	1	23623	8311	11	2	24	145	2	40148
1991	2	92	2	78488	3641[f]	3	1	0	0	1	82423
1992	2	5	2	46960	3703[g]	4	1	0	0	1	50678

[a] Includes 13 724 tonnes of unspecified fish caught by the Soviet Union
[b] Includes 2 387 tonnes of unspecified Nototheniidae caught by Bulgaria
[c] Includes 4 554 tonnes of unspecified Channichthyidae caught by the GDR
[d] Includes 11 753 tonnes of unspecified fish caught by the Soviet Union
[e] Before 1988, it is not confirmed that these were *E. carlsbergi*
[f] Includes 1 440 tonnes taken before 2 November 1990
[g] Includes 1 tonne taken as research catch by the UK, 132 tonnes taken as research catch by Russia before 30 June

6.29 The total catch in 1991/92 was dominated by 46 963 tonnes of *E. carlsbergi*, which was about 60% of the catch in 1990/91 and considerably less than the precautionary TAC of 245 000 tonnes set by the Commission for the period commencing 2 November 1991 (Conservation Measure 38/X). The remainder included 3 703 tonnes of Patagonian toothfish, *D. eleginoides*, which was in excess of the TAC of 3 500 tonnes set by the Commission for the period commencing 2 November 1991 (Conservation Measure 35/X) (see paragraph 5.4). A research catch of 59 tonnes of *D. eleginoides* was taken after 30 June 1992, and is therefore not included in the total in Table 3.

6.30 No commercial catch of *C. gunnari* in Subarea 48.3 was reported for the 1991/92 season, due to the closure of the fishery by the Commission in November 1991 until the end of the Commission meeting in 1992 (Conservation Measure 33/X). Research landings amounted to 5.3 tonnes reported from the UK survey in January 1992.

6.31 Catches of other species in Subarea 48.3, including *N. rossii, P. guntheri*, *N. gibberifrons*, *C. aceratus*, *P. georgianus* and *N. squamifrons*, were limited to a research vessel catch from the UK survey in January 1992 and amounted to 10 tonnes. Directed fishing on these species was prohibited in 1991/92 (Conservation Measures 3/IV and 34/X).

Notothenia rossii (Subarea 48.3)

6.32 *N. rossii* was severely affected by fishing primarily in the early 1970s but also in the late 1970s. Conservation Measures have been in force since 1985 (Conservation Measures 2/III and 3/IV). These prohibited directed fishing of *N. rossii* and aimed to keep by-catches of the species to as low a level as possible. The reported catch in 1991/92 was only 1 tonne (Table 3) which originated from a research vessel survey. It is unlikely to have been higher due to the absence of commercial trawling on demersal species in the subarea (Conservation Measure 34/X).

6.33 Length compositions from research vessel catches (*Falklands Protector*, WG-FSA-92/17) did not exhibit significant differences in comparison with previous years. Catches consisted mostly of fish 40 to 65 cm long, with a mean length of 52 to 53 cm (WG-FSA-92/17). The biomass estimate of 7 309 tonnes (CV 60.7%) was within the range of biomass estimates from previous cruises since the mid 1980s. This suggests that the stock has remained at a low level.

6.34 The distribution of *N. rossii* is extremely patchy and the fish often appear to be concentrated in underwater canyons. This contagious distribution is not adequately taken into account in the design of surveys which are currently undertaken. These surveys aim to provide estimates of stock size of *C. gunnari* and other, more evenly distributed species, such as *N. gibberifrons* and *C. aceratus*. The CCAMLR Workshop on the Design of Bottom Trawl Surveys (Annex H) therefore felt that a survey targetting this species should be stratified to better survey these areas of high aggregation. The design of such a survey must make use of haul-by-haul information from historical catches in determining sampling localities. This information has not been made available to CCAMLR. The Working Group recommended that this information should be submitted and that a survey on the species be undertaken in the near future in order to obtain a more accurate estimate of the standing stock of *N. rossii* in this subarea.

Management Advice

6.35 In view of the likely low stock size of *N. rossii* at present, all conservation measures for this species should remain in force.

Champsocephalus gunnari (Subarea 48.3)

Fisheries Surveys

6.36 A bottom trawl survey of the same design as that in January 1991 was undertaken by the *Falklands Protector* in January 1992 with scientists from the UK, Germany and Poland on board (WG-FSA-92/17). No large aggregations of *C. gunnari* of the type seen during surveys in 1989/90 (WG-FSA-90/13) were encountered during this survey. The total standing stock was estimated by the 'swept area' method to be 37 311 tonnes (CV 18.3%) around South Georgia and a further 2 935 tonnes (CV 35%) around Shag Rocks. The comparatively low CV of the estimate for South Georgia is indicative of the relatively even distribution of fish over the shelf encountered during the survey.

6.37 No other surveys aimed at *C. gunnari* in Subarea 48.3 during 1991/92 were reported to the Working Group.

6.38 The estimate of standing stock of *C. gunnari* in Subarea 48.3 from the survey is in accordance with the predicted growth of the population since the *Falklands Protector* survey in January 1991.

6.39 The Working Group considered that the results of the 1992 trawl survey served to substantiate the hypothesis that the dramatic drop in biomass between 1989/90 and 1990/91 indicated by trawl surveys (Table 4) was a genuine reflection of the stock abundance over that period. It was agreed that, in view of this, the conservative management approach adopted by the Commission in 1991/92 was the most appropriate.

Table 4: Reported catches and summary of biomass estimates of *C. gunnari* from surveys in Subarea 48.3.

Season	Reported Catch (tonnes)	Stock Assessment Surveys: South Georgia Biomass	South Georgia CV%	Shag Rocks Biomass	Shag Rocks CV%	Source
1986/87	71 151	151 293	95	62 867	84	Balguerías *et al.*, 1989[2]
1986/87		50 414[4]	18	10 023	55	SC-CAMLR-VI/BG/12
1986/87		51 017		4 229		SC-CAMLR-IX[1]
1986/87		47 312	-			Sosinski and Skora, 1987
1987/88	34 620	15 086[4]	21	1447	78	SC-CAMLR-VII/BG/23
1987/88		15 716		509		SC-CAMLR-IX[1]
1987/88		17 913	-			Sosinski (unpubl.)
1988/89	21 356	21 069	50			WG-FSA-89/6
1988/89		22 328				SC-CAMLR-IX[1]
1988/89		31 686[4]	45			Parkes (unpubl.)[3]
1989/90	8 027	95 405[4]	63	279 000	83	*Hill Cove* survey[6]
1989/90		878 000	69	108 653	31	*Akademik Knipovich* survey[6]
1989/90		887 000	31			*Anchar* survey[6]
1990/91	92	22 285[4]	16	3 919	75	WG-FSA-91/14
1990/91		172 920	44	19 225	23	WG-FSA-91/23
1991/92	5[5]	37 311	18	2 935	35	WG-FSA-92/17

1 Calculated at WG-FSA-90 to take account of new sea bed areas in WG-FSA-90/8
2 Semipelagic trawl used as a bottom trawl
3 Data from *Professor Siedlecki* survey, February 1989 re-worked according to model 3 in WG-FSA-90/13 and using seabed areas in Everson and Campbell (1991)
4 Survey indices used for tuning VPA in WG-FSA-92/27
5 Research vessel catch
6 SC-CAMLR-IX, Annex 5

6.40 Analysis of diet composition and feeding intensity of *C. gunnari* from data collected during the survey is reported in WG-FSA-92/26. Krill, the preferred prey item, was present in the stomachs of 65% of fish at South Georgia compared to 22% in January 1991, indicating that it was available in greater quantities this year. Feeding intensity was also significantly higher in 1992 than in 1991. Preliminary results of a comparison of condition factor between samples collected during January 1991 and January 1992 is presented in WG-FSA-92/18. The mean condition factor of mature fish was significantly higher in 1992 than in 1991 at both South Georgia and Shag Rocks. Little difference between South Georgia and Shag Rocks was detected in either year.

6.41 The survey in January 1992 therefore suggests that there has been a general increase in the abundance and improvement of the condition of *C. gunnari* in Subarea 48.3 compared to 1991.

6.42 The distribution of *C. gunnari* around South Georgia and Shag Rocks from a series of eight trawl surveys by Soviet vessels between 1973/74 and 1989/90 was presented in WG-FSA-92/4. Considerable variation in catch rates between years was noted. Analysis of annual variation in distribution was confounded by variation in the timing of the surveys in different seasons. High localised catch rates in some years were indicative of the presence of aggregations on the shelf. The high catch rates encountered during April 1990 (*Anchar* survey) were also detected in similar locations during the *Hill Cove* survey in January of the same year. The Working Group stressed the need for the submission to CCAMLR of haul-by-haul data from random stratified surveys of this type (including surveys conducted in the past), which can be used for optimal allocation of sampling stations on future surveys.

6.43 WG-FSA-92/6 presents data on the abundance of juvenile *C. gunnari* around South Georgia from a series of surveys between 1984 and 1990. Most of this information has not been previously reported to CCAMLR. Unfortunately, with the exception of the 1985 survey reported in Boronin *et al.*[1] (1986), the details of the design and analysis of these surveys has not been reported to CCAMLR. The Working Group was therefore unable to assess the validity of the results shown in Figures 2 to 8 of WG-FSA-92/6.

6.44 The Working Group agreed that data of this type, which could potentially provide an index of recruitment, is of extremely high value and should be reported in the appropriate detail and format as soon as possible.

6.45 WG-FSA-92/6 also presents an analysis of data on the by-catch of juvenile *C. gunnari* in krill trawls collected by a scientific observer working on the fishing vessel *More Sodruzhestva.* A full discussion of this report is presented in paragraphs 7.2 to 7.4.

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[1] BORONIN, V.A., G.P. ZAKHAROV and V.P. SHOPOV. 1986. Distribution and relative abundance of juvenile icefish (*Champsocephalus gunnari*) from a trawl survey of the South Georgia shelf in June-July 1985. In: *Selected Scientific Papers 1986 (SC-CAMLR-SSP/3).* CCAMLR, Hobart, Australia: 58-63.

Stock Assessment

6.46 Attempts were made at last year's meeting to assess the status of the *C. gunnari* population in Subarea 48.3 using virtual population analysis (VPA). Two assessment papers were presented (WG-FSA-91/15 and 27) which showed highly divergent stock trajectories, largely due to differences in the use of tuning data. Two VPA runs were made at the 1991 meeting using the Laurec-Shepherd tuning method (MAFF VPA version 2.1), which followed the same general trend as the two tabled assessments (SC-CAMLR-X, Annex 6, Figure 3).

6.47 Concern was expressed at the Working Group meeting in 1991 that the large biomass of 5 year olds predicted by the VPA runs for 1991/92 might be an artefact of the analysis. In the absence of this year class, any TAC would be extracted from the younger, less abundant year classes, with potentially severe effects on a population already apparently under considerable stress from a shortage of krill, the preferred food of *C. gunnari* (WG-FSA-91/15 and 29). Concerns over the credibility of the VPA and resulting uncertainties in the estimation of total stock size lead to the closure of the fishery for *C. gunnari* in Subarea 48.3 for the 1991/92 season by the Commission (Conservation Measure 33/X).

6.48 The 5 year old age group, predicted as abundant by the VPAs presented at WG-FSA-91 comprised less than 5% of the fishable population biomass (age 2+) estimated from the survey in January 1992. Assuming the survey provided a representative sample of the population, it appears that the VPAs and projections presented to and performed at the 1991 Working Group meeting provided a misleading representation of the *C. gunnari* population structure in Subarea 48.3 in 1991/92.

6.49 An attempt to rework the VPA (starting from 1991 because catch in 1991/92 was zero), using both Laurec-Shepherd and ADAPT tuning methods was presented in WG-FSA-92/27. Data for tuning was derived from a series of surveys between 1987 and 1991 (see Table 4) and from CPUE data presented in WG-FSA-91/27. Criteria for the selection of the survey series were discussed in detail during last year's meeting (SC-CAMLR-X, Annex 6, paragraphs 7.42 to 7.52). Projections from the VPA estimates in 1991 consistently indicated that the population in 1991/92 would be composed of a large proportion of 5 year olds, despite the use of various combinations of survey and CPUE indices for tuning. Breakdown in the credibility of the VPA results in most recent years was attributed by WG-FSA-92/27 to the invalid assumption of constant **M** over a period when several surveys indicated a large reduction in stock size in the absence of fishing.

6.50 The Working Group used the CCAMLR version of ADAPT (FADAPT8.EXE) to confirm the VPA results presented in WG-FSA-92/27. Five runs were performed (Run 1 to Run 5) using tuning data inputs listed in Table 5. Catch-at-age and mean weight-at-age were as used at last year's meeting (SC-CAMLR-X, Annex 6, Appendix F).

Table 5: Tuning data inputs for FADAPT8 runs on *C. gunnari* in Subarea 48.3.

Run	Period	**M**	Tuning Indices (Ages 1-6)	Weighting of Indices	Reference
1	1977-1991	0.48	Survey indices 1987 to 1991	Equal weighting	WG-FSA-92/27
2	1977-1991	0.48	Survey indices 1987 to 1991	Inverse variance of surveys	WG-FSA-92/27 WG-FSA-91/15
3	1977-1990	0.48	CPUE indices 1981 to 1990	Equal weighting	WG-FSA-91/27
4	1977-1991	0.48	Combination of CPUE and survey indices	Equal weighting	WG-FSA-92/27
5	1977-1991	0.48	CPUE and survey indices input separately	Equal weighting	WG-FSA-91/27 WG-FSA-92/27

6.51 Figure 1 illustrates the total biomass (age 2+) from these five runs. The diagnostics provided by the program indicated that the final year parameters (**F** and **q**) of runs tuned to survey indices had coefficients of variation between 40% and 80%. The CVs of the **q**s estimated on runs tuned to CPUE indices were in the region of 20% due to the greater number of data points. The pattern of stock trajectories produced using the different tuning indices was similar to that produced by the Laurec-Shepherd tuned VPAs presented in WG-FSA-92/27; the estimated population size, however, was generally higher with the ADAPT method.

6.52 Cohort projections from 1990/91 to 1991/92 (two years, from 1989/90 to 1991/92 in the case of run 3) assuming zero catch, M = 0.48 and mean recruitment between 1985/86 and 1989/90 were made, in order to compare the projected age distribution with the observed age distribution from the 1992 survey (Figure 2). The projected age distribution over the most recent years was fairly consistent between runs, with a large proportion of the fishable biomass (>2 years) in 1991/92 in most runs consisting of 5 year olds. In runs 1 and 4, 4 year olds made up about 40% of the fishable biomass.

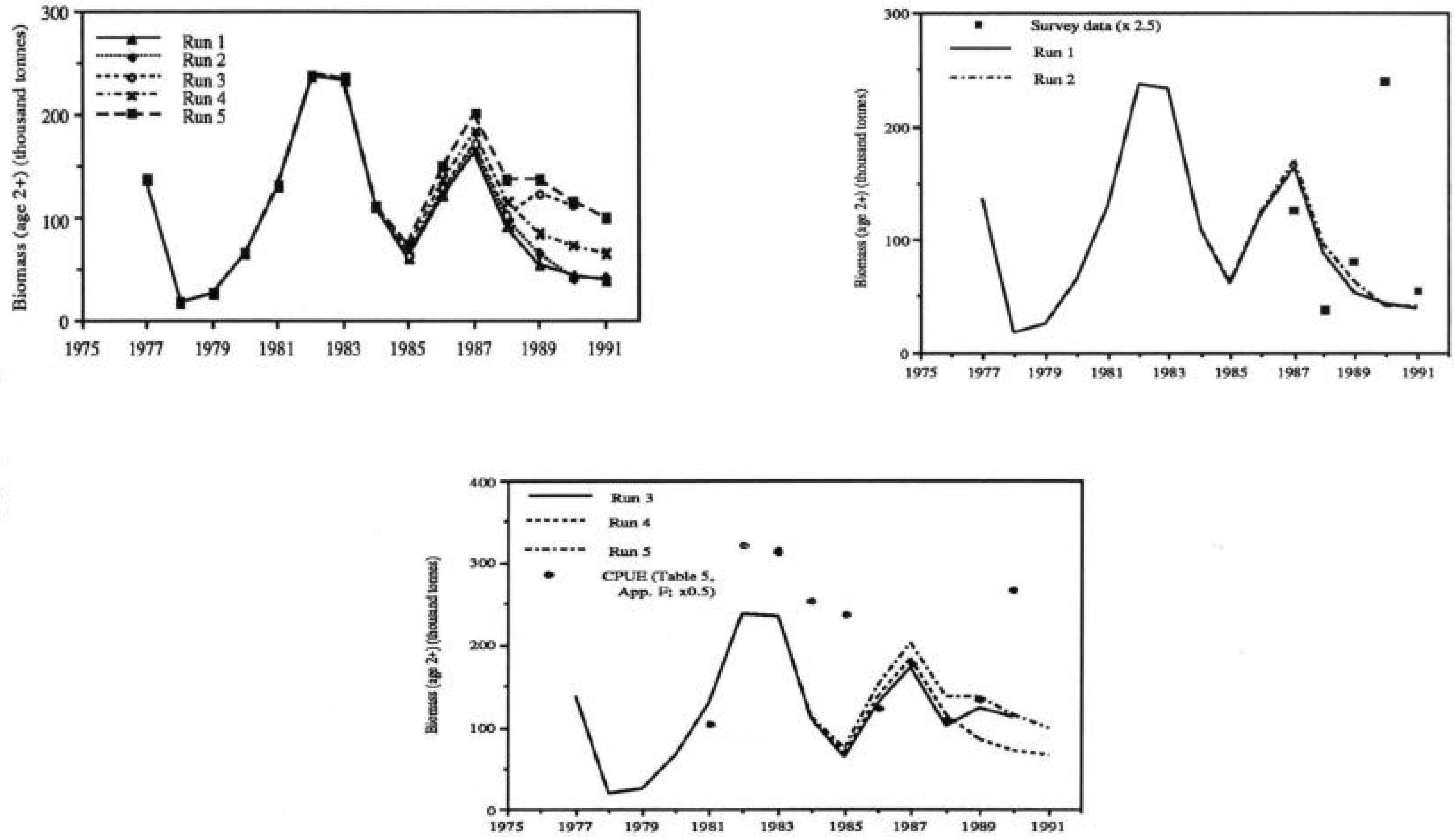

Figure 1: Total biomass derived from VPA tuning runs in Table 5. Survey data (from Table 4, superscript 4) and CPUE data (from SC-CAMLR-X, Annex 6, Appendix F, Table 5) are plotted with their various tuning runs.

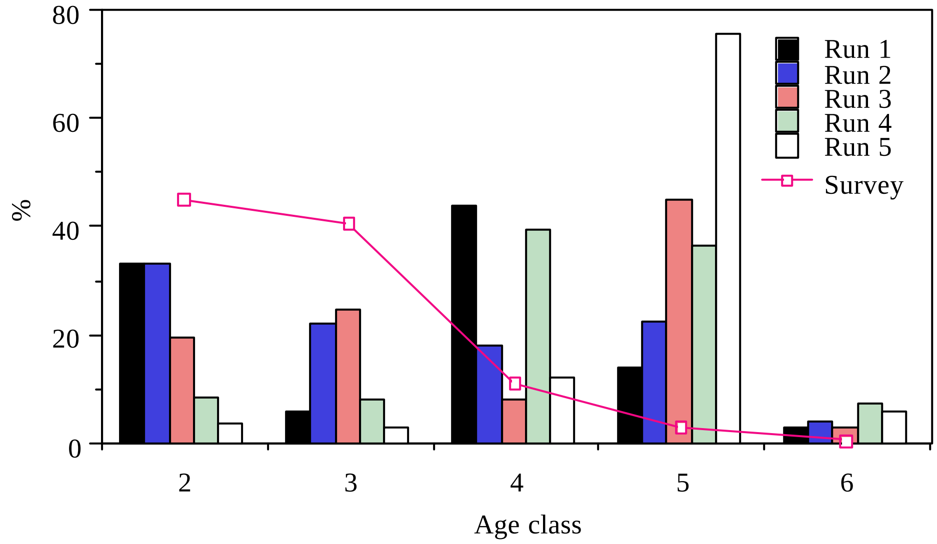

Figure 2: Age distribution of exploitable biomass (age 2+) of *C. gunnari* in 1991/92 estimated from the VPA runs (bars) and observed during a scientific survey in January 1992 (line) - WG-FSA-92/17.

6.53 The Working Group considered that the parameters of the VPAs were generally estimated with poor precision. The resulting projections of recent stock biomass and age structure were not consistent with the patterns observed from research vessel surveys over the past few years.

6.54 Trawl surveys in 1989/90 surveys indicated that two abundant year classes had entered the stock. Projections from the VPA predict that these fish are abundant in the population as 4 and 5 year olds in 1991/92. Trawl surveys in 1990/91 and 1991/92, however, indicate that these fish are no longer abundant.

6.55 The Working Group believed that this inconsistency is explained by the invalid assumption of constant **M** used in the VPA, the resulting projection, which did not take account of the large drop in biomass in the absence of substantial **F**, and uncertainties in the age structure of the input data. The Working Group was concerned that basing management advice for 1992/93 on the results of the VPA could result in damage to the stock, due to the apparent absence of the predicted abundance of older fish in the population.

6.56 The Working Group therefore concluded that the results of VPAs performed at this year's meeting should not be used as an assessment of the current status of the stock of *C. gunnari* in Subarea 48.3.

6.57 The only other information available to the Working Group for the assessment of the current status of the *C. gunnari* stock in Subarea 48.3 was the results of the stock assessment surveys performed by *Falklands Protector* in January 1991 (WG-FSA-91/14) and January 1992 (WG-FSA-92/17). The Working Group recognised that the catchability of the survey was unlikely to be 1 and that survey abundance indices are generally regarded as underestimates of true population size. However, given the obvious uncertainty in the current assessment, the trawl survey results represent the best measure of abundance.

6.58 The approach adopted was to use the results of the 1992 survey, which shows a picture of total biomass which is reasonably consistent with the previous year's survey, and project forwards to 1992/93 and 1993/94, assuming either no catch (maintenance of the current conservation measure) or a catch based on a target **F**, such as $\mathbf{F_{0.1}}$, in 1992/93. Projected recruitment of 1 year olds was input as a mean value with a log-normal error, which was used to simulate recruitment uncertainty. Mean recruitment and the variance of $\log_e$ recruitment were taken from the VPA between 1977 and 1986, prior to the period when the analysis apparently broke down. These parameters were highly consistent between runs, being equal to 900 million individuals and 0.45 respectively. $\mathbf{F_{0.1}}$ was calculated under the same assumptions used at WG-FSA-91 ($F_{0.1}$ = 0.39, with knife edge selection at age 2).

6.59 Annual recruitment **R**, was generated independently for each year on each run as follows:

$$R = \bar{R} \cdot e^{\left(x - \frac{\sigma^2}{2}\right)}$$

where: $\bar{R}$ = mean recruitment

$\mathbf{X}$ = $\sqrt{\sigma^2 \cdot Z}$

s^2 = variance of $\log_e$ recruitment

$\mathbf{Z}$ = normal (0,1) random variable

The value of s^2 was well within the range of values listed for other marine species (Beddington and Cooke, 1983[1]). Each projection was run 500 times to simulate recruitment uncertainty making it possible to obtain 95% confidence limits.

6.60 The values of $\bar{R}$ and s^2 were very similar to those given in WG-FSA-92/27. The Working Group agreed to accept the results of these projections to save re-running the simulation which would yield essentially the same results.

6.61 The results of all projections are presented in Table 6 and Figure 3.

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1 BEDDINGTON, J.R. and J.G. COOKE. 1983. The potential yield of fish stocks. *FAO Fish. Techn. Pap. 242*: 47 pp.

Table 6: Results of cohort projections with variable recruitment for *C. gunnari* in Subarea 48.3, 1991/92 to 1993/94.

Total Biomass (tonnes), Age 2+, Subarea 48.3						
	1990/91 Survey	1991/92 Survey	1992/93 Projection	Without Catch in 1992/93	With Catch ($F_{0.1}$) in 1992/93	
				1993/94 Projection	1992/93 Catch	1993/94 Projection
Upper 95%			154 100	277 200	43 600	240 600
Mean	22 400 CV 16%	38 000 CV 18%	87 000	137 400	24 300	110 800
Lower 95%			52 000	62 700	15 200	49 400

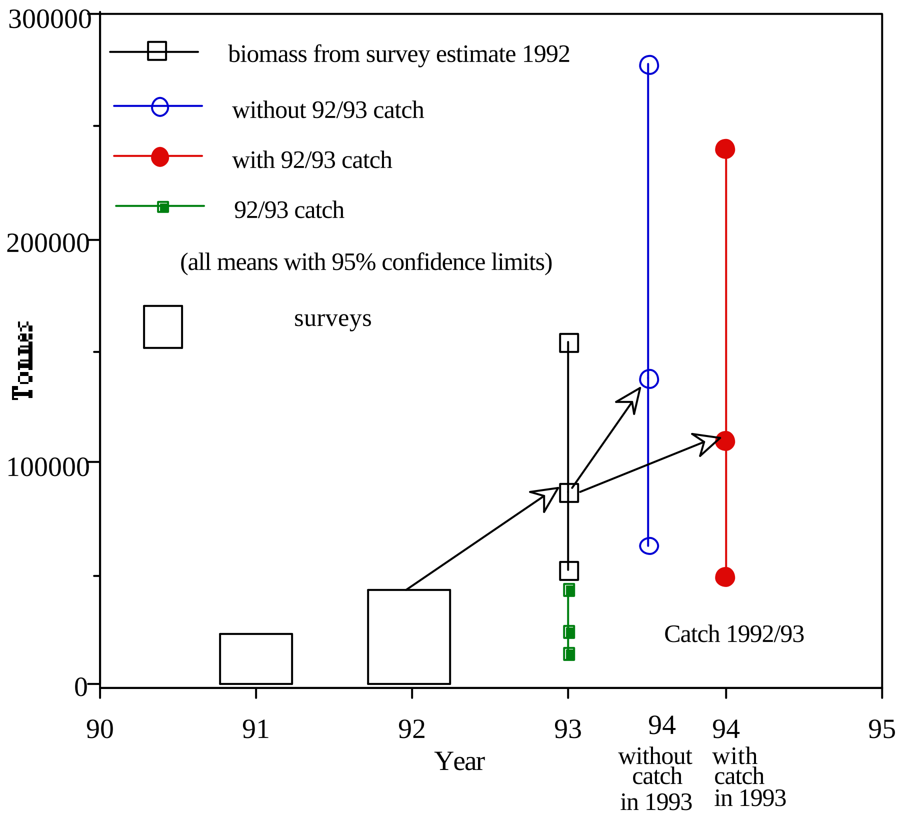

Figure 3: Projection scenarios for *C. gunnari* with variable recruitment.

6.62 In the absence of fishing, the mean biomass was projected to grow to about 137 400 tonnes (95% confidence limits 62 700 to 277 200) by 1993/94, with an increase in the biomass of 4 and 5 year olds.

6.63 The $\mathbf{F_{0.1}}$ catch level in 1992/93 was estimated to be of the order of 24 300 tonnes (95% confidence limits 15 200 to 43 600), however, about 50% of this was composed of 2 year olds and was thus highly dependent on the estimated recruitment of 1 year olds in 1991/92. It has been assumed that the recruitment in 1991/92 would be similar to those which occurred over the period 1977 to 1986. However, the observations of fish in poor condition which may have led to increased mortality and poor spawning performance mean that this assumption may not be justified. The Working Group thought that projections relying heavily on this mean recruitment should be treated with caution.

6.64 At the lower 95% confidence limit of the projected catch (15 200 tonnes), the assessed proportion of 2 year olds in the catch was 25%. At this level of TAC the fishery in 1992/93 would therefore be less dependent on the assumed size of the recruitment of one year olds in 1991/92.

6.65 Following a catch at $\mathbf{F_{0.1}}$ in 1992/93 the mean biomass was projected to grow to about 110 800 tonnes (95% confidence limits 49 400 to 240 600) in 1993/94. The lower bound of the 95% confidence interval on the total biomass, however, was lower in 1993/94, following the catch, than it was in 1992/93.

Considerations for a Re-opening of the *C. gunnari* Fishery

6.66 The Working Group recognised that a fishery for *C. gunnari* in Subarea 48.3 in 1992/93 could involve bottom trawling, pelagic trawling or both.

6.67 The implications of bottom trawling in relation to both the by-catch of demersal fish species and the adverse effect on the benthos have been considered during past meetings of the Working Group and the Scientific Committee (SC-CAMLR-X, Annex 6, paragraphs 7.189 to 7.197 and SC-CAMLR-X, paragraphs 8.39 and 8.40). Bottom trawl catches of *C. gunnari* usually contain a mixture of the by-catch species *N. gibberifrons*, *C. aceratus* and *P. georgianus*, the proportion in the catch probably varying considerably from one season to another and from one fishing ground to another. Quantitative information on the by-catch is available from the Polish fishery for a number of years, but not from the Soviet fishery, which has taken the bulk of the catches. During years when the Polish fishery targetted *C. gunnari*, the relative weights of major species in the catch were as given below (SC-CAMLR-X, Annex 6, Appendix H):

N. gibberifrons	1
C. aceratus	1
P. georgianus	1
C. gunnari	6

6.68 The TAC of *C. gunnari* in Subarea 48.3 of a fishery using bottom trawls could therefore be limited by by-catch considerations to six-times the TAC of either *N. gibberifrons*, *C. aceratus* or *P. georgianus*, whichever is the least.

6.69 No new projections of the potential yield of the three by-catch species were performed by the Working Group. The status of these stocks is thought to be little changed since 1990/91 (see paragraphs 6.95 and 6.96).

6.70 According to the calculations given at last year's meeting (SC-CAMLR-X, Annex 6, paragraph 7.196), the TAC of *C. gunnari* in Subarea 48.3 using bottom trawls would be limited to six-times the MSY for *N. gibberifrons*. This was calculated in 1991 as equal to about 8 800 tonnes of *C. gunnari*.

6.71 The working Group also reiterated its concerns over the potential adverse effects of bottom trawling on benthos, which in turn could affect fish communities in the medium or longterm.

6.72 There are also implications of by-catch of other finfish species in a pelagic trawl fishery for *C. gunnari*. Despite requests for data at last year's meeting (SC-CAMLR-X, Annex 6, Appendix E), no new information on this by-catch was made available to this year's meeting. Data analysed at the 1990 meeting showed that the by-catch of *N. gibberifrons* in pelagic trawls targetting *C. gunnari* is potentially of the order of 3 to 16%*. A TAC of 15 200 tonnes of *C. gunnari* (the lower 95% confidence interval given above), for instance, would therefore imply a by-catch of *N. gibberifrons* of between 460 and 2 432 tonnes. The by-catch of *C. aceratus* is likely to be of similar magnitude to the by-catch of *N. gibberifrons*, given its similar distribution in the water column. *P. georgianus*, however, is believed to undergo vertical migrations into the water column, which would make it more vulnerable to pelagic trawls. The by-catch of this species is therefore thought to be potentially considerably greater than that of *N. gibberifrons*. Future TACs of a pelagic fishery for *C. gunnari* in Subarea 48.3 will potentially be limited by the magnitude of this by-catch in relation to the potential yield of these species. The Working Group reiterated its request made last year for more detailed data on this subject.

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* $\frac{\text{catch of } N.\ gibberifrons}{\text{catch of } C.\ gunnari} \times 100$

6.73 The potential MSY of *N. gibberifrons* in Subarea 48.3, estimated at last year's meeting was 1 470 tonnes (SC-CAMLR-X, Annex 6, Table 16). If the by-catch of *N. gibberifrons* is not to exceed 1 470 tonnes then the implications of the 3 to 16% range of by-catch percentage are as follows:

By-catch Percentage by Weight	By-catch Limit	Potential Ceiling of *C. gunnari* Catch
16%	1 470	9 200
3%	1 470	49 000

6.74 The Working Group considered that steps should be taken to investigate concerns over the potential impact of the *C. gunnari* fishery on by-catch species and benthos. For this to succeed, data on the by-catch in pelagic and bottom trawl fisheries should be reported and incorporated in simulation models which investigate the potential impacts on stock dynamics of different fishing strategies using pelagic and/or bottom trawls. An experimental design should be employed to look at the impact of different types of bottom gear on the benthic community. For these experiments to be possible, the Working Group agreed that control areas would need to be designated as soon as possible in a way that ensures that there are some areas in which the benthic communities are free from the disturbance of trawling (SC-CAMLR-X, paragraph 8.41).

Management Advice

6.75 Given the uncertainty surrounding the current status of the exploitable stock of *C. gunnari* in Subarea 48.3 the Working Group considered that a conservative approach to management is appropriate in the immediate future.

6.76 A conservative approach would be the maintenance of the current conservation measure prohibiting directed fishing for *C. gunnari* in Subarea 48.3 (Conservation Measure 33/X). Such an approach, however, should be supported by monitoring of the stock, ideally on an annual basis, to observe the rate of recovery in the absence of fishing.

6.77 The Working Group recommended that a scientific survey be carried out during the 1992/93 season. No plans for scientific surveys on *C. gunnari* in Subarea 48.3 during the 1992/93 season have been received by the Secretariat.

6.78 The Working Group considered a number of possible TAC levels which are given in Table 7.

Table 7: TAC levels and assumptions for *C. gunnari* in Subarea 48.3.

C. gunnari TAC (tonnes)	Assumptions/Rationale
15 200	Lower 95% confidence limit of projected catches at $\mathbf{F_{0.1}}$
9 200 - 15 200	Pelagic trawl fishery only Maximum by-catch of *N. gibberifrons* = 1 470 tonnes (SC-CAMLR-X, Annex 6, Table 16) and *N. gibberifrons* $\leq$16% of *C. gunnari* catch
8 800	Bottom trawl fishery only *C. gunnari* catch = 6 x maximum by-catch of *N. gibberifrons* (1 470 tonnes)

6.79 The Working Group stressed that biological information and information on by-catch from any commercial trawl fishery in Subarea 48.3 during 1992/93 is of vital importance for future assessments. If the fishery were to be re-opened in 1992/93, the Working Group felt that an effort and biological reporting system similar to that for *D. eleginoides* in Subarea 48.3 (Conservation Measure 37/X) would be appropriate for *C. gunnari* in Subarea 48.3.

6.80 In the event that the fishery is re-opened in 1992/93, the Working Group recommended the closure of directed fishing for *C. gunnari* between 1 April and the end of the Commission meeting in 1993 (as in the 1990/91 season; Conservation Measure 21/IX) to protect spawning.

6.81 The Working Group noted that a pelagic trawl fishery in Subarea 48.3 would allow both a higher TAC of *C. gunnari* and would also avoid the possible adverse affects of bottom trawling on the benthic community. It was therefore concluded that in the event of a TAC being set for *C. gunnari* in 1992/93 the ban on bottom trawling (as in Conservation Measure 20/IX) should be reinstated.

6.82 No new information was presented to the Working Group concerning *C. gunnari* mesh selectivity. The Working Group therefore had no reason to propose changes to the 90 mm mesh size regulation (Conservation Measure 19/IX).

Patagonotothen guntheri (Subarea 48.3)

6.83 Conservation Measure 34/X prohibited directed fishing for this species in the 1991/92 season. The only catch of *P. guntheri* (1.5 tonnes) reported to CCAMLR originated from a research vessel survey in January 1992 (WG-FSA-92/17).

6.84 The distribution of *P. guntheri* is confined to the waters around Shag Rocks. For the first time, an individual *P. guntheri* was caught on the western shelf of South Georgia at a depth of 365 to 392 m (WG-FSA-92/17).

6.85 A new biomass estimate of 12 764 tonnes (CV 61.4%) from a bottom trawl survey was available to the Working Group (WG-FSA-92/17). Due to the benthopelagic mode of life of this species, the Working Group reiterated its findings from previous years, notably that any biomass estimate from a bottom trawl survey is likely to be an underestimate.

6.86 No new information on natural mortality and recruitment of this species has been submitted to CCAMLR. At last year's meeting the Working Group expressed concern about the accuracy of fine-scale data reported to CCAMLR. This referred in particular to catch and effort data from the South Georgia area, an area in which this species has not been found in larger numbers during research vessel surveys (SC-CAMLR-X, Annex 6, paragraph 7.13), and asked the relevant authorities for clarification. However, no additional information was received.

Management Advice

6.87 The very low level of fishing in 1989/90 and the absence of commercial fishing in 1990/91 and 1991/92 would have been expected to result in an increase in the biomass of *P. guntheri*. However, the Working Group reiterates its statement from last year that it is unable to assess the current state of the stock due to the lack of information, such as an accurate biomass estimate, estimates of natural mortality and recruitment values for recent years. As the species is short-lived, the current state of the stock is critically dependent upon the strength of the year classes which have been recruited to the stock in very recent years.

6.88 The Working Group recommended that the present conservation measure (Conservation Measure 34/X which applied to the 1991/92 season) should be retained until information, which would allow a reassessment of the stock to be made, becomes available.

Notothenia squamifrons (Subarea 48.3)

6.89 Following the adoption of a by-catch provision of 300 tonnes in 1988/89 and 1989/90 (Conservation Measures 13/VIII and 20/IX), the directed fishery for the species was prohibited from 1990/91 onwards (Conservation Measures 22/IX and 34/X). In 1991/92, *N. squamifrons* were only taken in small numbers during a research vessel survey in January 1992 (WG-FSA-92/17).

6.90 Despite a request in 1991 for the provision of length and age data from past commercial catches (SC-CAMLR-X, Annex 6, Appendix E) no new information has become available to the Working Group. The Working Group was therefore unable to assess the current state of the stock.

Management Advice

6.91 In the absence of any information which would allow an assessment of the stock to be made, the Working Group recommended that the conservation measure presently in force (Conservation Measure 34/X) should be retained.

Notothenia gibberifrons, *Chaenocephalus aceratus*
and *Pseudochaenichthys georgianus* (Subarea 48.3)

6.92 All three species have been common by-catch species particularly in the bottom trawl fishery for *C. gunnari* since the mid 1970s. In some years they have been targetted by the fishery. Both bottom trawling and directed fishing for the species have been prohibited since 1990/91 (Conservation Measures 20/IX, 22/IX and 37/X). A research vessel survey in January 1992 reported catches of 8 tonnes (WG-FSA-92/17).

6.93 No new information on by-catches of the three species in the fishery for *C. gunnari* from historic catches made either by bottom trawl or pelagic trawl have been made available to the Working Group. These were offered two years ago (CCAMLR-IX, paragraph 13.16) but not received, and have been repeatedly requested by the Working Group (SC-CAMLR-X, Annex 6, paragraph 8.10).

6.94 Since 1988/89 little or no commercial fishing has taken place for these three species. Due to the absence of catch-at-age information from commercial catches for the last four seasons, no new analytical assessments such as VPA have been carried out by the Working Group.

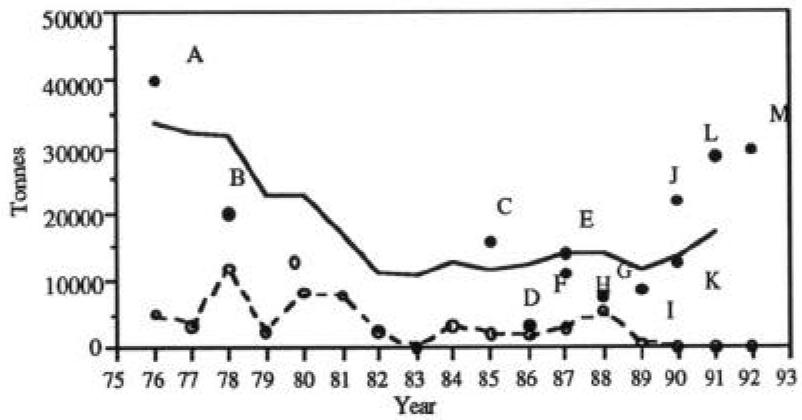
6.95 New biomass estimates were available from a research vessel survey in January 1992 (WG-FSA-92/17). These were:

N. gibberifrons	29 574 tonnes (CV 15.4%)
C. aceratus	12 466 tonnes (CV 14.9%)
P. georgianus	13 469 tonnes (CV 14.6%)

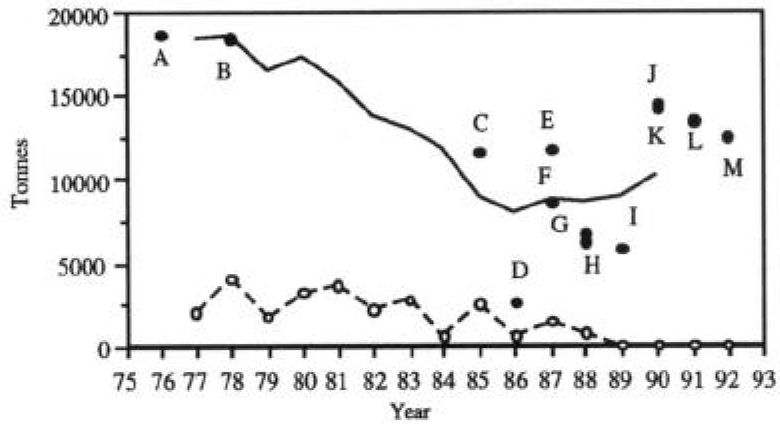
6.96 Biomass estimates were consistent with estimates from surveys carried out in 1990 and 1991 and the results of assessments by the Working Group in 1991 (Figure 4). They support the conclusions of last year's Working Group meeting that all three species show an upward trend in stock size since the introduction of more stringent conservation measures for these species by CCAMLR in 1989.

6.97 Length frequency distributions from UK surveys since 1990 show a steady increase in the proportion of adult *N. gibberifrons*, and small fluctuations in the stock structure and size of *C. aceratus* and *P. georgianus*. This is consistent with trends in biomass estimates from these surveys.

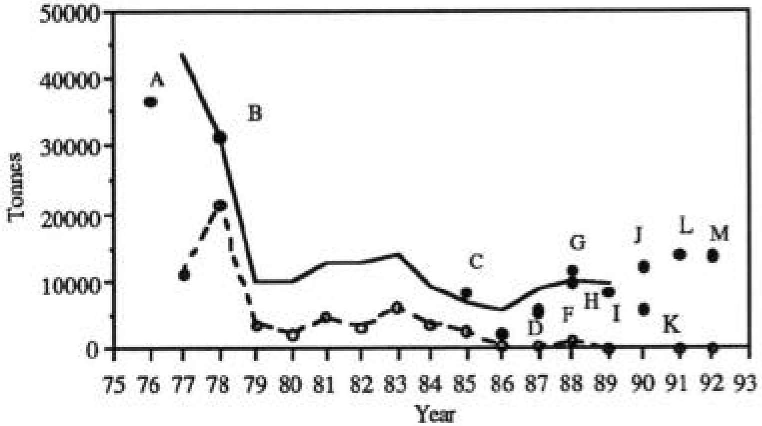
N. gibberifrons



C. aceratus



P. georgianus



Sources for survey estimates:

A	Kock, Duhamel and Hureau (1985)
B	Kock, Duhamel and Hureau (1985)
C	SC-CAMLR-IV/BG/11
D	Balguerías *et al.* (1987)
E	SC-CAMLR-VI/BG/12
F	Sosinski and Skora (1987)
G	SC-CAMLR-VII/BG/23
H	Sosinski (unpubl.)
I	WG-FSA-89/6
J	WG-FSA-90/13
K	WG-FSA-90/11
L	WG-FSA-91/14
M	WG-FSA-92/17

Figure 4: Abundance trends (VPA and survey biomass estimates) and catch history of *N. gibberifrons*, *C. aceratus* and *P. georgianus*.

——— VPA trajectory   - - o - - Total catch   • Survey biomass estimates

6.98 Biomass estimates (in tonnes) for the three species from the initial phase of the fishery (1975/76 for *N. gibberifrons* and 1976/77 for *C. aceratus* and *P. georgianus*) are given in the following table:

Table 8: Biomass estimates (tonnes) for *N. gibberifrons, C. aceratus* and *P. georgianus*.

	Date	Research Surveys	VPA	1992 Estimate as a Proportion of the Initial Level
N. gibberifrons	1975/76	40 094[1]	33 982[2]	73 - 87%
C. aceratus	1976/77	18 719[1]	18 365[3]	66 -67%
P. georgianus	1976/77	36 401[1]	43 580[3]	30 - 37%

1 from Kock, Duhamel and Hureau (1985)
2 from SC-CAMLR-X, Annex 6, Figure 12
3 from Agnew and Kock (1990)

These estimates suggest that *N. gibberifrons* and *C. aceratus* have recovered more than *P. georgianus*.

6.99 It is noteworthy that recovery of *N. gibberifrons* and *C. aceratus* has been faster than that of *P. georgianus*. The former are believed to be more long-lived than *P. georgianus*. One possible explanation is that the standing stock of *P. georgianus* in the mid 1970s was much higher than average, due to the presence of several strong year classes in the stock. After these had been fished out in the late 1970s no similarly strong year classes have occurred and the stock may now have stabilised at a much lower level.

Management Advice

6.100 Stocks of *N. gibberifrons* and *C. aceratus* have apparently recovered to a high proportion of their initial levels. *P. georgianus* may not have recovered to the same extent. A re-opening of the fishery on these species might be considered. All three species have been taken in quantity only by bottom trawling in the commercial fishery. None of these species can be taken without a significant by-catch of other species.

6.101 The Working Group recommended that a directed fishery on these three species should remain prohibited because the potential yields could be entirely taken as by-catch in the *C. gunnari* fishery.

Electrona carlsbergi (Subarea 48.3)

6.102 The reported catch of *E. carlsbergi* in 1991/92 was 46 960 tonnes in Subarea 48.3. This catch was less than the catch in 1990/91 and 19% of the TAC set in Conservation Measure 38/X. Although some fine-scale data has been submitted by Ukraine and Russia, not all fine-scale data for this catch has been submitted.

6.103 New data were available to the Working Group on species composition of by-catch in research trawls targetting *E. carlsbergi* in the Polar Frontal Zone north of South Georgia Island in 1987 to 1989 (WG-FSA-92/12). The catches in these trawls were dominated by myctophids, with *E. carlsbergi* dominating the catch (>90%) in catches greater than 0.5 tonnes. The presence of *E. carlsbergi* was more variable in smaller catches with other myctophids, particularly of the genus *Gymnoscopelus*, often making up significant proportions of the catch. The Working Group welcomed this information provided in response to a request last year for details of by-catch in this fishery (SC-CAMLR-X, Annex 6, paragraph 7.148). However, details of the by-catch in the commercial fishery are necessary for evaluating whether the fishery should be considered as a single species fishery on *E. carlsbergi* or whether it is a multispecies fishery on a number of myctophid species.

6.104 No description of the trawls used in this fishery were provided to this year's meeting as requested in SC-CAMLR-X, paragraph 4.76.

6.105 The Working Group noted that the stock assessments of last year were based on survey data from 1987/88. Data on length composition in the 1991/92 fishery showed a size structure in the fishery similar to that reported in 1990 (SC-CAMLR-X, Annex 6, paragraph 7.131) with sizes ranging between 62 to 85 mm. No other data to refine the uncertainties in the assessments from 1991 (SC-CAMLR-X, Annex 6, paragraph 7.149) have been submitted. As these fish are short lived (four to five years), there are no data on the current biomass of the stock. New surveys of the myctophid stocks in Subarea 48.3 are needed to provide an assessment of the current stock status.

Management Advice

6.106 The Working Group noted the difficulty in providing advice based on data and assessments which are no longer current.

6.107 On the basis of the known biological characteristics of the stock, the current level of fishing on *E. carlsbergi* in Subarea 48.3 may be sustainable. However, the fishery is now based on a stock for which the age structure and biomass are unknown and the catch and biological parameters of related species are also unknown. Thus, the Working Group was unable to advise on an appropriate TAC for the current fishery. The Working Group reiterated the need for further surveys to estimate current biomass (SC-CAMLR-X, Annex 6, paragraph 7.149).

Dissostichus eleginoides (Subarea 48.3)

6.108 Catches of *D. eleginoides* in Subarea 48.3 were initially reported in 1977. Until the mid 1980s, the fishery was carried out entirely by bottom trawls. The longline fishery probably began in April 1986 (WG-FSA-92/13). The annual catch data are summarised in Table 3.

6.109 In accordance with Conservation Measure 35/X, the total catch of *D. eleginoides* for the period from 4 November to the end of the Commission meeting in 1992 was limited to 3 500 tonnes. Conservation Measures 36/X and 37/X, relating to the reporting of catch and effort and biological data, were also in force.

6.110 Catch and effort data were reported to the Secretariat by five-day period and in fine-scale longline format. In addition, length frequency data were reported by Chile and Russia.

6.111 The 1991/92 fishing season for *D. eleginoides* was shorter than previous seasons, mainly because of entry into the fishery of the Chilean fleet. The fishery opened on 4 November 1991. The TAC was reached on 10 March and the fishery closed. During the season the fishery was prosecuted by one Bulgarian, five Russian and eight Chilean vessels, fishing for different periods as shown in Figure 5.

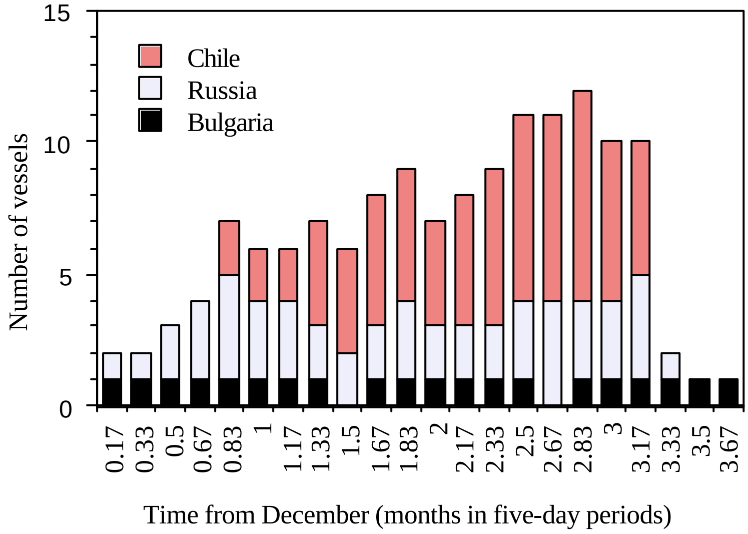


Figure 5: Number of vessels taking part in the fishery.

Review of Catch and Effort Data

Catch Location from Fine-Scale Data

6.112 The position of all catches by Russian and Chilean vessels is shown in Figure 6. In contrast to earlier fishing seasons the fishery took place all around Shag Rocks and South Georgia. The depth of fishing ranged from 500 to 2 000 m with highest effort between 1 300 and 1 400 m.

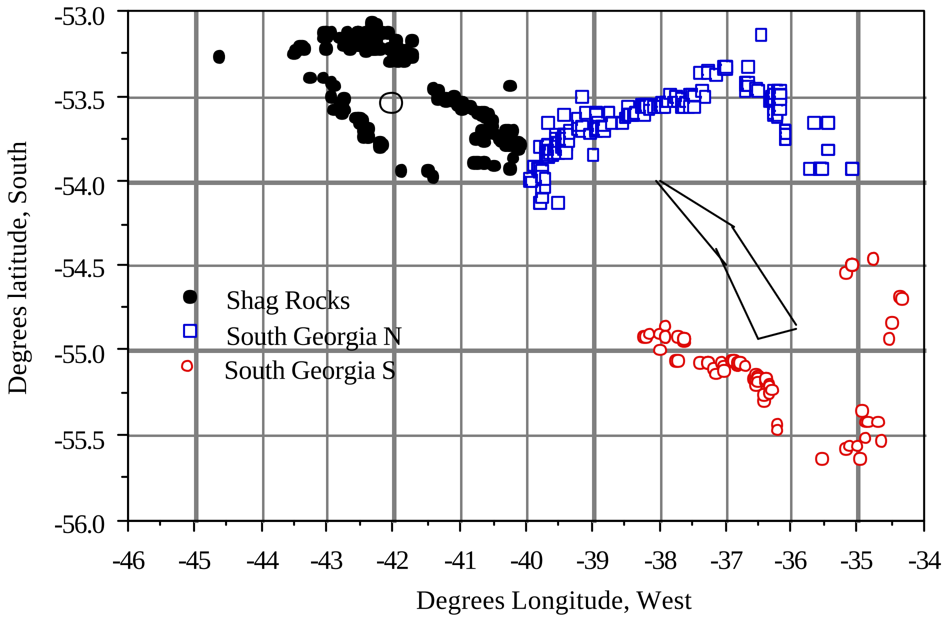


Figure 6: Position of catches of *D. eleginoides* around South Georgia and Shag Rocks.

Effort Data

6.113 Vessel size was reported as 300 to 1 000 tonnes (WG-FSA-92/28). The number of vessels taking part in the fishery per five-day period ranged from one (second half of March) to 12 (end of February).

6.114 The number of hooks varied considerably. The mean number of hooks/line was 8 809 (Chile), 4 794 (Russia) and 3 630 (Bulgaria). The Chilean fleet used six different types and sizes of hooks, while only two types were used by Russian vessels.

Selectivity of Trawls

6.115 A trawl survey around South Georgia in the depth range 50 to 500 m reported catches of *D. eleginoides* ranging from 20 to 86 cm, with very rare occurrences of specimens larger than 46 cm (WG-FSA-92/17, Figure 17).

Selectivity of Hooks

6.116 The size of fish caught in the longline fishery ranged from 45 to more than 200 cm with the bulk of fish being between 70 and 120 cm long (WG-FSA-92/13, 24 and 28). The most important factor influencing mean length of *D. eleginoides* catches seems to be hook type. Seasons and fishing sites seem to have little or no effect (see Table 9).

Table 9: Mean length of *D. eleginoides* for different hook types (CCAMLR coding[1]), sites and fishing nations.

Fishing Nation	Area	Hook Type	$\bar{L}$ * (Total Length)	SD
Chile	South Georgia	5	95.4	14.1
Chile	South Georgia	9	99.0	15.2
Chile	South Georgia	6	117.1	14.0
Chile	South Georgia north of 54.2°S	6	116.4	13.6
Chile	South Georgia south of 54.2°S	6	117.9	13.4
Chile	Area west of 48.3	5	99.2	17.7
Russia	South Georgia		104.5	13.8
Russia (WG-FSA-92/31)	Kerguelen	?	92.95 - 93.4	

* Standard length converted to total length using TL = 1.247+1.118 (SL) (Kock *et al.*, 1985)

6.117 Due to the use of different types of bait, it still remains unclear if the type of hook or bait have greater effect on the CPUE and selectivity for *D. eleginoides*. The Working Group recommends that research be undertaken to allow the estimation of selectivity factors for use in assessments.

Biological Information

Distribution and Stock Identity

6.118 *D. eleginoides* is widely distributed in sub-Antarctic waters from approximately 30°S off Chile and approximately 37°S off Argentina in the north and Shag Rocks and South Georgia in the

[1] Code 5 = 20 to 25 mm width, 6 = 25 to 30 mm width, 9 = 40 to 45 mm width

south as well as around Crozet, Kerguelen, and Heard Islands, Ob and Lena Banks, an unnamed bank north of Kara Dag Bank in the Indian Ocean sector, and around Macquarie Island on the Indo-Pacific boundary. The southern limit of the distribution of *D. eleginoides* is currently thought to be 56°S. The bathymetric range of the species extends down to more than 2 500 m, with smaller fish being found above 500 m (Yukhov, 1982[1]; Salas *et al*.[2], 1987; De Witt *et al*.[3], 1990).

6.119 The location of spawning grounds of this species is unknown, but fish caught on the slope of Burdwood Bank from May to August 1978 (Kock, unpubl.) and fish caught in July 1992 around the northwest of South Georgia and Shag Rocks were found to be in pre-spawning condition (WG-FSA-92/13 and 14). This suggests that spawning may take place over the continental slope from June to August/September.

6.120 The relationship between the population of *D. eleginoides* around South Georgia and those in other areas is unknown. Genetic similarities of *D. eleginoides* caught in Subarea 48.3 and in areas around southern Chile, Falklands/Malvinas and the Indian Ocean are currently being evaluated. Zakharov[4] (1976) distinguished two separate populations, one on the Patagonian Shelf and the other around South Georgia, based on differences in morphological and meristic characters. However, statistical techniques employed in this discrimination (e.g., Student's t-test) appear to be inadequate (Kock, 1992[5]). The Working Group identified stock identity as an important issue to be resolved because fishing occurs on *D. eleginoides* in four areas in close proximity - South Georgia, Shag Rocks, southern Chile and around the Falklands/Malvinas. There are also proposals to carry out exploratory fishing around the South Sandwich Islands in Subarea 48.4 (Chile - CCAMLR-XI/7; USA - CCAMLR-XI/5). If *D. eleginoides* migrates easily between these shelf areas, constituting a single population, then an assessment of the status of the fishery in Subarea 48.3 should include the fisheries in these other locations, some of which are outside the Convention Area.

6.121 The presence of squid and myctophids in their diet (WG-FSA-92/13) and their regular occurrence in sperm whale stomachs in pelagic waters of the Southern Ocean (Yukhov, 1982) indicate that these fish are likely to spend time in the pelagic environment. The proportion of the stock found in the pelagic environment, compared with the benthic environment on the continental

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[1] YUKHOV, V.L. 1982. Antarkticheskij Klyklach. Moscow: Nauka. 113 pp.

[2] SALAS, R., H. ROBOTHAM and G. LIZAMA. 1987. Investigación del Bacalao en VIII Region Informe Técnico. Intendencia Región Bió-Bió e Instituto de Fomento Pesquero. Talcahuano. 183 pp.

[3] DE WITT, W.H., P.C. HEEMSTRA and O. GON. 1990. Nototheniidae (notothens). In: GON, O. and P.C. HEEMSTRA (Eds). *Fishes of the Southern Ocean*. Grahamstown, South Africa: J.L.B. Smith Institute of Ichthyology.

[4] ZAKHAROV, G.P. 1976. Morphological characterisation of Patagonian toothfish (*Dissostichus eleginoides* Smitt) in the Southwest Atlantic. Trudy Atlantic Research Institute of Marine Fisheries and Oceanography. Kaliningrad 65: 20-30.

[5] KOCK, K.-H. 1992. *Antarctic Fish and Fisheries*. Cambridge University Press, Cambridge.

shelf and slope, is unknown. Further work on the distribution of these fish in the water column and the potential for movement between shelf areas would facilitate greatly the evaluation of stock identity.

Age, Length and Weight Data

6.122 Length frequency distributions have been provided from longlining activities (WG-FSA-92/13, 14, 15) and trawl surveys (WG-FSA-92/17). Ages were not determined for fish in these catches.

6.123 As requested last year (SC-CAMLR-X, Annex 6, paragraph 7.102) age/length keys from larger sample sizes have been derived for South Georgia and southern Chile from catches obtained by Chilean commercial longline vessels (WG-FSA-92/30) (Appendix G, Tables G.1 and G.2). Age/length keys have been provided for different areas of the Kerguelen Island area in three different years (WG-FSA-92/8). However, these keys are based on small numbers of fish and most of these fish are in the size range between 70 and 110 cm. Age/length keys for *D. eleginoides* around South Georgia (n = 133) and Shag Rocks (n = 123) from a trawl survey early in 1992 have been submitted to the CCAMLR Data Centre. Ages were determined from scales.

6.124 Two problems need to be addressed before these keys are accepted as representative of the stock around South Georgia. First, there is controversy on the age determinations in *D. eleginoides* and methods have not yet been validated. Lic. E. Barrera-Oro (Argentina) noted that in otolith-sections the ageing is difficult due to the presence of false checks, whereas in scales, the ages of large fish are often underestimated due to the blending of rings at the outer edges, a common problem in other fish (e.g., Beamish and McFarlane, 1983[1]). Dr Kock noted also that the ages of all *D. eleginoides* may be underestimated by one year because the formation of the first readable annulus in the scales is likely to occur in the second year. The Working Group agreed that refining the methods of age determination should be given a high priority. This could be facilitated by comparing age readings from growth rings in otoliths and scales taken from the same fish and, also, by comparing readings from different readers.

6.125 The second problem is that the age/length characteristics of the entire stock are unlikely to be represented in catches from longlining. This may result from the selectivity of hooks for particular sizes of fish. WG-FSA-92/28 described the influence of hook type on the size of fish caught and describes a number of hook types which are currently used in the fishery. If large fish are excluded from the catch then the length-at-age could be underestimated for older fish. Similarly, if small fish

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[1] BEAMISH and MCFARLANE. 1983. The forgotten requirement for age validation in fisheries biology. *Trans. Am. Fish. Soc. 112*: 735-743.

are excluded then the length-at-age could be overestimated for younger fish. The truncated distributions of size at the youngest and oldest ages in the samples from southern Chile and South Georgia suggest that these data may suffer from this problem. The data from Kerguelen Island shows an under-representation of the smaller (less than 70 cm) and larger (greater than 110 cm) sizes.

6.126 The reliability of age/length keys and growth parameters is dependent on the adequate representation of the range of lengths at each age in the stock.

6.127 Length-weight relationships for different size ranges of *D. eleginoides* in different areas have been compiled in Appendix G, Table G.3 and Figure G.1.

Growth Parameters

6.128 Estimates of von Bertalanffy growth parameters for *D. eleginoides* in different areas are shown in Appendix G, Table G.4 and Figure G.2. Most estimates are derived from Ford-Walford plots. This was considered by the Working Group to be a less reliable method than non-linear regression methods which are widely available. The Working Group recommends that non-linear methods of estimating von Bertalanffy parameters be used in future analyses.

6.129 A serious problem with estimating von Bertalanffy parameters arises when the age/length relationship in the samples is not representative of the stock (see above). Given the low likelihood of complete representation of younger and older age groups, these estimates should be treated with caution.

Natural Mortality

6.130 An evaluation of estimates of **M** (see Table G.5 in Appendix G) was submitted to the Working Group in WG-FSA-92/21. This evaluation compared estimates of **M** based on different growth curves, catch data from different areas (pooled across depths and different gear types) and different methods for estimating **M**.

6.131 The use of the Chapman-Robson age-based method can bias estimates of **M** if it is an increasing or decreasing function of age, i.e. **M** will be overestimated if **M** increases with age and underestimated if **M** decreases with age. Estimates using Heincke's estimator should also be considered in future, since this is insensitive to age-dependence in mortality rate, and may be less affected by underestimation of age in older fish. The Working Group chose two models, which use only length data and growth curve parameters, to examine how estimates of **M** might vary with area, growth curve and method. Given the data available, the results indicate variation between 0.07 and 0.19. The mean for each method (see WG-FSA-92/21) was:

Beverton and Holt length-based method	= 0.10
Alverson-Carney method	= 0.16
Grand Mean	= 0.13

6.132 The Working Group accepted this range and the mean of 0.13 as the most suitable estimates of **M** to work with in the current assessments.

6.133 The Working Group emphasised that estimates of **M** are affected by gear selectivity and will need to be refined as more data on selectivity comes to hand (see paragraphs 6.115 and 6.116).

Diet

6.134 Stomach content analysis of *D. eleginoides* caught on longlines showed that most stomachs contained little or no food (WG-FSA-92/13). Fish were found to be the prevalent food item. This is corroborated by earlier findings that *D. eleginoides* feeds mostly on fish and to a lesser extent, on benthic invertebrates, such as octopus (Permitin and Tarverdiyeva, 1972[1]; Chechun, 1984[2]; Duhamel, 1987[3]). Species composition in the diet varied considerably locally and ranged from mesopelagic to demersal species. This suggests that the species is an opportunistic feeder taking advantage of any locally abundant fish resource.

Sexual Maturity

6.135 Three papers submitted to this year's Working Group meeting contain information on the size at sexual maturity and size at first spawning respectively: WG-FSA-92/13, 14 and 15.

6.136 WG-FSA-92/13 provides a size range over which most specimens become sexually mature. It is:

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1 PERMITIN, Y.Y., M.I. TARVERDIYEVA. 1972. The food of some Antarctic fish in the South Georgia area (in Russian). *Vopr. Ikhtiol. 12*(1): 120-132.

2 CHECHUN, I.S. 1984. Feeding and food interrelationships of some sub-Antarctic fishes of the Indian Ocean (in Russian). *Trudy Inst. Zool. Leningrad 127*: 38-68.

3 DUHAMEL, G. 1987. Ichthyofaune des secteurs indien occidental et atlantique oriental de l'océan austral: biogéographie, cycles biologiques et dynamique des populations. Ph.D. Thesis, P. et M. Curie University of Paris. 687 p.

72 - 90 cm (≅ 7 - 11 years) in males, and
90 - 100 cm (≅ 9 - 12 years) in females.

6.137 Tables 7 to 9 of WG-FSA-92/14 provide length/maturity tables by sex, fishing month and fishing grounds separately. These were combined to estimate size at first spawning. The Russian investigators used a maturity scale which is different from the one commonly used in CCAMLR, and was not available to the Working Group. It was assumed that maturity stages 3 and over contained those individuals which were likely to spawn in the current season. Due to size selectivity and a possible different bathymetric distribution, immature fish were poorly represented in the catches: a situation which is particularly likely to occur for males, which reach sexual maturity at a smaller size than females. The following estimates are thus biased to an unknown extent, the estimate for males having a larger bias than that for females:

L_m = 77 cm for males,
L_m = 92 cm for females.

Furthermore, the number of fish investigated in the size range in which size at first spawning is attained, was small (<150 fish). This further limits the value of these estimates.

6.138 WG-FSA-92/15 provides size compositions for sexes combined on several fishing grounds and on approximate proportion of immature fish in these catches. Assuming that these immatures were comprised of smaller fish, size at first spawning was estimated to be L_m = 95 cm.

6.139 The Working Group concluded that none of the three data sets provide an accurate estimate of size at sexual maturity and/or size at first spawning. A first approximation (of size at first spawning) may be to assume:

L_m = 85 cm for males, and
L_m = 95 cm for females

until better data become available. The estimated age at first spawning will depend on which growth function is to be used.

6.140 The Working Group recommended that the number of maturity stage determinations needs to be increased substantially in the size ranges 75 to 95 cm in males and 85 to 110 cm in females to estimate size at sexual maturity and size at first spawning more accurately.

Assessment Work

Length-based Cohort Analysis

6.141 Length-based cohort analyses were carried out according to Jones (1974) method. This method calculates the stock biomass under the assumption that it has been stable under exploitation. Given that this assumption cannot be verified, the calculated biomasses should not be considered as estimates of current biomass, but rather as estimates of the biomass which would occur if the stock was stable with the average catches at length used in the calculation. The method requires estimates of **M** and growth curve parameters, along with catch at length data. The latter were calculated from the available length frequency data from the catch and total catch data, averaged over the years 1989 to 1992. Thus, the annual average catch used in the calculations was approximately 5 000 tonnes. The results were calculated for the three values of **M**, and for the growth curves given by Shust *et al.* (1990)[1] and Aguayo (WG-FSA-92/30). The growth curve reported in Shust *et al.* is near the middle of the range of those presented in Table G.2 of Appendix G, while that of Aguayo is near the upper end of the reported growth curves. The results, given in Table 10 show that the method is very sensitive to the value of natural mortality and the growth curve used.

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[1] SHUST, K.V., P.S. GASIUKOV, R.S. DOROVSKIKH and B.A. KENZHIN. 1990. The state of *D. eleginoides* stock and TAC for 1990/91 in Subarea 48.3 (South Georgia). Document *WG-FSA-90/34*. CCAMLR, Hobart, Australia.

Table 10: Summary of biomass calculations of the exploitable biomass of *D. eleginoides* in Subarea 48.3.

Method (see text)	Parameter (see text)	Exploitable Biomass (tonnes)
De Lury over fishing season (WG-FSA-92/24)		12 000
De Lury (local density) (see paragraphs 6.156 to 6.159)		9 800
Area coverage (per longline) (see paragraph 6.160)	1.0 n mile	8 000
	0.5 n mile	16 000
	0.05 n mile	160 000
Area coverage (per hook) (see paragraph 6.169)	10 m	102 000
	15 m	45 000
	20 m	25 000
	25 m	19 000
Length cohort analysis (see paragraphs 6.141 and 6.142)	M=0.10, *GC=1	36 000
	M=0.13, GC=1	61 000
	M=0.16, GC=1	119 000
	M=0.13, GC=2	14 000

* GC - 1: $L_\infty = 174.8$, $K = 0.0712$, $L_o = -0.005$, GC - 2: $L_\infty = 210.8$, $K = 0.0644$, $L_o = 0.783$

6.142 Carrying out this analysis was unnecessarily time consuming because the length frequency data from different operations was submitted in different formats. It is recommended that in future length frequency data for this species be submitted as total lengths in 1 cm length classes. It would be desirable for the length measurements to be submitted in computer readable format for inclusion in the CCAMLR database.

ABUNDANCE ESTIMATES USING CPUE OR SURVEY DATA

6.143 At the 1991 meeting of the Working Group three types of analyses were attempted on the CPUE data from the longline fishery. Problems were encountered during the analyses mainly because no haul-by-haul data were submitted and the STATLANT B data did not allow for standardisation of the effort indices.

6.144 Haul-by-haul data were submitted to CCAMLR from all fishing Members for the 1991/92 season, in accordance with Conservation Measure 37/X.

6.145 Paper WG-FSA-92/24 presents a De Lury analysis of the haul-by-haul CPUE data from the Chilean fleet over the whole season. Two separate fishing grounds could be clearly distinguished from the locations of the hauls: one at the north of South Georgia, including Shag Rocks and the second at the south of the island. Results from the De Lury analysis suggest a recruited biomass of around 12 000 tonnes.

6.146 Application of the De Lury analysis to these data assumes that there is no substantial immigration or emigration during the period under consideration. If there is substantial immigration into the local area, the population size would be overestimated. Conversely, substantial emigration would lead to underestimation of population size. The locations of fishing from the haul-by-haul data, as well as the observation that the CPUE series for the three areas do not have strong trends, suggests that fishable aggregations persist throughout the season. Therefore, any substantial movements of fish into or out of the fishing grounds during the fishing season are unlikely.

6.147 An analysis of CPUE data also assumes that CPUE is proportional to the population size or a power function of population size. In the longline fishery, there are five potentially important factors that could affect the catch rates. These factors are: hook size and shape, soak time, depth of fishing, location of fishing and seasonality (i.e., timing of fishing). The analyses in WG-FSA-92/24 does not take these factors into account and the Working Group investigated the effects of these factors on catch rates using the haul-by-haul data from the Chilean and Russian fleets.

6.148 The hook type affects both the length frequency distribution (see paragraph 6.116) and the catch rate. This implies that the effort should be standardised for hook type before combining data to use in CPUE analyses. Unfortunately not all data records contained a code for the hook type and the Chilean data did not contain any records where vessels fished with different (known) hook types in the same location and at the same time. The Working Group could not calibrate or standardise the CPUE for hook type. The Russian data contains some records for two hook types in the Shag Rocks area and the same period but this sample is relatively small.

6.149 The Working Group encouraged the collection of haul-by-haul data from vessels fishing in the same local area at the same time for use in the calibration of effort data.

6.150 The current CCAMLR hook code only reflects size and not shape. Both these aspects of hooks affect the way they operate and the Working Group recommended that a new coding system which reflects both these aspects should be developed by the Secretariat.

6.151 Only a subset of the data (those from the Russian fleet) were used to investigate soak times and catch rates. These data did not show any relationship between catch rates and soak time. It is, however, premature to conclude that there is no relationship and these data should continue to be collected.

6.152 Catch rates from the Chilean fishery did not show any clear relationship with depth (WG-FSA-92/28). At this stage, there does not seem to be a need to consider fishing depth when calibrating effort data. It is, however, still essential to record this information since the current analyses are only preliminary, representing a single fishing season.

6.153 As indicated in WG-FSA-92/24 and 28, the locations of the hauls clearly suggested two or three fishing grounds. The possible effect of location was investigated on a relatively coarse scale. The area around South Georgia was divided into three fishing grounds (Figure 6 above):

(i) Shag Rocks, west of 40°W;
(ii) South Georgia north, east of 40°W, north of 54.2°S; and
(iii) South Georgia south, east of 40°W, south of 54.2°S.

6.154 The CPUE series for these three areas are all of similar magnitude although the patterns over time are somewhat different (WG-FSA-92/24) (Figure 7). This suggests that, at least during the 1991/92 season, there was no need to adjust the effort for fishing ground. What is, however, very clear from all three series is the 'seasonality' which may be caused by various factors. The possible effects of weather conditions could not be considered. There may be seasonality in the population numbers on the grounds caused, for example, by migration or changes in aggregation. Investigation of the catch rates on a smaller area scale also shows that the vessels tend to move from one location to another. This sometimes occurs when local catch rates have declined after some days of fishing.

6.155 This effect was used to estimate local population densities in order to try and estimate overall fishable biomass. The advantage is that the CPUE of a single vessel or pair of vessels with similar gear can be used without the need for calibration or correction for seasonal effects. Three such examples of declining catch rates in a local area were identified:

(i) in the South Georgia north area, where two vessels with the same hook types were fishing over a period of nine days;

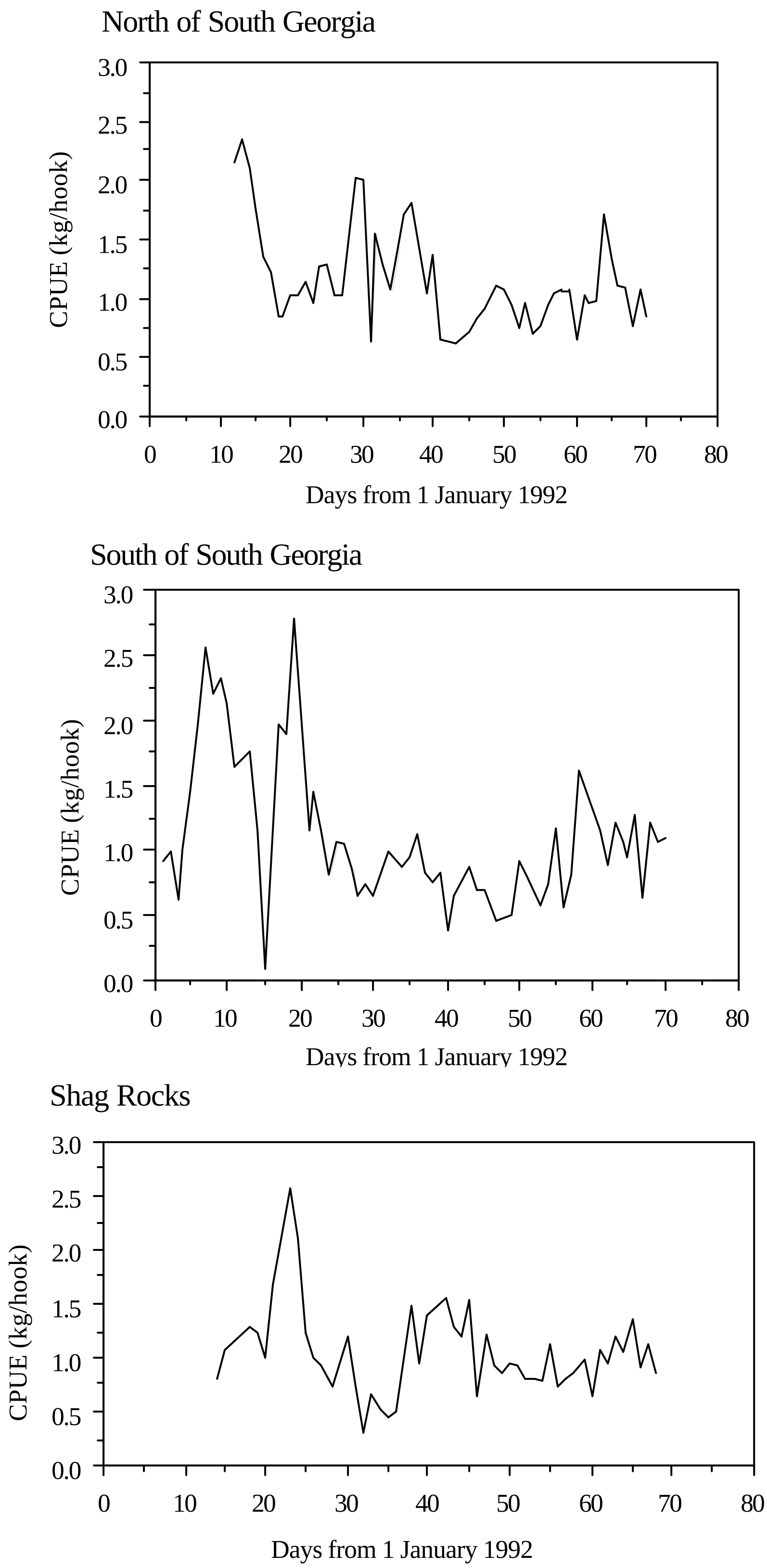


Figure 7: CPUE kg/hook for the Chilean fishery in the three major fishing areas of Subarea 48.3.

(ii) to the north of Shag Rocks area where a single vessel fished for a period of six days; and

(iii) to the west of Shag Rocks area where a single vessel fished for a period of 11 days.

6.156 The De Lury method was used to estimate the initial local population size from the CPUE (Figures 8a, b and c). The main assumption of this method is that, for the short period under consideration, the local population within the small region where the hauls were taken is ‘closed’ (i.e., there is no substantial movement of fish into or away from each location). It is thus also assumed that catches taken outside these localities do not affect the density of fish within them within the short period considered.

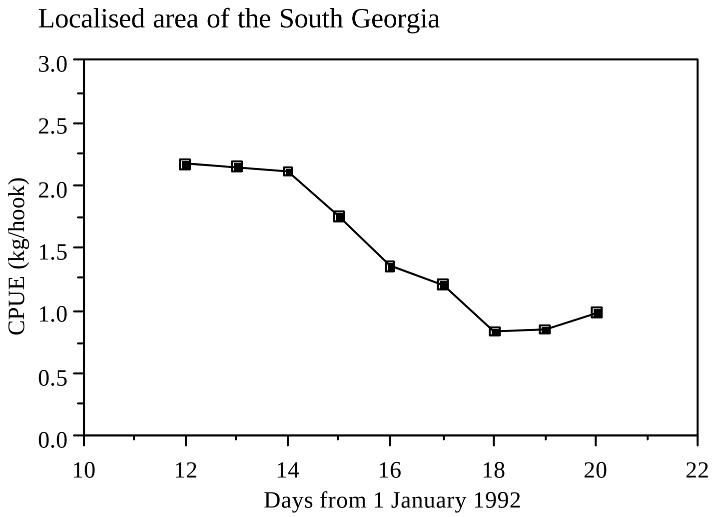


Figure 8a: CPUE for *D. eleginoides* in the localised area of South Georgia.

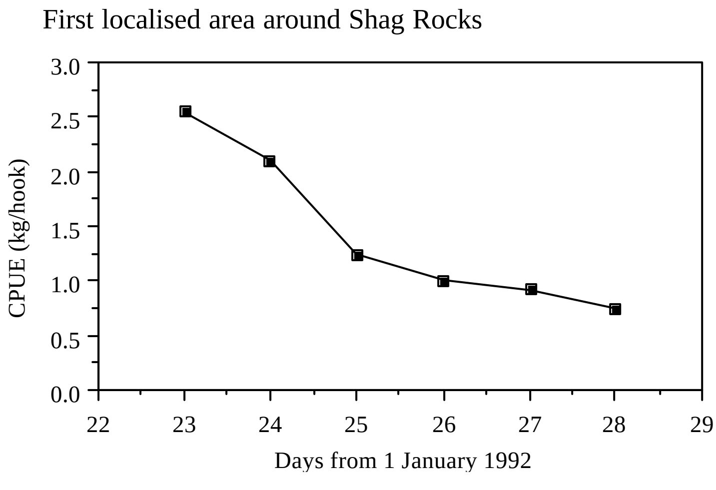


Figure 8b: CPUE for *D. eleginoides* in the first localised area around Shag Rocks (South Georgia).

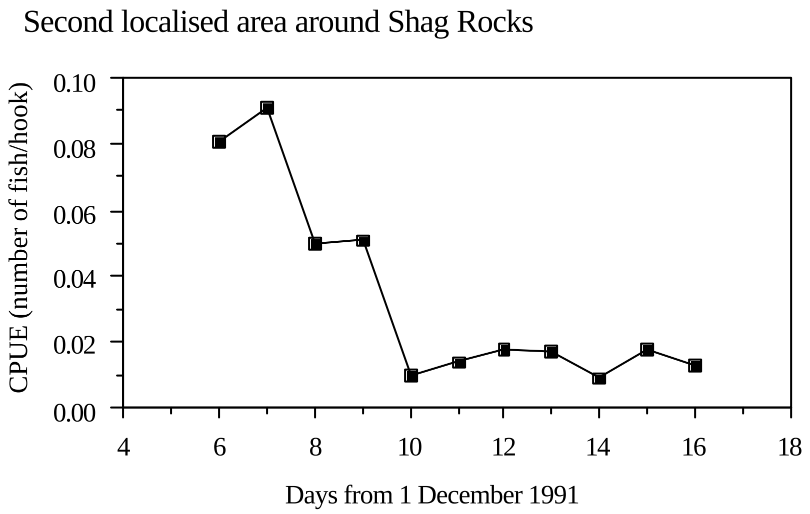


Figure 8c: CPUE for *D. eleginoides* in the second localised area around Shag Rocks (South Georgia).

6.157 Because daily CPUE-values were used, the value for natural mortality (**M**) is so small that there is no need to include this in the analysis. (If **M** is included, there is hardly any difference between results for the range of values given in paragraph 6.131). In all cases the regression fit was satisfactory although residuals for the third case did show some degree of non-randomness.

6.158 Local density is obtained by dividing the local population estimates by the effective area fished. This area should be seen as the area over which the population was affected by the fishing leading to the observed local decline in the CPUE.

6.159 The effective area fished was estimated using two methods. The first method involved calculating areas within boundaries which enclosed groups of hauls. These areas were chosen to be at least 0.05° latitude and 0.2° longitude. A square of 0.05° latitude by 0.2° longitude (at 53°S) is approximately 200 n miles^2. This method leads to an average density of about 1.09 tonnes/n mile^2 for the three cases.

6.160 The second method of estimating the effective fishing area considers the total length of each longline set (calculated from the number of hooks times the distance between hooks) multiplied by an effective width. The effective width is far more difficult to assess, especially since the fishing gear is left in the water for a period of time and fish are highly mobile. Three arbitrary values were therefore used: 0.05, 0.5, 1 n mile. Table 11 below summarises the density estimates obtained for the three cases.

Table 11: Density estimates (tonnes/n mile^2) for *D. eleginoides.*

	Method A	Method B		
		Effective Width of Longline		
		1.00	0.50	0.05
Shag Rocks west	0.43	0.40	0.81	8.10
Shag Rocks north	1.50	1.06	2.11	21.10
South Georgia north	1.33	1.19	2.39	23.90
Average	1.09	0.88	1.77	17.70

6.161 For comparison, the average density of *D. eleginoides* from the 1992 *Falklands Protector* trawl survey was 0.74 tonnes/n mile^2. It is of course known that the trawl survey mainly catches small fish at shallower depths, but the comparison suggests that the above estimates of around 1 to 2 tonnes/n mile^2 are not unrealistic.

6.162 Estimates of total exploitable biomass were obtained by multiplying the average density estimates by the total seabed area around South Georgia and Shag Rocks between depths of 500 to 2 000 m (see Appendix E). This total area was estimated to be 9 000 n miles^2. Results are given in Table 10.

6.163 There are many caveats associated with the above method and the estimates of exploitable biomass. First, Tables 10 and 11 clearly show that the method is very sensitive to the assumption about the effective width of the area fished by a longline. Knowledge about the soak time, swimming speed of fish and the distribution of fish on the hooks may throw further light on this problem in future.

6.164 Second, the calculation of biomass in the whole of Subarea 48.3 involves extrapolating from a local density to the whole area between in the 500 to 2 000 m depth range. Since fishing in the most recent season took place in about 70% of the 9 000 n miles^2 area and the calculation assumes the calculated density applies over the whole region, the above biomass values may tend to be overestimates. At this stage, the variance in density between locations is also unknown. Further analyses of the kind described above are necessary to try to estimate the seasonal and temporal variability in density.

6.165 A further potential problem with this analysis, as well as with the more conventional De Lury analysis presented in WG-FSA-92/24, is the possibility that the CPUE is not linearly related to population size but by a power function. This would imply that a relatively small change in CPUE could in fact reflect quite a substantial change in the population size.

6.166 Any saturation effect of the fishing gear would also affect CPUE analyses. However, the haul-by-haul data do not show any signs of saturation.

Estimates Based on Trawl Surveys

6.167 Paper WG-FSA-92/17 presents estimates of biomass around South Georgia and Shag Rocks from the *Falklands Protector* bottom trawl survey conducted in January/February 1992. These estimates are:

South Georgia	2 460 tonnes (CV 21%)
Shag Rocks	3 353 tonnes (CV 35%)

6.168 Bottom trawl surveys only estimate the biomass of young (juvenile) fish rather than exploitable biomass. The length frequency distribution from the survey consists almost entirely of fish between 20 and 50 cm total length. The above biomass estimates can be considered as indices of future recruitment to the fishery. Comparison with estimates from similar surveys since 1984, show that these values are in the middle of the range (Tables 15 and 16 in WG-FSA-92/17). No attempt was made to estimate exploitable biomass from the survey estimates, because of the problems associated with this method (SC-CAMLR-X, Annex 6, paragraphs 7.90 to 7.98).

Estimates Based on Area Fished by Each Hook

6.169 This method attempts to estimate density directly by assuming that fish are caught from within a certain radius of each hook. The data used came from the Chilean fishery, where the catch per hook averaged one fish per 10.7 hooks. The average fish weight was 11.3 kg, and so the catch per hook was 1.06 kg. The area fished per hook, in n miles^2, is given by:

$$A = \pi r^2/(1852^2)$$

where **r** is the radial distance of the influence of the hook in metres. The density of fish, in tonnes/n mile^2, is calculated as:

$$D = C/A*1000$$

6.170 As in the case of the local density De Lury estimates, biomass estimates are calculated by extrapolating the density estimated on the fishing ground to the whole bottom area in Subarea 48.3 within the appropriate depth range. The results are given in Table 12. Given that the average distance between hooks is about 3 m and that one fish is taken per 10.7 hooks, it was suggested that the result for the influence radius of 15 m is likely to be the most appropriate. Density estimates using this approach are sensitive to the range of influence of each hook. Refinement of this parameter could be based on measurements of the swimming and foraging behaviour of the fish, or might be approached by varying the density of the hooks on a line.

Table 12: Densities and extrapolated estimates from the radius of influence of each hook.

Influence Radius (m)	Density (tonnes/n mile^{-2})	Density (fish/n mile^{-2})	Exploitable Biomass (tonnes)
10	11.30	1 000	101 700
15	5.02	424	45 180
20	2.82	249	25 380
25	2.08	184	18 720

Yield-Per-Recruit Analyses

6.171 Y/R analyses (Table 13) were conducted using weights-at-age calculated from the length-based growth curve for Subarea 48.3 in Shust *et al*. (1990) (see Table G.2 of Appendix G) and converted to weights using the lenght-weight relationship in Gasiukov *et al*.[1] (1991) (Table G.1 of Appendix G). These analyses were carried out for three values of **M** (see discussion on natural mortality, paragraph 6.131). These calculations have not taken into account the possibility of a lower selectivity in larger fish. Some difficulties arose with the current CCAMLR standard yield-per-recruit software at low values of **M** (see paragraph 9.6). The analyses were done using the software package MathCad.

1 GASIUKOV, P.S., R.S. DOROVSKIKH and K.V. SHUST. 1991. Assessment of the *Dissostichus eleginoides* stock in Subarea 48.3 for the 1990/91 season and calculation of TAC for the 1991/92 season. Document *WG-FSA-91/24*. CCAMLR, Hobart, Australia.

Table 13: Yield-per-recruit values for catch and stock-per-recruit at $\mathbf{F_{0.1}}$ for three levels of **M**. Spawning stock biomass in the absence of fishing is included.

	Natural Mortality		
	0.10	0.13	0.16
$\mathbf{F_{0.1}}$	0.104	0.119	0.138
Yield (kg)	2.164	1.538	1.131
Catch (**n**)	0.292	0.238	0.201
Stock (**n**)	7.478	6.342	5.501
Spawning Stock (**n**)	2.307	1.557	1.059
Stock (kg)	27.207	18.23	12.604
Spawning stock (kg)	21.664	13.413	8.416
Spawning stock biomass at F=0 (kg)	51.608	32.896	21.418

6.172 The selection pattern for fishing mortality was approximated from catch-at-length data from the commercial catches and converted to age. Full recruitment was considered to have occurred by age 10. The selection pattern for ages less than 10 used in the analyses was:

Age	1	2	3	4	5	6	7	8	9	10
Pattern	0	0	0.1	0.2	0.3	0.4	0.5	0.75	0.9	1.0

TAC CALCULATIONS

6.173 Table 14 gives the TACs corresponding to the three different values of $\mathbf{F_{0.1}}$ for each calculated biomass excluding the values calculated from the length-based cohort analysis. The results based on length cohort analysis were excluded because they are calculated under the assumption that the stock is in equilibrium with the average catch over recent years. Since the catch increased sharply only in 1990, it is too soon for this relatively long-lived population to stabilise under exploitation. The Working Group considered these analyses to be a cross-check on the results obtained by the methods which attempted to estimate density directly. Given that the length-cohort results lie within the range obtained by the other methods, little has been lost by excluding them.

Table 14: TACs corresponding to the calculated exploitable biomasses for *D. eleginoides* in Subarea 48.3.

Exploitable Biomass	TAC		
	$F_{0.1}$ = 0.104	$F_{0.1}$ = 0.119	$F_{0.1}$ = 0.138
12 000	1 130	1 260	1 430
9 800	920	1 030	1 170
8 000	750	840	950
16 000	1 500	1 690	1 910
160 000	15 000	16 900	19 090
102 000	9 600	10 070	2 170
45 000	4 230	4 740	5 370
25 000	2 350	2 630	2 980
19 000	1 790	2 000	2 270

Management Advice

6.174 The Working Group noted with appreciation the submission of haul-by-haul data from the fishery. This detailed data has allowed considerable refinement of the estimates of stock abundance. Last year, the range of estimates of stock abundance was 8 000 to 610 000 tonnes. The improvements in data have allowed this range to be refined to 8 000 to 160 000 tonnes. Further fine-scale data collection should allow a steady improvement in assessments, particularly if experiments on hook selection factors could be carried out by ensuring that different hook types were fished on the same grounds at the same time.

6.175 In spite of the improvements in estimates of abundance, considerable uncertainty still remains about the size of this stock and its sustainable yield. Given the wide range of possible TACs the Working Group considered that a conservative approach should be taken in setting a TAC. The Working Group considered that a stock biomass in excess of 45 000 tonnes is unlikely. Accordingly, the Working Group recommends a TAC in the range 750 to 5 370 tonnes. Given that the most recent TAC is near the middle of this range, the Working Group agreed that a TAC similar to that set in 1992 would be appropriate. It was also agreed that it is better if large year to year variations in TAC can be avoided when possible. The Working Group noted that the TAC in 1992 was reached early in the fishing season. It was agreed that further expansion of the number of vessels taking part in the fishery would not be appropriate, as this would lead to even earlier closure of the fishing season, which could introduce extra complications into the CPUE and other fine-scale data, with consequent deleterious effects on assessments.

Data Requirements and Future Research Needs

6.176 The following matters were identified as requiring further data and research:

- the submission of fine-scale and haul-by-haul data should be continued;
- studies on hook selection factors should be carried out;
- data on loss rates of fish observed to drop off the line as it is retrieved, and which are not recovered, should be reported;
- intercomparisons between age-readings from scales and otoliths should be undertaken, along with intercomparisons between readers;
- full analyses of sexual maturation and other biological parameters from any fish taken during winter should be undertaken and reported; and
- investigations of stock identity in conjunction with studies on the Patagonian shelf.

SOUTH ORKNEY ISLANDS (SUBAREA 48.2)

Catch History

6.177 Catches in Subarea 48.2 were only significant in the 1977/78 and 1978/79 seasons when 169 000 tonnes were landed, consisting almost exclusively of *C. gunnari*. In subsequent years reported catches for the subarea have substantially decreased being of the order of a few thousand tonnes, except in 1982/83 and in 1983/84, when 34 000 tonnes were taken. The most abundant species in the catches have been *C. gunnari* and *N. gibberifrons*. A significant proportion of the catch has been reported under the classification of Pisces nei (fish not elsewhere included), that is believed to be composed of different species of channichthyids (mainly *C. aceratus*, *C. rastrospinosus* and *P. georgianus*) and *N. kempi*, but may have also included *N. gibberifrons*.

Table 15: Catch by species in Subarea 48.2.

Year	*C. gunnari*	*N. gibberifrons*	*N. rossii*	Osteichthyes nei	Total
1978	138 895	75	85	2 603	141 658
1979	21 439	2 598	237	3 250[1]	27 524
1980	5 231	1 398	1 722	6 217[2]	14 568
1981	1 861	196	72	3 274	5 403
1982	557	589		2 211	3 357
1983	5 948	1		12 463[3]	18 412
1984	4 499	9 160	714	1 583	15 956
1985	2 361	5 722	58	531	8672
1986	2 682	341		100	3 123
1987	29	3		3	35
1988	1 336	4 469			5 805
1989	532	601		1	1 134
1990	2 528	340			2 868
1991*	14	9		27	50
1992	-	-		-	-

* Catches from research activities
[1] Mainly *C. aceratus*
[2] *P. georgianus*, unidentified nototheniids and channichthyids
[3] Unknown species

6.178 A total of 1 518 tonnes of laternfish (Myctophidae) was reported in CCAMLR-X/MA/8 as being taken from Subarea 48.2 in 1990/91, but the correctness of the location of these catches was questioned (SC-CAMLR-X, paragraph 4.17). No clarification of this matter has yet been provided.

6.179 A conservation measure prohibiting fishing activities for finfish in Subareas 48.1 and 48.2 for the 1990/91 season (Conservation Measure 27/IX) remained in force during 1991/92 (Conservation Measure 41/X). No commercial catches have been reported for Subarea 48.2 in 1991/92.

6.180 The scarcity of historical data from the commercial fishery has made it very difficult to make any assessment of the fish stocks in Subarea 48.2. However, some attempts have been made to assess the stocks of *C. gunnari* and *N. gibberifrons* using VPA (SC-CAMLR-VII, Annex 5; SC-CAMLR-VIII/18; WG-FSA-88/18; WG-FSA-90/16). Standing stock biomass has been estimated by the swept area method from several surveys conducted in the subarea by the Federal Republic of Germany (1975/76, 1977/78, 1984/85) and Spain (1986/87, 1990/91).

Champsocephalus gunnari (Subarea 48.2)

6.181 No new information was available to the Working Group on *C. gunnari* in Subarea 48.2 during 1991/92. A series of simulations have been performed at this year's meeting to try to assess the state of the stock during the forthcoming season (1992/93) to give management advice on this species. In doing so it was necessary to make the following assumptions.

6.182 Total biomass in 1990/91 was taken as the estimate from the Spanish survey "ANTARTIDA 9101" calculated at last year's meeting following restratification of the sampling area, which gave an estimate of 9 620 tonnes (SC-CAMLR-X, Annex 6, paragraph 7.204). The length frequency distribution from the same cruise was extrapolated to this biomass estimate, and a pooled age/length key from the former Soviet Union fishery occurring in the area in the period from 1978 to 1989 was applied, in order to estimate an age structure of the stock in 1990/91.

6.183 It was noted that age groups 6 and older dominated the age structure at the time of the survey (Figure 9). Three possible explanations were considered:

(i) sampling problems during the survey (i.e., few hauls conducted in shallow water);

(ii) recruitment to the area occurring at age 6, as a result of migration; and

(iii) several strong year groups (cohort) were present in the fishery at the time of the cruise.

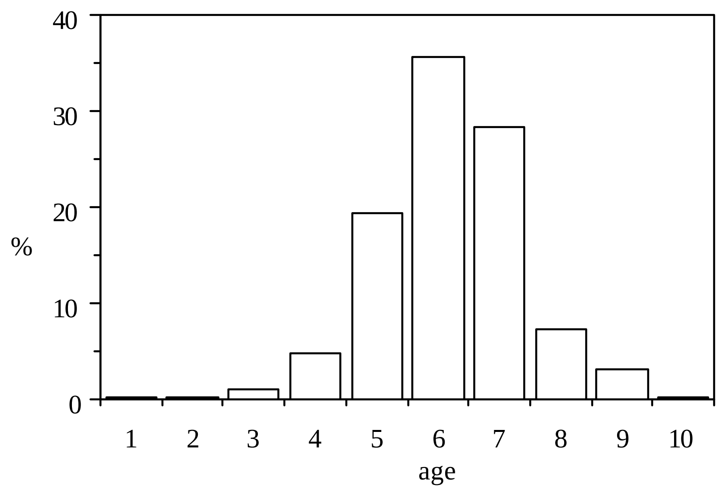


Figure 9: Estimated age distribution of *C. gunnari* in the 1991 Spanish survey, Subarea 48.2.

6.184 The potential bias in the length distribution from the survey resulting from the distribution of stations is unknown, however, Mr E. Balguerías (Spain) considered that this was likely to be insignificant.

6.185 Dr Kock pointed out that the presence of 1 and 2 year old fish in the commercial fishery in some years indicated that the hypothesis of fish recruiting to the stock at age 6 was unlikely to be correct.

6.186 Observations from the fishery and from several surveys conducted in Subarea 48.2, suggest that periods in the fishery with high catch rates are associated with the presence of several strong cohorts in the stock. Therefore the Working Group felt that the most plausible explanation for the high relative proportion of ages 6 and over in the survey catch was that described in paragraph 6.183(iii).

6.187 However, all three explanations given in paragraph 6.183 were taken into account in projecting stock abundance forwards from 1990/91. The first explanation was addressed by including age groups 2 to 10 in the projections (scenario 1). The second explanation was addressed by including age groups 6 to 10 in the projections (scenario 2). The third explanation was also addressed by considering age groups 6 to 10 in 1990/91 (scenario 3), but this scenario implies that the projection for 1991/92 (for example) only includes age groups 7 to 10 since the recruitment to age group 6 in subsequent years is assumed to be negligible.

6.188 The mean level of recruitment (age group 2) was calculated from estimates of the number of age group 2 individuals in the period 1978 to 1981 obtained from previous VPA analyses (WG-FSA-88/18). The numbers of individuals in age groups 2 to 5 in 1990/91 were reconstructed from the mean level of recruitment and assuming that M=0.35.

6.189 For scenario 1, the numbers in age groups 2 to 10 (in 1990/91) were taken to be the numbers in age groups 2 to 5 calculated from the mean recruitment plus the numbers in age groups 6 to 10 estimated from the survey. For scenarios 2 and 3, the numbers in age groups 6 to 10 in 1990/91 were those estimated from the survey.

6.190 The population numbers in 1990/91, associated with each of the three scenarios, were projected forwards to subsequent seasons (until 1995/96) assuming no fishing (F=0) and M=0.35. The assumptions for recruitment were as follows:

scenario 1: mean recruitment (age group 2) estimated from previous VPA analyses (paragraph 6.188);

scenario 2: mean recruitment (age group 6) estimated from mean recruitment age group 2, projected forwards to age group 6 using M=0.35;

scenario 3: no recruitment.

The third scenario does not include recruitment because of the assumption that there were one or more strong cohorts spawned in 1984/85 and before.

6.191 Results of these calculations are given in Table 16.

Table 16: *C. gunnari* , Subarea 48.2. Biomass projections (tonnes).

Scenario	Split-Year					
	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
1	26 578	28 443	29 729	30 633	30 565	30 660
2	7 461	9 326	10 613	11 516	11 449	11 543
3	7 461	5 807	4 334	3 118	1 344	-

6.192 The evolution of both the expected total biomass (scenario 1 above) and the biomass of fish in the stock older than 6 with recruitment (scenario 2 above) show a similar trend with a slight increase in biomass up to 1992/93 reaching an equilibrium level of around 30 000 tonnes and 11 000 tonnes respectively.

6.193 Scenario 3 above illustrates the development of the biomass of the cohort born in 1984/85 (age group 6 in 1990/91) and older cohorts (age groups 7 to 10) until their extinction in 1994/95. The level of biomass calculated for these cohorts in 1992/93 was around 4 000 tonnes.

6.194 The two scenarios that represent the highest and lowest estimates of exploitable biomass (scenarios 1 and 3) were used to calculate the maximum and the minimum possible TACs of *C. gunnari* in Subarea 48.2 for 1992/93 by considering the maximum yield obtained from the Thompson and Bell method.

6.195 The exploitation pattern (fishing mortality vector) was assumed to be the mean **F**s in the fishery during the period from 1978 to 1981 obtained from past VPA analyses (WG-FSA-88/18).

6.196 Results of this analysis are shown in Figure 10.

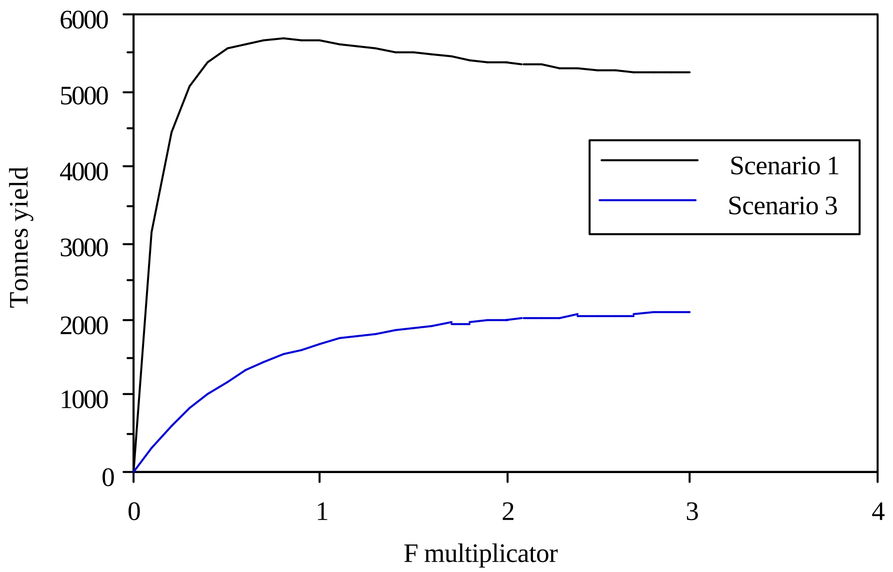


Figure 10: *C. gunnari* (Subarea 48.2) projected yield in 1992/93.

6.197 Estimated maximum yields range from 2 000 to 5 700 tonnes. The lower value was estimated from age group 8 and older (1984/85 cohort is age group 8 in 1992/93) which exhibited a flat-topped yield curve, from which it was very difficult to establish the maximum yield point and its corresponding optimum **F**. The higher value, obtained from age groups 2 to 10, shows a typical yield curve, with a well defined point of inflexion.

6.198 The exploitation pattern used in the yield calculations was estimated from the fishery prior to the introduction of the mesh regulation of 80 mm in 1985 (Conservation Measure 2/III) and is likely to be different from that which would be obtained if a fishery were to re-open. The fishing effort applied during the historical fishery (**F** multiplicator = 1) was above the MSY level (scenario 1). To reach the MSY objective while maintaining the same exploitation pattern it would be necessary to reduce the fishing effort by 20%.

Management Advice

6.199 The Working Group noted the large number of assumptions and the uncertainties associated with both the projections and the maximum yield calculations and concluded that a conservative approach would be appropriate. A conservative strategy would be to maintain the closure of the fishery for *C. gunnari* in Subarea 48.2 until a survey is conducted to provide a more accurate estimate of the status of the stock.

Notothenia gibberifrons, Chaenocephalus aceratus, Pseudochaenichthys georgianus, Chionodraco rastrospinosus and *Notothenia kempi* (Subarea 48.2)

6.200 No new information has been reported for any of these species during the last season.

6.201 The last research survey conducted in the area in 1990/91 ("ANTARTIDA 9101") suggested that the biomass of these species had significantly increased since the middle of the 1980s. Some species, such as *C. aceratus* and *C. rastrospinosus*, seemed to have reached a similar level to the pristine stock, although this information was regarded with caution by the Working Group because surveys from which the different biomass estimates were derived may not be comparable due to different gear types, vessels, etc. and also due to the uncertainty associated with the estimates (SC-CAMLR-X, Annex 6, paragraph 7.123).

Considerations for a Re-opening of the Mixed Species Fishery in Subarea 48.2

6.202 In the light of the recommended continued closure of the *C. gunnari* fishery in this subarea, the re-opening of a mixed species fishery in Subarea 48.2 was not considered. The Scientific Committee's attention is drawn to the Working Group's conclusions on this matter at its 1991 meeting (SC-CAMLR-X, paragraphs 7.218 to 7.224).

ANTARCTIC PENINSULA (SUBAREA 48.1)

6.203 The finfish fishery in the Antarctic Peninsula subarea has been closed during the 1991/92 season (Conservation Measure 41/X). The Working Group expressed its concern about the reported catch of 50 tonnes of *E. carlsbergi* taken in Subarea 48.1.

6.204 Document CCAMLR-XI/7 briefly mentions the research activity of the Chilean longliner *Frioaysén SA* between 60° and 62°S in the region of the Antarctic Peninsula during 1990/91. Dr Moreno reported that this activity was of an extremely limited nature and had resulted in a catch of only two specimens of *Dissostichus mawsoni*.

6.205 Pre-recruit monitoring in the South Shetland Islands (Barrera-Oro and Marschoff, pers. comm.) indicated that the proportion of juveniles of *N. rossii* and *N. gibberifrons* in fjord fish catches, remained at the low levels previously reported (SC-CAMLR-X, Annex 6, paragraphs 7.225 and 7.226).

6.206 Pending further information on the fish stocks in the area, the Working Group recommended that conservation measures in force should be maintained (Conservation Measure 41/X) until a research survey is carried out to enable the Working Group to re-assess the status of the fish stocks in Subarea 48.1.

STATISTICAL AREA 58

6.207 In 1991/92 fishing took place only in Division 58.5.1. The catch in the Kerguelen division (58.5.1) comprised 6 787 tonnes of *D. eleginoides* caught in the Ukranian and French trawl fisheries, 705 tonnes of *D. eleginoides* caught by Ukrainian longliners, 44 tonnes of *C. gunnari* and 1 tonne of *N. squamifrons* (Table 17).

Division 58.5.1 (Kerguelen)

6.208 Data are only available for *D. eleginoides* from the trawl fishery and from an experimental longline fishery. These include description of the longlining method and data on length frequency and sex of *D. eleginoides* caught by this method (WG-FSA-92/31). Data from the former Soviet Union and more recently, the Ukrainian trawl fishery (WG-FSA-92/8 and 9) include details of the age/length composition, and stock size and TAC estimates.

6.209 The catch of this species increased markedly over previous years to 7 492 tonnes. This is the highest catch of this species ever recorded in this area. The average annual catch between 1984/85 and 1990/91 has been 2 210 tonnes, and the previous largest catch was 6 677 tonnes in 1984/85 when the trawling grounds on the western shelf area were first exploited (Table 17). The trawl catch of 6 787 tonnes was caught mostly in the grounds in the northern part of the plateau which were discovered in the 1990/91 season. The exploratory longline fishery was conducted in the western part of the plateau (at 400 to 600 m; WG-FSA-92/31) by two vessels to assess the effects of this type of fishery on *D. eleginoides*, the efficiency of the regulations imposed and the measures to minimise incidental mortality of seabirds. 705 tonnes of fish were caught by this method.

6.210 At its 1991 meeting, the Working Group reiterated its advice of 1989 that the annual catch in the western sector should not exceed 1 100 tonnes in view of the steadily declining CPUE. It further recommended that catches in the new grounds in the northern sector be also

Table 17: 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 (*Notothenia 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	58.4	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				6061			12200					548			
1977	10450				XX				97			308					11			
1978	72643	250	82		196	-	2	-	46155			31582		98	234		261			
1979				101	3	-	-	-				1307					1218			
1980		1631	8	14		56	138	-			1742		4370	11308				239		
1981		1122	2			16	40	-		217	7924		2926	6239				375	21	
1982		16083				83	121	-		237	9812		785	4038		50		364	7	
1983		25852				4	128	17			1829		95	1832		229		4	17	1
1984		7127				1	145	-		50	744		203	3794					611[1]	17
1985		8253		279		8	6677	-		34	1707		27	7394		966		11	7	4
1986		17137		757		8	459	-		-	801		61	2464		692				3
1987		2625		1099		34	3144	-		2	482		930	1641		28		22		
1988		159		1816		4	554	488		-	21		5302	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	3660	-	30	17
1990	226	-	339	5	1062	-	155	1450	-	-	-
1991	13283[2]	-	-	-	1944	-	287	575	-	-	-
1992	44	3	-	-	7492[3]	-	-	-	1	-	-

1 Mainly *Rajiformes spp.*

2 There are some discrepancies between the French statistics for the Soviet fishery under licence (12 644 tonnes) in Division 58.5.1 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.

limited to 1 100 tonnes per annum, at least until more data become available, to avoid a similar decline in abundance. The actual catch of nearly 7 500 tonnes is thus more than three-times that recommended and is an alarming increase.

6.211 New data on the fishery were scanty. WG-FSA-92/8 gives data on length and age composition on *D. eleginoides* from both fishing grounds. It confirms that fish size and age correlates well with depth, with deeper water (>500 m) producing larger fish than the shallower depth range of trawling (300 to 500 m). Taking this depth effect into account, there was little difference in length or age structure of the catches from the two areas. WG-FSA-92/9 gives figures for stock size, calculated from length composition data for the 1984/85 season (when the first exploitation of the western fishing ground took place) and for the 1991/92 season for the northern grounds, of 43 000 and 50 000 tonnes respectively. Estimates of TAC were 7 330 and 7 500 tonnes. The Working Group, however, was not able to repeat these results, because the annual average catch used in WG-FSA-92/9 was not specified. Insofar as the methodology in WG-FSA-92/9 could be followed, a spawning stock size of about 6 000 tonnes was calculated. Moreover, the CPUE in the 1991/92 season, in the northern area, had fallen from 2.5 to 1.0 tonnes/hour. This was a marked decrease from the 3.4 tonnes/hour recorded in the first year of exploitation of the northern grounds reported to last year's Working Group meeting and appears to follow the rapid decline in CPUE observed in the western grounds. This decline in CPUE applies to the shallower as well as the deeper waters.

Management Advice

6.212 The rapid increase in catches to unprecedented levels and simultaneous decline in CPUE, when viewed in the light of the caution urged at last year's meeting, is cause for concern.

6.213 The Working Group noted that a similar trend in catches of *D. eleginoides* had been evident in Subarea 48.3 with a peak catch of 8 311 tonnes in 1989/90. The rapid expansion of the Kerguelen fishery to a similar catch level may be of equal or greater significance since the catch contains a high proportion of immature fish.

6.214 Data from the fishery are now also seriously out of date, with few data available from the last two years of fishing. This leads to even greater uncertainty in assessments and forces the Working Group to recommended a TAC no greater than the 1 100 tonnes for each ground recommended last year.

Notothenia rossii (Division 58.5.1)

6.215 No data on this species were submitted. The very low catch of *C. gunnari* meant there was no reported by-catch of *N. rossii*. The further assessment of the results of a research survey conducted in May/June 1991 promised at last year's meeting were not available.

Management Advice

6.216 The existing regulation in force (no directed fishery) should continue in order to allow the adult stock to recover. Research on prespawner and spawner biomass should continue.

Notothenia squamifrons (Division 58.5.1)

6.217 In the 1991/92 season, no directed fishery occurred on this species. No biological data are available and no new assessment is possible.

Management Advice

6.218 Previous assessments to 1990 indicated the stock size was very low. In the absence of new data, the fishery should remain closed until new data on biomass and age structure indicate a fishery is possible.

Champsocephalus gunnari (Division 58.5.1)

6.219 A very low catch (44 tonnes) was taken during the 1991/92 season in the Kerguelen Division. It is not clear whether this was a result of lack of fish or low effort. Analyses made during last year's meeting of the Working Group demonstrated that a strong cohort of the species would be at age 3+ during the 1991/92 season and thus a significant catch could be expected. There was, however, some evidence that successive strong cohorts since the 1979 cohort had shown a gradual decline in abundance. The lack of data on the 3+ year old fish in the latest strong cohort is thus regrettable, as is the continued absence of information on the apparent disappearance of fish older than 3 years.

Management Advice

6.220 If the pattern observed in this fishery for over a decade continues, there is likely to be a low abundance of this species in the 1992/93 fishery, as the strong 1988 cohort has died out, and the next expected strong cohort of 1991 will not yet have been recruited to the fishery. It is difficult to suggest a TAC, but the fishery will probably be self limiting because of the low abundance of recruited fish.

Division 58.5.2 (Heard Island)

6.221 No fishery occurred in this area. Some data on distribution, abundance and biology of important species were collected during an Australian research cruise from January to March 1992 and will be presented at future meetings. No new advice can yet be provided.

Division 58.4.4 (Ob and Lena Banks)

6.222 No catches were reported from Ob and Lena Banks for the 1991/92 season, following the prohibition of directed fishing on *N. squamifrons* under Conservation Measure 43/X. In 1990/91, TACs of 267 tonnes and 305 tonnes were set for Ob and Lena Banks respectively (Conservation Measure 28/IX). A total catch of 575 tonnes was reported for these two areas together in the 1990/91 season.

6.223 A new catch history for *N. squamifrons* at Ob and Lena from 1977/78 to 1989/90 was presented in WG-FSA-92/5. The Working Group noted that these were markedly different to the catches reported to the Working Group two years ago (WG-FSA-90/37). In particular, the total catch from the two areas prior to 1985/86 was different and the reported areal division of catches was not consistent between the above two papers. These differences cannot be explained by a simple split-year as opposed to calendar year division and implies that at best, one of the reported catch series is incorrect. The total catch for 1977/78 to 1988/89 from Lena Bank is about 3 000 tonnes higher than previously reported, while some 2 500 tonnes less are attributed to Ob Bank (Table 18).

6.224 At its 1991 meeting, WG-FSA requested that both catch and biological data for the *N. squamifrons* fishery in Subarea 58.4 should be submitted to the Secretariat (SC-CAMLR-X, Annex 6, Appendix E). Length frequency and catch-at-age data from 1977/78 to 1989/90 were presented in WG-FSA-92/5, although no new data for 1990/91 were reported.

Table 18: Reported catches of *N. squamifrons* from Ob and Lena Banks.

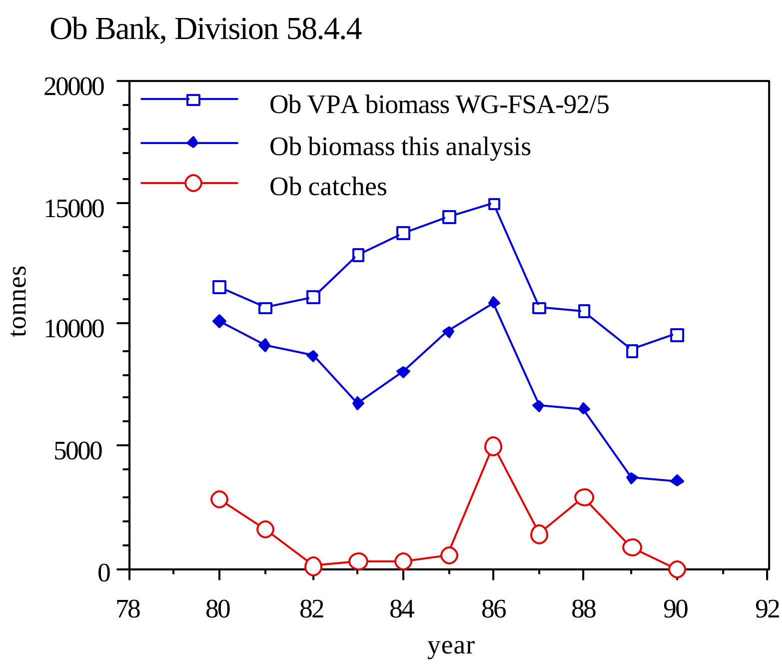
Year:	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	Total 1977/78 to 1988/89	Reference
Ob	4952	1511	2830	1586	70	313	341	513	4999	1457	2989	850	867	22411	WG-FSA-92/5
	4821	234	4167	41	56	588	40	1023	9531	1601	1971	913	-	24986	WG-FSA-90/37
Lena	1071	585	201	3073	514	426	822	57	6284	506	2013	3166	596	18718	WG-FSA-92/5
	1592	267	2616	1934	59	840	397	87	1977	441	2399	3003	-	15612	WG-FSA-90/37
Ob and Lena	6023	2096	3031	4659	584	739	1163	570	11283	1963	5002	4016	1463	41129	WG-FSA-92/5
	6413	501	6783	1975	115	1428	437	1107	11508	2045	4370	3916	-	40598	WG-FSA-90/37

Stock Assessment

6.225 WG-FSA-92/5 presented assessments of *N. squamifrons* at Ob and Lena Banks based on VPA using CPUE to tune the model. Natural mortality (**M**) was assumed to be 0.36 and the VPA was fitted to data from 1977/78 to 1989/90. For the reasons discussed at its 1989 meetings, the Working Group felt that the above **M** value was too high for this species (SC-CAMLR-VIII, Annex 6, Appendix 5).

6.226 It was also not possible to recreate the VPA presented in WG-FSA-92/5 since details of the CPUE tuning procedures were not given. The Working Group reiterated the importance it has attached to ensuring that appropriate and necessary details underlying reported results are submitted in the agreed format for the reporting of stock assessments (SC-CAMLR-IX, Annex 5, Appendix F). Consequently, the authors of WG-FSA-92/5 were requested to provide the essential details of the methodologies they had employed in their paper.

6.227 Using the revised catch history presented in WG-FSA-92/5, the VPAs for Ob and Lena Banks were recalculated (Figure 11). Trawl survey estimates of abundance from 1980 and 1986 were used to fit the model in a similar fashion to that employed by WG-FSA in 1990 (SC-CAMLR-IX, Annex 4, paragraphs 246 to 261). The value of **M** was 0.15.



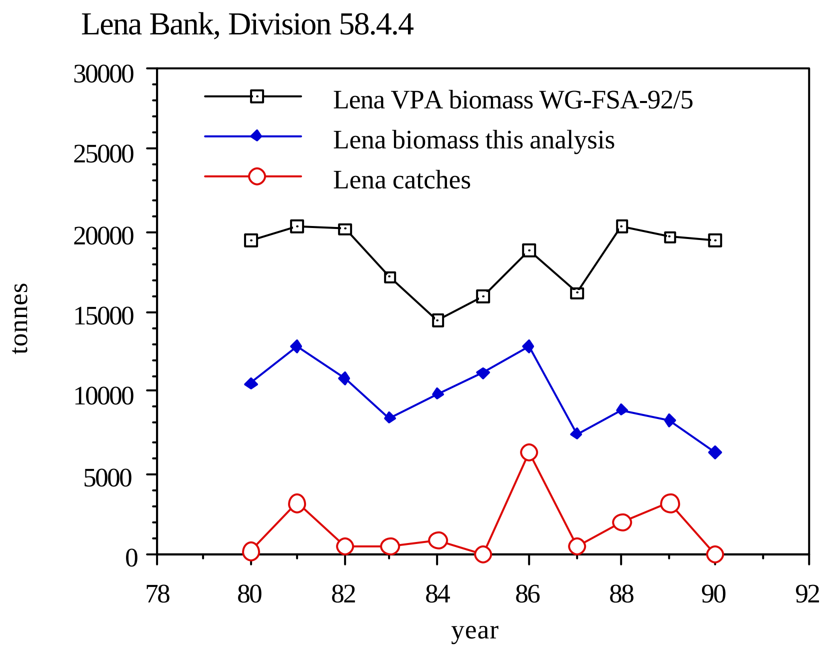


Figure 11: Results of VPAs of *N. squamifrons* in Division 58.4.4.

Lena Bank

6.228 Figure 11 shows the biomass trajectory for the VPA results calculated by the Working Group, compared with the VPA results and reported catches from WG-FSA-92/5 for 1979/80 to 1989/90. There is a wide discrepancy in the estimated stock sizes and particularly the biomass at the end of the period.

Ob Bank

6.229 Figure 11 illustrates the biomass trajectories for Ob Bank following the procedure above. The projected stock biomass decreases with increased catches between 1985/86 to 1989/90, but the end point projections differ markedly for the two alternative models.

Management Advice

6.230 The uncertainty surrounding the catch history of *N. squamifrons* for Ob and Lena Banks adds to the apparent discrepancies in the VPAs for the two areas. The Working Group therefore strongly recommends that the separate catch histories for these two banks should be verified. In addition, details of the method used to tune the VPA reported in WG-FSA-92/5 and catch-at-age data for 1990/91 are still required.

6.231 The divergent assessments for the period up to 1990/91 indicate different trends in stock biomass. The results calculated by the Working Group indicate a stock in 1990 of about 6 000 tonnes on Lena Bank and 3 500 tonnes on Ob Bank (Figure 11). As the species is relatively slow growing, the stock size is likely to have changed little since 1990. Although it appears that the stock could sustain a fishery of a few hundred tonnes, it is recommended that a survey to determine age structure and stock size at both Ob and Lena Banks should be undertaken before the fishery is re-opened.

Division 58.4.2 (Coast of the Antarctic Continent)

6.232 Fine-scale catch and effort data from research cruises for *Chaenodraco wilsoni* and *Trematomus eulepidotus* have been provided for 1990.

6.233 An outline of the biology of *Pleuragramma antarcticum* in this division is given in WG-FSA-92/11. Fish from various locations within the dvision have different parameters of the von Bertalanffy growth equation. As the only truly pelagic fish on the Antarctic continental shelf, its biology is significantly different from other species in the area. Sexual maturity is reached relatively early (13 to 16 cm, 4 to 6 years for females; 12 to 18 cm, 4 to 7 years for males) and the fecundity is relatively high. Estimates of **M** vary from 0.26 to 2.21.

6.234 Paper WG-FSA-92/11 reported that biomass in various areas and years varied widely, with values between 171 and 285 tonnes/km for Gunnerus Bank, 60 to 3 459 tonnes/km^3 for the Vernadsky Peninsula area, 1 560 to 2 599 tonnes/km^3 for Kemp Land, 21 to 2 327 tonnes/km^3 for the Mawson Coast area and 311 to 2 886 tonnes/km^3 for Prydz Bay. WG-FSA-92/11 proposed a series of TACs: Kemp Land, 14 500 tonnes; Prydz Bay, 5 800 to 28 100 tonnes; Kosmonavtov Sea, 37 900 tonnes; and Mawson Coast, 25 000 tonnes.

6.235 The Working Group noted that no detailed age structure is given, or details of how biomass figures were derived. The TACs are based on an age of fish entering a fishery at 2.62 to 3.45 years (7.5 to 10.0 cm length), which is well below the age (length) at maturity. These TACs should therefore be treated with extreme caution until more details of the assessment are available.

6.236 As *P. antarcticum* is very important in the diet of vertebrate predators, WG-FSA-92/11 recommends no fishery should be started in areas where monitoring is being conducted. The Working Group agreed with this recommendation.

6.237 The Working Group agreed that its deliberations on the US crab fishery had highlighted a number of issues pertinent to managing fishing mortality in a new fishery.

6.238 The Working Group noted that, as a general principle, the Commission had agreed in 1987 that the most direct ways to control fishing mortality (**F**) are to limit the amount of fishing effort or to establish a total allowable catch (TAC) (CCAMLR-VI, paragraph 60).

6.239 For the most part, the Commission has adhered to a management strategy whereby conservation measures on finfish have been established in accordance with a set level of **F** ($\mathbf{F_{0.1}}$) and the corresponding TAC applied.

6.240 In a new fishery, such as the crab fishery, estimates of current biomass and the strength of recruitment are required in order to manage the fishery using a TAC. The information necessary for this process will take some time to collect and consequently there is a possibility that unacceptably high levels of **F** may occur before information necessary for an initial assessment can be collected. The Working Group considered that such situations would be contrary to Article II and would also not be in accordance with the precautionary approach to management adopted by the Commission.

6.241 The Working Group agreed that control of fishing effort could offer a useful alternative to a TAC as a means of controlling **F**, despite the limitations imposed by a need for detailed knowledge about fishing power of vessels and operational constraints of the fishery.

6.242 The implementation of effort controls could also be viewed as “precautionary” insofar as they can be applied in the absence of the detailed information necessary to set an acceptable TAC. Such controls could thus not only be used to minimise the risk of an uncontrolled expansion in fishing effort on an under-exploited stock, they could also be applied in combination with an emergent TAC regime which would be modified as the necessary information for such a regime is collected from the fishery or through scientific research. This approach would be in direct accordance with “feedback” management control.

6.243 Effort controls may be useful adjuncts to TAC controls so that over-runs in TACs may be avoided. Without effort controls, TACs could be over-run when catch rates in the reporting periods are very high. The reliability of assessments can also be enhanced if the fishing season does not become truncated by excessive effort.

6.244 The Working Group therefore drew the Scientific Committee's attention to the potential utility of effort limitation as a method to control fishing mortality. The Working Group emphasised, however, that the implementation of effort controls has certain practical difficulties and that some guidance from the Commission is necessary.

6.245 Advice is required on policy matters such as effort levels, and how frequently and to what extent fishing effort can be modified. This is a necessary condition to the setting of appropriate effort levels. Similarly, the application of effort controls in a precautionary management approach should contribute to the selection of suitable effort levels.

CONSIDERATIONS OF ECOSYSTEM MANAGEMENT

INTERACTIONS WITH WG-KRILL

7.1 For a number of years, the Scientific Committee has highlighted the importance of investigating the significance of the by-catch of young fish in the krill fishery (e.g., SC-CAMLR-X, paragraph 3.22). This matter was also considered at the most recent meeting of WG-Krill (SC-CAMLR-XI/4, paragraphs 3.17 to 3.19) and a number of papers were presented to to this meeting of WG-FSA.

7.2 WG-FSA-92/6 presented an analysis of data on the by-catch of juvenile *C. gunnari* in krill trawls collected by a scientific observer working on a Russian krill fishing vessel around South Georgia. The mortality of *C. gunnari* juveniles was estimated to be very small, being equal to about 0.3 to 0.5% of fish that survived up to the age of one year. The by-catch was found to be greatest on the periphery of krill swarms and less internally. Data presented in WG-FSA-92/20 duplicated this information and had been presented in direct response to a request by WG-Krill (SC-CAMLR-XI/4, paragraph 3.18).

7.3 Several other papers were available to the Working Group on this subject; these included WG-Krill-91/25, Kompowski (1980)[1] and Slosarczyk (1983)[2]. It is generally believed that the by-catch of juvenile *C. gunnari* in krill trawls is greater over certain parts of the shelf (e.g., Clerke Rocks, east of South Georgia), and largest at low or moderate krill catch rates. It is thought that this process could have a significant and detrimental effect on recruitment of *C. gunnari*.

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[1] KOMPOWSKI, A. 1980. On feeding of *Champsocephalus gunnari* Lönnberg, 1905 (Pisces, Chaenichthyidae) off South Georgia and Kerguelen Islands. *Acta Ichthyol.Piscat. 10*(1): 25-43.

[2] SLOSARCZYK, W. 1983. Juvenile *Trematomus bernacchii* and *Pagothenia brachysoma* (Pisces, Nototheniidae) within krill concentrations off Balleny Islands (Antarctic). *Pol. Polar Res. 4*(1-4): 57-69.

7.4 In discussing the results presented in WG-FSA-92/6, members of the Working Group felt that the method of sampling (observing fish on a moving conveyor belt 4 m long) and the small sample sizes were inadequate to provide reliable results of the by-catch, particularly if these were to be extrapolated over the entire krill fishery. Concern was also expressed about the method of extrapolation which could result in an under-estimation of the potential overall by-catch. In addition, the assessed impact on recruitment was probably an underestimate, since the estimated average annual recruitment of 1 000 million 1 year olds, taken from the VPA assessment presented in WG-FSA-91/27, is probably an overestimate of current recruitment to the population (paragraph 6.63). The CV of this recruitment is high, being in the region of 0.67 to 0.71. Given these reservations, the paper was referred back to authors for further details of the sampling and the underlying analytical procedures.

7.5 Limited information was available on species other than *C. gunnari*, such as *Gymnoscopelus*.

7.6 Information on the juvenile fish by-catch in krill trawls was presented for the Indian Ocean sector in WG-FSA-92/10. A very useful set of haul-by-haul data was provided, but again details of the sampling methodology were unclear. In commercial catches between 114 and 1 million fish per tonne of krill were recorded. Most of the large by-catches (>100 000 fish per tonne of krill caught) were taken in relatively low to medium-sized krill catches (1 to 5 tonnes). The authors of the paper concluded that the juvenile fish by-catch could therefore be minimised by targetting dense krill aggregations. As *P. antarcticum* comprised the bulk of the by-catch, with the balance consisting of shelf-dwelling nototheniids and channichthyids, the authors recommended that to reduce the incidental by-catch of juvenile fish further, the area of krill fishing should be limited to water depths of 1 200 m or greater.

7.7 Taking note of this new information and the Scientific Committee's concern in this matter, the Working Group reiterated the conclusion of WG-Krill-91/25 that there is still an urgent requirement for more detailed monitoring of the krill fishery to properly assess the magnitude of the fish by-catch problem, and to determine the locations and times of year when young fish are at greatest risk. The Working Group also emphasised the need to ensure that future information should be submitted in accordance with the formats set out in the Draft Scientific Observers Manual along with full details of the sampling procedures employed according to the agreed guidelines (see SC-CAMLR-IX, Annex 5, Appendix F).

INTERACTIONS WITH WG-CEMP

7.8 In considering interactions with the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP), the Working Group noted that these could be divided into those concerned with ecological relationships between fish and other species, and those dealing with the possible consequences of finfishing operations for marine mammals and birds.

Ecological Relationships Between Fish and Other Species

7.9 The Working Group noted that in addressing the need to incorporate krill predation by fish into estimates of prey requirements, WG-CEMP's priorities have shifted and no specific proposals have yet been made for scheduling a CEMP workshop on prey requirements (SC-CAMLR-XI, Annex 4, paragraph 7.20).

7.10 The Working Group also noted that WG-CEMP had suggested it considers Table 4 in WG-CEMP's report as an initial attempt to provide an inventory of fish data which could assist in interpreting changes in abundance and distribution (cf. SC-CAMLR-X, paragraph 6.57) of predator and prey species.

7.11 The Working Group saw Table 4 as a useful first, essentially qualitative, step in identifying the type of data required to assess key ecological properties of fish in the interests of improving the development of appropriate scientific advice to WG-CEMP and the Scientific Committee. In this context, the Working Group agreed that a clear distinction needs to be made as to whether fish are considered as predators in their own right or as prey for other species.

7.12 The Working Group agreed that when fish are viewed as predators, then certain of the headings in WG-CEMP Table 4 should be adapted. For example, "breeding success" should be replaced by "spawning condition", "year-class strength" and "age-at-first spawning". The Working Group did not pursue the matter further, however, since it felt that some time is required to refine the type of parameters to be included and to evaluate the applicability of the approach as a whole. Submissions on this topic to WG-FSA's next meeting were encouraged.

7.13 Both WG-FSA-92/18 and 11 contained information relevant to the consideration of ecological relationships between fish and other species.

7.14 WG-FSA-92/18 linked differences in the condition of *C. gunnari* around South Georgia and Shag Rocks to the availability of food in different years. Food quality and low feeding intensity may also affect ovarian development and gonadal maturation.

7.15 The reporting of biological data on *P. antarcticum* in WG-FSA-92/11 represents the first such comprehensive data presented on this species. WG-FSA drew WG-CEMP's attention to this significant development since *P. antarcticum* is a CEMP monitoring species and one for which information is currently lacking.

Possible Ecological Consequences of Finfishing

7.16 Various reports on the assessment and avoidance of incidental mortality in the Convention Area were reviewed. CCAMLR-XI/7 indicated that "no incidental mortality of birds or mammals was reported in association with commercial fishing operations and scientific sampling". A similar negative report was contained in CCAMLR-XI/8.

7.17 Since 1990, six records of entanglement with longline hooks and nylon line were reported for giant fulmars near Palmer Station (CCAMLR-XI/BG/6). This is the first time that such entanglement has been reported in the Palmer area and suggests that a longline fishery may now be operating within the foraging range of the species. The Working Group was of the opinion, however, that birds were likely to have become entangled farther afield either near South Georgia or even off the Patagonian coast where there are a large number of vessels carrying out longline operations. It was also felt that it would be useful to ascertain the type of nylon or polypropylene line concerned as this may enable identification of the particular fishery from which the line originated.

7.18 Several incidents of fur seal entanglement were observed during a survey off Bird Island between November 1991 and March 1992 (SC-CAMLR-XI/BG/9). Five of these entanglements were in plastic packaging bands while the remainder were in fishing net fragments.

7.19 Information contained in the report of an attempted inspection of a Russian longline vessel (CCAMLR-XI/BG/9) suggested the deployment of a tori pole (or streamer) in accordance with Conservation Measure 29/X had been effective in minimising incidental mortality of birds during longline fishing operations.

7.20 The Working Group noted that there had been some problems of interpretation of Conservation Measure 29/X. The major problem was seen to be that in implementing the five conditions of the measure, certain operators appear to consider that the setting of longlines at night negates the need for a streamer line. The Working Group emphasised that streamer lines should be deployed during all daylight operations and that "daylight" for these purposes should include "nautical twilight" as defined in a nautical almanac, corrected for latitude and date. The Scientific Committee's attention was drawn to this definition which was provided in the interests of ensuring that a streamer line is deployed during the period when incident light levels are sufficient to allow foraging birds to be visually attracted to baited longline hooks.

Other Interactions

7.21 At its last two meetings, the Working Group has noted the potentially serious affect that bottom trawling may have on benthic assemblages (see WG-FSA-90/24 and SC-CAMLR-X/BG/19). No new information was submitted on this problem to the current meeting.

7.22 WG-FSA noted, however, that a major component of the SCAR-sponsored program of research on the Ecology of the Antarctic Sea Ice Zone (EASIZ) will focus on benthos. The Working Group urged the Scientific Committee to keep itself informed of developments in the SCAR program. It was also suggested that there may be some utility in seeking advice from SCAR on the potential of comparing benthic assemblages in coastal areas which have been subject to heavy demersal fisheries compared with other areas where no fishing has occurred.

7.23 The potential importance of studying benthic communities in the context of monitoring global environmental change was also recognised.

7.24 The Working Group noted that information presented in WG-FSA-92/12 suggests that at certain times the *E. carlsbergi* fishery may be targetting assemblages of myctophid species and that significant catches of species other than *E. carlsbergi* may be taken (paragraph 6.103). The need for further investigation of such effects was emphasised.

Proposals for Working Group Co-ordination Meeting

7.25 The Scientific Committee (SC-CAMLR-X, paragraph 12.4) has suggested that a meeting of the Conveners of the three Working Groups and other interested parties would serve to improve co-ordination of the Groups' activities prior to SC-CAMLR-XI. The Working Group saw such a meeting as being useful in the identification of common problems between the three Working Groups and in addressing matters of common concern.

7.26 The Working Group endorsed the principle of referring papers back to authors for clarification as well as the independent validation of methods, analytical procedures and computer programs used in the formulation of management advice. Similar principles have been established in WG-Krill.

7.27 The question of a common approach to the publication of information used during deliberations of the Working Groups, particularly in the formulation of management advice was considered to be a little more difficult to resolve. As such it was seen as a priority topic which the coordination meeting should address.

7.28 As a general rule, it was agreed that data which had been used in the formulation of management advice by WG-FSA should remain in the CCAMLR database and should be accessible to the Working Group, the Scientific Committee, the Commission and accredited members of these bodies as well as other working groups.

7.29 The classification of papers submitted to WG-FSA into Working Papers, Background Papers and papers of general scientific interest was seen as one way of ensuring that important information is not lost whilst also providing for the greatest possible access to information used in the formulation of management advice.

7.30 The final publication of papers was still seen to be the preserve of authors provided that the already agreed provisions concerning permission from data originators are met. As a unifying principle, therefore, the Working Group felt most strongly that in accordance with Article IX of the Convention, every effort should be made to facilitate the analysis, dissemination and publication of research information, data on the status of stocks and on fisheries catches.

RESEARCH SURVEYS

WORKSHOP ON THE DESIGN OF BOTTOM TRAWL SURVEYS

8.1 Difficulties associated with the design of bottom trawl surveys and the application of the swept area method (Saville, 1977[1]) and associated t-statistics on species with a patchy distribution, such as *C. gunnari*, have been a considerable problem to the Working Group in the past. Therefore the Working Group, at its meetings in 1990 and 1991, drew attention to the need for investigation of the problem as a matter of priority (SC-CAMLR-IX, Annex 5, paragraph 91).

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[1] SAVILLE. A. 1977. Survey methods of appraising fishery resources. *FAO Fish. Tech. Pap. 171*: 76 pp.

Because of the specialised and detailed examination required, this work could not be done during a regular meeting of the Working Group. It therefore recommended that a workshop on survey design and analyses of research vessel surveys be held in the intersessional period (SC-CAMLR-X, paragraph 4.108). The terms of reference for this workshop combine theoretical aspects, such as survey design for sampling different types of fish distribution, two-phase surveys and properties of estimators of biomass with practical aspects, such as sources of errors in comparisons between surveys, into a synthesis on survey design and cost effective allocation of sampling resources (SC-CAMLR-X, paragraph 4.109).

8.2 The Workshop was held at the Bundesforschungsanstalt für Fischerei (Federal Research Centre for Fisheries), Hamburg, Germany from 16 to 19 September under the convenership of Dr Kock. Despite the great interest of Members in the Workshop in its initial phase during SC-CAMLR-X only four scientists from three Member countries attended the Workshop. No statistician was present which limited the discussion on theoretical aspects. No scientist familiar with bottom trawl surveys in the Indian Ocean was present at the Workshop, so deliberations were mainly based on experience from the Atlantic Ocean sector. The Workshop reviewed:

(i) Factors affecting the accuracy of bottom trawl surveys:
- trawl geometry, rigging and performance;
- fish behaviour in relation to fishing gear;
- fish distribution in the area:
  (a) small-scale distribution; and
  (b) large-scale distribution.

(ii) Design of bottom trawl surveys:
- non-random (systematic) surveys;
- random surveys;
- stratification;
- two-stage surveys (three approaches).

(iii) Analysis of bottom trawl survey data.

(iv) Manual for bottom trawl surveys.

It was agreed that the main aim of the Workshop would be to begin the development of a manual describing the techniques to be used for bottom trawl surveys for fish stock assessment purposes within the Convention Area and the information from the surveys which need to be reported to CCAMLR.

8.3 The Report of the Workshop is given in Appendix H.

8.4 The Working Group welcomed the report as a useful first step in the further analysis of survey data for fish species with a contagious distribution, such as *C. gunnari*.

8.5 To proceed further, the Working Group recommended that historic information from surveys, such as those provided in WG-FSA-92/4 in a summarised form, as well as those from the commercial fishery should be made available to the Working Group in detailed form to investigate if regularities exist in the occurrence of aggregations from one year to another.

8.6 This information could then be used to formulate a range of hypotheses how fish may behave. These hypotheses would then be developed into a range of models of possible fish behaviour in the area. Properties of trawl surveys from the range of models should be tested by simulation studies and the most appropriate methods of analysis selected for application to historic and future trawl data sets.

8.7 The Working Group felt that these activities should be coordinated by a steering group consisting of the Convener of the Working Group, Dr W. de la Mare (Australia) and Dr Kock. A progress report on these activities will be submitted to next year's meeting.

8.8 The Working Group agreed that the 'Draft Manual for Bottom Trawl Surveys in the Convention Area' (Appendix H, Attachment E) should be circulated by the Secretariat among Members in the intersessional period to obtain further comments. A new draft including these comments would then be prepared by the Secretariat for next year's meeting for final approval by the Working Group.

8.9 Estimates of areas of seabed within selected depth ranges which are an important prerequisite for the design and analysis of bottom trawl surveys, have so far only been published for the Atlantic Ocean sector (Appendix H, Attachment E, Tables 1A to 1O). It was recommended that unpublished estimates of areas of seabed in the Indian Ocean sector (Kerguelen Islands, Heard and Macdonald Islands) be made available to CCAMLR to be included in the manual.

8.10 Estimates of areas of seabed within selected depth ranges for Subarea 48.3 were so far only available for the depth ranges 0 to 50 m, 50 to 150 m, 150 to 250 m and >500 m (Everson, 1987). In the course of the analysis of the *D. eleginoides* fishery, the Data Manager provided estimates of areas of seabed within selected depth ranges from 500 to 2 000 m.

8.11 Estimates of areas of seabed around the South Orkney Islands (Subarea 48.2) and in the Antarctic Peninsula region (Subarea 48.1) which have been based mostly on Admiralty Charts may not be very precise. More detailed bathymetric charts of the Peninsula region have been prepared in laboratories of some Member countries (Spain, Germany and Poland) by refining Admiralty Charts with soundings from their own research cruises. The Working Group recommended that these bathymetric charts be submitted to CCAMLR. The Secretariat should then extend its estimates of areas of seabed within selected depth ranges to other subareas and provide refined estimates for next year's meeting.

8.12 Mr Balguerías drew the attention of the Working Group to the existence of very detailed and precise bathymetric charts in use in the Russian fishery. The Secretariat was asked to approach the Russian authorities to see if these detailed charts could be made available to CCAMLR.

8.13 No information has been submitted to CCAMLR since 1987 to assess the state of fish stocks in the Peninsula region. WG-FSA-92/7 provided the survey design for bottom trawl surveys to be carried out in this region in the near future. The Working Group welcomed this initiative. However, it was noted that the proposed survey design did not take the meridional decrease in fish abundance into account. Fish abundance during surveys in the 1980s was usually highest along the north coast of Elephant Island and the South Shetland Islands. Most of the commercial fishery in the late 1970s/early 1980s had been carried out in this area. It was therefore recommended that most hauls during future surveys should be allocated to these areas and comparatively few need to be allocated to the shelf of the Antarctic Peninsula. Furthermore, experience from previous surveys indicates that only very limited areas are found suitable for trawling along the Peninsula. Any extended trawling in these areas are likely to result in a high loss of bottom gear and would require extended periods of searching to find grounds suitable for trawling.

8.14 The Working Group recommended that the proposed survey design should be modified accordingly. The number of hauls required to survey the area may be reduced and additional time might become available to extend the survey to Subarea 48.2.

RECENT AND PROPOSED SURVEYS

8.15 A bottom trawl survey was carried out around South Georgia in January 1992 by the UK in collaboration with scientists from Poland and Germany. The results of this survey have been used extensively by the Working Group during this year's meeting.

8.16 No research surveys have been proposed for the 1992/93 season. The Working Group noted that a Chilean company will carry out an exploratory longline fishery around the South Sandwich Islands to determine the feasibility of extending the *D. eleginoides* fishery to this subarea. This cruise will be accompanied by two scientific observers.

8.17 A Russian survey on *D. eleginoides* was carried out in the Shag Rocks/South Georgia area from May to July 1992 using two commercial longliners. The catch taken during the survey made up approximately 6% of the TAC set by the Commission for the 1991/92 season which was exhausted in March 1992. It was noted that no provisions have been made to take these catches into account when considering a TAC for 1992/93.

8.18 A plan detailing the survey design and the objectives of this research cruise was not submitted to CCAMLR six months in advance as requested by the Commission in 1986 (CCAMLR-V, paragraph 60). As a result the research plan was not subject to scrutiny by the Scientific Committee and the Working Group. WG-FSA was unable to assess if the research plan set out in COMM CIRC 92/23 was directed to specific questions and gaps in knowledge addressed by the Working Group at its last meeting.

8.19 Fine-scale haul-by-haul data and length composition data from the research cruise were submitted to CCAMLR. Preliminary analyses of biological characteristics (age, reproduction) were provided in WG-FSA-92/13, 14 and 15. However, the Working Group noted that the submission of biological data did not follow the guidelines and standards set out by the Working Group (SC-CAMLR-IX, Annex 5, paragraphs 249 to 254) earlier. It was noted that biological sample size was small compared with the approximate 20 000 fish taken.

8.20 The Working Group concluded that information provided so far from these surveys contributed little to improve the assessments carried out by the Working Group during this year's meeting. It reiterates earlier statements and the Commission's decision from 1986 that research plans should be submitted at least six months in advance to allow careful review of research proposals to ascertain that they address specific requests by the Working Group.

FUTURE WORK

DATA REQUIREMENTS

9.1 The Commission in 1991 adopted several conservation measures to apply to the *D. eleginoides* fishery in Subarea 48.3 (Conservation Measures 35/X to 37/X). Chile had been unable to comply with Conservation Measure 37/X and had objected to it within the objection period set out in Article IX(6)(c) of the Convention.

9.2 In CCAMLR-XI/11 the reasons for Chile's objection are presented. Dr Moreno explained that whilst Chile always intended to provide the detailed haul-by-haul and biological data requested it had not been possible to collate these data every five days because the vessels did not have facsimile facilities. The only opportunity to collect the data was therefore when the vessels completed a fishing cruise, the duration of which was usually 50 days. Because of this, and paragraph 3 of Conservation Measure 37/X which states that the fishery should be closed to any Contracting Party which did not supply these data to the Executive Secretary for three consecutive reporting periods, Chile objected to the Measure.

9.3 The Working Group agreed that the reason for requesting haul-by-haul and biological data to be reported as the fishery progresses is to ensure that these data are submitted to the CCAMLR Data Centre in time to be incorporated in the database and be available to the Working Group. It appreciated the difficulties that Chile had in acquiring these data. However, because of the volume of data to be submitted, entered into the CCAMLR database and validated, the Data Manager suggested that fixing data reporting to a single submission date, such as 30 September, would not allow enough time for the data to be entered before the Working Group meeting. Accordingly, the Working Group recommended that any reconsideration of Conservation Measure 37/X should include the requirement that reporting should proceed periodically throughout the course of the fishery.

9.4 Details of data requirements identified by the Working Group are given in Appendix D.

SOFTWARE AND ANALYSES REQUIRED FOR THE 1993 MEETING

9.5 Some problems had been encountered in running the yield-per-recruit program with long lived species and low **M**. These problems should be fixed for the next meeting.

9.6 Several *ad hoc* calculations had been performed during the meeting on MathCad. Using this software, it is easy to construct and run models which are subsequently well documented in standard mathematical notation. The Working Group recommended that the Secretariat acquire this program in the intersessional period.

9.7 During the past year the Secretariat had acquired the new version of the MAFF VPA and a FORTRAN-based ADAPT program as requested in (SC-CAMLR-X, Annex 6, paragraph 8.29). The Working Group expressed its gratitude for these additions to the Secretariat's software.

9.8 During the course of the meeting the Secretariat had provided the Working Group with data on seabed areas at selected depth ranges around South Georgia by fine-scale square (Appendix E). The Working Group requested the Secretariat to continue this work to compile data on other subareas in as much detail as available charts of the areas will allow, and down to 2 500 m. To facilitate this work, participants were encouraged to send copies of high resolution charts of relevant areas within the Convention Area to the Secretariat.

OTHER BUSINESS

10.1 The Working Group had received a paper on FISHBASE from Dr A. Jarre-Teichmann (Germany) (WG-FSA-92/25). FISHBASE is a database system designed to include biological information on fish on a global scale and is being developed by the International Centre for Living Aquatic Resources Management (ICLARM, Manilla, Philippines). The paper encouraged scientists wishing to contribute papers or reports containing relevant data on Antarctic fish, for inclusion in FISHBASE, to write to Dr Jarre-Teichmann.

10.2 A glossary of terms used in stock assessment, compiled by the Secretariat, was circulated. The Working Group agreed that this glossary could provide a useful guide to readers of its reports.

10.3 The Working Group noted that in previous years many papers had been submitted late (after 9 am on the first day of the meeting) and had therefore been unavailable for appraisal prior to the meeting. The Working Group was pleased to note that all papers considered at its present meeting had been submitted by the 9 am deadline. It was agreed that at any meeting, papers submitted after the 9 am deadline would not be considered at the meeting.

10.4 The Working Group noted the large amount of work now involved in assessing all the fish stocks and the difficulty in assessing stocks with no new data or methods that improve assessments of previous years. It was recommended that in future if no new data were available for a particular stock and there was no reported fishery or knowledge of intended fishing on that stock, then, in the absence of specific direction from the Scientific Committee or Commission, the stock should not be considered in the agenda of the Working Group at that meeting.

ADOPTION OF THE REPORT

11.1 The Report of the 1992 Meeting of the Working Group on Fish Stock Assessment was adopted.

CLOSE OF THE MEETING

12.1 In closing the meeting, Dr Kock expressed his gratitude to the Secretariat, Rapporteurs, Conveners of subgroups and to all members for their hard work during the meeting.

12.2 He noted that at the present meeting there had been no time to discuss some of the more philosophical aspects of stock assessment techniques, such as precautionary approaches and simulated management scenarios. Several members agreed that it would be useful to devote a day to this at the next meeting and the Working Group suggested that Members give some thought to the topics that could be discussed at such a time so that these could be incorporated in the annotated agenda.

12.3 Several members thanked Dr Kock for assuming chairmanship of the meeting at such short notice when Dr Everson was regrettably unable to attend. Dr Basson conveyed Dr Everson's thanks to Dr Kock for performing this task.

LIST OF PARTICIPANTS

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(Hobart, Australia, 13 to 22 October 1992)

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APPENDIX B

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 13 to 22 October 1992)

1. Opening of the Meeting

2. Organisation of the Meeting

3. Adoption of the Agenda

4. Observation and Inspection

5. Review of Material for the Meeting
   - 5.1 Data Requirements endorsed by the Commission in 1991
   - 5.2 Catch and Effort Statistics
   - 5.3 Mesh/Hook Selectivity and Related Experiments Affecting Catchability
   - 5.4 Other Documents

6. Assessment Work and Management Advice
   - 6.1 New Fisheries
   - 6.2 South Georgia (Subarea 48.3)
   - 6.3 South Orkney Islands (Subarea 48.2)
   - 6.4 Antarctic Peninsula (Subarea 48.1)
   - 6.5 Kerguelen Islands (Division 58.5.1)
   - 6.6 Ob and Lena Banks (Divisions 58.4.4)
   - 6.7 Coastal Areas of Antarctic Continent (Divisions 58.4.1 and 58.4.2)
   - 6.8 Pacific Ocean Sector (Area 88)

7. Considerations of Ecosystem Management
   - 7.1 Interactions with WG-Krill
   - 7.2 Interactions with WG-CEMP
   - 7.3 Other Interactions (e.g., Multispecies, Benthos, etc.)
   - 7.4 Proposals for Working Group Coordination Meeting

8. Research Surveys
   - 8.1 Workshop on Survey Design and the Analyses of Research Vessel Surveys
   - 8.2 Recent and Proposed Surveys

9. Future Work
   - 9.1 Data Requirements
   - 9.2 Software to be Prepared or Developed Prior to the Next Meeting and Data Analyses Required

10. Other Business

11. Adoption of the Report

12. Close of the Meeting.

LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 13 to 22 October 1992)

WG-FSA-92/1	AGENDA
WG-FSA-92/2	LIST OF PARTICIPANTS
WG-FSA-92/3	LIST OF DOCUMENTS
WG-FSA-92/4	*CHAMPSOCEPHALUS GUNNARI* LÖNNBERG DISTRIBUTION ON SOUTH GEORGIA SHELF FROM INVENTORY SURVEY DATA COLLECTED BY ATLANTNIRO I.A. Trunov (Russia)
WG-FSA-92/5	COLLECTED DATA AND STOCK ASSESSMENT RESULTS FOR *NOTOTHENIA SQUAMIFRONS* FROM OB AND LENA BANKS, DIVISION 58.4.4 A.K. Zaitsev and S.M. Pronenko (Ukraine)
WG-FSA-92/6	BY-CATCH OF JUVENILE *CHAMPSOCEPHALUS GUNNARI* IN KRILL FISHERY ON THE SHELF OF SOUTH GEORGIA ISLAND G.A. Frolkina, V.I. Latogursky, V.A. Sushin (Russian Federation)
WG-FSA-92/7	A FISH STOCK ASSESSMENT SURVEY DESIGN FOR SUBAREA 48.1 George Watters (USA)
WG-FSA-92/8	LENGTH-AGE COMPOSITION OF THE PATAGONIAN TOOTHFISH, *DISSOSTICHUS ELEGINOIDES*, FROM THE KERGUELEN ISLAND AREA V.G. Prutko and V.N. Chikov (Ukraine)
WG-FSA-92/9	STOCK SIZE AND TAC ESTIMATION FOR THE PATAGONIAN TOOTHFISH, *DISSOSTICHUS ELEGINOIDES*, FROM THE KERGUELEN ISLANDS AREA S.M. Pronenko, P.B. Tankevich, V.V. Gerasimchuk and V.N. Chikov (Ukraine)
WG-FSA-92/10	ON THE PROBLEM OF BY-CATCH OF JUVENILE FISH IN KRILL FISHERY C.A. Pankratov and E.A. Pakhomov (Ukraine)
WG-FSA-92/11	A BRIEF OUTLINE OF THE BIOLOGY OF THE ANTARCTIC SILVERFISH, *PLEURAGRAMMA ANTARCTICUM* BOULENGER, 1902 (NOTOTHENIIDAE) FROM THE ANTARCTIC INDIAN OCEAN V.V. Gerasimchuk (Ukraine)

WG-FSA-92/12	SPECIES COMPOSITION OF BY-CATCH IN CATCHES OF *ELECTRONA CARLSBERGI* TAKEN DURING COMMERCIAL/RESEARCH FISHING NORTH OF SOUTH GEORGIA ISLAND IN 1987-89 VNIRO (Moscow, Russia)
WG-FSA-92/13	PRE-SPAWNING AND SPAWNING BIOLOGY OF THE PATAGONIAN TOOTHFISH, *DISSOSTICHUS ELEGINOIDES*, AROUND SOUTH GEORGIA (SUBAREA 48.3) I.N. Konforkin and A.N. Kozlov (VNIRO, Moscow, Russia)
WG-FSA-92/14	BRIEF REPORT OF RESEARCH CARRIED OUT BY THE VESSEL *MIRGOROD* IN THE SHAG ROCKS AND SOUTH GEORGIA AREAS DURING THE PERIOD MAY-JUNE 1992 Russia
WG-FSA-92/15	BRIEF REPORT OF RESEARCH CARRIED OUT BY THE VESSEL *MAKSHEEVO* IN THE SHAG ROCKS AND SOUTH GEORGIA AREAS DURING THE PERIOD JUNE-JULY 1992 Russia
WG-FSA-92/16	CCAMLR WORKSHOP ON DESIGN OF BOTTOM TRAWL SURVEYS (Hamburg, Germany, 16 to 19 September 1992)
WG-FSA-92/17	FISH STOCK ASSESSMENT SURVEY IN SUBAREA 48.3 I. Everson, G. Parkes, S. Campbell (UK), K.-H. Kock (Germany), J. Szlakowski, D. Cielniaszek (Poland), C. Goss (UK), and S. Wilhelms (Germany)
WG-FSA-92/18	CONDITION FACTOR STUDY OF *CHAMPSOCEPHALUS GUNNARI* I. Everson, G. Parkes, S. Campbell (UK), K.-H. Kock (Germany), J. Szlakowski, D. Cielniaszek (Poland), C. Goss (UK), and S. Wilhelms (Germany)
WG-FSA-92/19	SECRETARIAT STOCK ASSESSMENT SOFTWARE Secretariat
WG-FSA-92/20	REPORTS OF JUVENILE FISH AS BY-CATCH IN THE KRILL FISHERY Secretariat
WG-FSA-92/21 Rev. 1	REMARKS ON NATURAL MORTALITY OF *DISSOSTICHUS ELEGINOIDES* IN SUBAREA 48.3 Carlos A. Moreno and Pedro S. Rubilar (Chile)
WG-FSA-92/22	CATCH-AT-AGE ANALYSIS APPLIED TO NEW FISHERIES: THE CASE OF *DISSOSTICHUS ELEGINOIDES* Alejandro V. Zuleta and Carlos A. Moreno (Chile)

WG-FSA-92/23 Rev. 1 AN ITERATIVE MODEL TO CONSTRUCT AN AGE-LENGTH KEY TO ASSESS THE AGE COMPOSITION OF A NEW FISHERY FOR *DISSOSTICHUS ELEGINOIDES* IN CHILEAN WATERS
Hugo Robotham V. and Zaida Young U. (Chile)

WG-FSA-92/24 FISHING OF THE PATAGONIAN TOOTHFISH (*DISSOSTICHUS ELEGINOIDES*) BY THE CHILEAN FLEET (1991/92) IN THE SUBAREA 48.3 (SOUTH GEORGIA ISLAND) AND PROPOSED TAC FOR THE 1991/1993 SEASON
Patricio Arana Espina, Marcelo Arredondo Araya and Vittorio Venturini Meniconi (Chile)

WG-FSA-92/25 DATABASE INFORMATION ON ANTARCTIC FISHES: CALL FOR COOPERATION
Astrid Jarre-Teichmann (Germany)

WG-FSA-92/26 VARIATIONS IN FOOD COMPOSITION AND FEEDING INTENSITY OF MACKEREL ICEFISH (*CHAMPSOCEPHALUS GUNNARI*) AT SOUTH GEORGIA
K.-H. Kock (Germany), I. Everson (UK), S. Wilhelms (Germany), S. Campbell (UK), J. Szlakowski (Poland), G. Parkes (UK), Z. Cielniaszek (Poland) and C. Goss (UK)

WG-FSA-92/27 NOTES ON THE USE OF VIRTUAL POPULATION ANALYSIS FOR STOCK ASSESSMENT OF THE MACKEREL ICEFISH, *CHAMPSOCEPHALUS GUNNARI* (LÖNNBERG, 1906) IN SUBAREA 48.3 FOR THE 1990/91 AND 1991/92 SEASONS
G. Parkes (United Kingdom)

WG-FSA-92/28 THE 1992 *DISSOSTICHUS* FISHERY IN SUBAREA 48.3
D.J. Agnew (Secretariat) and C.A. Moreno (Chile)

WG-FSA-92/29 A PRELIMINARY REPORT ON RESEARCH CONDUCTED DURING EXPERIMENTAL CRAB FISHING IN THE ANTARCTIC DURING 1992 (CCAMLR AREA 48)
Robert S. Otto and Richard A. MacIntosh (USA)

WG-FSA-92/30 PRELIMINARY ANALYSIS OF THE GROWTH OF *DISSOSTICHUS ELEGINOIDES* FROM THE AUSTRAL ZONE OF CHILE AND SOUTH GEORGIA
M. Aguayo H. (Chile)

WG-FSA-92/31 Rev. 1 EXPLORATORY LONGLINE FISHING AROUND THE KERGUELEN ISLANDS (DIVISION 58.5.1). DESCRIPTION OF THE FISHING EFFORT; CATCHABILITY AND TARGET SIZE OF *DISSOSTICHUS ELEGINOIDES*
G. Duhamel (France)

WG-FSA-92/32 CCAMLR GLOSSARY OF TERMS
Secretariat

OTHER DOCUMENTS

CCAMLR-XI/5	PLAN FOR RESEARCH AND DATA COLLECTION DURING EXPLORATORY FISHING FOR *DISSOSTICHUS ELEGINOIDES* IN CCAMLR SUBAREA 48.4 Delegation of the USA
CCAMLR-XI/6	PROPOSAL FOR A CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION Delegation of EEC
CCAMLR-XI/7	APPLICATION FOR PERMIT TO CARRY OUT EXPLORATION AROUND THE SOUTH SANDWICH ISLANDS IN ORDER TO DETERMINE THE FEASIBILITY OF A NEW FISHERY Delegation of Chile
CCAMLR-XI/11	COMMENTS ON THE APPLICATION OF CCAMLR CONSERVATION MEASURES 36/X AND 37/X WITH REGARD TO THE *DISSOSTICHUS ELEGINOIDES* FISHERY IN SUBAREA 48.3 Delegation of Chile
CCAMLR-XI/BG/6	REPORT ON THE ASSESSMENT OF INCIDENTAL MORTALITY, PALMER STATION, 1991-1992 Delegation of USA
SC-CAMLR-XI/BG/2	CCAMLR DATABASES AND DATA AVAILABILITY Secretariat
WG-KRILL-92/14 Rev.1	MANAGING SOUTHERN OCEAN KRILL AND FISH STOCKS IN A CHANGING ENVIRONMENT I. Everson (UK)
SC-CAMLR-X/BG/20	NEW AND DEVELOPING FISHERIES: A REVIEW OF US ACTIVITIES IN PERMITTING AN EXPLORATORY CRAB FISHERY IN STATISTICAL AREA 48 Delegation of USA

DATA REQUIREMENTS FOR THE WORKING GROUP

I Data Required by WG-FSA-91	II Data Received by WG-FSA	III Data Required by WG-FSA-92
1.		Data from the crab fishery should be collected and submitted (paragraphs 6.20 (v) and (vi))
2. Length and age data from *D. eleginoides* in Subarea 48.3. Continued requirement from historical fishery	Data reported to CCAMLR under item 4 below and in accordance with Conservation Measure 37/X	-
3. Data on size selectivity of longline fishery for *D. eleginoides* in Subarea 48.3	Fine-scale data submitted (Chile, USSR) in WG-FSA-92/28	-
4. *D. eleginoides,* Subarea 48.3: • length and age data in WG-FSA-90/34 and 91/24 should be submitted • changes to five-day reporting to include vessel days and number of hooks	Data were submitted to CCAMLR Data Centre (CDC), including haul-by-haul data from the commercial longline fishery (CCAMLR-X, paragraph 4.14)	-
5.		*D. eleginoides*, Subarea 48.3 (paragraph 6.176) • studies on hook selection factors required • studies on loss rates of fish
6.		*D. eleginoides*, Subarea 48.3 • age and maturity determination required for an expanded range of lengths from historical and current commercial and research catches (paragraph 6.123 to 6.126) • fish should be measured in 1 cm length classes and all data should be submitted to CCAMLR (paragraph 6.142)
7. Report *E. carlsbergi* catches from north of convergence	No information on areas north of the convergence	-
8. Biological data from historical catches of *E. carlsbergi* requested Fine-scale data requested	Some length composition data submitted to CDC, fine-scale data submitted	-
9. *E. carlsbergi*, Subarea 48.3: • description of operations (CCAMLR-IX, paragraph 4.27) • details of by-catch • full reporting of existing biological and survey data	• no information • WG-FSA-92/12 (research) • some length composition data	• description of operation (CCAMLR-IX, paragraph 4.2.7) • further information requested on by-catch in commercial *E. carlsbergi* fishery (paragraph 6.103) • new surveys required (paragraph 6.105)

I	II	III
10. Representative length frequency from the commercial catch of *C. gunnari* in Subarea 48.3 should be reported for recent years	No information	Representative length frequency from the commercial catch of *C. gunnari* in Subarea 48.3 should be reported for recent years
11. *C. gunnari* Subarea 48.3: • quantitative information on by-catch in midwater and demersal fisheries • reports from past surveys should be submitted in detail • research data should be submitted to Secretariat	• no information • some research data reported	Trawl fisheries in Subarea 48.3 • detailed data on the by-catch in pelagic (midwater) and demersal (bottom) trawl fisheries in Subarea 48.3 are urgently required to establish management advice (paragraphs 6.72 and 6.93) • research data should be submitted to the Secretariat
12. Biological information on incidental catch of *N. rossii* in Subarea 48.3	No information	*N. rossii*, Subarea 48.3 • biological information on incidental catch • haul-by-haul data from historical fishery requested (paragraph 6.34)
13. Length and age, *N. squamifrons*, Subarea 48.3 - commercial data for past years	No further information	Length and age, *N. squamifrons*, Subarea 48.3 - commercial data for past year's (paragraph 6.90)
14. Commercial age and length data for *N. gibberifrons*	No further information	Commercial age and length data for *N. gibberifrons*
15.		*P. guntheri*, Subarea 48.3 - clarification of position of past catches around South Georgia requested (paragraph 6.86)
16.		*E. carlsbergi* • clarification of position and time of catch of 1 518 tonnes reported for Subarea 48.2 in 1990/91 (paragraph 6.178) • clarification of position and time of catch of 50 tonnes in Subarea 48.1 in 1991/92 (paragraph 6.203)
17. *N. squamifrons*, Division 58.4.4 • STATLANT catches should be corrected to agree with those in WG-FSA-90/37 • catches should be reported for Ob and Lena Banks in fine-scale format • commercial age and length data should be submitted to Secretariat	All data submitted in WG-FSA-92/5 and will be used to update the CDC	-
18. Age/length data from catches of *C. gunnari* in Division 58.5.1 prior to 1980	No data	-
19. Commercial length and age data for the *D. eleginoides* trawl and longline fisheries in Division 58.5.1	Some data reported from France and WG-FSA-92/8 and 31	-
20. *N. squamifrons*, Division 58.5.1 • length and age/length key data • catch data separated for Division 58.5.1 • data consistency	Some data in WG-FSA-92/9; length composition from France; see Table 1	-

I	II	III
21. Reports requested from *Slavgorod, Borispol, Passat 2* fishing in October 1989 (SC-CAMLR-VIII, paragraph 3.7)	No information	-
22. Haul-by-haul information from research vessel surveys and experimental fisheries	No further information from Russia	-
23. Information on levels of discarding and conversion rates from fish products to nominal weight are required	No information	Information on levels of discarding and conversion rates from fish products to nominal weight are required
24.		Call for detailed charts to assist the Secretariat in the calculation of seabed areas (paragraph 8.11)
25.		Call for historic information from surveys to assist the Workshop on the Design of Bottom Trawl Surveys in investigating the interannual variability in the occurrence of fish aggregations (paragraphs 8.5 and 8.6)

SEABED AREA AT SELECTED DEPTH RANGES AROUND SOUTH GEORGIA AND SHAG ROCKS

Secretariat

The following seabed areas were calculated using the British Antarctic Survey bathymetric chart BAS (MISC) 4 Edition 1. Images were scanned into the Secretariat's Macintosh computers and relative areas calculated using the drawing package "Canvas". The distorting effects of latitude were assumed to be negligible at the scale of 0.5° latitude by 1° longitude (CCAMLR Fine-Scale Squares).

Latitude (northern boundary)	Longitude (eastern boundary)	Area of FS Square	Area (n miles^2) Within Depth Intervals				Total
			500-750 m	750-100 m	1000-1500 m	1500-2000 m	
53°	35°	1077.1	64.9	81.1	106.1	106.9	**359.0**
	36°	1077.1	0.0	62.3	143.1	98.9	**304.3**
	37°	1077.1	0.0	22.6	130.9	124.0	**277.6**
	38°	1077.1	0.0	0.0	0.0	14.3	**14.3**
	41°	1077.1	32.0	35.5	106.1	365.4	**539.0**
	42°	1077.1	59.2	51.7	126.2	373.4	**610.4**
	43°	1077.1	60.8	26.3	383.9	473.3	**944.3**
53.5°	35°	1064.4	34.9	49.7	141.6	40.0	**266.2**
	36°	1064.4	89.3	102.4	74.3	54.8	**320.8**
	37°	1064.4	54.1	83.4	87.7	0.0	**225.3**
	38°	1064.4	35.9	41.1	61.5	94.1	**232.6**
	39°	1064.4	70.2	29.3	48.2	227.2	**374.8**
	40°	1064.4	205.7	83.7	254.2	144.1	**687.7**
	41°	1064.4	39.7	42.0	62.7	40.0	**184.5**
	42°	1064.4	34.6	49.1	123.1	132.9	**339.8**
	43°	1064.4	0.0	0.0	5.6	69.3	**75.0**
54°	34°	1051.7	0.0	0.0	30.2	69.8	**100.0**
	35°	1051.7	39.2	47.4	126.6	39.0	**252.2**
	38°	1051.7	231.1	0.0	0.0	0.0	**231.1**
	39°	1051.7	76.2	42.2	147.9	157.9	**424.3**
54.5°	34°	1039.0	159.2	114.5	228.5	93.7	**595.9**
	35°	1039.0	4.9	5.4	18.9	0.0	**29.2**
55°	34°	1026.4	53.0	78.1	125.9	157.7	**414.8**
	35°	1026.4	14.6	6.2	7.1	0.0	**27.9**
	36°	1026.4	112.2	84.4	116.7	75.4	**388.9**
55.5°	34°	1013.0	3.7	50.1	124.6	222.8	**401.2**
	35°	1013.0	47.0	59.0	87.9	146.4	**340.3**
	36°	1013.0	0.0	2.3	14.5	22.2	**39.0**
Total		**29522.4**	**1522.5**	**1250.2**	**2884.2**	**3343.6**	**9000.3**

APPENDIX F

FORMATS FOR SUBMISSION OF DATA FROM THE CRAB FISHERY

FORMAT 1C

OBSERVER SUMMARY INFORMATION (CRAB FISHERY)

CRUISE NUMBER ______

CRAB FISHING DETAILS*

LENGTH OF LINE (m) ___________________________

SPACING OF POTS (m) _____

NUMBER OF POTS _______ SHAPE OF POTS _________

MESH SIZE OF POT COVER (mm)_____________________

Haul No. (HN)	Sample No. (SN)	Date	Coordinates	Surface Water t°C	State of Sea**	Target Species	Type of Bait	Bottom Depth (m)	Begin to Set Pots (GMT)	Finish Setting Pots (GMT)	Begin to Haul Pots (GMT)	Finish Hauling Pots (GMT)	Number of Empty Pots	Total Catch (kgs)	By-Catch (species/kg)

* If other than one type of pot string (different length of line, spacing and number of pots) had been used during the observed fishing cruise, separate forms should be used for each type

** State of the Sea Scale is given overleaf

FORMAT 6

SUBSAMPLE FOR MATURITY AND AGE DETERMINATION FOR CRABS

CRUISE NUMBER: __________ SPECIES: ________________________________

HAUL NUMBER: __________ TOTAL NUMBER IN THE SUBSAMPLE __________

SAMPLE NUMBER: __________ TOTAL WEIGHT OF THE SUBSAMPLE __________

SUBSAMPLE NUMBER: __________

CARAPACE MEASUREMENT USED IN THE TABLE
(Tick the appropriate box)*

CL	CW

Carapace Size (mm)	Males					Females									Number of parasites (see ***)
	Maturity**	Relative age (carapace condition)**				Maturity**					Relative age (carapace condition)**				
	Chela height (mm)	1 (soft)	2 (new hard)	3 (old)	4 (very old)	I (eggs uneyed)	II (eggs eyed)	III (eggs dead)	IV (empty egg cases)	V (non ovigerous)	1 (soft)	2 (new hard)	3 (old)	4 (very old)	

* For definitions of CL and CW see Appendix 2

** For definitions of maturity stages of female crabs and relative age see Appendices 7 and 10

*** Number of parasites of the genus Briarosaccus (Crustacea) and parasite scars found underneath the crab abdomen

SUMMARIES OF AVAILABLE INFORMATION AND ESTIMATES OF BIOLOGICAL PARAMETERS FOR *DISSOSTICHUS ELEGINOIDES*

Table G.1: Summary of available age/length keys for *D. eleginoides*.

Southern Chile:
Source: WG-FSA-92/30
Catches: 1991/92
Ages determined from: Scales
Lengths represent the minimum of 5 cm length classes

Sex	Age (yrs)		Length (cm)		Length (cm)	n
	Young	Old	Small	Large	Youngest/Oldest	
Males	5	19	45	170	45 / 140	1 305
Females	3	20	50	185	55 / 165	1 146

South Georgia:
Source: WG-FSA-92/30
Catches: February to March 1991
Ages determined from: Scales
Lengths represent the minimum of 5 cm length classes

Sex	Age (yrs)		Length (cm)		Length (cm)	n
	Young	Old	Small	Large	Youngest/Oldest	
Males	5	18	60	140	60 / 140	695
Females	5	21	55	180	55 / 180	537

Kerguelen Island Area:
Source: WG-FSA-92/8
Ages determined from: Scales
Lengths represent the minimum of 5 cm length classes

Location	Age (yrs)		Length (cm)		Length (cm)	n
	Young	Old	Small	Large	Youngest/Oldest	
West shelf (Oct-Nov 1984)	4	14	35	115	35 / 115	110
West shelf (Mar-Apr 1987)	2	14	20	115	20 / 115	184
North shelf (Jan 1992)	3	17	35	155	35 / 155	205

Table G.2: Summary of available length frequency data for *D. eleginoides* in Subarea 48.3.

Longline data:
- Sept/91 - Jun/92 - WG-FSA-92/23
- May-Jun - WG-FSA-92/14
- Jun-Jul - WG-FSA-92/15

Trawl data:
- Jan-Feb - WG-FSA-92/17

WG-FSA-92/17
Length frequency distribution from trawl survey

WG-FSA-92/13
Length frequency data for longlines in 1986

WG-FSA-92/14 and 15
(two longline vessels)

Data for South Georgia and Shag Rocks; May-July 1992
- Length frequency data
- Weight length data

Table G.3: Summary of available length-weight relationships for *D. eleginoides*. See Figure G.1 showing the differences between the relationships.

Weight = a.L^b , W (g), L(cm).

	a	*b*	Length Range (cm)	Source
South Georgia:				
Both sexes	0.00590	3.131	mostly <90	Kock *et al*. (1985)[1]
Both sexes	0.04570	2.653	??	Gasiukov *et al*. (1991)[2]
Male	0.07567	2.559	60-134	Aguayo and Cid (1991)[3]
Female	0.15997	2.407	20-164	Aguayo and Cid (1991)
Both sexes	0.07568	2.559	20-164	Aguayo and Cid (1991)
Male	0.00444	3.18	21-110	WG-FSA-92/17
Female	0.00334	3.25	26-94	WG-FSA-92/17
Southern Chile:				
Males	0.01104	2.970	??	WG-FSA-92/30
Females	0.00692	3.109		WG-FSA-92/30
Both sexes	0.00695	3.063		WG-FSA-92/30
Chilean Shelf:				
Both sexes	0.00382	3.221	51-127	Martinez (1975)*
Patagonian Shelf:				
Both sexes	0.00350	3.29	mostly <90	Zakharov and Frolkina (1976)[4]
Both sexes	0.0026	3.326	mostly <90	Messtorff and Kock (1978)[5]
Kerguelen, Crozet				
Both sexes	0.0015	3.58	8.9-95.7	Hureau and Ozouf-Costaz (1980)[6]
Kerguelen:				
Male	0.0033	3.260	20.3-129	Duhamel (1981)[7]
Female	0.0032	3.269	26.1-141	Duhamel (1981)

* Original estimates considered to be in mm by Kock *et al*. (1985). The estimate of ***a*** was transformed to make conversion from lengths in cm.

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1 KOCK, K.-H., G. DUHAMEL and J.C. HUREAU. 1985. Biology and status of exploited Antarctic fish stock: a review. *BIOMASS Scientific Series No. 6*: 143 pp. ISCU Press.

2 GASIUKOV, P.S., R.S. DOROVSKIKH and K.V. SHUST. 1991. Assessment of the *D. eleginoides* stock in Subarea 48.3 for the 1990/91 season and calculation of the TAC for the 1991/92 season. Document *WG-FSA-91/24*. CCAMLR, Hobart, Australia.

3 AGUAYO, M. and CID. 1991. Recopilación, proceso y análisis de los antecedentes biológico - pesqueros en la pesca exploratoria de bacalao de profundidad realizada por el BP *Rriosur V*. *Informe interno, Inst. Form. Pesq*. 63 pp.

4 ZAKHAROV, G.P. and ZH.A. FROLKINA. 1976. Some data on the distribution and biology of the Patagonian toothfish (*Dissostichus eleginoides* Smitt) occurring in the southwest Atlantic. *Trudy. Atlant. Nauchno-Issled. Ryb. Khoz. Oceanogr. 65*: 143-150.

5 MESSTORFF, J. and K.-H. KOCK. Deutsch-Argentinische Zusammenarbeit in der Fischereiforschung mit FFS *Walther Herwig* efrolgreich fortgesetzt. *Infn. Fischwirtsch. 25* (6): 175-180.

6 HUREAU, J.C. and C. OZOUF-COSTAZ. 1980. Age determination and growth in *Dissostichus eleginoides* Smitt 1898 from Kerguelen and Crozet Islands. *Cybium, 4*(1): 23-32.

7 DUHAMEL, G. 1981. Caractéristiques biologiques des principales espèces de poissons du plateau continental des Iles Kerguelen. *Cybium, 5*(1): 19-32.

Table G.4: Summary of available estimates for growth parameters. See Figure G.2 showing the differences between the growth curves.

Area	L_{∞}	K	t_0	Method	Source
Patagonian Shelf	204.3	0.0563	-0.545	??	Zakharov and Frolkina (1976)
South Georgia	174.8	0.0712	-0.005	??	Shust *et al*. (1990)[1]
	210.8	0.0644	0.783	Walford	Moreno (data from WG-FSA-92/30)
	170.8	0.0916	-0.031	Non-linear	Moreno (data from WG-FSA-92/30)
	164.8	0.097	0.430	Tomlinson & Toramson	Moreno (data from WG-FSA-92/30)
Southern Chile	216.1	0.062	-0.877	Walford	WG-FSA-92/30
Males	199.2	0.0714	-0.809	Walford	WG-FSA-92/30
Females	214.0	0.062	-1.265	Walford	WG-FSA-92/30

1 SHUST, K.V., P.S. GASIUKOV, R.S. DOROVSKIKH and B.A. KENZHIN. 1990. The state of *D. eleginoides* stock and TAC for 1990/91 in Subarea 48.3 (South Georgia). WG-FSA-90/34.

Table G.5: Estimates of natural mortality for *D. eleginoides*.

Estimates of **M** pre 1992			
Area	**M**	Method	Source
Patagonian Shelf	0.06 0.12	Pauly (1980) Rikhter and Efanov (1976)	Kock *et al*. (1985) Kock *et al*. (1985)
South Georgia	0.18 0.16	Alverson-Carnee Rikhter-Efanov	Shust *et al*. (1990) Shust *et al*. (1990)

Estimates of **M** - Summary from WG-FSA-92/21 Natural mortality estimates based on length data for three fishing areas and three growth curves.				
Area	Method	Growth Curve		
		1	2	3
Shag Rocks	B and H	0.09	0.12	0.15
	A-C	0.17	0.14	0.18
	Mean	0.13	0.13	0.17
South Georgia north	B and H	0.10	0.09	0.12
	A-C	0.15	0.13	0.16
	Mean	0.13	0.11	0.14
South Georgia south	B and H	0.08	0.07	0.09
	A-C	0.17	0.14	0.19
	Mean	0.13	0.11	0.14

Means: B and H = Beverton and Holt length based estimate
A-C = Alverson-Carnee estimate

Growth Curves:
1) $L_t = 204.3\ (1-e^{-0.0563[t+0.545]})$; Zakharov and Frolkina (1976)
2) $L_t = 174.8\ (1-e^{-0.0712[t+0.0049]})$; Shust *et al*. (1990)
3) $L_t = 210.8\ (1-e^{-0.0644[t+0.783]})$; Aguayo (1991)

Means: B and H = 0.10
A-C = 0.16
Grand Mean = 0.13

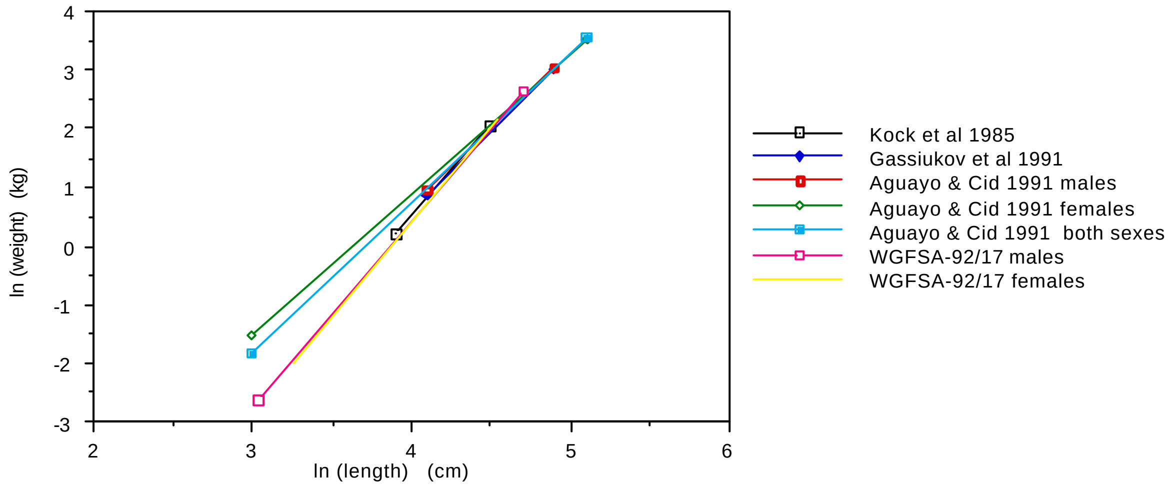

Figure G.1: *D. eleginoides*, Subarea 48.3. Length-weight relationship (parameters from Table 3).

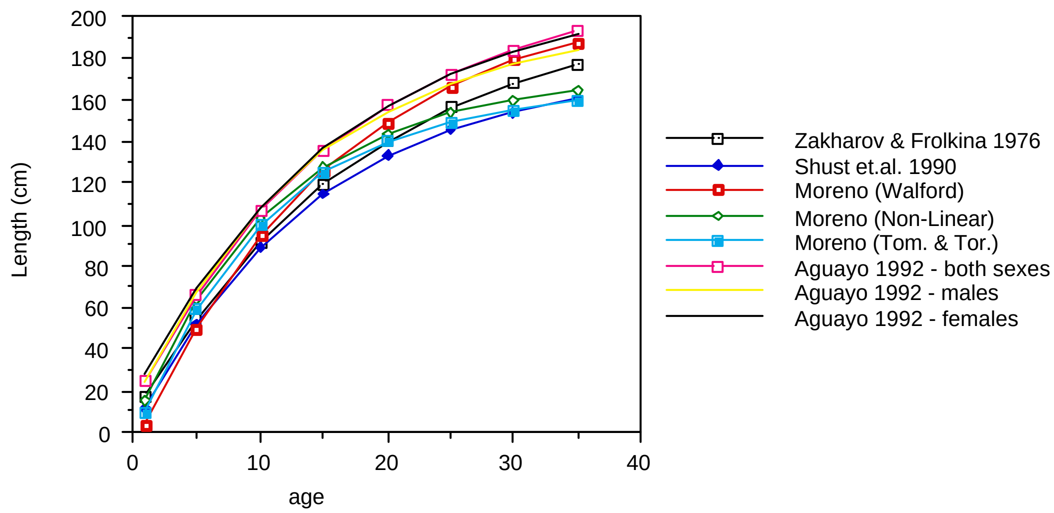

Figure G.2: *D. eleginoides*, Subarea 48.3 and Patagonian slope, growth in length (parameters from Table G.4)

CCAMLR WORKSHOP ON DESIGN OF BOTTOM TRAWL SURVEYS

(Hamburg, Germany, 16 to 19 September 1992)

CCAMLR WORKSHOP ON DESIGN OF BOTTOM TRAWL SURVEYS

(Hamburg, Germany, 16 to 19 September 1992)

OPENING OF THE MEETING

1.1 The workshop was held at the Bundesforschungsanstalt für Fischerei (Federal Research Centre for Fisheries), Hamburg, Germany, from 16 to 19 September 1992. The Convener Dr K.-H. Kock (Germany) chaired the workshop.

1.2 The participants of the workshop were welcomed by the Director of the Institut für Seefischerei (Sea Fisheries Research Institute), Dr. G. Hubold, on behalf of the Federal Research Centre for Fisheries.

ORGANISATION OF THE MEETING AND APPOINTMENT OF RAPPORTEURS

2. 1 The following were appointed rapporteurs:

Dr Kock (Agenda Items 1 to 4, appendices)
Dr I. Everson (UK) (Agenda Items 5 to 12).

A list of participants is given in Attachment A. A list of papers tabled and references is given in Attachment B.

ADOPTION OF THE AGENDA

3.1 A draft agenda had been prepared by the Convener. This agenda, with minor modifications and additions was adopted and is included as Attachment C.

BACKGROUND OF THE MEETING

4.1 Difficulties concerning bottom trawl survey design and the application of the 'swept area' method and associated t-statistics on species with a contagious distribution, such as the mackerel icefish (*Champsocephalus gunnari*), have been a considerable problem to the CCAMLR Working Group on Fish Stock Assessment (WG-FSA) in the past. The Working Group at its meetings in

1990 and 1991 drew attention to the need for investigation of this problem as a matter of priority (SC-CAMLR-IX, Annex 5, paragraph 91). Because of the specialised and detailed examination required, this work could not be done during a regular meeting of the Working Group. The Working Group therefore recommended that a workshop on survey design and analyses of research vessel surveys be held in the 1991/92 intersessional period (SC-CAMLR-X, paragraph 4.108). The terms of reference for this workshop are set out in SC-CAMLR-X, paragraph 4.109. They combine theoretical aspects, such as survey design for sampling different types of fish distribution, two-phase surveys and properties of estimators of biomass, with practical aspects, such as sources of errors in comparisons between surveys, into a synthesis on survey design and cost effective allocation of sampling resources.

4.2 The workshop was originally scheduled for May 1992 but was delayed until September when the report of an ICES workshop covering similar topics was to be distributed. The report of the ICES workshop was unfortunately not available in time for the meeting.

4.3 It was noted with great regret that despite the great interest of Members in the workshop expressed during SC-CAMLR-X, only four scientists from Member countries attended the workshop. No statistician was present at the workshop which limited the discussion on theoretical aspects to a large extent. Since no scientist familiar with bottom trawl surveys in the Indian Ocean sector was present at the workshop, deliberations were mainly based on experience from the Atlantic Ocean sector.

OBJECTIVES OF THE MEETING

5.1 It was agreed that the main aim of the meeting would be to begin the development of a manual describing the techniques to be used for bottom trawl surveys for fish stock assessment within the Convention Area.

5.2 Bottom trawl surveys could be undertaken for two major purposes. These were identified as:

(i) the estimation of Standing Stock; and
(ii) to provide information on Population Structure

5.3 Currently the main target species for bottom trawl surveys is *C. gunnari*. Other species of likely commercial interest, and for which bottom trawl suveys were appropriate, are: *Notothenia* *gibberifrons*, *Notothenia rossii*, *Notothenia squamifrons*, *Chaenocephalus aceratus* and *Pseudochaenichthys georgianus*.

5.4 Other fish resources, such as *Dissostichus eleginoides* and the myctophid *Electrona carlsbergi*, which are of current interest to CCAMLR, were not considered in detail because they either occur deeper than the range of normal bottom trawls or are holopelagic.

FACTORS AFFECTING THE ACCURACY OF BOTTOM TRAWL SURVEYS

Trawl Geometry, Rigging and Performance

6.1 The ideal situation would be for all operators to use the same trawl design, rigged in a standard manner. In spite of this it is accepted that there will always be variations between operators.

6.2 The following characteristics of the gear should be included in the description of a trawl survey:

(i) full net plan; and
(ii) full description of ground tackle from trawl door to trawl door.

6.3 The geometry of trawl nets is known to vary due to a variety of causes. These include water depth, bottom type, warp length, wind and current direction relative to ship's heading (Carrothers, 1981; Engås, 1991). The high natural variation in fish distribution corresponds to a high intrinsic variance in the data which often masks variation due to these operational characteristics. Even so, the group recommended that these variables should be monitored whenever possible.

6.4 Electronic equipment is now available for monitoring many aspects of the trawl configuration during fishing, such as headline height, wing spread, door spread, effective fishing area, and water temperature and depth. Wherever possible it was recommended that these devices be used to monitor the behaviour of the net.

6.5 In the absence of electronic monitoring equipment other devices, such as a cable between the doors to control the door spread, might be helpful in standardising the operation of the gear (Engås, 1991).

6.6 The degree to which the target species are herded into the net by sweep wires and wings in the net is unknown. This affects the effective area of the net and hence the swept area, the parameter that is used for standing stock estimation. It was agreed that for standing stock estimation by the swept area method the width of the net should be defined as the estimated distance between the wings in a straight line when the net is in operation.

6.7 Current practice is to use a standard haul time of 30 minutes with the net on the bottom. Recent studies by Vølstad (1990) have indicated that shortening the haul time to 10 minutes or less allows more hauls to be made during the course of a survey without any loss of precision in standing stock estimates. Bearing in mind the distance between sampling sites and the problems of finding suitable trawling grounds it was felt that such gains would be unlikely to be made in Antarctic waters. It was also noted that a longer haul time would improve sampling for population structure studies. The group agreed that 30 minutes was probably the best standard haul time for surveys in Antarctic waters.

6.8 It is current practice to assume that the net is fishing correctly on the bottom from the time that the winch brakes are applied until hauling commences. This may not be the case, particularly for deep hauls. The group recommended that whenever possible the time on the bottom should be monitored precisely using a net sounder or similar device.

Fish Behaviour in Relation to Fishing Gear

6.9 The main clues that the fish have of the presence of a net are either visual, sight of the net or a 'sand cloud', or vibration, from strain in the rigging wires or noise from the fishing vessel.

6.10 Responses by fish to the presence of a net vary greatly even between closely related species. For example, in the North Sea, cod (*Gadus morhua*) swim down towards the seabed when a net approaches whereas haddock (*Gadus aeglefinus*) swim upwards (Main and Sangster, 1981, 1982; Ehrich, 1991). No information is available to indicate how Antarctic fish respond to the presence of trawls.

6.11 There is evidence that the pattern of reaction behaviour by fish to an approaching net is largely controlled by visual stimuli. Reaction ceases below a certain level of light and fish react to a trawl only when struck by the net (Glass and Wardle, 1989). This may lead to a different pattern of entrance to the net. It suggests that catchability may be dependent on the time of the day and fishing depth. The sensitivity of Antarctic fish to light is unknown but it must be assumed that, at least in shallow water, the fish are likely to see the net or sweep wires before they reach them. No information is available to indicate the likely response of the fish to these visual cues.

6.12 Fast swimming fish, such as mackerel (*Scomber scombrus*) have been observed swimming for up to 15 minutes in the mouth of a trawl net (He and Wardle, 1988), behaviour that is likely to affect the catching efficiency of the net. Evidence from physiological studies on Antarctic fish indicates that they would be unlikely to sustain a high level of swimming activity for more than perhaps a minute (Johnston and co-authors, see Kock, 1992). This would indicate that fish that are located in front of the net will be unable to avoid it and are therefore likely to be caught.

6.13 The group was unable to discuss extensively all factors potentially or effectively influencing catchability (see Carrothers, 1981; Godø, 1990; Engås, 1991 for a review). Due to the absence of information, most estimates of standing stock biomass using the swept area method have assumed a catchability (**q**) of 100 %, i.e. $q = 1$. This is unlikely to be met in reality, but the assumption that $q < 1$ is somewhat balanced by the herding effect of the doors and bridles increasing the area effectively swept by the net. As fish behaviour is an important factor affecting catchability the group strongly recommends that studies be undertaken to investigate the responses of Antarctic fish to the presence of the gear using techniques, such as remotely controlled underwater cameras, acoustic equipment and split-panel nets.

Fish Distribution in the Area

6.14 The distribution of fish within the survey area was discussed from two perspectives, small-scale distribution with respect to the volume of water sampled by the net and larger scale distribution over the whole area surveyed.

Small-Scale Distribution

6.15 *C. gunnari* are known to occur close to the bottom during daytime and an unknown proportion migrate upwards at night to feed in the water column. They are rarely more than 15 m from the bottom by day with the bulk of the fish less than 5 to 7 m from the bottom (Duhamel, 1987; Frolkina and Shlibanov, 1991). There is some evidence for the larger, and therefore older, fish being present closest to the seabed during the day. Therefore, the group recommended that net sampling during trawl surveys targetted at *C. gunnari* should be undertaken during daylight.

6.16 *C. aceratus* and *N. gibberifrons* primarily feed on the bottom and are thought to occur predominantly within about 1 m of the seabed.

6.17 *N. rossii, N. squamifrons, P. georgianus* and *Chionodraco hamatus* are known to feed on fish, krill and salps and probably feed well above of the seabed. The extent and frequency of these feeding migrations is unknown, but it is assumed that they occur during darkness.

Large-Scale Distribution

6.18 The main aspects of large-scale distribution that were considered of relevance to survey design were the geographical limits of individual stocks and the degree of aggregation of the fish. Previous surveys have provided some information on these aspects. In addition, much useful data could be derived from an analysis of haul-by-haul data from the commercial fishery. These data are currently unavailable to CCAMLR. The group recommends that these data be made available so that they can be used in planning future surveys.

6.19 At South Georgia during the summer, *C. gunnari* are likely to be found over most of the shelf in water less than 300 m deep. When the standing stock is low, as for example during the 1990/91 season, the fish are thought not to form larger concentrations. When the standing stock is high, dense aggregations do form which often extend some way above the seabed even in daytime.

6.20 It is unknown how long these aggregations persist but, because they have formed the focus of large-scale commercial fishing, it is assumed that they are present for several days or perhaps weeks.

6.21 Information from bottom trawl surveys indicates that these aggregations are likely to be found in small localities almost anywhere on the shelf. So far, it is impossible to identify where these aggregations might be in a particular season.

6.22 The presence of these aggregations is thought to be associated with the distribution of krill (*Euphausia superba*), a major food of *C. gunnari*. The distribution of krill is known to be dependent on the water circulation pattern in the South Georgia area in particular and the Scotia Sea in general.

6.23 Unequivocal information on the location of concentrations was not available to the meeting but it was felt that analysis of haul-by-haul data from the krill and *C. gunnari* fisheries might provide some further insight into the subject.

6.24 Spawning concentrations of *C. gunnari* have been observed inside bays on the northeast side of South Georgia during March, April and May. No information is available to indicate what proportion of the spawning stock enters these bays to spawn or whether these fish represent a constant proportion of the total spawning stock.

6.25 At Kerguelen during September, *C. gunnari* spawn inshore in water depths of 100 to 150 m. After spawning the fish move along the shelf on a feeding migration. It is not clear whether the extent of this feeding migration is dependent on the abundance of the fish.

6.26 No information was available to the meeting on the distribution of spawning concentrations of *C. gunnari* in Subareas 48.1 and 48.2.

6.27 The group agreed that surveys for standing stock estimation should not be undertaken during the spawning season due to the uneven distribution of fish at this time.

6.28 The distribution of *N. gibberifrons*, *C. aceratus* and *P. georgianus* appears to be more uniform than that of *C. gunnari* over the shelf at South Georgia. Local concentrations may nonetheless occur.

6.29 The distribution of *N. rossii* is extremely patchy and appears to be concentrated in canyons, for example at the eastern end of South Georgia and also north of Cumberland Bay. The group felt that surveys targetting on this species should be concentrated in these specific areas and also make use of any haul-by-haul information from historical catches in determining sampling localities.

6.30 *N. squamifrons* has occasionally occurred in large concentrations in single hauls of surveys at South Georgia but these concentrations are unlikely to be representative since an unknown part of the population is found deeper than 500 m.

6.31 At Kerguelen the major concentrations of each species of commercial importance appear to be located in different areas of the shelf and shelf break (Duhamel, 1987). The group thought that surveys could be designed so that the effort could be concentrated in the area of greatest abundance of the primary target species.

DESIGN OF BOTTOM TRAWL SURVEYS

7.1 Using the information described in the preceeding paragraphs and from the tabled papers several options for bottom trawl surveys were considered.

Non-Random (Systematic) Surveys

7.2 Surveys based on a grid of regularly spaced sampling stations were considered to be useful when there was no *a priori* information available about the distribution of the resource. The approach has the distinct disadvantage that, due to the uneven nature of the seabed on many Antarctic fishing grounds, few stations on a regular grid would be suitable for fishing. No standing stock surveys have been reported to CCAMLR that have used regular pattern sampling grid. This approach was not recommended by the group.

Random Surveys

7.3 The normal practice in recent years has been to undertake surveys using series of randomly located sampling stations. Due to the widespread presence of bad trawling grounds the sampling stations have been determined as 'the nearest available trawlable location to the given position'. In some instances this may be several miles from the pre-selected position. Subsequent surveys have sampled at the same sites rather than in other randomly selected localities.

7.4 The optimum time to undertake such surveys is when the fish are as dispersed as possible; at South Georgia this is most likely to occur during the summer months when all the target fish species are actively feeding. Although spawning, and hence aggregation, of *C. gunnari* at Kerguelen occurs later than at South Georgia, the fish are likely to be most widely dispersed on the shelf during the same months.

Stratification

7.5 Stratification of the survey has distinct advantages because it allows the concentration of sampling effort into regions of highest abundance. At South Georgia the surveys have been divided into three strata based on water depth. These are: 50 to 150, 150 to 250 and 250 to 500 m. The number of stations allocated to each of these strata is based on the area of seabed within each depth stratum weighted by abundance observed on previous surveys within that depth stratum (Parkes *et al*., 1990). An alternative approach is to incorporate the variance of the standing stock estimate into the weighting factor (Sparre *et al*., 1989).

7.6 Surveys for *C. gunnari* at South Georgia have indicated that the highest concentrations are present in the depth range 150 to 250 m whereas at Shag Rocks the density is approximately the same in this and the 50 to 150 m depth stratum.

7.7 At Kerguelen *C. gunnari* tends to be concentrated in the depth range 100 to 200 m.

7.8 The group agreed that it would be advantageous to stratify the survey further by identifying areas where the abundance was likely to be high. Even though it is known that concentrations are likely to be encountered no information was available to provide a reasonable indication of where they might be. This form of stratification was considered important in survey design and it was agreed that some mechanism needed to be incorporated into the design to allow increased sampling of high density patches that might be located during the survey.

Approaches to Survey Design that Take Account of Local High Concentrations

7.9 Three options were considered, all of which are based on a series of randomly located sampling stations which would be augmented by additional sampling at areas of high concentration.

Two-Stage Survey - First Approach

7.10 The time available for the survey would be apportioned to two phases, the standard random sampling stations and intensive sampling on concentrations. The division between these two phases would be made based on the number and size of concentrations that are expected to be encountered. Stations would be sampled sequentially and the location of any concentration of fish that is detected would be noted. At the end of this first phase the remaining sampling period would be divided up to allow sampling on the concentrations. The sampling on the concentrations would include hauls to estimate density and small-scale surveys to map the concentrations. This ‘encounter-response’ approach is described in Leaman (1981).

7.11 This approach has the advantage that the effort allocated to the high density stratum can be apportioned to the concentrations in advance of that phase of the sampling program. A disadvantage of this approach is that the time allocation may not be sufficient to sample all the concentrations adequately. Therefore up two weeks may have elapsed between the concentration being first detected and the vessel returning to sample on it; there is a significant chance that after this amount of time the concentration might not be found again.

Two-Stage Survey - Second Approach

7.12 This approach is similar to the First Approach described in paragraph 7.10 except that the intensive sampling on the concentrations is undertaken when the concentrations are detected.

7.13 This approach has the advantage that the concentration can be relocated for sampling. It has the disadvantage that in the event that several concentrations are detected early in the survey this might constrain sampling activity later in the program.

7.14 Both of these approaches have the disadvantage that it is unlikely that all concentrations within the survey area will be detected and sampled. A scaling factor, determined by consideration of the sizes of concentrations detected in relation to the survey track, will need to be incorporated to take account of the underestimation of the standing stock in this stratum.

An Adaptive Approach

7.15 Using a simple model, Everson *et al*. (1992) had considered options for incorporating information on the presence of patches obtained during a survey into the design.

7.16 All of the randomly located sampling sites would be given a randomly selected ranking in addition to their 'sampling order'. Stations would be sampled in 'sampling order' and the total distance sailed between the stations measured. When a concentration is located it would be sampled and its chord length measured. As each patch is sampled the lowest ranked station is deleted from the list of remaining stations. Thus, as concentrations are detected sampling effort is increased in these high density locations at the expense of the predetermined sampling sites.

7.17 The ratio of the total intersected chord length of all concentrations detected to the total distance steamed during the survey provides an estimate of the proportion of the survey area that is occupied by concentrations. This factor, multiplied by the mean 'within concentration' density provides an estimate of the standing stock in the high density stratum.

7.18 As a practical aspect it was suggested that when the vessel is in transit, as for example from station 'A' to station 'B', if a concentration is detected the vessel should complete the track to station 'B' before breaking off and fishing at the concentration. This would ensure that the chord length of the concentration is properly determined. The net haul could be made at the mid-point of the concentration.

7.19 This approach has the advantage that all the time allocated to the survey can be used effectively irrespective of how many concentrations are present in the area. It has the disadvantage that it provides little information on the size or density of individual concentrations; such information could be provided by further sampling following completion of the survey.

Consideration of the Different Approaches

7.20 The group favoured the adaptive approach as it offered the most effective utilisation of sampling effort. Formulae for parameter estimation and combining data over strata are given in Attachment D.

7.21 The similarity of the approaches depends on their ability to take into account the limits of fish concentrations. Experience has shown that although fish concentrations often appear as more or less continuous layers close to the seabed (see Duhamel, 1987: Figure 98; Kock, 1992: Figure 63), in which case determination of the limits of the concentrations present little difficulty, they are frequently present only as separate but close aggregations (see Frolkina and Shlibanov, 1991: Figure 4).

7.22 The group recommended that further work be undertaken so as to better define the characteristics of echotraces of *C. gunnari* aggregations.

7.23 The group discussed the approaches to sampling within high concentration regions. The ‘rules’ of the two-stage and the adaptive approaches indicate that the net hauls within the concentrations should be randomly located because the aim is to provide estimates of density within this high density stratum. Where the distribution is discontinuous within the concentration the hauls should not be targetted at local high concentrations. It was agreed that this situation could only be resolved by examination of echocharts from actual hauls within concentrations. The group also agreed that statistical advice should be sought on sampling strategies when the target species is discontinuously distributed within a small area.

7.24 The group also considered the possibilities of repeat sampling within concentrations. Repeat sampling has the advantage that the sample size is increased. It also has the disadvantages that samples subsequent to the first are unlikely to be statistically independent and also there may be behavioural responses (dispersion or aggregation) resulting from the initial haul.

ANALYSIS OF BOTTOM TRAWL SURVEY DATA

8.1 For many applications the Normal distribution is assumed to fit the distributions of the data. When the target species is widespread and not present in aggregations this is probably appropriate (Saville, 1977). The approach has the advantage that there is a wide range of statistical tests that can be applied to the data.

8.2 Bottom trawl survey data do contain many datasets where the distribution is markedly skewed and for which Normal statistics are not appropriate. Under these circumstances transformations are applied to the data. Of those that are commonly used are Poisson, negative binomial, log(x+1), gamma, delta and beta distributions (e.g., Steinarsson and Stefansson, 1986; Pennington, 1986; Conan, 1987; Gröger and Ehrich, 1992).

8.3 The group noted some situations when different transformations might be appropriate for different components of a survey. For example, on a survey at South Georgia the more or less uniform distribution of *N. gibberifrons* might be analysed using Normal statistics on untransformed data whereas data on *C. gunnari*, which are generally highly skewed might warrant an alternative treatment. It was also noted that for one species data from different strata might warrant different treatments.

8.4 The group was unclear on some applications of these techniques. Specifically these were:

- Conversion of transformed to untransformed data for the purposes of providing values of mean and variance that could be included in management advice.

- Combination of means and variances from stratified surveys where different functions had been applied to different strata.

8.5 In the absence of specialist statistical advice the group was unable to comment further.

8.6 The group was aware of developments in the use of geostatistics for analysing survey data (e.g., Conan, 1987; Petitgas, 1990), but nobody in the group had specialist knowledge of the technique.

MANUAL FOR BOTTOM TRAWL SURVEYS IN THE CONVENTION AREA

9.1 Based on information included in the reports of WG-FSA and also presented at this meeting, the group prepared a draft manual to describe standard procedures to be used in undertaking bottom trawl surveys. A copy of the draft manual is included as Attachment E for further consideration by the Working Group on Fish Stock Assessment.

ADOPTION OF THE REPORT

10.1 The Report of the Workshop on the Design of Bottom Trawl Surveys was adopted.

CLOSE OF THE MEETING

11.1 In closing the meeting, the Convener thanked the participants for their input and the good humour throughout the three days. Dr Everson, on behalf of the participants of the workshop, expressed his thanks to the Convener and his staff for their hospitality in hosting the meeting.

Table 1.A: Areas of seabed within selected depth ranges in Subarea 48.1 west (from Everson, 1987).

Sub-division	Coordinates				Percentage of Sea Area in Depth Range (m)					Area (km²)	
	N	S	E	W	0-50	50-150	150-250	250-500	>500	Sea	Total
21	62°00’	62°20’	60°30’	61°10’	-	2.2	8.7	44.6	44.6	1284	1284
22	62°20’	62°40’	60°30’	61°10’	-	85.7	7.7	6.6	0	964	1266
23	62°40’	63°05’	60°30’	61°10’	-	24.7	27.4	44	3.9	1476	1565
24	62°40’	63°05’	60°00’	60°30’	-	7.3	5.5	9.6	77.6	1036	1174
25	62°20’	62°40’	60°00’	60°30’	-	95.2	2.1	2.8	0	564	947
26	62°00’	62°20’	60°00’	60°30’	-	54.1	17.8	19	9.1	961	961
27	60°00’	64°00’	64°00’	70°00’	0	0	0	3.4	96.6	371299	371299
28	60°00’	61°00’	60°00’	64°00’	0	0	0	0	100	24340	24340
29	64°00’	66°00’	68°00’	70°00’	-	0.4	-	49.2	50.4	20886	20886
30	66°00’	67°00’	68°00’	70°00’	-	3.9	3.1	67.9	25.1	9226	9850
31	67°00’	68°00’	68°00’	70°00’	-	51.8	12.7	25	10.5	6607	9456
32	68°00’	69°00’	68°00’	70°00’	-	19.2	6	61.4	13.5	9049	9054
33	66°00’	67°00’	66°00’	68°00’	-	22.1	23.4	49.7	4.8	8110	9850
34	67°00’	68°00’	66°00’	68°00’	-	36.6	17.2	37.6	8.6	2261	9456
35	68°00’	69°00’	66°00’	68°00’	-	53.4	23	23.6	0	3555	9054
36	61°00’	62°00’	61°10’	64°00’	0	0	0	0	100	16703	16703
37	62°00’	63°00’	61°10’	64°00’	-	15.9	5	6.8	72.3	15952	16159
38	63°00’	64°00’	61°10’	64°00’	-	19.2	12.9	36.2	31.7	14894	15617
39	61°00’	62°00’	60°00’	61°10’	-	0	0	3.2	96.8	6877	6877
40	63°05’	64°00’	60°00’	61°10’	-	22.3	5.2	9.2	63.3	5586	5874
41	65°00’	66°00’	66°00’	68°00’	-	13.9	23	50.9	12.2	10085	10245
42	64°00’	65°00’	66°00’	68°00’	0	0	2.4	67.1	30.5	10637	10637
43	64°00’	65°00’	64°00’	66°00’	-	15.3	7.2	43	34.5	10407	10637
44	65°00’	66°00’	64°00’	66°00’	-	42.2	42.2	11.2	4.4	8685	10245
45	66°00’	67°00’	64°00’	66°00’	-	5.6	5.6	1	0	1196	9850
46	64°00’	65°00’	62°00’	64°00’	-	35.9	35.9	16	12.1	6744	10637
47	64°00’	65°00’	61°00’	62°00’	-	33.7	33.7	18.4	14.2	2686	5319
	Total for Subarea 48.1 west				-	10.4	6.1	18.6	64.9	572070	609242

Table 1.B: Areas of seabed within selected depth ranges in Subarea 48.1 west (from Everson, 1987).

Sub-division	Coordinates				Percentage of Sea Area in Depth Range (m)							Total Sea Area (km^2)
	N	S	E	W	0-150	0-250	0-500	>50	>150	>250	>500	
21	62°00’	62°20’	60°30’	61°10’	2.2	10.8	55.4	100	97.8	89.2	44.6	1284
22	62°20’	62°40’	60°30’	61°10’	85.7	93.4	100	100	14.3	6.6	0	964
23	62°40’	63°05’	60°30’	61°10’	24.7	52.1	96.1	100	75.3	47.9	3.9	1476
24	62°40’	63°05’	60°00’	60°30’	7.3	12.9	22.4	100	92.4	87.1	77.6	1036
25	62°20’	62°40’	60°00’	60°30’	95.2	97.2	100	100	4.8	2.8	0	564
26	62°00’	62°20’	60°00’	60°30’	54.1	71.9	90.9	100	45.9	28.1	9.1	961
27	60°00’	64°00’	64°00’	70°00’	0	0	3.4	100	100	100	96.6	371299
28	60°00’	61°00’	60°00’	64°00’	0	0	0	100	100	100	100	24340
29	64°00’	66°00’	68°00’	70°00’	0.4	0.4	49.6	100	96.6	96.6	50.4	20886
30	66°00’	67°00’	80°00’	70°00’	3.9	7	74.9	100	96.1	93	25.1	9226
31	67°00’	68°00’	68°00’	70°00’	51.8	64.5	89.5	100	48.2	35.5	10.5	6607
32	68°00’	69°00’	68°00’	70°00’	19.2	25.2	86.5	100	80.8	74.8	13.5	9049
33	66°00’	67°00’	66°00’	68°00’	22.1	45.5	45.2	100	77.9	54.5	4.8	8110
34	67°00’	68°00’	66°00’	68°00’	36.6	53.8	91.4	100	63.4	46.2	8.6	2261
35	68°00’	69°00’	66°00’	68°00’	53.4	76.4	100	100	46.6	23.6	0	3555
36	61°00’	62°00’	61°10’	64°00’	0	0	0	100	100	100	100	16703
37	62°00’	63°00’	61°10’	64°00’	15.9	20.9	27.7	100	84.1	79.1	72.3	16159
38	63°00’	64°00’	61°10’	64°00’	19.2	32.1	68.3	100	80.8	67.9	31.7	15617
39	61°00’	62°00’	60°00’	61°10’	0	0	3.2	100	100	100	96.8	5877
40	63°05’	64°00’	60°00’	61°10’	22.3	27.5	36.7	100	77.7	72.5	63.3	5586
41	65°00’	66°00’	66°00’	68°00’	13.9	37	87.8	100	86.1	63	12.2	10085
42	64°00’	65°00’	66°00’	68°00’	0	2.4	69.5	100	100	97.6	30.5	10637
43	64°00’	65°00’	64°00’	68°00’	15.3	22.5	65.5	100	84.7	77.5	34.5	10407
44	65°00’	66°00’	64°00’	66°00’	42.2	84.4	95.6	100	57.8	15.6	4.4	8685
45	66°00’	67°00’	64°00’	66°00’	5.6	11.2	12.1	100	94.4	88.8	87.9	1196
46	64°00’	65°00’	62°00’	64°00’	35.9	71.9	87.9	100	64.1	28.1	12.1	6744
47	64°00’	65°00’	61°00’	62°00’	33.7	67.4	85.8	100	66.3	32.6	14.2	5319
	Total for Subarea 48.1 west				10.0	15.4	33.8	100	90	84.1	66.2	575633

Table 1.C: Areas of seabed within selected depth ranges in Subarea 48.1 east (from Everson, 1987).

Sub-division	Coordinates				Percentage of Sea Area in Depth Range (m)					Area (km^2)	
	N	S	E	W	0-50	50-150	150-250	250-500	>500	Sea	Total
1	62°00’	62°20’	59°30’	60°00’	-	2.2	8.7	44.6	44.6	956	957
2	62°00’	62°20’	58°30’	59°30’	-	91.6	2.9	3.7	1.8	1359	1934
3	62°00’	62°20’	57°30’	58°30’	-	27.6	6.4	12	54	1500	1934
4	62°20’	62°40’	57°30’	58°30’	-	0	0	0	100	1898	1898
5	62°20’	62°40’	58°30’	59°30’	-	9.5	2.7	3.2	84.5	1809	1898
6	62°20’	62°40’	59°30’	60°00’	-	63.3	8.7	9.7	18.4	772	949
7	62°40’	63°05’	59°00’	60°00’	-	0.3	0.3	2.6	96.7	2350	2352
8	62°40’	63°05’	58°00’	59°00’	-	4.6	3.4	22.7	69.3	2352	2352
9	62°40’	63°05’	57°30’	58°00’	-	95.3	2	2.7	0	1176	1176
10	60°00’	61°00’	50°00’	60°00’	-	0.6	1.2	2.6	95.6	60850	60850
11	61°00’	63°00’	50°00’	53°00’	0	0	0	0	100	34819	34819
12*	58°00’	60°00’	50°00’	58°00’	0	0	0	0	100	101837	101837
13	61°00’	62°00’	57°30’	60°00’	-	6.6	4.3	20.4	68.8	14417	14740
14	61°00’	62°00’	56°00’	57°30’	-	1.5	2.4	28.4	67.4	8843	8843
15	61°00’	62°00’	53°00’	56°00’	-	11.6	2.8	12.1	73.5	17110	17686
16	62°00’	63°00’	56°00’	57°30’	-	14.4	11.1	12.9	61.6	8539	8555
17	62°00’	63°00’	53°00’	56°00’	-	2	18	41.8	38.2	17109	17109
18	63°05’	64°00’	57°30’	60°00’	-	31.7	5.8	16.5	45.9	5136	12587
19	63°00’	64°00’	56°00’	57°30’	-	15.4	3.6	7.2	73.8	6279	8268
20	63°00’	64°00’	50°00’	56°00’	-	4.5	1.8	86.1	7.5	30827	33082
	Total for Subarea 48.1 east				-	5.6	3.2	11.6	79.6	218101	226989

* Subdivision 12 is outside Subarea 48.1

Table 1.D: Areas of seabed within selected depth ranges in Subarea 48.1 east (from Everson, 1987).

Sub-division	Coordinates				Percentage of Sea Area in Depth Range (m)							Total Sea Area (km^2)
	N	S	E	W	0-150	0-250	0-500	>50	>150	>250	>500	
1	62°00’	62°20’	59°30’	60°00’	2.2	10.8	55.4	100	97.8	89.2	44.6	956
2	62°00’	62°20’	58°30’	59°30’	91.6	94.5	98.2	100	8.4	5.5	1.8	1359
3	62°00’	62°20’	57°30’	58°30’	27.6	34	46	100	72.4	66	54	1500
4	62°20’	62°40’	57°30’	58°30’	0	0	0	100	100	100	100	1898
5	62°20’	62°40’	58°30’	59°30’	9.5	12.2	15.5	100	90.5	87.8	84.5	1809
6	62°20’	62°40’	59°30’	60°00’	63.3	71.9	81.6	100	36.7	28.1	18.4	772
7	62°40’	63°05’	59°00’	60°00’	0.3	0.7	3.3	100	99.7	99.3	96.7	2350
8	62°40’	63°05’	58°00’	59°00’	4.6	8	30.7	100	95.4	92	69.3	2352
9	62°40’	63°05’	57°30’	58°00’	95.3	97.3	100	100	4.7	2.7	0	1176
10	60°00’	61°00’	50°00’	60°00’	0.6	1.8	4.4	100	99.4	98.2	95.6	60850
11	61°00’	64°00’	50°00’	53°00’	0	0	0	100	100	100	100	34819
12*	58°00’	60°00’	50°00’	58°00’	0	0	0	100	100	100	100	101837
13	61°00’	62°00’	57°30’	60°00’	6.6	10.8	31.2	100	93.4	89.2	68.8	14417
14	61°00’	62°00’	56°00’	57°30’	1.5	3.8	32.2	100	98.5	96.2	67.8	8843
15	61°00’	62°00’	53°00’	56°00’	11.6	14.4	26.5	100	88.4	85.6	73.5	17110
16	62°00’	63°00’	56°00’	57°30’	14.4	25.5	38.4	100	85.6	74.5	61.6	8539
17	62°00’	63°00’	53°00’	56°00’	2	20	61.8	100	98	80	78.2	17109
18	63°05’	64°00’	57°30’	60°00’	31.7	37.6	54.1	100	68.3	62.4	45.9	12587
19	63°00’	64°00’	56°00’	57°30’	15.4	19	26.2	100	84.6	81	73.8	6279
20	63°00’	64°00’	50°00’	56°00’	4.6	6.4	92.5	100	95.4	93.6	7.5	30827
	Total for Subarea 48.1 east				5.6	8.8	20.4	100	94.6	91.5	80.3	218101

* Subdivision 12 is outside Subarea 48.1

Table 1.E: Areas of seabed within selected depth ranges around Elephant Island (Subarea 48.1) (from Kock, 1986).

Depth (m)	Area of Seabed (nm^2)
0 - 100	458.8
101 - 200	461.5
201 - 300	500.0
301 - 400	736.5
401 - 500	1012.1

Table 1.F: Areas of seabed within selected depth ranges in Subarea 48.2 (from Everson, 1987).

Sub-division	Coordinates				Percentage of Sea Area in Depth Range (m)					Area (km^2)	
	N	S	E	W	0-50	50-150	150-250	250-500	>500	Sea	Total
73	60°21’	60°40’	44°10’	45°00’	-	10.8	7.8	15.9	65.5	1601	1603
74	60°40’	61°00’	44°10’	45°00’	-	27.6	61.4	11	0	1930	2008
75	60°40’	61°00’	45°00’	46°00’	-	19	29	52	0	1927	2008
76	60°40’	61°00’	46°00’	47°00’	-	11.2	70.8	18	0	2008	2008
77	60°00’	64°00’	30°00’	50°00’	0	0	0	4.5	95.5	452647	452647*
78	57°00’	60°00’	30°00’	50°00’	0	0	0	0	100	387430	387430
79	60°21’	60°40’	46°00’	47°00’	-	65	10.7	5	19.3	1919	1926
80	60°21’	60°40’	45°00’	46°00’	-	29.2	16	18.1	36.6	1535	1926
	Total for subarea				0	0.4	0.5	2	97.1	850997	851556

* Excludes areas 73 to 76, 79 and 80.

Table 1.G: Areas of seabed within selected depth ranges in Subarea 48.2 (from Everson, 1987).

Sub-division	Coordinates				Percentage of Sea Area in Depth Range (m)							Total Sea Area (km^2)
	N	S	E	W	0-150	0-250	0-500	>50	>150	>250	>500	
73	60°21'	60°40'	44°10'	45°00'	10.8	18.6	34.5	100	89.2	81.4	65.5	1601
74	60°40'	61°00'	44°10'	45°00'	27.6	89	100	100	72.4	11	0	1930
75	60°40'	61°00'	45°00'	46°00'	19	48	100	100	81	52	0	1927
76	60°40'	61°00'	46°00'	47°00'	11.2	82	100	100	88.8	18	0	2008
77	60°00'	64°00'	30°00'	50°00'	0	0	4.5	100	100	100	95.5	452647*
78	57°00'	60°00'	30°00'	50°00'	0	0	0	100	100	100	100	387430
79	60°21'	60°40'	46°00'	47°00'	65	75.7	80.7	100	35	24.3	19.3	1919
80	60°21'	60°40'	45°00'	46°00'	29.2	45.2	63.4	100	70.8	54.8	36.6	1535
	Total for Subarea 48.2.3				0.4	0.8	2.9	100	99.6	99.2	97.1	850997

* Excludes areas 73 to 76, 79 and 80.

Table 1.H: Areas of seabed within selected depth ranges in Subarea 48.3 between 53° and 54°30'S (from Everson and Campbell, 1990).

Areas of seabed (km²) around South Georgia between 53° and 54°30'S.

NE Corner			0-50	50-100	100-150	150-200	200-250	250-500	>500
S Deg	S Min	W							
53	0	43	0.0	0.0	0.0	0.0	0.0	12.0	3673.9
53	0	42	0.0	0.0	0.0	129.8	158.3	445.2	2952.6
53	0	41	0.0	0.0	88.9	116.9	41.4	26.8	3411.9
53	0	40	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	0	39	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	0	38	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	0	37	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	0	36	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	0	35	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	0	34	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	30	43	0.0	0.0	0.0	0.0	0.0	0.0	3642.8
53	30	42	0.0	0.0	93.3	174.9	115.0	178.6	3081.0
53	30	41	0.0	0.0	1209.8	500.2	495.1	410.5	1027.2
53	30	40	0.0	3.8	77.7	101.3	37.6	536.9	2885.5
53	30	39	0.0	0.0	0.0	39.5	138.1	689.2	2776.0
53	30	38	51.2	105.8	363.9	819.4	340.7	640.9	1320.9
53	30	37	107.6	232.7	1025.4	585.5	246.5	732.9	690.8
53	30	36	0.0	0.0	131.0	808.2	728.6	723.1	1251.9
53	30	35	0.0	0.0	6.0	57.7	81.6	270.5	3227.0
53	30	34	0.0	0.0	0.0	0.0	0.0	0.0	3642.8
54	0	43	0.0	0.0	0.0	0.0	0.0	0.0	3599.2
54	0	42	0.0	0.0	0.0	0.0	0.0	0.0	3599.2
54	0	41	0.0	0.0	0.0	0.0	0.0	0.0	3599.2
54	0	40	0.0	0.0	0.0	0.0	0.0	0.0	3599.2
54	0	39	0.0	0.0	15.8	260.6	457.5	482.7	2382.6
54	0	38	54.0	106.7	113.1	782.7	2466.2	66.5	0.0
54	0	37	124.4	46.6	41.6	14.3	5.5	4.6	0.0
54	0	37(S)	447.6	313.6	703.4	605.3	510.9	251.3	0.0
54	0	36	138.4	313.4	447.4	309.2	414.7	176.6	0.0
54	0	36(S)	175.0	76.7	26.2	24.9	23.8	0.0	0.0
54	0	35	0.0	38.8	100.5	451.4	1261.8	528.7	1218.0
54	0	34	0.0	0.0	0.0	0.0	0.0	0.0	3599.2

Table 1.I: Areas of seabed within selected depth ranges in Subarea 48.3 between 54°30 and 56°S (from Everson and Campbell, 1990).

Areas of seabed (km^2) around South Georgia between 54°30’ and 56°S.

NE Corner			0-50	50-100	100-150	150-200	200-250	250-500	>500
S Deg	S Min	W							
54	30	43	0.0	0.0	0.0	0.0	0.0	0.0	3555.5
54	30	42	0.0	0.0	0.0	0.0	0.0	0.0	3555.5
54	30	41	0.0	0.0	0.0	0.0	0.0	0.0	3555.5
54	30	40	0.0	0.0	0.0	0.0	0.0	0.0	3555.5
54	30	39	0.0	0.0	0.0	14.1	113.1	106.0	3322.3
54	30	38	0.0	0.0	0.0	542.9	715.0	273.8	2023.8
54	30	37	0.0	0.0	422.0	649.6	1034.7	455.5	993.7
54	30	36	17.9	2.6	10.3	0.0	0.0	0.0	0.0
54	30	36(S)	234.8	263.5	565.0	492.2	597.5	903.7	0.0
54	30	35	180.8	371.8	922.0	792.9	443.1	554.0	84.9
54	30	34	0.0	8.9	142.4	145.0	199.4	317.7	2742.1
55	0	43	0.0	0.0	0.0	0.0	0.0	0.0	3511.5
55	0	42	0.0	0.0	0.0	0.0	0.0	0.0	3511.5
55	0	41	0.0	0.0	0.0	0.0	0.0	0.0	3511.5
55	0	40	0.0	0.0	0.0	0.0	0.0	0.0	3511.5
55	0	39	0.0	0.0	0.0	0.0	0.0	0.0	3511.5
55	0	38	0.0	0.0	0.0	0.0	0.0	0.0	3511.5
55	0	37	0.0	0.0	0.0	0.0	0.0	6.9	3504.6
55	0	36	0.0	4.6	22.8	262.8	94.8	178.2	2948.3
55	0	35	0.0	52.8	1321.2	810.1	586.4	457.9	283.1
55	0	34	0.0	18.1	523.9	221.0	55.5	153.4	2539.6
55	30	43	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	42	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	41	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	41	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	39	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	38	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	37	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	36	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	35	0.0	0.0	0.0	0.0	0.0	18.3	3448.8
55	30	34	0.0	0.0	0.0	0.0	0.0	209.5	3257.7

Table 1.J: Areas of seabed within selected depth ranges in Subarea 48.3 between 53° and 54°30'S (from Everson and Campbell, 1990).

Areas of seabed (km^2) around South Georgia between 53° and 54°30'S.

NE Corner			50-150	150-250	250-500	>500
S Deg	S Min	W				
53	0	43	0.0	0.0	12.0	3673.9
53	0	42	0.0	2887.1	445.2	2952.6
53	0	41	88.9	158.3	26.8	3411.9
53	0	40	0.0	0.0	0.0	3685.9
53	0	39	0.0	0.0	0.0	3685.9
53	0	38	0.0	0.0	0.0	3685.9
53	0	37	0.0	0.0	0.0	3685.9
53	0	36	0.0	0.0	0.0	3685.9
53	0	35	0.0	0.0	0.0	3685.9
53	0	34	0.0	0.0	0.0	3685.9
53	30	43	0.0	0.0	0.0	3642.8
53	30	42	93.3	289.9	178.6	3081.0
53	30	41	1209.8	995.3	410.5	1027.2
53	30	40	81.5	138.9	536.9	2885.5
53	30	39	0.0	177.6	689.2	2776.0
53	30	38	469.7	1160.1	640.9	1320.9
53	30	37	1258.1	832.0	732.9	690.8
53	30	36	131.0	1536.8	723.1	1251.9
53	30	35	6.0	139.3	270.5	3227.0
53	30	34	0.0	0.0	0.0	3642.8
54	0	43	0.0	0.0	0.0	3599.2
54	0	42	0.0	0.0	0.0	3599.2
54	0	41	0.0	0.0	0.0	3599.2
54	0	40	0.0	0.0	0.0	3599.2
54	0	39	15.8	718.1	482.7	2382.6
54	0	38	219.8	3248.9	66.5	0.0
54	0	37	88.2	19.8	4.6	0.0
54	0	37(S)	1017.0	1116.2	251.3	0.0
54	0	36	760.8	723.9	176.6	0.0
54	0	36(S)	102.9	48.7	0.0	0.0
54	0	35	139.3	1713.2	528.7	1218.0
54	0	34	0.0	0.0	0.0	3599.2

Table 1.K: Areas of seabed within selected depth ranges in Subarea 48.3 between 54°30' and 56°S (from Everson and Campbell, 1990).

Areas of seabed (km²) around South Georgia between 54°30' and 56°S.

NE Corner			50-150	150-250	250-500	>500
S Deg	S Min	W				
54	30	43	0.0	0.0	0.0	3555.5
54	30	42	0.0	0.0	0.0	3555.5
54	30	41	0.0	0.0	0.0	3555.5
54	30	40	0.0	0.0	0.0	3555.5
54	30	39	0.0	127.2	106.0	3322.3
54	30	38	0.0	1257.9	273.8	2023.8
54	30	37	422.0	1684.3	455.5	993.7
54	30	36	12.9	0.0	0.0	0.0
54	30	36(S)	828.5	1089.7	903.7	0.0
54	30	35	1293.8	1236.0	554.0	84.9
54	30	34	151.3	344.4	317.7	2742.1
55	0	43	0.0	0.0	0.0	3511.5
55	0	42	0.0	0.0	0.0	3511.5
55	0	41	0.0	0.0	0.0	3511.5
55	0	40	0.0	0.0	0.0	3511.5
55	0	39	0.0	0.0	0.0	3511.5
55	0	38	0.0	0.0	0.0	3511.5
55	0	37	0.0	0.0	6.9	3504.6
55	0	36	27.4	357.6	178.2	2948.3
55	0	35	1374.0	1396.5	457.9	283.1
55	0	34	542.0	276.5	153.4	2539.6
55	30	43	0.0	0.0	0.0	3467.1
55	30	42	0.0	0.0	0.0	3467.1
55	30	41	0.0	0.0	0.0	3467.1
55	30	40	0.0	0.0	0.0	3467.1
55	30	39	0.0	0.0	0.0	3467.1
55	30	38	0.0	0.0	0.0	3467.1
55	30	37	0.0	0.0	0.0	3467.1
55	30	36	0.0	0.0	0.0	3467.1
55	30	35	0.0	0.0	18.3	3448.8
55	30	34	0.0	0.0	209.5	3257.7

Table 1.L: Summary of areas of seabed within selected depth ranges in Subarea 48.3 (from Everson and Campbell, 1990).

Summary of areas of seabed for Shag Rocks, South Georgia and the whole of Subarea 48.3. An asterisk (*) indicates that there are no reported soundings for this depth range.

Depth Range (m)	Area of Seabed (km^2)		
	Shag Rocks	South Georgia	Subarea 48.3
0 - 50	*	1 531.7	1 531.7
50 - 100	3.8	1 956.6	1 960.4
100 - 150	1 469.7	6 903.8	8 373.6
150 - 200	1 023.1	8 689.3	9 712.4
200 - 250	847.5	10 515.0	11 362.8
250 - 500	1 610.0	8 201.9	9 811.9
> 500	24 360.0	144 798.0	169 158.9
Total	29 314.1	182 597.6	211 911.7

Table 1.M: Areas of seabed within selected depth ranges in Subarea 48.4 (from Everson, 1987).

Sub-Division	Coordinates				% Sea Area in Depth Range (m)		Area (km^2)	
	N	S	E	W	0-500	>500	Sea	Total
66	56°00’	60°00’	24°00’	29°30’	0.9	99.1	143782	144073
67	50°00’	53°00’	26°00’	30°00’	0	100	92322	92322
68	53°00’	56°00’	26°00’	30°00’	0	100	86121	86121
69	60°00’	64°00’	24°00’	30°00’	0	100	139235	139235
70	56°00’	60°00’	29°30’	30°00’	0	100	13097	13097
71	50°00’	56°00’	20°00’	26°00’	0	100	267758	267758
72	56°00’	60°00’	20°00’	24°00’	0	100	104782	104782
	Total for subarea				0.1	99.9	847097	847388

Table 1.N: Areas of seabed within selected depth ranges in Subarea 48.4 (from Everson, 1987).

Sub-Division	Coordinates				% Sea Area in Depth Range (m)		Area (km²)	
	N	S	E	W	0-500	>500	Sea	Total
81	65°00’	70°00’	50°00’	66°00’	50	50	313029	378286
82	64°00’	65°00’	50°00’	60°00’	51.6	48.4	49890	53196
83	64°00’	65°00’	30°00’	50°00’	0	100	106396	106396
84	65°00’	70°00’	30°00’	50°00’	0	100	472858	472858
85	64°00’	78°00’	20°00’	30°00’	9.9	90.1	507572	561341
86	70°00’	78°00’	30°00’	62°00’	15.8	84.2	733571	871718
	Total for subarea				9.6	90.4	2183316	2445595

Table 1.O: Areas of seabed within selected depth ranges in Statistical Area 88 (from Everson, 1987).

Sub-division	Coordinates				Percentage Sea Area in Depth Range (m)							Total Sea Area (km²)
	N	S	E	W	0-150	0-250	0-500	>50	>150	>250	>500	
87	60°00’	66°00’	70°00’	92°00’	0	0	0	100	100	100	100	740541
88	66°00’	70°00’	70°00’	92°00’	4.6	5.5	15.6	100	95.4	94.5	84.4	393266
	Total for Area 88				1.7	2.0	5.6	100	98.3	96.3	94.4	1133807

Table 2: Maturity scale for nototheniids and channichthyids based on ovarian and testis cycles in *Notothenia coriiceps*, *Champsocephalus gunnari*, *Chaenocephalus aceratus* and *Pseudochaenichthys georgianus* (from Kock and Kellermann, 1991).

Maturity Stage	Description
Females:	
1. Immature	Ovary small, firm, no eggs visible to the naked eye
2. Maturing virgin or resting	Ovary more extended, firm, small oocytes visible, giving ovary a grainy appearance
3. Developing	Ovary large, starting to swell the body cavity, colour varies according to species, contains oocytes of two sizes
4. Gravid	Ovary large, filling or swelling the body cavity, when opened large ova spill out
5. Spent	Ovary shrunk, flaccid, contains a few residual eggs and many small ova
Males:	
1. Immature	Testis small, translucent, whitish, long, thin strips lying close to the vertebral column
2. Developing or resting	Testis white, flat, convoluted, easily visible to the naked eye, about $^{1}/_{4}$ length of the body cavity
3. Developed	Testis large, white and convoluted, no milt produced when pressed or cut
4. Ripe	Testis large, opalescent white, drops of milt produced under pressure or when cut
5. Spent	Testis shrunk, flabby, dirty white in colour

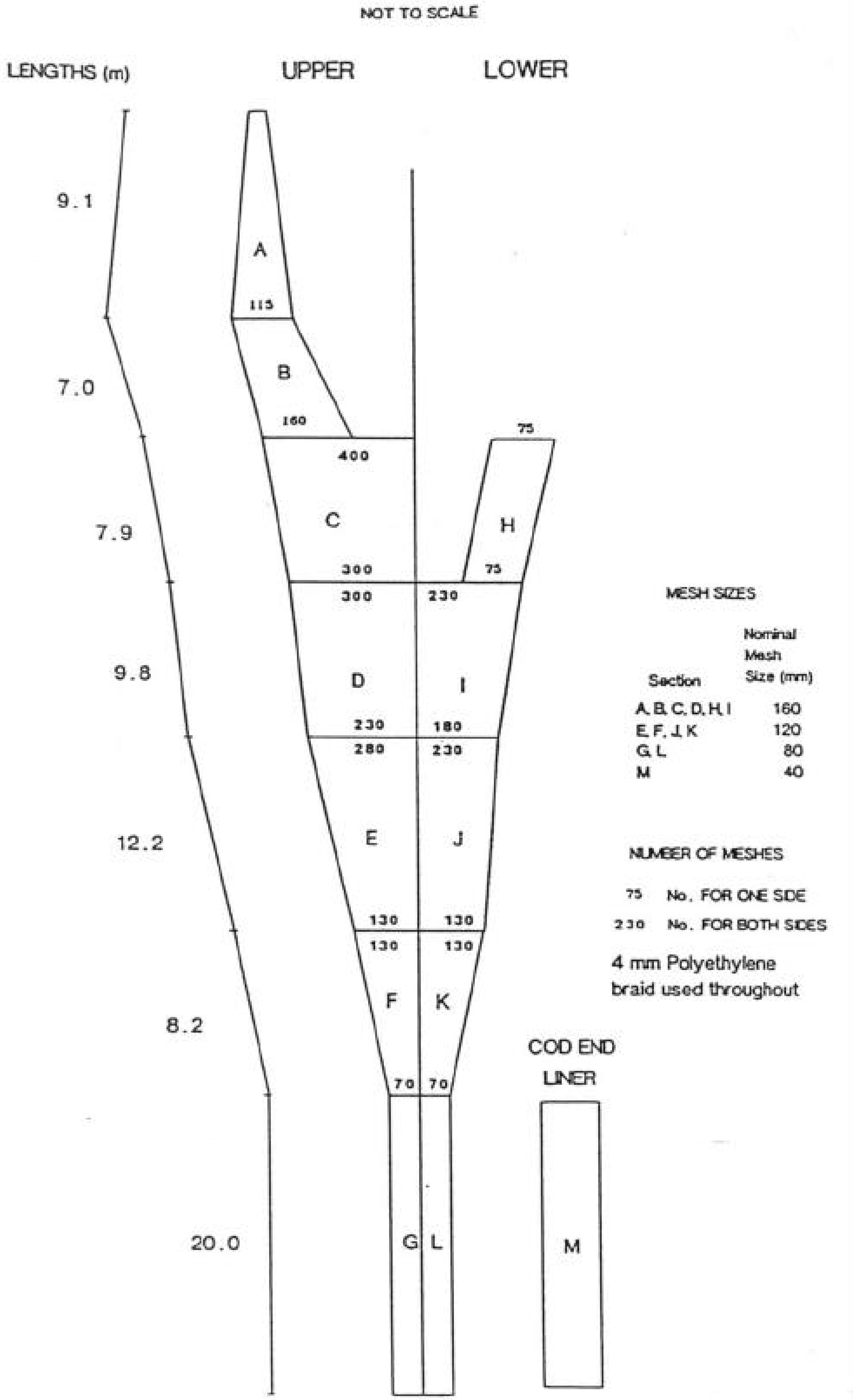

Figure 1: Construction of the FP-120 net (from Parkes, 1991).

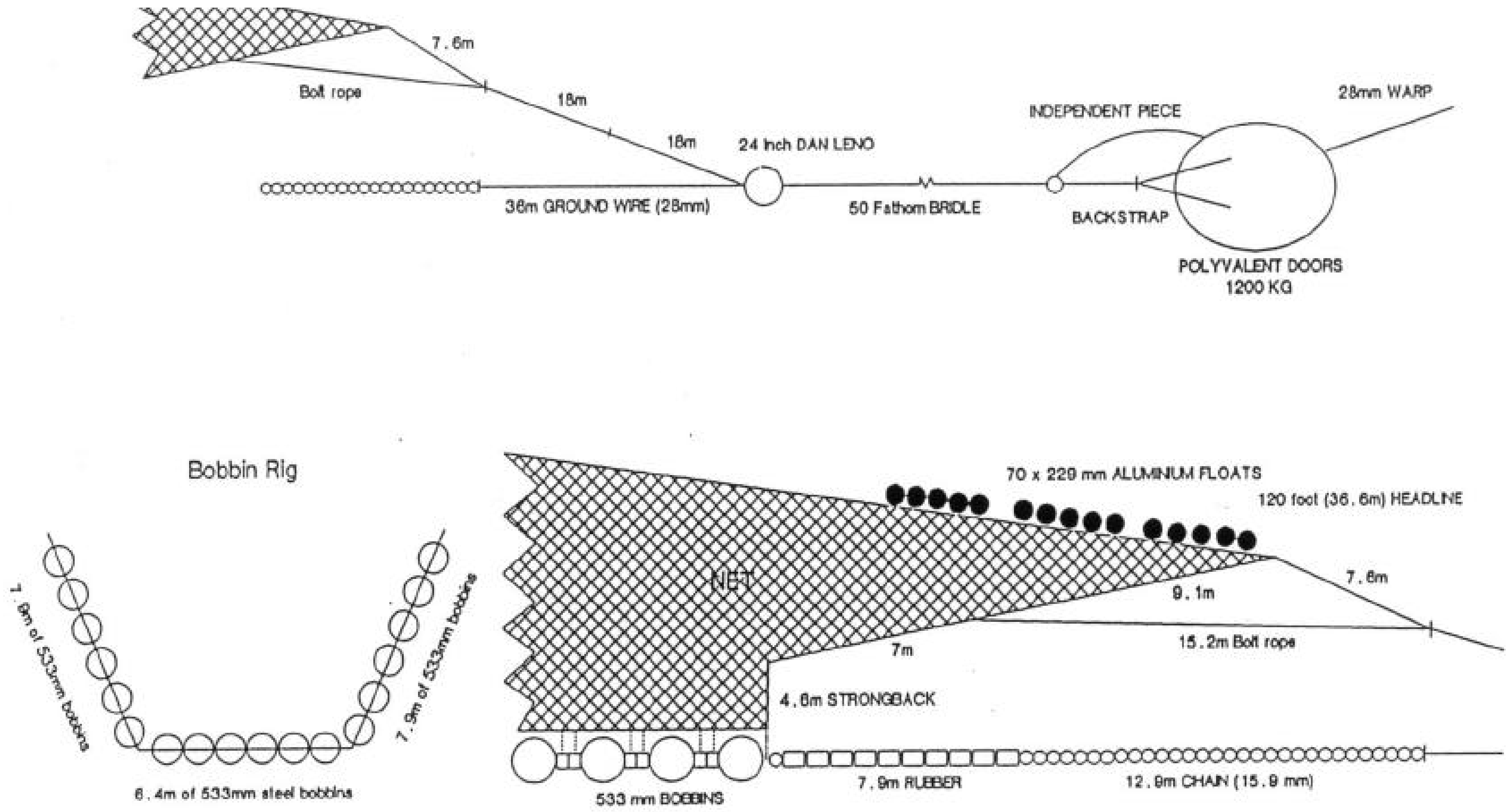

Figure 2: Rigging of the FP-120 trawl (from Parkes, 1991).

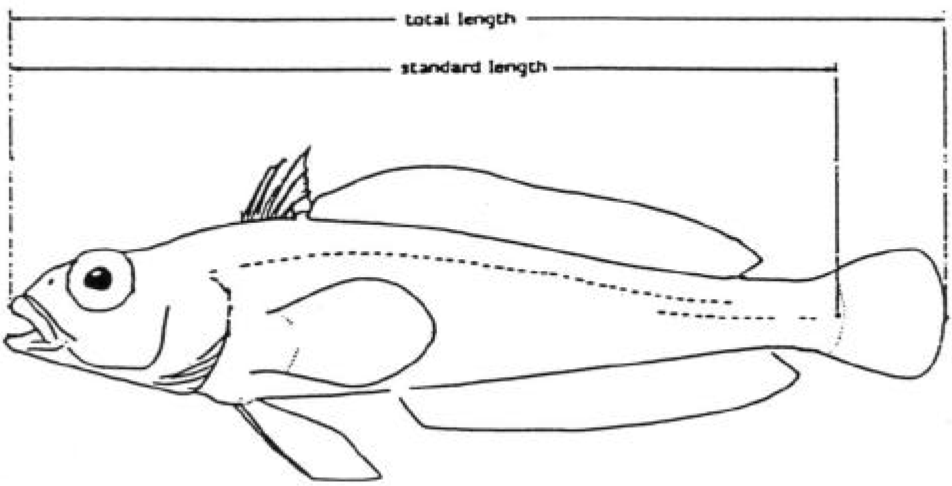

Figure 3: Standard body length measurements of fish.

TL - Total Length is from the most anterior part of the snout to the most posterior part of the caudal fin when this fin is extended along the length of the body.

SL - Standard length is from the most anterior part of the snout to the end of the vertebral column (usually marked by a vertical groove in the caudal peduncle when it is flexed).

LIST OF PARTICIPANTS

Workshop on Design of Bottom Trawl Surveys
(Hamburg, Germany, 16 to 19 September 1992)

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REFERENCES

Workshop on Design of Bottom Trawl Surveys
(Hamburg, Germany, 16 to 19 September 1992)

CARROTHERS, P.J.G. 1981. Catch variability due to variations in groundfish otter trawl behaviour and possibilities to reduce it through instrumental fishing gear studies and improved fishing procedures. In: DOUBLEDAY, W.G. and D. RIVARD (Eds). Bottom trawl surveys. *Canadian Special Publication of Fisheries Aquatic Sciences* 58: 247-257.

CONAN, G.Y. 1987. The paradigm of random sampling patches and the genesis of lognormal and negative binomial related models. Conseil International pour l'Exploration de la Mer C.M.1987/K:25. 11 pp. (mimeogr.).

DOUBLEDAY, W.G. and D. RIVARD. 1981. (Eds). Bottom trawl surveys. *Canadian Special Publication of Fisheries and Aquatic Sciences 58*: 1-273.

DUHAMEL, G 1987. *Ichtyofaune des secteurs indien occidental et atlantique oriental de l'océan austral: biogéographie, cycles biologiques et dynamique des populations*. Ph.D. Thesis. Université P. et M. Curie, Paris, France. 687 pp.

EHRICH, S. 1991. Comparative fishing experiments by research trawlers for cod and haddock in the North Sea. *Journal du Conseil. Conseil International pour l'Exploration de la Mer 47*: 275-283.

ENGÅS, A. 1991. *The effects of trawl performance and fish behaviour on the catching efficiency of sampling trawls*. Ph.D. Thesis. University of Bergen, Department of Fisheries and Marine Biology, Norway. 94 pp.

EVERSON, I. 1987. Areas of seabed within selected depth ranges in the South-West Atlantic and Antarctic Peninsula regions of the Southern Ocean. In: *Selected Scientific Papers 1987 (SC-CAMLR-SSP/4)*. CCAMLR, Hobart, Australia: 49-76.

EVERSON, I. and S. CAMPBELL. 1990. Areas of seabed within selected depth ranges in CCAMLR Subarea 48.3, South Georgia. Document *WG-FSA-90/8*. CCAMLR, Hobart, Australia: 7 pp. (mimeogr.).

EVERSON, I., M. BRAVINGTON and C. GOSS. 1992. Trawl survey design: results from a simulation study of the mackerel icefish, *Champsocephalus gunnari* at South Georgia. Document for the CCAMLR Workshop on Bottom Trawl Survey Design, Hamburg, Germany, 16-19 September, 1992.

FROLKINA, Zh.A. and V.I. SHLIBANOV. 1991. On the problem of icefish (*Champsocephalus gunnari*) vertical migration on the South Georgia shelf. Document *WG-FSA-91/6*. CCAMLR, Hobart, Australia: 11 pp. (mimeogr.).

GLASS, C.W. and C.S. WARDLE. 1989. Comparison of the reactions of fish to a trawl gear at high and low light intensities. *Fisheries Research 7*: 249-266.

GODØ, O.R. 1990. *Factors affecting accuracy and precision in abundance estimates of gadoids from scientific surveys*. Ph.D. Thesis. University of Bergen, Institute of Fisheries and Marine Biology, Norway. 169 pp.

GRÖGER, J. and S. EHRICH. 1992. The importance of catch frequency distributions for the interpretation of catch data and the fit by the very adaptable and realistic beta distribution. *International Council for the Exploration of the Sea C.M.1992/D:18*. 22 pp.

HE, P. and C.S. WARDLE. 1988. Endurance at intermediate swimming speeds of Atlantic mackerel, *Scomber scombrus* L., herring, *Clupea harengus* L. and saithe, *Pollachius virens* L. *Journal of Fish Biology 33*: 255-266.

KOCK, K.-H. 1986. The state of exploited Antarctic fish stocks in the Scotia Arc region during SIBEX (1983-1985). *Archiv. für Fischereiwissenschaft 37* (Beiheft 1): 129-186.

KOCK, K.-H. 1992. *Antarctic Fish and Fisheries*. Cambridge: Cambridge University Press. 359 pp.

KOCK, K.-H. and A. KELLERMANN. 1991. Reproduction in Antarctic notothenioid fish. *Antarctic Science 3* (2): 125-150.

LEAMAN, B.M. 1981. A brief review of survey methodology with regard to groundfish stock assessment. In: DOUBLEDAY, W.G. and D. RIVARD (Eds). Bottom trawl surveys. *Canadian Special Publication of Fisheries Aquatic Sciences 58*: 113-123.

MAIN, J. and G.I. SANGSTER. 1981. A study of the fish capture process in a bottom trawl by direct observations from a towed underwater vehicle. *Scottish Fisheries Research Report 23*: 23 pp.

MAIN, J. and G.I. SANGSTER. 1982. A study of a multi-level bottom trawl for species separation using direct observation techniques. *Scottish Fisheries Research Report 26*: 17 pp.

PARKES, G.B. 1991. The UK fish stock assessment survey bottom trawl for South Georgia. Document *WG-FSA 91/16*. CCAMLR, Hobart, Australia: 19 pp. (mimeogr.).

PARKES, G.B., I. EVERSON, J. ANDERSON, Z. CIELNIASZEK, J. SZLAKOWSKI and R. TRACZYK. 1990. Report of the UK/Polish fish stock assessment survey around South Georgia and Shag Rocks in January 1990. Document *WG-FSA-90/11 Rev. 1*. CCAMLR, Hobart, Australia: 71 pp.

PENNINGTON, M. 1986. Some statistical techniques for estimating abundance indices from trawl survey. *Fishery Bulletin 84* (3): 519-525.

PETITGAS, P. 1990. A geostatistical variance of the total abundance estimate for a regular sampling grid. *International Council for the Exploration of the Sea C.M.1990/D:12* (mimeogr.).

SAVILLE, A. (Ed.). 1977. Survey methods of appraising fisheries resources. *FAO Fisheries Technical Paper 171*: 76 pp.

SPARRE, P., E. URSIN and S.C. VENEMA. 1989. Introduction to tropical fish stock assessment. Part 1 - Manual. *FAO Fisheries Technical Paper 306/1*. 337 pp.

STEINARSSON, B. and G. STEFANSSON. 1986. Comparison of random and fixed trawl stations in Icelandic groundfish surveys and some computational considerations. *International Council for the Exploration of the Sea C.M.1986/D:13*. 25 pp. (mimeogr.).

VØLSTAD, J.H. 1990. *Some aspects of the design and analysis of marine abundance surveys.* Sc.D. Thesis. University of Bergen, Department of Fisheries Biology, Norway. 107 pp.

AGENDA

CCAMLR Workshop on Bottom Trawl Survey Design
(Hamburg, 16 to 19 September 1992)

1. Opening of the Meeting

2. Organisation of the Meeting and Appointment of Rapporteur(s)

3. Adoption of the Agenda

4. The Objectives of Bottom Trawl Surveys in the Convention Area

5. Factors Affecting the Accuracy of Bottom Trawl Surveys

   (i) Trawl Geometry, Rigging and Performance
   (ii) Fish Behaviour in the Catching Process
   (iii) Fish Distribution in the Area
   (iv) Stock Characteristics

6. Design of Bottom Trawl Surveys

   (i) Non-Random (Systematic) Surveys
   (ii) Random Surveys
   (iii) Stratification

7. Analysis of Bottom Trawl Surveys

   (i) Distributions Fitted to the Data
   (ii) Models Used to Analyse the Data
   (iii) Geostatistical Methods

8. Manual for Bottom Trawl Surveys in the Convention Area

9. Adoption of the Report

10. Close of the Meeting.

FORMULAE FOR PARAMETER ESTIMATION AND COMBINING DATA OVER STRATA FOR THE 'ADAPTIVE APPROACH'

1. Proportion '**p**' of area occupied by concentrations

If a total of **k** patches is encountered in a track of total length **L**, and the length of the track within the **i**th is $\mathbf{l_i}$, then the estimator of $\hat{\mathbf{p}}$ is:

$$\hat{p} = \frac{\sum l_i}{L}$$

2. Stratified Mean Biomass $\hat{\mathbf{B}}$

To provide a combined mean biomass from two strata, the within stratum mean densities $\hat{\mathbf{B}}$ and $\hat{\mathbf{D}}_{\mathbf{b}}$ are weighted by the area of the strata. Assuming that $\hat{\mathbf{p}}$ is the proportion of the survey area occupied by concentrations whose mean density is $\hat{\mathbf{D}}_{\mathbf{a}}$ and mean density of the remaining area is $\hat{\mathbf{D}}_{\mathbf{b}}$, and the total area is **A**, the formula for the weighted mean is:

$$\hat{B} = [\hat{D}_a \bullet \hat{p} + \hat{D}_b \bullet (1-\hat{p})]A$$

3. Combined Variance $\mathbf{V[\hat{B}]}$

The combined variance must incorporate terms for the variance of $\hat{\mathbf{D}}_{\mathbf{a}}$, $\hat{\mathbf{D}}_{\mathbf{b}}$ and $\hat{\mathbf{p}}$.

The formula for combining these variances is:

$$V[\hat{B}] = A^2\{V_a \bullet \hat{p}^2 + V_b \bullet (1-\hat{p})^2 + V_p[V_a + \hat{D}_a^2) + (V_b + \hat{D}_b^2) - 2\hat{D}_a \bullet \hat{D}_b]\}$$

DRAFT MANUAL FOR BOTTOM TRAWL SURVEYS IN THE CONVENTION AREA

1. INTRODUCTION

Research vessel surveys should ideally provide the following information:

- standing stock biomass for all species (exploited and unexploited);
- length and age structure from the exploited stocks;
- length/age-weight relationships;
- maturity ogives;
- year class strengths of pre-recruits.

To date, bottom trawl surveys in the Convention Area have been national surveys with varying degrees of comparability among surveys and nations. The objective of this Manual is to increase comparability between these surveys by standardising fishing methods, survey methods, sampling of catches, and recording and analysis of data. This Manual incorporates results of earlier deliberations of the Working Group, such as in SC-CAMLR IX, Annex 5, p. 249 to 254, and the CCAMLR Workshop on Bottom Trawl Survey Design.

2. THE SURVEY TRAWL

Survey results are critically dependent on the size, construction and rigging of the trawl. The trawl should preferably be a commercial sized trawl with a codend lining of max mesh size of 40 mm. As it is unlikely that a standard trawl will used by all nations, a full description of the net, and ground tackle including doors, should be provided as indicated in Figures 1 and 2.

It is crucial to achieve a good bottom contact of the whole groundrope, and this should be checked regularly. A proper contact could be indicated by inspecting for wear on bobbins and chains.

3. SURVEY DESIGN AND FISHING POSITIONS

The survey should cover the main geographical and bathymetric range of the target species within a given statistical subarea. It should follow a random survey design stratified by depth and, if known, fish density. The areas of seabed within selected depth ranges in the Atlantic Ocean sector are set out in Tables 1.A to 1.O. Fishing positions have to be chosen randomly in the first survey, but may be used as known clear tow stations during subsequent surveys. To reduce or avoid covariance between fishing stations in adjacent strata, fishing stations should be separated by at least 5 miles. Fishing must not be directed towards fish shoals located by sonar or echosounder. The survey design and the method of stratification needs to be carefully described.

If an adaptive ('encounter-response') survey design is used, in which acoustic equipment is utilised to identify high density and low density regions, the acoustic equipment should be described in detail.

4. STANDARD FISHING METHOD

Standard fishing speed measured as trawl speed over the ground should be used. The actual ground speed and distance towed should be monitored and reported.

Each haul should last 30 minutes. Start time is defined as the moment when the net settles on the bottom or in case of a continuous recording of net parameters, when vertical net-opening and wing spread indicate that the net is in its stable fishing configuration. Stop time is defined as the start of hauling. Hauls of less than 15 minutes duration should not be included for subsequent estimate of standing stock of the data.

Vertical net-opening, wing spread and door spread should be monitored at 30 second intervals.

Trawling should be carried out only during daylight hours, i.e. between sunrise and sundown.

Any incidental mortality of marine mammals or birds must be recorded.

All fishing gear lost during the course of the survey must be logged and reported.

5. ANALYSIS OF THE CATCH

Fish in the catch should be sorted into species and the total weight and total number of each species recorded. In case of large catches, a representative subsample should be sorted. Attention must then be given to a possible uneven distribution of species and/or size classes in the hold.

In order to assess the impact of bottom trawling on benthic communities the catch of benthos should be weighed.

6. BIOLOGICAL SAMPLING

Representative length distributions should be recorded for all exploited species (high priority) and all other species (if time permits). The size of a representative sample is difficult to define but usually contains a minimum of 100 fish measured. Length is defined as total length (Figure 3) measured to the nearest centimetre below.

Concurrently with length measurements sex and maturity data should be collected. Maturity stages should be classified according to the maturity scale given in Table 2. Otoliths (and scales for nototheniids) should be collected on a survey area basis, or in the case of the presence of two or more stocks according to their stock boundaries. For the commercially exploited species a minimum sampling level of 10 otoliths per sex and 1 cm length class should be maintained. For the smaller size groups, that presumably contain only one age class, the number of otoliths per sex and length class may be reduced.

7. INFORMATION TO BE REPORTED TO CCAMLR

7.1 Survey Design and Data Collection

- Survey area
- Geographical boundaries: latitude and longitude
- Map of area surveyed including location of fishing stations (and preferably bathymetry)
- Scientist in charge

7.2 Description of Vessel

- Name of vessel
- Vessel size (length, GRT, HP)
- Vessel type
- Included in CCAMLR register of commercial or research vessels.

7.3 Description of Fishing and Other Gear

- Description of gear used, e.g. bottom or semi-pelagic trawl, including construction drawing and rigging diagram (see Figures 1 and 2)
- Auxiliary gear (dan leno assembly, etc.)
- Type of mesh (diamond, square, other)
- Mesh size in cod end (mm) (measurements according to standards set out in the CCAMLR Inspection Manual).

7.4 Description of Acoustic Equipment

- Operating frequency
- Calibration method
- Calibration details, e.g.
    Source level
    Pulse length
    Directivity index
    Receiving sensitivity
    Calibration constant (source level plus receiving sensitivity)
    TVG correction details

7.5 Survey Design

- Survey design (random, systematic, etc.)
- Target species
- Stratification (according to depth zones, fish density, etc.)
- Details of sources of stratification
- Haul duration
- Number of stations planned and carried out
- Locations and map of fishing stations

7.6 Methods of Survey Data Analyses

for example:

- Swept area method
- Statistical properties of the estimator

7.7 Data to be Reported to CCAMLR

Haul-by-haul data including

Date and time

Designated stratum for the haul

Start and end position of trawl

Method of position fixing (e.g., GPS)

Duration of haul

Mean trawling depth

Wire out

Distance trawled over ground

Net mouth opening (vertical-horizontal)

Catch by species in weight and numbers

Length frequency distributions of exploited species

Benthos weight

Maturity stage information

Feeding information

Other (e.g., parasitic infestation, lesions, etc.)

Combined for rectangle subarea:

Length/weight-age information of exploited species

Incidental mortality of mammals and birds

Fishing gear lost

Data should be reported to CCAMLR using Formats C1, C4, B2, B3 and B4.

1992 ASSESSMENT SUMMARIES

Assessment Summary: *Notothenia rossii*, Subarea 48.3

Source of Information: This Report

Year:	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC				0				
Agreed TAC				300	300	0		
Landings	216	197	152	2	1	1	24897	1
Survey Biomass	11471[a] 1634[b]	1699	2439	1481[a] 3915[b] 3900[b]	4295[c] 10022[d]	7309[c]		
Surveyed by	Spain[a] USA/POL[b]	USA/POL	UK/POL	UK/POL[a] USSR[b]	UK[c] USSR[d]	UK[c]		
Sp. Stock Biomass[3]		No information available since 1985/86						
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: 2/III and 3/IV

Catches: UK 1 tonne (research).

Data and Assessment: No new data for an assessment.

Fishing Mortality:

Recruitment:

State of Stock: Stock remains at a low level.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	SSB	Catch	**F**	SSB	Catch	

Weights in tonnes

Assessment Summary: *Champsocephalus gunnari*, Subarea 48.3

Source of Information: This Report

Year:	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC		31500	10200	12000		8400-61900		
Agreed TAC		35000	- [4]	8000	26000	0		
Landings	71151	34619	21359	8027	92	5	128194[6]	25
Survey Biomass	159283	15716	22328[5]	149598[a] 442168[b]	26204[a] 192144[b]	40246[a]		
Surveyed by	Spain	USA/POL	UK/POL	UK/POL[a] USSR[b]	UK[a] USSR[b]	UK[a]		
Sp. Stock Biomass[3]								
Recruitment (age...)								
Mean **F** (.....)[1]						0		

Weights in tonnes

1 ... weighted mean over ages (...)
2 Over period 1982 to 1992
3 From VPA using (..........)
4 Prohibition from 4 November 1988
5 Standard estimate from WG-FSA-91, Appendix D
6 Maximum catch in 1983

Conservation Measures in Force: 19/IX and 33/X

Catches: UK 5 tonnes (research).

Data and Assessment: VPA assessment tuned to survey abundance and CPUE indices in WG-FSA-92/27 and at the meeting gave poor results for most recent years, current abundance estimate provided by 1992 trawl survey.

Fishing Mortality: Zero **F** in 1991/92 due to closure of the fishery.

Recruitment: Recent levels of recruitment uncertain, poor reproductive performance reported from 1991 survey (WG-FSA-91/14) may result in poor recruitment of one year olds in 1992/93.

State of Stock: Stock abundance increased since 1990/91 in line with expectations. Condition of fish and feeding intensity improved since 1990/91.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	Stock	Catch	**F**	Stock	Catch	
$\mathbf{F_{0.1}}$	Zero	38000[1]	5	0.39	52000[2]	15200[2]	Lower 95% confidence limit of stock in 1993/94 49400[3]
Closure	Zero	38000	5	Zero	52000[2]	Zero	Lower 95% confidence limit of stock in 1993/94 62700[3]

Weights in '000 tonnes

1 Age 2+
2 Age 2+, assumes recruitment in 1991/92 at lower 95% confidence limit
3 Age 2+, assumes recruitment in 1992/93 at lower 95% confidence limit

Assessment Summary: *Patagonotothen guntheri*, Subarea 48.3

Source of Information: This Report

Year:	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC			-	-	20-36000	0		
Agreed TAC			13000	12000	0	0		
Landings	8810	13424	13016	145	0	0	36788[4]	5029
Survey Biomass	81000				584[a] 16365[b]	12746		
Surveyed by	Spain				UK[a] USSR[b]	UK		
Sp. Stock Biomass[3]				na				
Recruitment (age 1)				na				
Mean **F** (3 - 5)[1]				na				

Weights in tonnes

1 ... weighted mean over ages (...)
2 Over period 1982 to 1992
3 From VPA using (..........)
4 Maximum catch in 1989

Conservation Measures in Force: 34/X

Catches: Research catch only (<1 tonne).

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock: Unknown.

Forecast for 1992/93:

Option Basis	1992 **F**	1992 SSB	1992 Catch	1993 **F**	1993 SSB	1993 Catch	Implications/ Consequences

Weights in tonnes

Assessment Summary: *Dissostichus eleginoides,* Subarea 48.3

Source of Information: This Report

Year:	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC				-				
Agreed TAC				-	2500[5]	3500		
Landings	1199	1809	4138	8311	3843	3703	8311	109
Survey Biomass	1208	674	326	9631*[a] 335+[a] 1693*[b] 3020+[b]	19315* 885+	3353* 2460+		
Surveyed by	USA/ POL[4]	USA/ POL[4]	UK/ POL[4]	POL/UK[a] USSR[b]	UK	UK		
Stock Biomass[3]				20745 - 435817			8000 - 160000[6]	
Recruitment (age...)				na				
Mean **F** (.....)[1]				na			na	

Weights in tonnes

1 ... weighted mean over ages (...)
2 Over period 1982 to 1992
3 Estimated from cohort projections
4 Survey excluding Shag Rocks
5 TAC from 1 November 1990 to 2 November 1991
6 Estimated from various methods
* Shag Rocks
\+ South Georgia

Conservation Measures in Force: 35/X, 36/X, 37/X

Catches: TAC of 3 500 tonnes reached 10 March (started 4 November). Bulgaria fished 11 tonnes after the closure. Russia 132 tonnes during a research cruise until 30 June 1992. After 30 June, 59 tonnes. UK bottom trawl survey, 1 tonne.

Data and Assessment: One assessment (De Lury) presented in WG-FSA-92/24. Problem with possible need to standardise effort for effects such as hook size/type, depth of fishing, area. Haul-by-haul data provided; this allowed investigation of effect of different factors on CPUE. At meeting: used De Lury method on subsets of data where one/two vessels fished in a 'local' area and CPUE showed a decline, to estmate 'local' density. Seabed area between 500 to 2 000 m was calculated to extrapolate from density to overall biomass.

Fishing Mortality: Not calculated.

Recruitment: Survey results (WG-FSA-92/17) suggest future recruitment at an average level.

State of Stock: Between 8 000 to 160 000 tonnes; thought unlikely to be above 45 000 tonnes.

Forecast for 1992/93: Suggested catch levels 750 to 5 370 tonnes.

Option Basis	1992			1993			Implications/ Consequences
	F	SSB	Catch	**F**	SSB	Catch	

Weights in tonnes

Assessment Summary: *Notothenia gibberifrons*, Subarea 48.3

Source of Information: This Report

Year:	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC						500-1500		
Agreed TAC						0		
Landings	2844	5222	838	11	3	4	11758	0
Survey Biomass	1400	7800	8500	17000	25000	29600		
Surveyed by	USA	USA	UK	UK USSR	UK USSR	UK		
Sp. Stock Biomass[3]	4700	4300	3300	4300	6200		18800	3300
Recruitment (age 2)	24000	24000	21000	27000	25000		27000	13000
Mean **F** (.....)[1]	0.36	0.86	0.54	0.014	0.0002		0.95	0

Weights in tonnes

1 Weighted mean over ages 2 to 16

2 Over period 1975/76 to 1991/92

3 From VPA using survey q = 1 model

Conservation Measures in Force: 34/X

Catches: Research catch only in 1990/91 and 1991/92.

Data and Assessment: No new information on past by-catch in the *C. gunnari* fishery. No new analytical assessment performed, due to no catch-at-age data for last four seasons.

Fishing Mortality: Zero in 1991/92.

Recruitment:

State of Stock: Steady increase in survey biomass estimates in recent years, now estimated to be 73 to 78% of the initial level.

Forecast for 1992/93:

Option Basis		1992			1993		Implications/
	F	Stock	Catch	F	Stock	Catch	Consequences
Survey q = 1 by-catch in *C. gunnari* fishery limited to MSY level	0	29600	4			1470	

Weights in tonnes

Assessment Summary: *Chaenocephalus aceratus*, Subarea 48.3

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC			1100	0	300	300-500		
Agreed TAC			0	300	300	0		
Landings	339	313	1	2	2	2	1272	1
Survey Biomass	8621	6209	5770	14226[a] 14424[b] 17800[b]	13474[c] 18022[d]	12500		
Surveyed by	USA/POL	USA/POL	UK/POL	UK/POL[a] USSR[b]	UK[c] USSR[d]	UK		
Sp. Stock Biomass[3]	4179	4156	4404	5098[4]				
Recruitment (age 2)	5375	8648	6717	4047[4]				
Mean **F** (.....)[1]	0.17	0.13	0.002					

Weights in tonnes, recruits in '000s

1 ... weighted mean over ages 3 to 11

2 Over period 1982 to 1992

3 From VPA using revised VPA from WG-FSA-90/6

4 Predicted

Conservation Measures in Force: 34/X

Catches: Research catch only in 1990/91 and 1991/92.

Data and Assessment: No new information on past by-catch in *C. gunnari* fishery. No new analytical assessment performed, due to no catch-at-age data for last four seasons.

Fishing Mortality: Zero in 1991/92.

Recruitment:

State of Stock: Survey biomass relatively consistent over recent year, now estimated to be 66 to 67% of initial level.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	Biomass	Catch	**F**	SSB	Catch	
Survey q = 1, catch limited to by-catch in *C. gunnari* fishery	0	12500	2				

Weights in tonnes

Assessment Summary: *Pseudochaenichthys georgianus*, Subarea 48.3

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC			1800	0	300	300-500		
Agreed TAC				300	300	0		
Landings	120	401	1	1	2	2	1661	1
Survey Biomass	5520	9461	8278	5761[a] 12200[b] 10500[b]	13948[c] 9959[d]	13469		
Surveyed by	USA/POL	USA/POL	UK/POL	UK/POL[a] USSR[b]	UK[c] USSR[d]	UK		
Sp. Stock Biomass[3]	5498	8090	8889[4]					
Recruitment (age 1)	4337	1372						
Mean **F** (.....)[1]	0.09	0.15						

Weights in tonnes, recruits in '000s

1 ... weighted mean over ages 3 to 6

2 Over period 1982 to 1992

3 From VPA described in WG-FSA-90/6

4 Predicted

Conservation Measures in Force: 34/X

Catches: Research catches only in 1990/92 and 1991/92.

Data and Assessment: No new information on past by-catch in *C. gunnari* fishery. No new analytical assessment performed, due to no catch-at-age data for last four seasons.

Fishing Mortality: Zero in 1991/92.

Recruitment:

State of Stock: Survey biomass relatively consistent over recent years, now estimated to be 30 to 37% of initial level. Recovery appears to be slower than for *N. gibberifrons* and *C. aceratus*.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	Biomass	Catch	**F**	SSB	Catch	
Survey q = 1 catch limited to by-catch in *C. gunnari* fishery	0	13500	2				

Weights in tonnes

Assessment Summary: *Notothenia squamifrons*, Subarea 48.3

Source of Information:

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[2]
Recommended TAC				0	300	300			
Agreed TAC				300	300	0			
Landings	190	1553	927	0	0	0	1553	0	563
Survey Biomass	13950	409	131	1359[a] 534[b]	1374	1232			
Surveyed by	USA/POL	USA/POL	UK/POL	UK/POL[a] USSR[b]	UK	UK			
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: 34/X

Catches: Research catches only in 1991/92.

Data and Assessment: Now new data, no assessment performed.

Fishing Mortality: Zero in 1991/92.

Recruitment:

State of Stock: Unknown.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	SSB	Catch	**F**	SSB	Catch	

Weights in tonnes

Assessment Summary: *Electrona carlsbergi*, Subarea 48.3

Source of Information:

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[2]
Recommended TAC	-	-	-	-	-	-	-	-	-
Agreed TAC	-	-	-	-	-	245000	-	-	-
Landings	1102	14868	29673	23623	78488	46960			
Survey Biomass		1200 kt	USSR[4]						
Surveyed by		160 kt	USSR[5]						
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean **F** (.....)[1]									

Weights in tonnes, recruits in ....

1 ... weighted mean over ages (...)

2 Over period 1982 to 1992

3 From VPA using (..........)

4 WG-FSA-90/21 large portion of Subarea 48.3

5 WG-FSA-90/21 Shag Rocks region

Conservation Measures in Force: 38/X; TAC 245 000 tonnes. 39/X, 40/X.

Catches: 46 960 tonnes - fine-scale data incomplete.

Data and Assessment: Length composition data August to October 1991 from commercial catches. By-catch data from research trawl 1987 to 1989. No new biomass surveys or estimates of biological parameters such as age stucture of the stock were available.

Fishing Mortality:

Recruitment:

State of Stock: With no estimates of biomass or age structure of the current stock (most of the stock originally surveyed over 1988/89 are likely to have disappeared) no assessments of stock size were possible.

Forecast for 1992/93:

Option Basis	1992 **F**	1992 Exploitable Biomass	1992 Catch	1993 **F**	1993 Exploitable Biomass	1993 Catch	Implications/ Consequences

Weights in '000 tonnes

Assessment Summary: *Notothenia rossii*, Division 58.5.1

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings	482	21	245	155	287	0	9812	0	1462
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 1992

3 From VPA using (..........)

Conservation Measures in Force: Conservation Measure 2/III. Resolution 3/IV. Limitation of trawlers allowed on fishing grounds each year. Arrêté N°: 18, 20, 32 (for details see SC-CAMLR-VIII, Annex 6, Appendix 10, page 290).

Catches: Nil

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1992/93:

Option Basis	1992 **F**	1992 SSB	1992 Catch	1993 **F**	1993 SSB	1993 Catch	Implications/ Consequences

Weights in tonnes

Assessment Summary: *Notothenia squamifrons*, Division 58.5.1

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC	5000	2000	2000[4]						
Landings	1635	39	1553	1262	98	1	7394	1	2191
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 1992

3 From VPA using (..........)

Conservation Measures in Force: Catch limits set since 1987 (French/Soviet agreement). Conservation Measure 2/III; Arrêté 20 and 32.

Catches: 1 tonne only - possibly as by-catch from *C. gunnari* fishery.

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1992/93:

Option Basis	1991 **F**	1991 SSB	1991 Catch	1992 **F**	1992 SSB	1992 Catch	Implications/ Consequences

Weights in tonnes

Assessment Summary: *Champsocephalus gunnari*, Division 58.5.1

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings (Kerguelen)	0	157	23628		12644	44	25852	44	10402
Landings (Combined)									
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 1992

3 From VPA using (..........)

Conservation Measures in Force: Conservation Measure 2/III; Arrêté 20; Conservation Measure as for *N. rossii* TACs set under French/Soviet Agreement.

Catches: Low catch of 44 tonnes despite expected high abundance of fish due to presence of strong 3+ cohort.

Data and Assessment:

Fishing Mortality:

Recruitment: Probably low this season.

State of Stock: If the pattern of recent years continues, there will be a strong 1+ cohort in the population in 1992/93. This will not be recruited to the fishery until 1993/94 season.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	SSB	Catch	**F**	SSB	Catch	

Weights in tonnes

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.1

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings	3144	554	1630	1062	1848	7492	7492	121	2123
Survey Biomass			27200						
Surveyed by									
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean **F** (.....)[1]									

Weights in tonnes, recruits in ....

1 ... weighted mean over ages (...)

2 Over period 1982 to 1992

3 From VPA using (..........)

Conservation Measures in Force: None.

Catches: Highest annual catch on record comprising:

1 589 tonnes by French trawlers in the northern grounds;
5 903 tonnes by Ukraine trawlers in the northern grounds; and
705 tonnes by Ukraine longliners in the western grounds.

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock: New grounds in the northern part of the area have been heavily exploited by trawlers in 1991/92. CPUE at 1.0 to 2.0 tonnes/hour has declined to similar levels to those experienced on the western grounds after several fishing seasons.

Forecast for 1992/93:

Option Basis	1992 **F**	1992 SSB	1992 Catch	1993 **F**	1993 SSB	1993 Catch	Implications/ Consequences

Weights in tonnes

Catches should be limited to not more than 1 100 tonnes from each ground until scientific data indicate otherwise.

Assessment Summary: *Notothenia squamifrons*, Division 58.4.4

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[3]
Recommended TAC (Lena Bank)									
Agreed TAC									
Landings (Ob Bank[a])	1457	2989	850	867	?	0	4999	0	1151
Landings (Lena Bank[a])	506	2013	3166	596	?	0	6284	0	1335
Landings (Combined[b])	1963	5002	4016	1463	575	0	11283	027	2487
Survey Biomass (Ob Bank)			12700						
Survey Biomass (Lena Bank)									
Surveyed by			USSR						
Sp. Stock Biomass[4]				na					
Recruitment (age...)				na					
Mean **F** (.....)[1]									

Weights in tonnes, recruits in ....

1 ... weighted mean over ages (...)

2 Over period 1982 to 1992

3 Assumes TAC of 267 tonnes for Ob Bank and 305 tonnes for Lena Bank was taken in 1991

4 From VPA using (..........)

a From WG-FSA-92/5

b From SC-CAMLR-IX/BG/2 Part 2 (Statistical Bulletin)

Conservation Measures in Force: 2/III and 4/V

Catches: A further set of catch histories (WG-FSA-92/5) was provided, which were inconsistent with the three previous reports.

Data and Assessment: There is much confusion over catch data, which must be considered as unreliable. A VPA was re-run using the new catch history and **M** of 0.15, which gave a stock of 6 000 tonnes for Lena Bank and 3 500 tonnes for Ob Bank.

Fishing Mortality: High prior to 1989, but moderate to low since then.

Recruitment: Unknown.

State of Stock: Severely depleted in the past, but now probably slowly recovering.

Forecast for 1992/93:

Option Basis	1992 **F**	1992 SSB	1992 Catch	1993 **F**	1993 Biomass	1993 Catch	Implications/ Consequences

Weights in tonnes

PARAGRAPHS EXTRACTED FROM CCAMLR-V AND CCAMLR-VIII

PARAGRAPHS EXTRACTED FROM CCAMLR-V AND CCAMLR-VIII

CCAMLR-V

60. The Commission noted that fishing for research purposes, while essential, could interfere with efforts to encourage recovery of depleted species and populations and could constitute wasteful use of both living resources and committed ship support if the survey effort or design were inadequate to provide statistically valid data. It concluded that fishing for research purposes should be designed and carried out so as to minimise possible adverse effects on protected species and populations while providing timely acquisition of information needed for essential assessment and monitoring purposes. Towards this end, the Commission agreed that:

(a) prior to the next meeting of the Commission, the Secretariat would compile a Registry of Permanent Research Vessels operated by Parties and that may engage in fishing for research purposes in the Convention Area;

(b) to expedite compilation of this Registry, Members would provide to the Executive Secretary the following information for all permanent research vessels that may engage in fishing for research purposes in the Convention Area:

(i) name of vessel;
(ii) name of vessel owner and address;
(iii) port of registration, registration number and radio call sign;
(iv) vessel type, size, fish processing and storage capacity; and
(v) gear type and fishing capacity.

(c) any Member planning to use commercial fishing or fishery support vessels to conduct fishing for research purposes in closed areas or seasons, or likely to involve the catching of protected species or size classes, or the use of prohibited gear or fishing techniques, shall notify and provide the opportunity for other Members to review and comment on their research plans, Except in unusual circumstances, plans for such research shall be provided to the Secretariat for distribution to Members at least six months in advance of the planned starting date.

(d) such plans for research fishing using commercial fishing or fishery support vessels shall include:

(i) a statement of the planned research objectives;

(ii) a description of when, where, and what activities are planned including the number and duration of hauls being planned;

(iii) the name(s) of the chief scientist(s) responsible for planning and coordinating the research, and the number of scientists and crew expected to be aboard the vessel(s); and

(iv) the name, type, size, registration number, and radio call sign of the vessel(s).

(e) a summary of the results of such research fishing shall be provided to the Scientific Committee no later than 30 September of the year following completion of the research. A full report shall be provided as soon as possible.

CCAMLR-VIII

51. The Commission recalled its decision taken at the Fifth Meeting concerning Scientific Research Exemptions (CCAMLR-V, paragraph 60) repeated here for ease of reference:

" (c) any Member ....
....as possible."

The Commission endorsed additional requirements recommended by the Scientific Committee on Scientific Research Exemptions:

(a) catches should be reported on a haul-by-haul basis to the Secretariat; and
(b) research vessel catches should be considered as part of TAC.

REPORT OF THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM

(Viña del Mar, Chile, 7 to 12 August, 1992)

REPORT OF THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM

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INTRODUCTION

1.1 The Seventh Meeting of the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) was held at the Hotel O'Higgins, Viña del Mar, Chile from 7 to 12 August 1992. The meeting was chaired by the Convener, Dr J.L. Bengtson (USA).

1.2 The Convener, on behalf of the Working Group, expressed thanks to the Government of Chile for inviting the Working Group to hold its meeting in Viña del Mar.

1.3 The Convener opened the meeting and welcomed participants. Scientists from nine Member countries, namely, Argentina, Australia, Chile, Italy, Japan, Norway, Russia, UK and USA, attended the meeting.

1.4 It was noted with regret that Brazil, who is actively involved in CEMP-related work and has supplied data to the CCAMLR Data Centre, was not able to send scientists to the meeting. The Convener reported that he had received a letter from the Brazilian Delegation conveying its apologies for not being able to arrange for a Brazilian scientist to participate in the meeting, and stating that it hoped to arrange Brazilian participation at future meetings of WG-CEMP. The Working Group welcomed this information and encouraged Brazil to make the necessary arrangements to include their scientists in the work of WG-CEMP.

1.5 The Working Group expressed concern that scientists from France, Germany, New Zealand and South Africa, all of whom have programs of direct relevance to CEMP, were not present at the meeting despite recent encouragement from the Scientific Committee (SC-CAMLR-X, paragraph 6.59) and Commission (CCAMLR-X, paragraph 4.19). Possible ways of encouraging scientists from these and other countries to actively participate in WG-CEMP were further discussed under "Review of Members' Activities".

ADOPTION OF THE AGENDA

2.1 The Provisional Agenda was introduced and discussed. It was suggested results of CEMP monitoring and reports of other related studies be considered under separate agenda items (Items 5 and 6). It was agreed that any matters arising from the Joint Meeting of the Working Group on Krill (WG-Krill) and WG-CEMP, which had not already been covered by major agenda items should be discussed under "General Matters". Two topics were proposed for consideration under "Other Business", namely, "Access to CEMP Data" and "IUCN Assessment of Marine Protected Areas". With these changes, the revised 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 submitted to the meeting as Appendix C.

2.3 The report was prepared by Drs P. Boveng (USA), J. Croxall (UK), K. Kerry (Australia) and E. Sabourenkov (Secretariat).

REVIEW OF MEMBERS' ACTIVITIES

3.1 During the past season Members were actively involved in monitoring and directed research in support of CEMP. In total, 72 documents were submitted for consideration at the meeting. A summary of Members' research activities are given in Tables 1, 2 and 3.

3.2 In 1991 the Secretariat was asked to propose a new format for Table 2 "Summary of Members' directed programs on assessing the utility of potential predator parameters". It was suggested that the table would be more useful if it summarised the data on each parameter collected and analysed by each Member in each year and if it allowed the inclusion of references to publications describing results of the analyses (SC-CAMLR-X, Annex 7, paragraph 3.3).

3.3 The Secretariat prepared a new format for Table 2 and circulated it to Members in advance of the meeting. A draft table was compiled from information available to the Secretariat and presented at the meeting. Participants made several amendments to the structure of the table, namely including information on future research and references to published results. This new format for Table 2 was adopted by the Working Group.

3.4 It was agreed that the report from the 1992 WG-CEMP meeting would include an updated Table 2 using the old format. The Secretariat was requested to contact Members during the intersessional period seeking information for the table using the newly adopted format, which will be included in the report of the next meeting of WG-CEMP.

3.5 Scientists present at the meeting provided brief reports on their recent and prospective activities as part of CEMP. A summary of Members' reports is attached at Appendix D.

3.6 A written report from New Zealand on their CEMP-related research program for 1992/93 was available to the meeting (WG-CEMP-92/24). Papers from New Zealand's penguin research were also available (WG-CEMP-92/21, 22 and 23).

3.7 It was noted that the research planned by Norway for 1992/93 at Svarthammaren, Dronning Maud Land (WG-CEMP-92/55) on the population dynamics of the Antarctic petrel represents research of direct relevance to the CEMP objectives on a species which is a designated indicator species for CEMP.

3.8 The Working Group agreed that both the New Zealand and Norwegian studies would be valuable contributions to CEMP. These research initiations were welcomed and the participation of scientists from these countries in the work of WG-CEMP was encouraged.

Members' Participation in CEMP

3.9 The Working Group again drew the Scientific Committee's attention to the situation that WG-CEMP did not have the benefit of contributions from several countries with active research programs of direct relevance to CEMP. Scientists from several Member countries, especially Germany, France, New Zealand and South Africa were known to be conducting research with relevance to CEMP, but they did not participate regularly in WG-CEMP meetings or contribute data. As noted above, Brazil has indicated that it hopes to increase its future participation in CEMP.

3.10 The Working Group commented that its analytical efforts would be strengthened considerably by having all Members participate in CEMP. With the aim of increasing participation, the Convener was asked to:

(i) send reports from the past two meetings of WG-CEMP, including the list of documents, and the CEMP brochure directly to scientists known to be involved in research of interest to CEMP; and

(ii) include with the above information a letter soliciting participation in WG-CEMP and contribution of relevant data.

3.11 Members were encouraged to provide to the Convener of WG-CEMP lists of names and addresses of appropriate scientists and researchers to be included in this mailing.

3.12 In regard to the request of the Working Group for material raising the awareness of CEMP and CCAMLR, Dr D. Vergani (Argentina) presented a video tape (described in WG-CEMP-92/43) concerning the biology of Adélie penguins and the principles of CEMP monitoring. The Working Group noted that the video was well produced and that it would be valuable for increasing the awareness of CEMP.

MONITORING PROCEDURES

Predator Monitoring

Sites and Species

4.1 No proposals were received for new additions to the list of designated CEMP species or monitoring sites.

4.2 Proposals were received for according protection, under Conservation Measure 18/IX, to the CEMP sites at Cape Shirreff, Livingston Island (WG-CEMP 92/4) and Magnetic Island, near Vestfold Hills, Princess Elizabeth Land (WG-CEMP-92/5).

4.3 The Working Group welcomed and supported, as a matter of principle, the protection of the CEMP site at Cape Shirreff. It was, however, unclear whether the proposed CEMP management plan was in exact conformance with the management already in effect under the Antarctic Treaty for Cape Shirreff as a Site of Special Scientific Interest (Number 32). The Working Group suggested that the Delegation of Chile revise the proposal during the intersessional period and resubmit it in time for consideration at the next meeting of WG-CEMP.

4.4 The Working Group supported the principle of according protection to the CEMP site at Magnetic Island. Although some questions were raised about some of the wording contained in the proposal, the concerns of the Working Group were of such a nature that it was felt the modifications could be accomplished by the Delegation of Australia in time for that delegation to submit the revised proposal to the 1992 meeting of the Scientific Committee.

4.5 To enhance the efficiency of Working Group operations it was agreed that three *ad hoc* subgroups should be established in order to review the details of future proposals relating to:

(i) designation and protection of monitoring sites and review of management plans;

(ii) practical aspects of standard monitoring methods and proposals for new methods; and

(iii) statistical aspects of monitoring methods.

4.6 The Convener was requested to consult with Members in order to form these *ad hoc* subgroups with the assistance of the Secretariat.

4.7 Each subgroup would be responsible for reviewing relevant submitted documents (including existing Standard Methods where appropriate) and presenting to the Working Group recommendations for appropriate action. Suggestions for future modifications to the Standard Methods will therefore only be considered on the basis of written proposals. These proposals should state the nature of and reason for the proposed change and should include the new text to be inserted in the method if the modification is accepted. Documents relating to the work of each of the subgroups will only be considered at a meeting of WG-CEMP if they are received by the Secretariat for circulation and review no later than three months prior to the start of the WG-CEMP meeting.

Procedures for Calculating Indices and Trends

4.8 At its 1991 meeting, the Working Group agreed (SC-CAMLR-X, Annex 7, paragraphs 4.27 to 4.34) that the Secretariat should compute indices that summarise the results of CEMP monitoring for each Standard Method, site, species, and year for which data have been submitted. The Working Group had also recommended that a document be prepared describing the methods of calculation of the indices, including worked examples and the computer source code used to accomplish the calculations.

4.9 WG-CEMP reviewed the document prepared by the Secretariat summarising these indices (WG-CEMP-92/7), and considered how each index is currently being compiled, as well as algorithms for simple comparisons among the indices and estimation of the statistical power of the methods to discern changes in each indexed parameter. The Data Manager noted that the FORTRAN code for all analysis routines is available from the Secretariat in a form appropriate for PC computers, as are the CEMP data from which the indices are derived. Members active in CEMP monitoring are encouraged to obtain and test the software on their own data sets and to critique the analytical methods.

4.10 It was noted that as calculations of indices are refined, the Working Group will need to establish a more statistically formalised approach to comparisons among sites, colonies, and years. Lic. E. Marschoff (Argentina) and others observed that most of the comparisons should be made in an analysis of variance (ANOVA) framework in order to produce the correct standard errors and to avoid the statistical significance problems associated with multiple pair-wise comparisons.

4.11 The Working Group requested that Lic. Marschoff and other interested participants use the existing CEMP data to develop examples of ANOVA designs for consideration at the next WG-CEMP meeting. It was felt, however, that the current approach developed by the Secretariat will continue to serve as a useful format for preliminary comparisons that the Working Group has initiated and is likely to continue for the next year or two.

4.12 The Working Group agreed that WG-CEMP-92/7 should receive wider circulation, to ensure that it was available to scientists actually conducting CEMP monitoring. It was agreed that the paper should be included as an appendix to the CEMP Standard Methods for Monitoring Studies and also be published in the CCAMLR Selected Scientific Papers.

Field Research Procedures

4.13 Several papers were tabled (WG-CEMP-92/20, 24, 28, 44, and 47), describing developments in field research techniques of relevance to CEMP.

4.14 Dr S. Focardi (Italy) described a technique (WG-CEMP-92/47) by which cetaceans can be assayed for exposure to certain organochlorine pollutants by analysis of biomarkers using small skin samples collected with biopsy darts.

4.15 Dr Kerry described results of continued development of an automated weighing and data logging system for penguins (WG-CEMP-92/20). Weights of the birds are recorded automatically as they pass over a weighbridge. The system uses small, implantable passive transponder tags to identify individuals and record their arrivals and departures from the colony. The Working Group noted that development of this pioneering technology had progressed for several years and welcomed the announcement that it is now fully functional. It was also noted that other researchers, for example Professor Y. Le Maho of France, have successfully used similar technology for about the past year.

4.16 In response to a previous discussion by WG-CEMP on standardising and comparing procedural details that are difficult to portray in the Standard Methods (SC-CAMLR-IX, Annex 6, paragraph 85), Dr Vergani presented a video tape (described in WG-CEMP 92/44) concerning the Standard Methods for CEMP Monitoring. The Working Group thanked Dr Vergani for his contribution.

4.17 The Convener reported (WG-CEMP-92/28) on progress toward a workshop on methods to monitor the at-sea behaviour of penguins and pinnipeds (SC-CAMLR-X, paragraphs 6.9 to 6.10 and SC-CAMLR-X, Annex 7, paragraphs 4.45 to 4.52). Informal discussions between the Convener and scientists at the 1991 meeting of the Society for Marine Mammalogy suggested that there might be an opportunity to hold such a workshop in association with the next meeting of the Society, to be held in Galveston, Texas, USA, in late 1993. Many of the researchers who would be interested in such a workshop will already be in attendance at that meeting and some of the hosts of that meeting indicated interest in co-sponsoring such a workshop with WG-CEMP.

4.18 There is, however, a workshop planned for September, 1992, by Dr J.W. Testa at University of Alaska, Fairbanks, USA. This workshop will address analysis of data from time-depth recorders (TDRs), one of the topics of interest to CEMP. The Working Group agreed that the results of the Alaska workshop, as well as new results in preparation by the British Antarctic Survey, should be reviewed before proposing a specific time for scheduling a workshop sponsored by WG-CEMP to develop standard methods for monitoring.

Prey Monitoring

4.19 At its last meeting, WG-CEMP discussed the designs suggested by WG-Krill's Subgroup on Survey Design for monitoring prey in support of CEMP predator monitoring (SC-CAMLR-X, Annex 7, paragraphs 4.55 to 4.68). No proposals were received for new procedures or modifications to those discussed last year.

Environmental Monitoring

Land-Based Observations

4.20 The Working Group agreed that no changes were needed to parameters F1, 3 and 4. (Method F2, which pertains to sea-ice data on an ISR scale, is discussed below).

Remote Sensing

4.21 Following a detailed submission by the Secretariat in 1991 on the possibility of acquiring satellite imagery for routine monitoring of sea-ice distribution around CEMP sites, WG-CEMP and SC-CAMLR recommended and endorsed a pilot study to be undertaken by the Secretariat. The aims of the study were (SC-CAMLR-X, paragraph 6.19):

(i) to establish the mechanism for the acquisition of data on sea-ice distribution from satellite imagery;

(ii) to compute relevant parameters from these data, such as distance from the CEMP site to the ice edge, ice cover, etc.; and

(iii) to compute indices from these data for use by CEMP.

4.22 In the original submission by the Secretariat (SC-CAMLR-X/7), two spatial and temporal scales were identified;

Large, long time-scale: on the scale of the subarea, and over the whole year at two-week intervals. The Secretariat was asked to acquire data over an unspecified period in this category.

Small, short time-scale: on a 200 km radius from CEMP sites. The Secretariat was asked to acquire data from two sites (Mawson Coast and South Orkney Islands) over a two-month period, with an image every 5 to 10 days. These two areas were chosen because they are amongst the most problematic areas to obtain images from; the Mawson Coast area is on the limit of signal reception at Casey Station (Australia), and is a mainland site. The South Orkney Island group is in an area of highly variable meteorological and oceanographic conditions, and is also towards the limit of signal reception at Palmer Station (USA).

4.23 The Data Manager reviewed the Secretariat's report on the results of the pilot study (WG-CEMP-92/9). The Working Group thanked the Secretariat for the excellent report on the pilot study. The pilot study revealed that the weekly Joint Ice Centre (JIC) charts for the whole of Antarctica could be readily obtained and digitised weekly for areas of 0.5° latitude and 5° longitude. Percentage ice cover can then be compiled for larger areas and the distance of CEMP sites from the ice edge determined.

4.24 The Advanced Very High Resolution Radiometry (AVHRR) data were more difficult to obtain and images require special equipment and processing. Once obtained, however, the data are superior to the derived JIC data and provide information on a scale of 10 to 30 km. A major problem, however, is in obtaining cloud-free images and it was recommended that the images must be selected at the receiving station. Subsequent specialist interpretation of the charts was required.

4.25 Images obtained from November 1991 to February 1992 by the Australian Bureau of Meteorology were presented for the Mawson region and one undated image from the South Orkneys. Ice fronts derived from the Mawson images were included in WG-CEMP-92/36.

4.26 It was noted that although the data derived from the AVHRR images are superior to the broad-scale data obtained from JIC ice charts it was decided not to proceed with acquiring AVHRR data since it was felt that ice data on a broader scale were all that was needed at present. Furthermore, in view of the problems of obtaining and interpreting AVHRR data and the likely higher costs of the images and their processing, the JIC charts were sufficient at present.

4.27 It was noted that JIC data were derived from satellite images together with data from ground stations, aircraft, ships and other sources. The data, when further subjected to processing, can provide an indication of the ice conditions prevailing on a scale of 100s of km. The Working Group accepted these limitations and believed analysis of the JIC data might provide useful information for interpretation of trends in predator and prey on an ISR basis.

4.28 As a first step, the Working Group recommended that the Secretariat be asked to obtain relevant JIC ice data and ice edge position data for the three ISRs and Subareas 48.1, 48.2 and 48.3. These data should be entered into the CCAMLR Database according to Method F2.

4.29 The Secretariat was asked to prepare an estimate for the Scientific Committee's consideration of the resources that would be necessary to undertake this task.

4.30 The Working Group requested that the Secretariat analyse the relevant sea-ice data to calculate the following indices on a twice-monthly basis:

(i) maximum extent of ice cover by 5° intervals of longitude within each subarea; and
(ii) percentage ice cover (proportional ice cover by subarea).

4.31 The following additional indices should be calculated for the CEMP sites at Bird Island, Signy Island, Laurie Island, Seal Island, Cape Shirreff, Ardley Island, Stranger Point, Hope Bay and Anvers Island:

(i) date on which the ice edge advances northward past each site;
(ii) date on which the ice edge retreats southwards past each site;
(iii) total time (weeks) that sea-ice is within 100 km of each site;
(iv) distance from each site to the edge of consolidated sea-ice each week during the breeding season (September to April).

4.32 The data requested will allow WG-CEMP to relate data on predator indices (population size and breeding success), the presence of krill and the krill fishery to ice conditions (Standard Method F2). This attempt at comparing trends in environmental conditions to the status of predators and prey will be a useful guide to future research.

4.33 If possible, it would be desirable for data collection to begin at the start of the 1992/93 season (September 1992). Retrospective data from September 1985 to the present are also requested to compare data on predator performance, the presence of krill and the location of fishing. It was noted that 1986/87 and 1987/88 were years of extensive and heavy ice cover in the vicinity of the Antarctic Peninsula and so a comparison with other years would be valuable. It was also considered useful to conduct similar analyses of sea-ice data from prior years, particularly during the years when surveys from the BIOMASS program were being conducted. It was agreed that priority should be given to data collection from current and future years, and that past years should be added as time permitted.

Formats for Publishing Future Editions of the Standard Methods

4.34 At its 1991 meeting, WG-CEMP discussed the need for establishing a cost-effective mechanism for publishing future editions of the *Standard Methods for Monitoring Studies*. The Secretariat had been asked to evaluate various options for publishing Standard Methods in a format that would allow inclusion of new methods, revisions of established methods, and occasional addenda (SC-CAMLR-X, Annex 7, paragraph 4.5).

4.35 The Data Manager introduced the Secretariat's report suggesting a change in the Standard Methods publication format (WG-CEMP-92/10). A loose-leaf ring-binder system was suggested as offering the most efficient format for future editions. This format would allow circulating and replacing only the revised and/or new portions of the methods rather than having to publish the entire contents of the Standard Methods each time a change was made.

4.36 The Working Group agreed that the format recommended by the Secretariat should be used when publishing future editions of the Standard Methods. The format offers flexibility in updating the Standard Methods as they are revised and supplemented. Moreover, it is expected that this format will result in future cost savings, even though the immediate costs of initiating a ring-binder system are anticipated to be higher than continuing with the old format.

4.37 The Secretariat was asked to make appropriate arrangements for implementing the new format for the next edition of the *Standard Methods for Monitoring Studies*. It is hoped that the new edition might be available for distribution in November 1992, so that it could be used by field personnel during the 1992/93 austral summer field season.

REVIEW OF MONITORING RESULTS

Predator Data

Status of Data Submissions

5.1 A table showing the methods, sites, species, and years for which CEMP predator monitoring data have been submitted to the Secretariat was presented in WG-CEMP-92/13. A list of all CEMP colony and site codes currently in use was also provided. The Data Manager noted that some data were submitted too late to include in the table.

Report on Indices and Trends

5.2 This summary was presented in two parts, one containing results from monitoring of penguin species (WG-CEMP-92/8) and one pertaining to flighted seabirds and Antarctic fur seals (WG-CEMP-92/12). The first part contains a set of "instructions for users", to aid in understanding the results and in making comparisons. In both parts, tables were provided under each method showing the index value computed for each site, species, and year. Matrices were also presented, which represented the pair-wise absolute differences between the index values and the levels of statistical significance of pair-wise tests for differences.

5.3 The Working Group noted that it had been very helpful, for the purpose of detecting possible computational and reporting problems, to have the indices presented in tabular form; Members that have submitted data were encouraged to scrutinise very closely the results based on their data.

5.4 It was noted, however, that the tables would grow rapidly as more data were added; therefore graphical summaries to supplement the tables should be included as feasible by the Data Manager.

Standard Methods for Penguins

Method A1 - Mean Weight at Arrival

5.5 Although differences among many of the index values for this parameter were statistically significant, the Working Group found it difficult to ascribe ecological meaning to the differences considering the experience at the monitoring sites and the results presented below for other methods. It was noted that the data submitted thus far have not included information to allow weighted averaging of the data to account for possible day-to-day variations in arrival date over the period of data collection. This may explain some of the significant differences, though it was further noted that sample sizes recommended in the Standard Methods may actually be higher than is necessary to detect differences of the magnitude that would be considered ecologically meaningful.

Method A2 - Duration of Incubation Shift

5.6 Although few data have as yet been submitted for this parameter, several members noted that the durations of the second incubation shifts of Adélie penguins at Béchervaise Island were substantially longer than those (not part of CEMP data) at other sites. This might be explained by the rather large distances over which the Béchervaise penguins are foraging (see WG-CEMP-92/36).

Method A3 - Breeding Population Size

5.7 The breeding populations of three penguin species at the Signy Island were much smaller in 1991 than in the previous and subsequent years. It was noted that 1991 was a year of heavy sea-ice in that area, and that other predator parameters (discussed below) indicated poor conditions in that year for penguins and seals in the Elephant Island area and at South Georgia.

5.8 Several participants noted that data collected under Method A3 constitute some of the most basic information about the status of penguin colonies and that many studies initiated outside CEMP may have collected this type of data by methods corresponding to the Standard Methods. However, the list of sites for which such data have been submitted to CEMP is not as long as might be expected. Some of these data have been presented to the Working Group in working papers (e.g., WG-CEMP-92/6, 45 and 54). The Working Group noted that this type of data is much more useful to CEMP if submitted to the CCAMLR Data Centre using CEMP data submission formats and reiterated its request to Members to submit results to CEMP from studies that had collected data using methods comparable to the Standard Methods.

Method A4 - Age-Specific Recruitment and Survival

5.9 WG-CEMP has not yet specified data submission formats or requested that data be submitted for this method. It was acknowledged, however, that relevant data are being obtained at several sites using this Standard Method. The Working Group encouraged Members to prepare progress reports on their activities with Method A4.

Method A5 - Duration of Foraging Trips

5.10 Data from this method yield separate indices for the brood period and the creche period. Some of the reported index values for the brood period were thought to be in error (foraging trips were unrealistically short) and it was left to the originators of the data and the Data Manager to determine the nature of the problem.

5.11 The Working Group noted the striking variability in foraging trip duration of Adélie penguins at Palmer Station during the creche period in the three years from 1990 to 1992. Some members commented on the possible relationship between the variance in trip duration and the degree of patchiness in the prey availability.

Method A6 - Breeding Success

5.12 The Data Manager reminded those submitting data that Procedure C of this method requires a count of nests with eggs on the date when 95% of nests have eggs. Some of the submitted data did not include this count and therefore the indices could not be computed for those sites and years. In addition, some index values were felt to be in error; those values will be checked and corrected by the data originators in consultation with the Data Manager.

5.13 Dr Croxall noted that in 1991 there were decreases in breeding population sizes and a catastrophic failure of breeding success across all krill-eating seabird species at South Georgia.

Method A7 - Chick Weight at Fledging

5.14 As with parameter A6, this parameter exhibited a decline in the index at South Georgia during 1991.

Method A8 - Chick Diet

5.15 This method is designed to detect gross changes in the species composition of food delivered to penguin chicks. The Working Group suggested that the table of indices for this method should show the percentages of fish and *Euphausia crystallorophias* in addition to the values for krill and total crustaceans already presented.

5.16 The data collected thus far contain some interesting contrasts between the penguins studied in the Prydz Bay ISR and those in the Antarctic Peninsula ISR. For example, the proportions of krill and total crustaceans are much lower in the food delivered to chicks in Prydz Bay and the total weights of stomach contents tend to be lower as well.

Standard Methods for Flying Seabirds

Methods B1 and B2 - Black-Browed Albatross Breeding Population Size and Success

5.17 Because only one year of data from one site has been submitted thus far, no interpretation of the data was possible.

Standard Methods for Fur Seals

Methods C1 and C2 - Duration of Foraging Trips by Females and Pup Growth Rate

5.18 During the 1991 season at both South Georgia and Seal Island, female fur seals made trips of longer than average duration. Dr Croxall noted that researchers at South Georgia have verified that there is a negative correlation between annual estimates of foraging trip duration and of pup growth, as would be expected from other documented relationships between these parameters and prey availability.

Prey Data

5.19 The Convener, in introducing this item recalled that WG-CEMP had requested the following data to enable it to undertake its annual assessments and to formulate advice based upon an integrated perspective of predator, prey and environmental data (SC-CAMLR-X, Annex 7, paragraph 5.6):

(i) summaries of fine-scale krill catch data and an analysis of the distribution of catches relative to predator colonies;

(ii) the most recent estimates of krill biomass (or relative biomass) in each ISR and other subareas or meso-scale survey areas as estimates become available; and

(iii) results of specific fine-scale surveys near CEMP sites or surveys to determine aspects of distribution movements or behaviour, as they become available.

Fine-Scale Krill Catch Data

5.20 Fine-scale catch data in Statistical Area 48 as reported to CCAMLR for 1990/91 were summarised by the Secretariat (WG-Krill-92/13). It was noted that fishing began at South Georgia in July, shifted to the South Orkney Islands and next to the South Shetland Islands, and then returned to the South Georgia region again during the winter of 1991. Although some fishing around South Georgia was reported in November/December, there was virtually none between October 1990 and April 1991 during the critical breeding period for land-based krill predators.

5.21 The location of the krill catch in Subarea 48.1 was similar to the pattern of previous years (WG-Krill-92/18 and 19). Virtually all of the catches in Subarea 48.1 occurred within approximately 100 km of the north coast of the South Shetland Islands. Near the Seal Island CEMP site, fishing occurred from the end of November 1990 to January 1991 and from mid-March to mid-April 1991.

5.22 In Subarea 48.2, the fishery in 1991 mostly operated within 100 km of land. The locations of these catches were similar to those in 1987 and 1988, but it was noted that in 1989 and 1990, krill fishing occurred much further offshore than in the other years.

5.23 The Working Group welcomed the paper illustrating fine-scale positions of Russian krill fishing vessels in Subarea 48.1 during the season 1988/89 (WG-CEMP-92/30). Data on catch-per-day and catch-per-hour were also presented.

5.24 WG-CEMP commended Dr V. Sushin (Russia) and his co-authors for producing this valuable contribution, and agreed that it would be most helpful to receive reports of similar analyses from subsequent seasons. Dr K. Shust (Russia) indicated that he believed such data were available and that he hoped it would be possible to table such papers at future meetings of WG-CEMP.

5.25 Chile also presented a paper, WG-Krill-92/21, showing graphically the distribution of hauls and the CPUE data in the vicinity of Livingston and Elephant Islands for the 1991/92 fishing season. CPUE data for the period from 1987 to 1992 showed medium values in 1987, low values in 1989 and 1990 and comparatively high ones in 1988, 1991 and 1992.

5.26 The Working Group expressed their thanks to Chile and Russia for their excellent and timely papers describing fine-scale aspects of the krill fishery. Both datasets viewed in conjunction with the hydroacoustic data available from scientific surveys for the same region provided excellent comparisons of krill distribution and relative changes in abundance which will help in interpreting changes in predator performance in the region.

5.27 In recognising the value of haul-by-haul data, the Working Group recalled that Japan and Korea had previously indicated that they are unable to report haul-by-haul data as a result of legislation in their countries (SC-CAMLR-X, paragraph 3.90).

5.28 Dr M. Naganobu (Japan) noted that, in his opinion, for the purposes of scientific study and resource management, the most detailed data possible are often desired. However, to respect commercial confidentiality, he felt that international organisations generally do not request such detailed haul-by-haul information.

5.29 The Working Group again emphasised that obtaining such data would represent a valuable source of information on krill distribution and relative abundance. It noted that although haul-by-haul data may not be available from the Japanese fishery, it might be possible to request reports of combined krill catches on a scale smaller than currently required. For example, it would be useful to have the catch levels for combined hauls reported at a scale of approximately 10 x 10 n miles. The Working Group recommended that the Scientific Committee request whether domestic legislation would preclude Japan from reporting combined krill catches on a very fine-scale (e.g., 10 x 10 n miles) in areas within the CEMP ISRs.

Pleuragramma antarcticum

5.30 The Secretariat circulated a compilation of fine-scale catch data for *Pleuragramma antarcticum* in Division 58.4.2 for the years 1978 to 1989. Catches occurred between 31°E to 76°E south of 65°30'S. Total catches ranged from 30.6 tonnes (1980) to 984 tonnes (1985). The catch of 67 tonnes in 1988 was taken within the apparent foraging range of Adélie penguins at the Béchervaise Island CEMP site during the third quarter of the reporting period.

Estimates of Krill Biomass in ISRs

5.31 In response to WG-CEMP's request for broad-scale biomass estimates for krill in the ISRs, WG-Krill had provided estimates of krill biomass from hydroacoustic surveys. These data were derived from surveys conducted in limited areas within the ISRs (SC-CAMLR-XI/4, paragraph 5.53 and Table 4). Although many surveys have been undertaken, WG-Krill considered that estimates based upon recalculated data from the FIBEX surveys of 1980/81 provided the best synoptic estimates for the ISRs as a whole for South Georgia and the Antarctic Peninsula. The 1992 Australian survey was accepted as providing the best estimate for the Prydz Bay region. The discrepancy between data obtained in 1981 from *Walther Herwig* and other surveys for the Antarctic Peninsula were noted (SC-CAMLR-XI/4, paragraph 4.57). It was emphasised that the biomass estimates from WG-Krill were only applicable to the area covered by the surveys and should not be extrapolated to cover the total area of the ISRs.

5.32 The Working Group thanked WG-Krill for these estimates. WG-CEMP requested that WG-Krill update these estimates, as possible, to cover the entire area of the ISRs, and to incorporate new data as they become available.

Fine-Scale Surveys Specifically in the Vicinity of CEMP Sites

5.33 Dr R. Holt (USA) presented WG-CEMP-92/16 which described research undertaken by the US AMLR Program during the 1991/92 field season. He noted this was the fourth year of an ongoing program which carried out *inter alia* hydroacoustic surveys around the Seal Island CEMP site (near Elephant Island). These hydroacoustic surveys were conducted within a 60 x 130 n mile rectangle according to the standard method (SC-CAMLR-X, Annex 4, Appendix D, Attachment 4) supplemented with MOCNESS zooplankton sampling and CTD/rosette hydrocasts.

5.34 The hydroacoustic surveys were conducted between 19 January and 6 February 1992 and repeated from 25 February to 11 March. Krill biomass decreased from 2.2 million tonnes to 1.1 million tonnes during this period (WG-CEMP-92/15). This was in marked contrast to the results from surveys conducted in 1990 and 1991 when krill abundance increased from mid-January to mid-March. The reason for the decrease is not known. No fishing took place in the region during this time.

5.35 It was noted that several measures of reproductive success of chinstrap penguins at the Seal Island CEMP site varied in correspondence with the estimates of krill biomass, being moderately high in 1990, very low in 1991 and very high in 1992.

5.36 The Working Group welcomed the report on the AMLR Program prey surveys near the Seal Island CEMP site. Such prey surveys conducted within the foraging range of land-based predators during this critical breeding season greatly assisted the understanding of the dynamics of krill, its predators and the marine ecosystem as a whole.

Environmental Data

5.37 Having considered the Secretariat's report of the pilot study on the methods regarding the acquisition of sea-ice data (WG-CEMP-92/9) (paragraphs 4.21 to 4.33) the Working Group noted that there were no further data for review at the present meeting.

ECOSYSTEM ASSESSMENT

6.1 At their 1990 meetings, the Commission (CCAMLR-IX, paragraph 4.34), Scientific Committee (SC-CAMLR-IX, paragraphs 5.4, 5.39 and 8.6), and WG-CEMP (SC-CAMLR-IX, Annex 6, paragraphs 41 to 43) agreed that WG-CEMP should determine annually the magnitude, direction and significance of trends in each of the predator parameters being monitored; evaluate annually these data by species, sites and regions; consider conclusions in light of relevant information (e.g., prey and environment); and formulate appropriate advice to the Scientific Committee.

6.2 It was agreed that this annual assessment procedure should include a review of background information available to the Working Group in submitted papers, in addition to consideration of CEMP monitoring results, fishery data, prey surveys and environment data.

Review of Background Information

6.3 The Working Group noted that the many papers submitted for its meeting contain valuable information on the status of predator, prey and the environment. A selection of these papers was reviewed by participants under the general sub-headings "Predator Studies", "Prey Studies", or "Environment Studies".

Predator Studies

Population Trends

6.4 Information on breeding populations of Adélie penguins and elephant seals at Stranger Point, King George Island was analysed (WG-CEMP-92/6). Penguin populations declined in 1982/83 and again in 1987. A relationship between reduced breeding success of Adélie penguins and declines of female elephant seals was observed. The declines were thought to be related to environmental changes.

6.5 Adélie penguin populations in the Ross Sea area had increased in the 1980s. In contrast, penguin populations in the species in the Antarctic Peninsula area were stable or declining (WG-CEMP-92/21, 22 and 23). Adélie penguins in these areas mostly rely on different prey species (*P. antarcticum* in the Ross Sea and krill in the Peninsula area). The observed trend of increasing seawater temperature in the Ross Sea may be associated with better survival and recruitment of *P. antarcticum* and thus a better food supply for penguins.

6.6 A comparison of the population abundance of Adélie penguins at Hope Bay was made using 1991 data (WG-CEMP 92/45) and unpublished data from British Antarctic Survey (Croxall, pers. comm.). Breeding success of Adélie penguins was compared in zones of high human impact and those without such impact. No difference was observed in breeding success of penguins in the different zones. However, an increase of populations was observed in both zones but in different proportions. These differences appeared to be related to different rates of recruitment between these zones.

6.7 Two censuses of fur seals were conducted at Cape Shirreff, Livingston Island during the 1991/92 season (WG-CEMP-92/53). The total number of fur seals in December 1991 was 5 861 with 2 033 pups and in January 1992 it was 7 826 animals with 2 926 pups. These data were compared with counts in 1990/91 giving 4 750 animals with 2 000 pups. Dr A. Aguayo (Chile) noted that counts from the 1965/66 and 1972/73 seasons included both Cape Shirreff and Telmo Islands, but were reported simply as counts for Cape Shirreff (Aguayo and Torres, 1967[1]; Aguayo, 1978[2]). Later counts have been reported separately. Therefore, previous interpretations of fur seal abundance and population growth rate at these sites may need clarification (Aguayo and Torres, in press[3]).

6.8 The effect of human disturbance on bird populations at Ardley Island was investigated (WG-CEMP-92/54). At present, it is not possible to distinguish among population changes due to human impact, environmental and/or fisheries effects.

Predator-Prey Interactions

6.9 WG-CEMP-92/38 provides the first detailed data on the depth, duration, frequency and timing of diving behaviour for macaroni penguins at the chick-rearing period at South Georgia. Modal dive-depths ranged from 5 m (night) to 20 to 35 m (day) with maxima of 11 m and 115 m, respectively. This indicates clearly the depth strata within which availability of krill is of relevance to this species. WG-CEMP-92/37 compares gentoo penguin diving pattern and performances in winter with similar data for the chick-rearing period (WG-CEMP-91/18). The major seasonal differences relate to frequency of foraging trips and mass of prey in stomachs rather than to changes in diving patterns. Various indices of foraging "effort" do not necessarily show simple, or direct relationships to foraging trip duration. Both studies derived from collaboration between UK and Japanese scientists.

6.10 The foraging ranges of six female and four male Adélie penguins breeding at Béchervaise Island near Mawson Station (Mac. Robertson Land) were determined by satellite tracking using the ARGOS system (November 1991 to January 1992) (WG-Krill-92/36). Birds were tracked during incubation and chick feeding periods. During the incubation period, birds made foraging trips to the continental shelf break approximately 110 km distant at its closest point. Birds feeding chicks continued to make some journeys of one to two days to the area of the Continental Shelf break. However, once fast-ice disappeared in mid-January, most foraging trips were less than 24 hours long and occurred within 12 km of the colony. There is potential therefore for overlap between the foraging range of Adélie penguins breeding along the Mac. Robertson Land and any future harvest

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1 AGUAYO, A. and D. TORRES. 1967. Observaciones sobre mamiferos marinos durante la Vigésina Expedición Antártica Chilena. Primer censo de pinípedos en las islas Shetland del Sur. *Rev. Biol. Mar., Valparaíso 13*(1): 1-57.

2 AGUAYO, A. 1978. The present status of the Antarctic fur seal, *Arctocephalus gazella*, at South Shetland Islands. *Polar Record (Field Work) 19*(119): 167-176.

3 AGUAYO, A. and D. TORRES. In press. Observaciones sobre el crecimiento poblacional de *Arctocephalus gazella* en Cabo Shirreff, isla Livingston, Antártica. *Ser. Cient. INACH 43*.

of krill in the region. The foraging range of the birds feeding chicks at Béchervaise Island may at times considerably exceed the 15 to 50 km determined for breeding penguins in the South Shetland and South Orkney Islands.

6.11 WG-CEMP-92/42 reviews past and present information on the nature and causes of population changes in Antarctic and sub-Antarctic seabirds, seals, and whales, particularly for the point of predicting effect of future environmental changes.

Predator Reproduction/Demography

6.12 WG-CEMP-92/39 reports the 1990/91 survey of breeding populations of fur seals at South Georgia; the total population is still increasing, albeit at a lower rate (<10%) than in the 1960 to 1975 period. WG-CEMP-92/40 shows that the duration of the perinatal period of fur seals is related to arrival and pupping date and that younger females tend to arrive later. In 1990/91, all females were in poorer condition, gave birth to smaller pups and had shorter perinatal periods. WG-CEMP-92/41 explains these latter relationships in more detail. Not only were foraging trips and pup growth indices significantly longer and lower, respectively, in 1990/91 but pup production and birth dates in 1991/92 were also reduced and delayed.

6.13 Factors affecting the breeding success of Adélie penguins in the Antarctic Peninsula area were investigated (WG-CEMP-92/46). The major cause was thought to be environmental effects.

Prey Studies

Krill Distribution/Abundance

6.14 Paper WG-CEMP-92/31 by Dr R. Makarov (Russia) presents a historical overview of krill biomass assessments and fishery data in the Atlantic Ocean Sector and adjacent waters of the Antarctic. The overview showed that commercial krill concentrations are found not only in well known areas in Subareas 48.1, 48.2 and 48.3 but also further to the east. The Bouvet Island area as well as coastal waters of the Weddell and Lasarev Seas are examples of such areas. Krill concentrations are also found in the coastal and open sea waters of the Scotia Sea.

6.15 Krill movement rates are evaluated in paper WG-CEMP-92/32 by Dr V. Popkov (Russia) taking into account published information as well as results of Russian surveys conducted in the Scotia Sea. It was found that in the north of Subarea 48.3, residence time of krill varied from 35 to

150 days in different years. These results imply two to three turnovers of krill biomass during the year in this area.

6.16 Paper WG-CEMP-92/35 analyses krill movement rates and water flow data obtained during a survey in a small area (8 x 6 n miles) in the southeast of Subarea 48.3. A high variability in krill patch distribution and biomass was found in the survey. Patches of krill were found at different depths ranging from 0-50 m to 5-150 m.

6.17 Papers WG-CEMP-92/33 and 34 complement each other. Results of these papers are based on a survey carried out by RV *Dimitry Stefanov* in the area to the north of South Orkney Islands (Subarea 48.2) in April 1992. The size of the survey area was 30 x 30 n miles. Data on water flow velocities and krill movement rates are reported.

6.18 Diurnal changes in such demographic characteristics of krill as size composition and sex ratio are described in the paper WG-Krill-92/9 for the area to the west of Coronation Island (Subarea 48.2). It was found that depending on the time of day and depth of sampling, krill have a different size composition and sex ratio.

6.19 Hydroacoustic surveys were conducted in the Prydz Bay Region (WG-Krill-92/23) in 1985, 1991 and 1992 for approximately the same area. Estimates of abundance for a standardised area of 350 000 km^2 were 7, 5 and 2 million tonnes in 1985, 1991 and 1992, respectively.

Krill Characteristics

6.20 A comprehensive review of available information on length/weight relationships for krill is given in WG-Krill-92/15. This information is of particular importance for diet studies of krill predators.

6.21 Length frequencies of krill collected from 1988 through 1992 around Elephant Island were investigated using cluster analyses to detect possible between-station differences in stock composition (WG-Krill-92/12). During the first four years, two distinct groups were identified; in the last year three groups were present. Length frequency distributions varied substantially between groups and among years. Information on strong and poor year classes of krill in the Antarctic Peninsula and Elephant Island region for the past 17 years were also summarised.

6.22 Acoustic and net sampling surveys for krill were conducted in the krill fishing area north of the South Shetland Islands from 18 January to 3 February 1991 (WG-Krill-92/26). Distinct offshore-inshore variability in abundance and maturity of krill were observed.

6.23 Shipboard tracking studies of penguins and female fur seals at Seal Island were conducted in early January 1991 to identify and evaluate their foraging areas (WG-Krill-92/27). Penguin foraging areas were found in inshore regions, where krill frequently occurred but not in high density. In contrast, fur seal foraging areas were found in offshore regions, where krill occurred only occasionally but tended to form large aggregations. These results were derived from a collaborative study by Japanese and US scientists.

6.24 Biological data for krill were collected from samples taken from 50 out of a total of 419 trawls taken by FV *Kirishima* during the 1990/91 fishing season (WG-Krill-92/33). The fishing grounds were located north of Livingston and King George Islands and north of Elephant Island. The sex composition of krill the first area was 65.1% females, 34.4% males and 1.4% juveniles. The sex composition for the second area was 47.1% females, 40.0% males and 12.9% juveniles. Males were more abundant in night catches, while females were more abundant in day catches. Catches in tonnes/mile and tonnes/hour were higher during daytime than during twilight and night time in both fishing areas.

Environment Studies

Oceanographic Characteristics

6.25 The RV *Kaiyo Maru* surveyed waters around the South Shetland Islands during the 1990/91 austral summer (WG-Krill-92/24). Two oceanic processes were found to be characteristic in this area. The first was the steady topographic upwelling of the Warm Deep Water and the second was the wind-driven coastal upwelling.

6.26 Information was reported on the hydrographic flux in the Statistical Area 48 (WG-Krill-92/25). Surface geostrophic flow was calculated from oceanographic data recorded since 1925. Geostrophic velocity and volume transport through five transects were calculated using data collected aboard RV *Kaiyo Maru* during the last nine years.

Assessment of Predator, Prey, Environmental, and Fishery Data

6.27 At its 1991 meeting, WG-CEMP reviewed the first sets of data submitted to the Secretariat under the CEMP monitoring protocol but noted that there were insufficient data and calculated indices to begin the assessment process described above. With the inclusion of data submitted prior to the 1992 meeting (1992 monitoring results and additional historical data) and the availability of calculated CEMP indices, there were sufficient results to begin considering trends and patterns among CEMP sites, species and years at the present meeting.

6.28 As a first approach to synthesising the CEMP predator data, fishery catch data, prey survey data and environmental data, the Working Group assembled Table 4. Summaries of the data were evaluated to indicate whether the data suggested low, average or high krill abundance and availability to predators. It was emphasised that the krill catch data were included for the purpose of providing an indication of the relative abundance of krill in certain years and areas, and not for the purpose of attempting to detect the potential effects of the fishery on predators or prey.

6.29 The summaries for Subarea 48.1 (Table 4.1 to 4.5) showed clearly that 1991 was a year of poor availability of krill. The breeding success and breeding population size of penguins were low at Seal Island, King George Island, and Anvers Island. Fur seal feeding trips and weight of pups on 1 January also indicated poor conditions at Seal Island in that year.

6.30 Data on Adélie and chinstrap population changes and breeding success in Subarea 48.2 (Table 4.6) dearly identify 1991 as a poor year (although the high survival of chinstrap chicks suggests a late season improvement in food availability). Similarly, 1989 and 1992 can be characterised as good years.

6.31 In Subarea 48.3, predator data indicated poor availability of prey in 1991 and relatively good availability in 1989 and 1992 (Tables 4.7 and 4.8). Late-season growth of fur seal pups in 1991 at South Georgia indicated that prey availability had improved, a finding consistent with fur seal data from Seal Island in Subarea 48.1.

6.32 It was noted that poor years for black-browed albatross in 1988 and 1992 at South Georgia were thought to be primarily due to the presence of heavy snow in the breeding colonies and not to a lack of prey availability; this emphasises the need to record local environmental conditions when monitoring predators. The Working Group agreed that columns for snow and ice within predator colonies should be added to the environment portions of Table 4.

6.33 The Working Group observed that 1991 appeared to be a year of poor krill availability to predators across all three subareas of Statistical Area 48. These effects were most easily recognised in the data from predator breeding success and population size. It was noted that the krill catch data, in some cases, do not show any apparent pattern consistent with predator and prey survey data. For example, in Subarea 48.1, the krill catch was not anomalous in 1991, but research surveys found low krill biomass in January and February.

6.34 Several factors that could make the krill catch data unreliable for indicating, even in a very general way, the availability of krill to predators were identified: (i) only a portion of the total catch is sometimes obtained in the same season in which the predator parameters are monitored; (ii) economic fluctuations affect fishery effort; and (iii) in Subareas 48.1 and 48.2 the fishery moves between several areas among which the concentrations of krill may not be well correlated.

6.35 The Working Group also noted that it would be helpful to have additional information indicating the relative availability of krill to the fishery in each year for the several subareas. This information might include additional or different measures of effort as well as subjective assessments from experts with experience in the fishery (e.g., reports containing the general impressions of fishing captains on whether it was a relatively good or bad fishing season).

6.36 The Working Group noted that this first effort in bringing together the predator, prey, environmental, and fishery data was of necessity a coarse treatment of the data, with a focus mainly on the presence and directions of changes. Future efforts should include consideration of the magnitudes and significance of changes.

Potential Impact of Localised Krill Catches

6.37 Last year WG-CEMP, in considering the fine-scale data on distribution of krill catches, noted the extensive temporal and spatial overlap between krill harvesting and foraging by land-based predators, especially in Subarea 48.1. It agreed that this demonstrated the potential for significant competition between the fishery and krill-dependent predators.

6.38 The Scientific Committee unanimously endorsed these conclusions, noting that a situation whereby a substantial krill fishery consistently operates within the foraging range of krill-dependent predators at a critical time of year (when the predators have dependent offspring), had long been identified as a most serious concern and one where close and urgent attention needs to be given to appropriate management action (SC-CAMLR-X, paragraph 6.29).

6.39 The Secretariat had continued the assessment of catch distribution with respect to predator colonies, incorporating the 1991 fine-scale data (WG-Krill-92/13) in WG-Krill-92/18. The overall picture for Subarea 48.1 was still remarkably consistent in all four years (1988 to 1991) for which data are available, with 96 to 98% of the krill catch from December to March in the subarea being taken within the critical period-distance[1] for foraging activity of breeding penguins and fur seals. For

[1] December to March within 100 km of predator colonies.

Subarea 48.2, the 1991 data showed 81% of the catch taken within the critical period-distance, similar to 1987 (83%) and 1988 (96%) and very different from 1989 (5%) and 1990 (17%).

6.40 Within the critical period-distance krill catches continued to be a significant fraction of the estimated krill requirement of breeding penguins; for 1991 the catch was 12% and 31% of the combined take of krill by the fishery and by penguins in Subareas 48.1 and 48.2, respectively.

6.41 The Secretariat was thanked for undertaking this valuable analysis and asked to continue to provide this documentation to WG-CEMP on an annual basis.

6.42 Dr Shust noted that in most years the location of the fishery within Subarea 48.1 changes during the season, which will tend to reduce the level of impact in any one part of the subarea. To assess the nature and significance of this the Secretariat was asked in the future (and also retrospectively if possible) to analyse the fine-scale data for the Elephant Island area separately from the rest of Subarea 48.1 and to consider if there were other parts of the subarea which could realistically be subdivided (e.g., Livingston and King George Islands).

6.43 Dr Shust also noted that some penguin colonies used in the calculation of krill consumption by predators were from the southern coast of the South Shetland Islands, whereas the fishery was virtually confined to the waters off the northern coast. It was explained, however, that not only were the fishing grounds (at least as deduced from the maps of the fine-scale data) within the theoretical foraging ranges of penguins from these colonies but that the colonies along the northern coast account for about 90% of the penguin biomass in the subarea.

6.44 There was agreement that the 1991 data strongly reinforced last year's findings in respect of the localised distribution of fishing effort. WG-CEMP reiterated the importance of enhanced research activity in Subareas 48.1 and 48.2, especially:

(i) urgent research into krill biomass, productivity and fluxes;

(ii) improving estimates of the prey requirements of land-based predators; and

(iii) enhancing the CEMP activities, especially expanded monitoring operations in Subarea 48.2 and, as a high priority, conducting monitoring at one or more additional sites on the north coast of the main South Shetland Island group.

6.45 The Working Group recalled last year's statement by the Scientific Committee noting the urgency of examining precautionary management measures to address the overlap of the fishery and krill-dependent predators in the critical period-distance zone (SC-CAMLR-X, paragraph 6.30).

6.46 Dr Naganobu, however, stated that he believed there was no urgency to consider the impact of the krill fishery on predators. He felt that both WG-Krill and WG-CEMP were too concerned about this matter and that considering possible precautionary catch limits for krill based on predator-fishery interactions was premature. The reasons for this opinion were that:

(i) the krill fishery is still small and none of the countries fishing at present has expressed an intention to expand its fishery in the near future;

(ii) there is no evidence that krill fishing has had an adverse influence on predators and that more scientific information (e.g., as described in paragraph 6.44 above) should be collected before management measures are considered; and

(iii) a realistic estimate of the krill requirements of predators has not yet been provided.

6.47 In addition he felt that it was sufficient to consider only penguins for calculations of predator demand when considering overlap between the fishery and predator foraging ranges. This is because the foraging range of fur seals extends beyond the fishing grounds and thus overlap between the fishery and this predator is much less.

6.48 Other members were very concerned at this statement which seems to run contrary to the spirit of the Convention, the content of Article II of the Convention and the expressed policy of both the Scientific Committee and Commission.

6.49 It was felt entirely proper for WG-Krill and WG-CEMP to give serious and urgent consideration to the circumstances whereby substantial krill catches are taken annually from within a very restricted area at a time of year when krill-eating predators, trying to rear offspring, are restricted to the same area. Indeed it would be difficult to imagine a situation of greater potential concern to WG-CEMP.

6.50 It is true that there is no evidence that krill fishing has had an adverse influence on predators. Equally, there is no evidence that there has <u>not</u> been an adverse effect. Indeed it is difficult to see how the situation described above can fail to have <u>some</u> adverse impact on krill-dependent predators. Many of the research initiatives within WG-Krill and WG-CEMP are designed to try to quantify the nature and magnitude of any such effects. However, there is no prospect of cause-effect relationships being established without many years of detailed study of krill abundance, availability and movements and of predator abundance, distribution and energetics. In the meantime it is essential to consider appropriate precautionary management measures, including, but not confined to, catch limits.

6.51 Dr Bengtson cleared up an apparent misapprehension concerning fur seal foraging ranges, noting that the available data in Subarea 48.1 indicated that nearly all foraging by breeding female fur seals takes place within 100 to 110 km of their breeding site.

6.52 Some members noted that the existing interim estimates of krill requirements of penguins and fur seals at this time are entirely realistic as minimum values of krill requirements of dependent species in the critical period-distance zone and are also the best data currently available.

6.53 Last year the Scientific Committee had agreed unanimously to examine precautionary management procedures relating explicitly to the overlap between the krill fishery and dependent predators. To facilitate this, discussions had been initiated with Members conducting krill fishing in Subareas 48.1 and 48.2, initially by posing questions relevant to the characteristics of the fishery and the consequent implications of various options for potential future conservation measures (SC-CAMLR-X, paragraph 6.36).

6.54 Members involved in the krill fishery had provided much useful information concerning the operations of their fishery, leading to extensive and valuable discussion at WG-Krill (SC-CAMLR-XI/4, paragraphs 5.1 to 5.35).

6.55 It was re-emphasised that the object of developing precautionary measures in this context is to try to identify management measures to afford adequate protection for krill-dependent predators in specific areas at critical times of year without this protection causing unnecessary or unacceptable restrictions for the krill fishery.

6.56 WG-CEMP recommended that the Scientific Committee consider defining zones within Subareas 48.1 and 48.2 for specific areas where there was a consistent pattern of commercial fishing within the critical period-distance of the foraging activities of land-breeding penguins and fur seals. A precautionary approach to management could be accomplished by applying management measures, or a mixture of measures, in such zones. WG-CEMP noted that WG-Krill had listed and elaborated options for management measures to control fishing in specific areas (SC-CAMLR-XI/4, paragraphs 5.46 to 5.51).

6.57 WG-CEMP also recommended that the Scientific Committee invite Members currently engaged in fishing for krill to consider and report on what potential measures, or combinations of measures, would be acceptable to them for application within Subareas 48.1 and 48.2 in order to address the specific problem of providing some precautionary protection for land-based krill predators foraging within 100 km of breeding colonies between December to March inclusive.

ESTIMATES OF PREY REQUIREMENTS FOR KRILL PREDATORS

7.1 This topic is being addressed by WG-CEMP in relation to:

(i) assessing significance (in terms of ecological and management implications) of overlap (geographical and temporal at a variety of scales) between the krill fishery and krill-dependent predators;

(ii) contributing to management objectives under Article II of the Convention (SC-CAMLR-X, Annex 7, paragraph 6.1).

Review of Progress

7.2 The Working Group considered first the progress made on initiatives developed last year to address the first set of objectives (SC-CAMLR-X, Annex 7, paragraph 6.8 to 6.24).

Synthesis of Fur Seal and Penguin Data

7.3 For the South Georgia ISR the latest data synthesis (and presentation of published results) remain those published in SC-CAMLR-VIII/BG/12 and BG/15, updated as described in WG-CEMP-90/31[1]. WG-CEMP-92/50 summarises all relevant published data for Antarctic fur seals, including the mass-specific energy costs of a range of breeding season activities. It also summarises current research which will significantly improve understanding of activity-specific energy budgets.

7.4 For the Antarctic Peninsula ISR WG-CEMP-92/17 reviews available data on penguin population size, breeding timetable, diet and body mass. WG-CEMP-92/18 similarly reviews data on metabolic rates, foraging ranges and assimilation efficiencies of penguins. These are a most valuable

[1] In: *Selected Scientific Papers, 1990 (SC-CAMLR-SSP/7)*: 489-520.

compendium of information and provide an excellent basis for use in ISR-wide prey consumption models. Members with relevant additional data are asked to make them available as soon as possible. WG-CEMP-92/19 synthesises available data for Antarctic fur seals in this ISR, which, together with appropriate data from the studies summarised in WG-CEMP-92/50, provide a good basis for assessing prey consumption of the breeding population of Antarctic fur seals in this region.

7.5 WG-CEMP-92/49 presents a review of data on breeding population size, diet and energy budgets of predators in the Prydz Bay ISR. Although this review is by no means fully comprehensive, it is a starting point for further efforts and provides useful information for inclusion as input parameters in modelling studies of prey requirements of krill predators.

7.6 The magnitude of these data compilation tasks have precluded any attempt to provide WG-CEMP, or the Scientific Committee, with interim estimates of predators' prey requirements based on these new data (SC-CAMLR-X, Annex 7, paragraph 6.21).

7.7 In any case, in the light of the recent discussions between WG-Krill and WG-CEMP and the plans for alternative priority activities developed there, it was agreed that developing interim estimates is now of less immediate urgency.

Synthesis of Crabeater and Leopard Seal Data

7.8 The results of the study investigating the feasibility of constructing energy and prey consumption budgets for crabeater seals were tabled as WG-CEMP-92/25. In the time available it had not been possible to make any similar compilations for leopard seals, for which relevant data are very sparse in most areas. The Working Group noted that the crabeater seal document was not only a valuable compilation but also represented a pioneering attempt to construct an energy budget for an Antarctic ice-breeding seal. It would be most valuable to incorporate these data into ISR prey consumption models in addition to the data for penguins and fur seals.

7.9 Dr D. Torres (Chile) reported that Chile had data from an aerial survey of seals around the South Shetland Islands in November 1980 which might be relevant to the above synthesis (Torres *et al*., 1981[1]).

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[1] TORRES, D., J. YAÑEZ, M. GAJARDO and M. SALLABERRY. 1981. Registros aéreos de mamíferos marinos y aves antárticas en las islas Shetland del Sur. *Bol. Antart. Chileno 1*(2): 6-10.

Advice of IWC Concerning Whales

7.10 Correspondence with the Scientific Committee of the International Whaling Commission regarding the availability of data for estimating energy requirements of baleen whales was reported in WG-CEMP-92/27. It was agreed that the Convener should thank Dr Hammond for this response and request that CCAMLR be informed when abundance estimates for minke whales (from IDCR sightings cruises) and data from the Japanese scientific catch on diet and energy requirements become available.

Data on Seabirds Other than Penguins

7.11 There had been little progress intersessionally on this topic, except for that reported in WG-CEMP-92/49 for Prydz Bay. Dr W. Trivelpiece (USA) noted that extensive data for King George Island were available in the review by Jablonski (1986)[2]. It was noted that Dr W. Fraser (USA) was reviewing the status and distribution of the Southern giant petrel throughout the Antarctic (i.e., including the Antarctic Peninsula ISR) as part of an ongoing initiative coordinated by the SCAR Bird Biology Subcommittee. Members with relevant data were asked to send them to Dr Croxall who would ensure that CCAMLR received a copy of the resulting synthesis from SCAR.

Future Progress

7.12 WG-CEMP decided that given its existing priorities for future work (which were recently modified according to recommendations from the Joint Meeting of WG-Krill and WG-CEMP) it was not advisable at present to schedule a major collaborative workshop to review in detail krill consumption by predators in the ISRs. Members were encouraged to provide WG-CEMP with updated estimates of krill consumption for ISRs or parts thereof. They were also asked to continue to accumulate relevant data to improve the basis for the models in preparation for a full-scale workshop to be scheduled at some later date.

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2 JABLONSKI, B. 1986. Distribution, abundance and biomass of a summer community of birds in the region of the Admiralty Bay (King George Island, South Shetland Islands, Antarctica) in 1978/79. *Polish Polar Research* 7(3): 217-260.

Estimates of Krill Escapement

7.13 Last year, WG-CEMP noted that the prospects of estimating desired levels of krill escapement on the basis of estimates of krill consumption by all natural predators (e.g. whales, seals, birds, fish, squid) were remote. As described above, WG-CEMP's recent efforts in this regard had been focused on developing estimates of the amount of krill required by selected species of marine mammals and birds.

7.14 In discussion of this item at the Joint Meeting of WG-Krill and WG-CEMP, in addition to clarifying definitions of escapement, the focus of attention was shifted from krill requirements of predators to the need to consider critical levels of predator performance in relation to escapement of krill from the fishery (SC-CAMLR-XI/5, paragraph 1).

7.15 Consequently an initial approach to improve understanding of possible functional relationships between krill availability and predator performance was developed (SC-CAMLR-XI/5, paragraph 2 and Appendix 1).

7.16 The Working Group endorsed this approach. It noted that, in respect of the predator element, the initial modelling exercise required the selection of two or three predator species and the provision of three types of data.

7.17 Based on the criteria outlined in the Appendix to the Joint Report, WG-CEMP agreed that the most appropriate species to select were Adélie penguin, crabeater seal and black-browed albatross.

7.18 The tasks of coordinating the provision of data on (i) average annual survival rate of adults; (ii) average age at first breeding; and (iii) the proportion of good, poor and bad years, from the perspective of predator performance, were allocated as follows:

Adélie penguin:	Dr W.Z. Trivelpiece
Crabeater seal:	Dr J.L. Bengtson
Black-browed albatross:	Dr J.P. Croxall.

7.19 The specified data should be submitted to the Convener as soon as possible.

Liaison with WG-FSA

7.20 There was a suggestion that the Working Group on Fish Stock Assessment (WG-FSA) work on krill predation by fish might be incorporated into WG-CEMP estimates of prey requirements (SC-CAMLR-X, paragraphs 6.55 to 6.56). WG-CEMP noted that WF-FSA should be made aware that because of shifting priorities, no specific proposals had yet been made for scheduling a CEMP workshop on prey requirements.

7.21 WG-CEMP had also been asked by the Scientific Committee to consult with WG-FSA to provide data and advice that would assist WG-FSA in interpreting changes in abundance and distribution of fish stocks (SC-CAMLR-X, paragraph 6.57). WG-CEMP suggested that WG-FSA consider Table 4 in this report.

GENERAL MATTERS

Approaches to Integrated Analyses of Predator/Prey/Environmental Data

8.1 Dr Torres summarised a study he is undertaking at Cape Shirreff (WG-CEMP-92/48) of the application of a geographical information system (GIS) which allows comparison of data on distribution of bird and seal colonies with data on terrain, insolation, and other environmental variables.

8.2 At its 1991 meeting the Scientific Committee had noted the existence of the Antarctic Digital Database Project. The Data Manager had been requested to contact the manager of the Project to discuss existing and potential developments of mutual interest (SC-CAMLR-X, paragraph 6.52). Although no reply to this enquiry had been received by the Secretariat, Dr Croxall informed the meeting that currently the database contained only outline and land-based topography, and that the next development would almost certainly include the addition of bathymetric data. Other hydrographic data, of potential interest to CCAMLR, would be unlikely to be added at this stage, but was expected to be included in future stages of the project.

8.3 The Convener noted that WG-CEMP had discussed under Agenda Item 6 (Ecosystem Assessment) several issues that are directly related to the topic of integrated analyses of predator, prey and environmental data.

Review of Opportunities for Collaborative Studies

8.4 The Working Group noted that past collaborative studies have succeeded in providing much valuable information for CEMP. Opportunities for such collaboration in the future should continue to be encouraged. It was noted that several areas of common interest for future collaborative work had been identified throughout the Working Group's discussions.

8.5 Dr Naganobu advised the Working Group that Japan plans to conduct research surveys during the 1994/95 austral summer and that there may be opportunities for collaborative studies associated with those surveys.

Matters Arising from the Joint Meeting of WG-Krill and WG-CEMP

8.6 A document prepared by the Conveners of WG-Krill and WG-CEMP and the Chairman of the Scientific Committee summarised the discussions and conclusions from the Joint Meeting of WG-Krill and WG-CEMP (SC-CAMLR-XI/5). Several items in that paper contained requests for information or action by WG-CEMP. The Working Group reviewed these requests to ensure that the relevant points had been addressed by WG-CEMP.

8.7 In paragraph 5 of SC-CAMLR-XI/5, WG-CEMP was requested to consider the use of estimated predator demands in calculating the allocation of precautionary catch limits. The Working Group agreed that it is presently not feasible to estimate krill demand by all krill predators (i.e., cetaceans, pinnipeds, birds, fish, squid) for all geographic portions of Statistical Area 48 and that the assumptions required to use proportions derived from land-based predators alone (without pelagic predators) would be scientifically unsound. The Working Group therefore agreed that using estimates of predator demands to allocate catch limits within subareas is presently not advised.

8.8 Paragraph 9 of SC-CAMLR-XI/5 calls for development of models to evaluate the statistical performance and cost-effectiveness of possible experimental harvesting regimes designed to distinguish between natural variation in predator performance and effects due to fishing. The Working Group noted that the sequence of events in such development should be initiated by proposals for the model framework (especially spatial and temporal scales) from proponents of such models within WG-Krill.

8.9 Paragraph 10 of SC-CAMLR-XI/5 addressed feedback mechanisms for management advice. CEMP is planning to attempt to define criteria and mechanisms for specifying how changes in indices derived from predator parameters being monitored could be used in the formulation of management procedures and advice. It was emphasised that an essential element of this process is the development of models and simulations investigating the performance of various criteria using the current and historical data sets in the CEMP database.

8.10 The Working Group noted that it had considered, in paragraphs 6.39 to 6.57 of this report, the issues addressed in paragraph 11 of SC-CAMLR-XI/5 pertaining to selection of precautionary management options in areas of localised krill catches.

OTHER BUSINESS

Access to CEMP Data

9.1 Dr Croxall noted that the present policy on access to CCAMLR data (SC-CAMLR-VIII, paragraphs 13.1 to 13.7) could pose a difficult problem for owners of the data if a scientist uses CEMP data for a paper tabled at a CCAMLR meeting and later wishes to publish the results. Problems could arise if there is a disagreement regarding whether or not, or under what circumstances, the paper should be published. This situation could be particularly acute when historical data from long-term studies are involved. Several researchers are presently considering submitting such historical datasets which would greatly expand the CCAMLR Database. Similarly, as the time series of CEMP data currently being collected grow, these will become increasingly valuable sources of data for analysis of subsequent publications.

9.2 Consequently, Dr Croxall proposed a change to the existing rules governing access to CEMP data. Recognising the potentially broad ramifications of any policy change regarding data access, it was agreed that this topic should be given careful consideration. CCAMLR's policy on data access and use is of fundamental importance in both ensuring that relevant data needed for CCAMLR's work are freely available, and that the owners/originators of the data are protected from inappropriate uses of their data.

9.3 The Working Group recommended that the Scientific Committee consider its policies on data access and use as a matter of priority.

IUCN Assessment of Marine Protected Areas

9.4 The Convener informed the Working Group of an initiative on global marine areas being undertaken by the World Conservation Union (IUCN) (WG-CEMP-92/29). The Commission on National Parks and Protected Areas (CNPPA) of the IUCN is conducting a project to assess the

World's marine protected areas and to identify priority areas for conserving global marine biodiversity. This project is being undertaken at the request of the World Bank Environment Department. It is expected that the project's report will offer guidance to the Global Environment Facility (GEF) in assigning priorities for providing grants and financial assistance. The GEF is a three-year pilot program (started in 1990) administered jointly by the World Bank, the United Nations Environmental Program, and the United Nations Development Program.

9.5 The CNPPA project on marine protected areas and the GEF's objective of supporting wise management of marine ecosystems may offer an opportunity to CEMP. If funds are to be made available from the World Bank to help support conservation of global marine biodiversity, providing some type of financial support to CEMP might be an effective way for the GEF to accomplish a part of its objectives.

9.6 The Convener was requested to obtain additional information on these programs and report back to WG-CEMP next year. The objectives of this request are to determine:

(i) whether these programs' goals correspond to those of CCAMLR and the work of WG-CEMP;

(ii) the prospects and circumstances under which funding may be made available for this initiative by the World Bank; and

(iii) whether or not WG-CEMP should consider recommending to the CCAMLR Scientific Committee that a proposal be developed requesting that the World Bank provide funds in support of CEMP.

FUTURE WORK

10.1 The Working Group reviewed progress made, work discussed and tasks identified at the meeting. The principal tasks in the coming year are as follows:

(i) the Convener was asked to solicit contributions from Members not currently contributing to the work of the Working Group (paragraph 3.10);

(ii) the Convener and Secretariat are asked to organise the formation of the three *ad hoc* subgroups (paragraphs 4.5 and 4.6);

(iii) Members are encouraged to test the software for calculating indices (paragraph 4.9);

(iv) Members are encouraged to develop examples of ANOVA analyses of the CEMP data (paragraph 4.11);

(v) the report of the Alaska Workshop on at-sea monitoring of marine mammals should be reviewed before identifying a specific CCAMLR meeting (paragraph 4.17);

(vi) the Secretariat is requested to obtain relevant satellite data (paragraph 4.28) and analyse them as appropriate (paragraphs 4.30 and 4.31);

(vii) the Secretariat is requested to make appropriate arrangements for implementing a new publication format for the next edition of the *Standard Methods for Monitoring Studies* (paragraph 4.37);

(viii) progress reports on activities concerning Method A4 should be prepared (paragraph 5.9);

(ix) the Working Group requests WG-Krill to update krill biomass estimates for the ISRs as available (paragraph 5.32);

(x) the Secretariat will continue analyses of overlap of fishing and predator foraging (paragraph 6.41);

(xi) encourage research activity on the localised distribution of fishing effort (paragraph 6.44);

(xii) Members with additional data on fur seal, penguin and other seabird consumption are asked to make these available as soon as possible (paragraph 7.4 and 7.11). The workshop on krill consumption by predators should be considered for scheduling at a later date (paragraph 7.12);

(xiii) data of survival rate, age at first breeding and proportion of good and bad years for calibration of the integrated modelling exercise identified by the joint workshop should be coordinated and reported as set out in paragraph 7.18 and 7.19; and

(xiv) the Convener was requested to obtain more information on the IUCN initiative on global marine areas (paragraph 9.6).

10.2 To accomplish the tasks identified above, to undertake its annual assessments, and to provide timely advice to the Scientific Committee, it was agreed that extensive discussions, based on intersessional preparatory work, will be needed. Such discussions cannot be effective without a meeting of the Working Group.

10.3 Accordingly, the Working Group recommended that it hold a meeting during the 1993 intersessional period.

Summary of Recommendations to the Scientific Committee

10.4 The Working Group made the following recommendations to the Scientific Committee:

(i) the Secretariat is requested to prepare an estimate for the collection of sea-ice data for the Scientific Committee (paragraph 4.29);

(ii) the Scientific Committee is asked to request whether domestic legislation would preclude Japan from reporting combined krill catches on a very fine-scale basis (paragraph 5.29);

(iii) the Scientific Committee consider defining zones within Subareas 48.1 and 48.2 for areas where there is a consistent pattern of overlap between predators and fishing activity (paragraph 6.56);

(iv) the Scientific Committee invite Members currently engaged in fishing to consider what potential management measures could be acceptable for application within Subareas 48.1 and 48.2 (paragraph 6.57); and

(v) the Scientific Committee consider its policies on data access (paragraph 9.3).

CLOSE OF THE MEETING

11.1 The Report of the Meeting was adopted.

11.2 The Convener thanked participants, rapporteurs, subgroups, the Secretariat and the Chilean Ministry of Foreign Affairs for their work and assistance during the meeting. He noted that the quality and relevance of the numerous working and background papers prepared during the intersessional period by participants contributed significantly to the meeting's excellent progress.

11.3 Special thanks were extended to the Secretariat for their contributions in support of WG-CEMP during the past year. In particular, the Working Group's activities in calculating and evaluating CEMP indices were advanced in large part because of the efforts of the Secretariat's superb staff.

11.4 The Working Group extended its gratitude to the Government of Chile, the Instituto Antártico Chileno and the University of Chile for hosting and assisting with the meeting in Viña del Mar. By arranging a pleasant venue with efficient facilities, they had enabled the Working Group to engage in a very productive meeting.

Table 1: Summary of Members' CEMP activities on monitoring approved predator parameters.

Parameter		Species[1]	Country	Site Name/ Integrated Study Region/ Network Site	Year Started[2]	Data Submitted[2]	Being Prepared[2]
Penguins							
A1	Weight on arrival at breeding colonies	A	Australia	Magnetic Is Prydz Bay	1984		1990-91
		A	Australia	Béchervaise Is		1992	
		A	Argentina	Stranger Point/ King George Is	1988	1988-90	1991
		A	Argentina	Laurie Is S. Orkney Is	1988	1988-90	1991
			Argentina	Esperanza St.	1991	1991	
		A	Germany	Ardley Is/ S. Shetlands	1991		
		M	UK	Bird Is/ South Georgia	1990	1990-92	
A2	Length of the first incubation shift	A	Australia	Magnetic Is Prydz Bay	1984		1989-91
		A	Australia	Béchervaise Is/ Mawson	1991	1991-92	
		A	Argentina	Stranger Point King George Is	1988		1990-91
			Argentina	Esperanza St.	1991		1991
		A	Germany	Ardley Is/ S. Shetlands	1991		
A3	Annual trends in breeding population size	A	Australia	Magnetic Is Prydz Bay	1984		1990-91
		A	Australia	Béchervaise Is		1992	
		A	Argentina	Stranger Point/ King George Is	1988		1990-91
				Esperanza St.	1991		1991
		M,C	Brazil	Elephant Is S. Shetlands	1986	1992	
		A,C	Chile	Ardley Is S. Shetlands	1982		1989-92
		A	Japan	Syowa Station/ Network site	1970		1989-91

Table 1 (continued)

Parameter		Species[1]	Country	Site Name/ Integrated Study Region/ Network Site	Year Started[2]	Data Submitted[2]	Being Prepared[2]
A3 continued		M,G	UK	Bird Is/ South Georgia	1976	1990-92	
		A,C,G	UK	Signy Is/ Network site	1979	1990-92	
		A	USA	Anvers Is	1992	1992	
		A	Germany	Ardley Is/ S. Shetlands	1991		
A4	Demography	C	Chile	Ardley Is S. Shetlands	1982		1989-92
		M,C	Brazil	Elephant Is S. Shetlands	1986	1989-92	1989-92[3]
		M,C	USA	Seal Is S. Shetlands	1988		1990-92[3]
		A	USA	Anvers Is Palmer Station	1988		1989-91[3]
A5	Duration of foraging trips	A	Australia	Magnetic Is Prydz Bay	1984		1990-91
		C	USA	Seal Is S. Shetlands	1988	1988-92	
		A	USA	Anvers Is Palmer Station	1990	1990-92	
		M	USA	Seal Is		1990	
A6	Breeding success	A	Australia	Magnetic Is Prydz Bay	1984		1989-91
		A	Australia	Béchervaise Is		1992	
		A	Argentina	Stranger Point/ King George Is	1988		1990-91
				Laurie Is/ Esperanza St.	1991		1991
		M,C	Brazil	Elephant Is S. Shetlands	1986	1990-92	
		C	Chile	Ardley Is S. Shetlands	1982		1989-92
		M,G	UK	Bird Is/ South Georgia	1976	1990-92	
		A,C,G	UK	Signy Is/ Network site	1979	1990-92	

Table 1 (continued)

Parameter		Species[1]	Country	Site Name/ Integrated Study Region/ Network Site	Year Started[2]	Data Submitted[2]	Being Prepared[2]
A6 continued		M,C	USA	Seal Is S. Shetlands	1988	1988-92	
		A	USA	Anvers Is Palmer Station	1988	1990-92	
		A	Germany	Ardley Is	1991		
A7	Fledging weight	A	Australia	Magnetic Is Prydz Bay	1984		1990-91
		A	Australia	Béchervaise Is		1992	
		M	Brazil	Elephant Is S. Shetlands	1986	1992	
		C	Brazil	Elephant Is S. Shetlands	1986	1990-92	
		M,G	UK	Bird Is/ South Georgia	1989	1990-92	
		C	USA	Seal Is S. Shetland Is	1988	1988-92	
		A	USA	Anvers Is Palmer Station	1988	1990-92	
		M	USA	Seal Is		1990	
		A	Germany	Ardley Is	1991		
A8	Chick diet	A	Australia	Magnetic Is Prydz Bay	1984		1990-91
		A	Australia	Béchervaise Is Mawson	1991	1991-92	
		M,C	Brazil	Elephant Is S. Shetlands	1986	1992	
		C	Chile	Ardley Is S. Shetland Is	1982		1989-90
		M	UK	Bird Is/ South Georgia	1986	1990-92	
		G	UK	Bird Is/ South Georgia	1986	1990-92	
		C	USA	Seal Is S. Shetlands	1988	1988-91	1992
		A	USA	Anvers Is Palmer Station	1988	1990-92	
		A	Germany	Ardley Is	1991		

Table 1 (continued)

Parameter		Species[1]	Country	Site Name/ Integrated Study Region/ Network Site	Year Started[2]	Data Submitted[2]	Being Prepared[2]
A9	Breeding chronology	A	Australia	Magnetic Is Prydz Bay	1984		1990-91
		A	Australia	Béchervaise Is/ Mawson	1991		1991
		C,M	USA	Seal Is S. Shetland Is	1988	1988-90	
		A	USA	Anvers Is	1988	1990-92	
Flying birds							
B1	Breeding population size	B	UK	Bird Is/ South Georgia	1977	1992	1990-92
B2	Breeding success	B	UK	Bird Is/ South Georgia	1977	1992	1990-92
B3	Age-specific annual survival and recruitment	B	UK	Bird Is/ South Georgia	1977	1990-91	
Seals							
C1	Cow foraging/ attendance cycles	F	Chile	Cape Shirreff	1988	1988	
		F	UK	Bird Is/ South Georgia	1979	1990-92	
		F	USA	Seal Is S. Shetland Is	1988	1988-92	
C2	Pup Growth	F	Chile	Cape Shirreff/ Ant. Peninsula	1985	1984-85 1990-92	
		F	UK	Bird Is/ South Georgia	1973 1978	1990-92	
		F	USA	Seal Is S. Shetland Is/	1988	1988-92	

[1] A - Adélie penguin, M - Macaroni penguin, C - Chinstrap penguin, B - Black-browed albatross, F - Fur seal

[2] All years referred to are split-years

[3] At present these data are not requested for submission to the CCAMLR Data Centre

Table 2: Summary of Members' directed programs on assessing the utility of potential predator parameters.

Parameter	Areas[(a)] from which data are available for analysis/ evaluation	Members' Research Activity					
		Undertaken 1990/91		Undertaken 1991/92		Proposed for 1992/93	
		Analysis of existing data	Acquisition of new data	Analysis of existing data	Acquisition of new data	Analysis of existing data	Acquisition of new data
-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-
Penguins[(b)]							
- Incubation shift (M)	2,4,5,11,14	S.Africa (14,M)	S.Africa (14,M)				
- Weight prior to moult (M)	2,15,14,4,5?	S.Africa (14,M)	S.Africa (14,M)				
- At-sea diving behaviour and activity patterns (A,C,M)	2,4,6	Australia (6,A) USA (2,C,M) Germany (11,A, G)	UK (4,G) USA (2,C,M) Germany (11,A, G)	Australia (6,A) UK (4,G) USA (2,C,M) Germany (11,A, G)	Australia (6,A) UK (4,G) USA (2,C,M) Germany (11,A, C,G)	Australia (6,A) UK (4,G) USA (2,C,M)	Australia (6,A) UK (4,M,G) USA (2,C,M)
- Weight recovery during incubation (A,C,M)	4,6	Australia (6,A)					
- Survival (A,C,M)	1,2,6,11	USA (2,C;11,A)	UK (4,M,G) USA (2,C;11,A)	USA (2,C)	UK (4,M,G) USA (2,C)	USA (2,C)	UK (4,M,G) USA (2,C)
- Chick growth rate	2,11	UK (4,G) Spain (2,C)	UK (4,G)	USA (2,C)	UK (4,G) USA (2,C)	USA (2,C)	UK (4,M,G) USA (2,C)
- Bioenergetics	2,4	Spain (2,C) USA (2,C,M; 11,A)	UK (4,G) USA (2,C,M)	USA (2,C,M)	UK (4,G) USA (2,C,M)	UK (4,G) USA (2,C,M)	UK (4,G)
- Reproductive strategies (C)	2	Spain (2,C)					

Table 2 (continued)

-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-
Flighted seabirds							
Black-browed albatross							
- Breeding population size	4,9?,15		UK (4)	UK (4)	UK (4)	UK (4)	UK (4)
- Breeding success	4,9?,15		UK (4)	UK (4)	UK (4)	UK (4)	UK (4)
- Duration of foraging trips	4			UK (4)	UK (4)	UK (4)	UK (4)
- Activity budget at sea	4		UK (4)		UK (4)	UK (4)	UK (4)
- Prey characteristics (diet)	4				UK (4)		UK (4)
Antarctic/Cape petrel							
- Breeding success	2,3,6,8,11,16		UK (3)	USA (2)	USA (2)	Norway (16)	UK (3)
- Chick weight at fledging	2,6,8,11			USA (2)	USA (2)		
- Prey characteristics (diet)	2,6,8,11						
Fur seals							
- Population size	3	Arg (3)	Arg (3)	Arg (3)	Arg (3)	Arg (3)	Arg (3)
- Population structure and demography	2,3	Chile (2) Arg (3)	Chile (2) Arg (3)	Chile (2) Arg (3)	Chile (2) Arg (3)	Chile (2) Arg (3)	Chile (2) Arg (3)
- Reproductive success	4,2		UK (4) USA (2)	UK (4)	UK (4) USA (2)	UK (4)	UK (4) USA (2)
- Prey characteristics (diet)	4,2	USA (2)	UK (4) USA (2)	USA (2)	USA (2)	USA (2)	USA (2)

Table 2 (continued)

-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-
Fur seals (continued)							
- At-sea diving behaviour and activity pattern	2,4	UK (4) USA (2)	UK (4) USA (2)	UK (4) USA (2)	UK (4) USA (2)	UK (4) USA (2)	UK (4) USA (2)
- Bioenergetics				UK (4)	UK (4)	UK (4)	UK (4)
- Indices of physiological condition	11				UK (4)		
- Fine structure of teeth	4		UK (4)		UK (4)		UK (4)
Crabeater seal							
- Reproductive rates	2,3,8,10-12	USA (11,12) Sweden (11,12)		USA (11,12) Sweden (11,12)		USA (11,12)	
- Age at sexual maturity	2,3,8,10-12	USA (11,12) Sweden (11,12)		USA (11,12) Sweden (11,12)		USA (11,12)	
- Cohort strength	2,3,8,10-12	USA (11,12)		USA (11,12)		USA (11,12)	
- Indices of physiological condition	11,12			USA (11,12)		USA (11,12)	
- Prey characteristics (diet)	11,12	USA (11)		USA (11,12)			
- At-sea diving behaviour and activity pattern	11,12	USA (11,12)		USA (11,12)		USA (11,12)	
- Satellite telemetry		USA (11,12)		USA (11,12) Sweden (11,12)		USA (11,12)	

Table 2 (continued)

-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-
Minke whales							
- Reproductive rate	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- Age of sexual maturity	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- Cohort strength	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- Analyses of existing data:							
- stomach contents	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- blubber thickness	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- density/patchiness	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- school size	13,1	Japan	Japan	Japan	Japan	Japan	Japan
- Feeding activity patterns	13,1	Japan	Japan	Japan	Japan	Japan	Japan

(a) Areas:

1.	Ross Sea	5.	Macquarie Island	9.	Crozet Island	13.	Mainly from the Indian Ocean (IWC Areas III and IV)
2.	South Shetland Is	6.	Davis Station	10.	Balleny Is	14.	Marion Is
3.	S. Orkney Is	7.	Syowa Station	11.	Antarctic Peninsula	15.	Kerguelen Is
4.	S. Georgia Is	8.	Dumont d'Urville Sea	12.	Weddell Sea	16.	Queen Maud Land

(b) Penguin species: A - Adélie, C - Chinstrap, M - Macaroni/Royal, G - Gentoo

(c) Petrel species: CP - Cape petrel, AP - Antarctic petrel

Table 3: Summary of Members' directed research on predator parameters required to provide essential background information needed to interpret changes in monitored predator parameters.

Research Topic	Countries Proposing Directed Research	
	Programs Currently Underway	Programs Proposed to Commence (season of initiation)
PENGUINS		
- Foraging areas	Chile, Japan, USA, South Africa, Australia	Japan, Australia (1992/93)
- Energy requirements	USA, UK, Germany	Japan, Australia (1992/93)
- Seasonal movements	South Africa	Japan, Australia (1992/93)
- Relationships between monitored parameters and physical environment (e.g., distribution and structure of sea-ice and frontal systems)	Chile, Australia, UK/USSR, USA, South Africa (frontal systems)	Japan, Australia (1992/93)
FUR SEALS		
- Local abundance/population structure	Argentina, Chile, UK, USA	Brazil
- Energy requirements/life history	UK, USA	
- Foraging areas	Chile, USA, UK, Japan (1990/91, with USA)	
- Relationships between monitored parameters and physical environment (e.g., distribution and structure of sea-ice and frontal systems)	Chile (partial), USA, UK/USSR	
CRABEATER SEALS		
- Foraging areas	USA, Sweden	
- Energy requirements/life history	USA, Sweden	
- Stock discreteness/seasonal movements	USA, Sweden	
- Relationships between monitored parameters and physical environment (e.g., distribution and structure of sea-ice and frontal systems)	USA	
- Abundance/population structure		USA (1992/93)

Table 4: Assessment of predator and prey studies, 1988 to 1992. Predator parameters were obtained from WG-CEMP-92/8 and 92/12 unless otherwise referenced in the tables. Catches within 100 km radius of sites were obtained from fine-scale data, and for the subarea from the *Statistical Bulletin Vol. 4*, over the whole year. CPUE data (tonnes-per-hour fishing) was obtained from Statlant B data for the subarea over the whole year. Data are given qualitative rankings High, Medium, Low, Very Low (H, M, L, VL). The symbols +, 0, - indicate temporal changes in parameters. Foraging duration is expressed as relative length of foraging trips to sea (S = short, M = medium, L = long).

4.1 Site: Anvers Is, Subarea 48.1

Year	Adélie		Krill				Environment		
	Breeding Population Size/Change	Breeding Success	Catch 100 km radius	Subarea	CPUE	Biomass	Snow	Sea-Ice	Ocean
1988		-	VL[1]	M	H				
1989		-	VL	H	M				
1990		M	VL	L	L				
1991		L	0	M	M				
1992	(First census)	H		?	?				

[1] Catches in 100 km radius are very low, < 50 tonnes per year

4.2 Site: Cape Shirreff, Livingston Is, Subarea 48.1

Year	Antarctic Fur Seal[1]		Chinstrap[2]		Krill				Environment		
	Breeding Population Size/Change	Breeding Success	Breeding Population Size/Change	Breeding Success	Catch		CPUE	Biomass	Snow	Sea-Ice	Ocean
					100 km radius	Subarea					
1988	L	M			H	M	H				
1989					H	H	M				
1990					L	L	L				
1991	M +	H	?		M	M	M				
1992	H +	H	0		?	?	?			+Brash	

[1] WG-CEMP-92/53 [2] *Boletin Antártico Chileno, Vol. 11*(1): 12-14.

4.3 Site: Admiralty Bay, King George Is, Subarea 48.1[1]

Year	Gentoo		Adélie		Chinstrap		Krill				Environment		
	Breeding Population Size/Change	Breeding Success	Breeding Population Size/Change	Breeding Success	Breeding Population Size/Change	Breeding Success	Catch		CPUE	Biomass	Snow	Sea-Ice	Ocean
							100 km radius	Subarea					
1988	M -	M	H +	M	L -	M	H	M	H				
1989	M +	H	H +	H	M +	H	H	H	M				
1990	M -	M	M -	M	M -	L	M	L	L				
1991	L --	M	L --	L	L --	L	M	M	M				
1992	H ++	H	L +	H	M +	H			?				

(This summary table was constructed without benefit of reviewing the actual data and may contain source errors)

4.4 Site: Ardley Island and Stranger Point combined, King George Island, Subarea 48.1. Esperanza data used for 1991 for Stranger Point.

Year	Adélie[1] - Ardley		Chinstrap[2] - Ardley		Adélie[3] - Stranger		Krill				Environment		
	Breeding Population Size/Change	Breeding Success	Breeding Population Size/Change	Breeding Success	Breeding Population Size/Change	Breeding Success	Catch		CPUE[4]	Biomass	Snow	Sea-Ice	Ocean
							100 km radius	Subarea					
1988	H	H	M	M	L -	H	H	M	H				
1989	H	M	M	H	L -	H	H	H	M				
1990	M	L	H	L	M -	M	M	L	L				
1991	L	M	L	M	M -	L	M	M	M				
1992	M	?	L	M	+	?	?	?	?				

1 WG-Krill-92/21; WG-CEMP-92/54
2 WG-CEMP-92/54
3 WG-CEMP-92/6; WG-CEMP-92/45
4 from submissions

Note: Esperanza data for 1991; Stranger Point not available.

4.5 Site: Seal Island, Elephant Island, Subarea 48.1

Year	Chinstrap[1]				Antarctic Fur Seal[2]				Krill				Environment		
	Breeding Population Size/Change	Breeding Success	Fledging Weight	Foraging Duration	Pups Born Number/ Change	Foraging Duration	Pup Growth Rate	Weight at Age	Catch		CPUE	Biomass E/M/L[3]	Snow	Sea-Ice	Ocean
									100 km radius	Subarea					
1988	M ?	M	H	S	M +	M	M	H	L	M	H	/L/			
1989	L -	L	H	M	VL -	?	H	L	H	H	M	/L/			
1990	H +	H	M	L	M +	M	L	L	L	L	L	/M/H			
1991	M -	L	L	S	L -	L	H	L	M	M	M	/L/L			
1992	H +	M	M	M	M +	M	M	H	?	?	?	/H/M			

1 Data are from the CCAMLR Data Centre and documents WG-CEMP-90/21, 91/11, 91/33 and 92/17
2 Data are from the CCAMLR Data Centre and documents WG-CEMP-89/21, 90/34, 90/41, 91/11 and 92/17
3 E/M/L = early, middle or late season; krill surveys (WG-CEMP-92/15)

4.6 Site: Signy Is, South Orkneys, Subarea 48.2

Year	Adélie		Chinstrap		Gentoo		Krill				Environment		
	Breeding Population Size/Change	Breeding Success	Breeding Population Size/Change	Breeding Success	Breeding Population Size/Change	Breeding Success	Catch		CPUE	Biomass	Snow	Sea-Ice[1]	Ocean
							100 km radius	Subarea					
1988	H +	M	L -	H	H ++	H	L	L	M			H	
1989	H 0	L-M	L 0	H	H +	H	VL	L	M			H	
1990	H-M -	L-M	M +	L	H +	L	H	H	L			L	
1991	L ---	M	L -	H	H -	M	H	H	M			M	
1992	L +	H	L-M +	H	M -	H	?	M	?			H	

[1] Murphy, *et al.* In: *Antarctic Ocean and Variability*, D. Sahrhage (Ed.): 120-130.

4.7 Site: Bird Island, South Georgia, Subarea 48.3

Year	Gentoo				Macaroni				Black-browed Albatross[1]			Krill[3]							Environment		
	Breeding Population Size/Change	Breeding Success	Krill in Diet	Meal Size	Breeding Population	Breeding Success	Krill in Diet	Meal Size	Breeding Population Size/Change	Breeding Success	Growth Rate	Catch				CPUE		Biomass	Snow[2]	Sea-Ice	Ocean
												100 km radius		Subarea							
												S	W	S	W	S	W				
1988	M -	M	?	?	M -	L	?	?	L - - -	VL	?	L	M	M	H	L	M	M	H		
1989	H ++	M	H	H	M +	H	M	H	M ++	M	H	L	M	H	M	H	M		M		
1990	H -	L-M	M	H	M -	H	M	H	M 0	M	L	L	L	M	M	M	M		M		
1991	L - -	VL	L	L	L -	H	L	L	L-M -	VL	M	VL		L		L		L	M		
1992	M +	H	H	M	M +	M	H	H	L ?	M	H							H	H		

[1] P.A. Prince, unpublished data

[2] Black-browed albatross only

[3] Catch and CPUE are given for the summer season (S: October to March) in the split-year, and winter (April to September) of the following season.

4.8 Site: Bird Island, South Georgia, Subarea 48.3

Year	Antarctic Fur Seal[1]									Krill							Environment		
	Breeding Population Size/Change		Birth Mass	Perinatal	Foraging Trip	Growth Rate		Wean Mass	Breeding Success	Catch				CPUE		Biomass	Snow	Sea-Ice	Ocean
						Overall	Late			100 km radius		Subarea							
										S	W	S	W	S	W				
1988	H	0	H	M	S	H	H	M	M	L	M	M	H	L	M	M			
1989	H	-	H	M	M	H	M	H	M	L	M	H	M	H	M				
1990	H	+	H	M	M	M	L	M	H	L	L	M	M	M	M				
1991	L	--	L	S	L	L	H	L	L	VL		L		L		L			
1992	M	+	M	M	M	H	H	M	M							H			

1 All data from Lunn and Boyd, in press (WG-CEMP-92/41)

4.9 Site: Béchervaise Island, Mawson, Division 58.4.2

Year	Adélie		Krill			Environment		
	Breeding Population Size/Change	Breeding Success	Catch	CPUE	Biomass[1]	Snow	Sea-Ice	Ocean
1991	Start year				M		Start Year	
1992	0	Start year	0	0	L		0	

1 WG-Krill-92/23

APPENDIX A

AGENDA

Working Group for the CCAMLR Ecosystem Monitoring Program
(Viña del Mar, Chile, 7 to 12 August 1992)

1. Opening of the Meeting

2. Adoption of the Agenda

3. Review of Members' Activities
   (i) Monitoring
   (ii) Directed Research
   (iii) Plans for Future Work

4. Monitoring Procedures
   (i) Predator Monitoring
      (a) Sites and Species
      (b) Proposals for New Procedures
      (c) Procedures for Calculating Indices and Trends
      (d) Field Research Procedures
   (ii) Prey Monitoring
   (iii) Environmental Monitoring
      (a) Land-Based Observations
      (b) Remote Sensing

5. Review of Monitoring Results
   (i) Predator Data
      (a) Status of Data Submissions
      (b) Report on Indices and Trends
   (ii) Prey Data
      (a) Review of WG-Krill Report
      (b) Fine-Scale Catch Data
      (c) Members' Fine-Scale Surveys

(iii) Environmental Data
    (a) Sea-Ice Patterns
    (b) Other Environmental Events or Trends

6. Ecosystem Assessment
    (i) Review of Background Information
        (a) Predator Studies
        (b) Prey Studies
        (c) Environmental Studies
    (ii) Potential Impact of Localised Krill Catches
    (iii) Formulation of Advice and Recommendations to the Scientific Committee

7. Estimates of Prey Requirements for Krill Predators
    (i) Review of Progress
        (a) Synthesis of Fur Seal and Penguin Data
        (b) Synthesis of Crabeater and Leopard Seal Data
        (c) Advice of IWC Concerning Whales
        (d) Data on Seabirds other than Penguins
    (ii) Interim Results and Report to the Scientific Committee
    (iii) Plans for Proposed Workshop
    (iv) Estimates of Krill Escapement

8. General Matters
    (i) Approaches to Integrated Analyses of Predator/Prey/Environmental Data
    (ii) Review of Opportunities for Collaborative CEMP Studies
    (iii) Matters Arising from the Joint Meeting of WG-Krill and WG-CEMP

9. Other Business
    (i) Access to CEMP Data
    (ii) IUCN Assessment of Marine Protected Areas

10. Summary of Recommendations and Advice

11. Adoption of the Report

12. Close of the Meeting.

LIST OF PARTICIPANTS

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(Viña del Mar, Chile, 7 to 12 August 1992)

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LIST OF DOCUMENTS

Working Group for the CCAMLR Ecosystem Monitoring Program
(Viña del Mar, Chile, 7 to 12 August 1992)

WG-CEMP-92/1	PROVISIONAL AGENDA
WG-CEMP-92/2	LIST OF PARTICIPANTS
WG-CEMP-92/3	LIST OF DOCUMENTS
WG-CEMP-92/4	CCAMLR ECOSYSTEM MONITORING PROGRAM DRAFT MANAGEMENT PLAN FOR CAPE SHIRREFF CEMP LAND-BASED SITE Delegation of Chile
WG-CEMP-92/5	CCAMLR ECOSYSTEM MONITORING PROGRAM DRAFT MANAGEMENT PLAN FOR MAGNETIC ISLAND CEMP LAND-BASED SITE Delegation of Australia
WG-CEMP-92/6	ELEPHANT SEAL AND PENGUIN POPULATION STUDIES: TOOLS TO UNDERSTAND ECOLOGICAL CHANGES AND/OR FISHERIES EFFECT D.F. Vergani, Z.B. Stanganelli, A.R. Carlini and G.E. Soave (Argentina)
WG-CEMP-92/7	CEMP INDICES: THEIR CALCULATION AND COMPARISON BY THE SECRETARIAT Data Manager
WG-CEMP-92/8 Rev. 1	CEMP INDICES AND TRENDS 1992 PART 1: PENGUIN PARAMETERS Secretariat
WG-CEMP-92/9	MONITORING SEA ICE DISTRIBUTION: REPORT OF THE SECRETARIAT PROJECT ON ACQUISITION OF SATELLITE IMAGERY Secretariat
WG-CEMP-92/10	SUGGESTION FOR CHANGE IN FORMAT OF CEMP STANDARD METHODS PUBLICATION Secretariat
WG-CEMP-92/11	CAN WE USE DISCRIMINANT FUNCTION ANALYSIS TO SEX PENGUINS PRIOR TO CALCULATING AN INDEX OF A MORPHOMETRIC PARAMETER? D.J. Agnew (Secretariat)

WG-CEMP-92/12	CEMP INDICES AND TRENDS 1992 PART 2: FLYING BIRDS AND SEALS Secretariat
WG-CEMP-92/13	CEMP DATA AVAILABILITY Secretariat
WG-CEMP-92/14	Withdrawn
WG-CEMP-92/15	DISTRIBUTION AND ABUNDANCE OF KRILL IN THE VICINITY OF ELEPHANT ISLAND IN THE 1992 AUSTRAL SUMMER Roger P. Hewitt and David A. Demer (USA)
WG-CEMP-92/16	AMLR 1991/92 FIELD SEASON REPORT; OBJECTIVES, ACCOMPLISHMENTS AND TENTATIVE CONCLUSIONS Delegation of the USA
WG-CEMP-92/17	ANTARCTIC PENINSULA INTEGRATED STUDY REGION PENGUIN BIOENERGETIC MODEL INPUT PARAMETERS Delegation of the USA
WG-CEMP-92/18	METABOLIC RATES, FORAGING RANGES AND ASSIMILATION EFFICIENCIES OF PENGUINS: A REVIEW Delegation of the USA
WG-CEMP-92/19	SYNTHESIS AND EVALUATION OF DATA FOR ESTIMATING PREY REQUIREMENTS OF ANTARCTIC FUR SEALS IN THE ANTARCTIC PENINSULA INTEGRATED STUDY REGION Delegation of the USA
WG-CEMP-92/20	AN AUTOMATED WEIGHING AND RECORDING SYSTEM AS AN AID FOR THE STUDY OF THE FORAGING ECOLOGY OF ADELIE PENGUINS (*PYGOSCELIS ADELIAE*) Knowles Kerry, Judith Clarke and Grant Else (Australia)
WG-CEMP-92/21	AN INTERPRETATION OF THE GROWTH OF THE ADELIE PENGUIN ROOKERY AT CAPE ROYDS, 1955-1990 N. Blackburn (Denmark) R.H. Taylor and P.R. Wilson (New Zealand)
WG-CEMP-92/22	RECENT INCREASE AND SOUTHERN EXPANSION OF ADELIE PENGUIN POPULATIONS IN THE ROSS SEA, ANTARCTICA, RELATED TO CLIMATIC WARMING R.H. Taylor and P.R. Wilson (New Zealand)
WG-CEMP-92/23	STATUS AND TRENDS OF ADELIE PENGUIN POPULATIONS IN THE ROSS SEA REGION R.H. Taylor, P.R. Wilson and B.W. Thomas (New Zealand)

WG-CEMP-92/24	NEW ZEALAND ANTARCTIC RESEARCH PROGRAMME SCIENTIFIC PROPOSAL FOR THE AERIAL SURVEY OF ADELIE PENGUIN ROOKERIES, 1992/93 P.R. Wilson (New Zealand)
WG-CEMP-92/25	PRELIMINARY ASSESSMENT OF THE DATA AVAILABLE FOR ESTIMATING THE KRILL REQUIREMENTS OF CRABEATER SEALS J.L. Bengtson (USA), T.J. Härkonen (Sweden) and P. Boveng (USA)
WG-CEMP-92/26	HOMOGENEITY OF ADELIE PENGUINS AS KRILL SAMPLERS E. Marschoff, B.González (Argentina)
WG-CEMP-92/27	ADVICE FROM THE IWC SCIENTIFIC COMMITTEE CONCERING ESTIMATION OF PREY REQUIRMENTS OF BALEEN WHALES IN THE CEMP INTEGRATED STUDY REGIONS (Convener, WG-CEMP)
WG-CEMP-92/28	PROGRESS IN PREPARING FOR A WORKSHOP ON METHODS TO STUDY THE AT-SEA BEHAVIOUR OF MARINE MAMMALS AND BIRDS (Convener, WG-CEMP)
WG-CEMP-92/29	POTENTIAL RELEVANCE OF THE GLOBAL ENVIRONMENTAL FACILITY AND A SYSTEM OF MARINE PROTECTED AREAS TO THE CCAMLR ECOSYSTEM MONITORING PROGRAM (Convener, WG-CEMP)
WG-CEMP-92/30	ON THE PROBLEM OF SOVIET KRILL FISHERY ALLOCATION AND INTENSITY IN THE AREA OF ELEPHANT ISLAND IN THE SEASON OF 1988-1989 V.A. Sushin, A.S. Myskov (Russian Federation)
WG-CEMP-92/31	GEOGRAPHIC ASPECTS OF *EUPHAUSIA SUPERBA* RESOURCES EXPLOITATION R.R. Makarov (Russian Federation)
WG-CEMP-92/32	INVESTIGATIONS OF INTENSITY OF KRILL DRIFT NEAR SOUTH GEORGIA ISLAND V.V. Popkov (Russian Federation)
WG-CEMP-92/33	PRELIMINARY RESULTS OF RV *DMITRIY STEFANOV* RESEARCHES IN THE ANTARCTIC AREA OF THE ATLANTIC OCEAN IN APRIL 1992 L.G. Maklygin, V.N. Shnar, A.V. Remeslo, A.P. Malyshko, I.A. Trunov, I.A. Barabanov, V.P. Shopov (Russian Federation) and A.G. Shepelev (Ukraine)
WG-CEMP-92/34	PRELIMINARY RESULTS OF THE EXPERIMENTS ON THE KRILL TRANSPORT STUDY IN THE SOUTH ORKNEY AREA (APRIL 1992) L.G. Maklygin, V.N. Shnar, A.P. Malyshko (Russian Federation) and A.G. Shepelev (Ukraine)

WG-CEMP-92/35	KRILL BIOMASS AND DISTRIBUTION VARIABILITY IN SUBAREA 48.3 IN JUNE 1991 S.M. Kasatkina, E.I. Timokhin, P.P. Fedulov and K.E. Shulgovskiy (Russian Federation)
WG-CEMP-92/36	THE FORAGING RANGE OF ADELIE PENGUINS AT BECHERVAISE ISLAND, MAC. ROBERTSON LAND, ANTARCTICA, AND ITS OVERLAP WITH THE KRILL FISHERY K.R. Kerry, J.R. Clarke and G.D. Else (Australia)
WG-CEMP-92/37	DIVING PATTERN AND PERFORMANCE IN NONBREEDING GENTOO PENGUINS (*PYGOSCELIS PAPUA*) DURING WINTER Tony D. Williams (UK), Akiko Kato (Japan), John P. Croxall (UK), Yasu Naito (Japan), Dirk R. Briggs, Steven Rodwell and Tim R. Barton (UK)
WG-CEMP-92/38	DIVING PATTERN PERFORMACE IN THE MACARONI PENGUIN *EUDYPTES CHRYSOLOPHUS* J.P. Croxall, D.R. Briggs (UK), A. Kato, Y. Naito, Y. Watanuki (Japan) and T.D. Williams (UK)
WG-CEMP-92/39	PUP PRODUCTION AND DISTRIBUTION OF BREEDING ANTARCTIC FUR SEALS (*ARCTOCEPHALUS GAZELLA*) AT SOUTH GEORGIA I.L. Boyd (UK)
WG-CEMP-92/40	EFFECTS OF MATERNAL AGE AND CONDITION ON PARTURITION AND THE PERINATAL PERIOD OF ANTARCTIC FUR SEALS N.J. Lunn and I.L. Boyd (UK)
WG-CEMP-92/41	INFLUENCE OF MATERNAL CHARACTERISTICS AND ENVIRONMENTAL VARIATION ON REPRODUCTION IN ANTARCTIC FUR SEALS N.J. Lunn and I.L. Boyd (UK)
WG-CEMP-92/42	SOUTHERN OCEAN ENVIRONMENTAL CHANGES: EFFECTS ON SEABIRD, SEAL AND WHALE POPULATION J.P. Coxall (UK)
WG-CEMP-92/43	LOS PINGUINOS Y EL HOMBRE (THE PENGUINS AND THE MAN) J.C. Ricca, M.A. Porretti and D.F. Vergani (Argentina) Abstract only in English
WG-CEMP-92/44	STANDARD METHODS OF CEMP IN VIDEO J.C. Ricca, M.A. Porretti and D.F. Vergani (Argentina) Abstract only in English
WG-CEMP-92/45	CHANGES IN ADELIE PENGUIN POPULATION BETWEEN 1963-1992 BREEDING SEASONS AT HOPE BAY A. Carlini, D.F. Vergani and M.A. Gasco (Argentina)

WG-CEMP-92/46	WHAT IS THE KEY FACTOR IN BREEDING SUCCESS OF ADELIE PENGUINS AT ANTARCTIC PENINSULA AREA Z.B. Stanganelli and D.F. Vergani (Argentina)
WG-CEMP-92/47	THE HAZARD ASSESSMENT OF CETACEANS BY THE USE OF A NON DESTRUCTIVE BIOMARKER IN SKIN BIOPSY M. Cristina Fossi, Letizia Marsili, Claudio Leonzio and Silvano Focardi (Italy)
WG-CEMP-92/48	ESPECIFIDAD DE HABITATS PARA *ARCTOCEPHALUS GAZELLA* (LOBO FINO ANTARTICO) Y *PYGOSCELIS* (PINGÜINOS) EN CABO SHIRREFF Leonardo Lavanderos, Hernán Torres E., y Juan Capella A. (Chile) Available in Spanish only
WG-CEMP-92/49	NOTES ON THE STATUS OF KRILL PREDATORS IN PRYDZ BAY INTEGRATED STUDY REGION 58.4.2 J.R. Clarke (Australia)
WG-CEMP-92/50	ESTIMATION OF PREY REQUIREMENTS FOR KRILL PREDATORS J.P. Croxall (UK)
WG-CEMP-92/51	EVALUACION Y PROPOSICION DE ESTUDIOS SOBRE BIOENERGETICA ANTARTICA CHILE Carlos Guillermo Guerra Correa (Chile) Available in Spanish only
WG-CEMP-92/52	SINTESIS DE LOS ESTUDIOS SOBRE IMPACTO AMBIENTAL EN CABO SHIRREFF, ISLA LIVINGSTON, ANTARTICA Daniel Torres N. (Chile) Available in Spanish only
WG-CEMP-92/53	DISTRIBUCION DE *ARCTOCEPHALUS GAZELLA* EN CABO SHIRREFF, ISLA LIVINGSTON, ANTARTICA, DURANTE DICIEMBRE DE 1991 Y ENERO DE 1992 Anelio Aguayo Lobo and Daniel Torres Navaro (Chile) Available in Spanish only
WG-CEMP-92/54	REPORT ON BIRD STUDIES ON ARDLEY ISLAND, SOUTH SHETLAND ARCHIPELAGO Michael Sallaberry A. and José Valenica (Chile)
WG-CEMP-92/55	THE POPULATION ECOLOGY OF SEABIRDS AT SVARTHAMAREN, DRONNING MAUD LAND: CAUSES AND CONSEQUENCES OF VARIATION IN REPRODUCTIVE SUCCESS OF TWO LONG-LIVED SEABIRDS SPECIES (ANTARCTIC PETREL AND SOUTH POLAR SKUA) AT SVARTHAMAREN. AN EXPERIMENTAL APPROACH A project proposal for the Norwegian Antarctic Expedition 1992/93 Trondheim, December 1991

OTHER DOCUMENTS

WG-KRILL/CEMP-92/4	CCAMLR ECOSYSTEM MONITORING AND A FEEDBACK MANAGEMENT PROCEDURE FOR KRILL A. Constable (Australia)
WG-KRILL-92/9	DIURNAL CHANGES OF SOME BIOLOGICAL CHARACTERISTICS OF *EUPHAUSIA SUPERBA* DANA IN SWARMS (WESTWARD OF THE SOUTH ORKNEY ISLANDS, 24 MARCH TO 18 JUNE 1990 - BASED ON DATA REPORTED BY BIOLOGIST-OBSERVER) A.V. Vagin, R.R. Makarov and L.L. Menshenina (Russia)
WG-KRILL-92/12	VARIABILITY OF KRILL STOCK COMPOSITION AND DISTRIBUTION IN THE VICINITY OF ELEPHANT ISLAND DURING AMLR INVESTIGATIONS 1988-1992 V. Loeb (USA) and V. Siegel (Germany)
WG-KRILL-92/13	FINE-SCALE CATCHES OF KRILL IN AREA 48 REPORTED TO CCAMLR 1990 TO 1991 Secretariat
WG-KRILL-92/15	REVIEW OF LENGTH-WEIGHT RELATIONSHIPS FOR ANTARCTIC KRILL V. Siegel (Germany)
WG-KRILL-92/16	ALTERNATIVE METHODS FOR DETERMINING SUBAREA OR LOCAL AREA CATCH LIMITS FOR KRILL IN STATISTICAL AREA 48 G. Watters and R.P. Hewitt (USA)
WG-KRILL-92/18	KRILL CATCH DISTRIBUTION IN RELATION TO PREDATOR COLONIES, 1987-1991 Secretariat
WG-KRILL-92/19	DISTRIBUTION OF KRILL (*EUPHAUSIA SUPERBA* DANA) CATCHES IN THE SOUTH SHETLANDS AND SOUTH ORKNEYS D.J. Agnew (Secretariat)
WG-KRILL-92/21	CHILEAN KRILL FISHING OPERATIONS 1992: ANSWERING SC-CAMLR-X, PARAGRAPH 6.36 Victor H. Marín, Darío Rivas and Antonio Palma (Chile)
WG-KRILL-92/23	ESTIMATION OF THE BIOMASS OF KRILL IN PRYDZ BAY DURING JANUARY/FEBRUARY 1991 AND FEBRUARY/MARCH 1992 USING ECHO INTEGRATION I. Higginbottom and T. Pauly (Australia)

WG-KRILL-92/24 CHARACTERSITICS OF OCEANIC STRUCTURE IN THE WATERS AROUND THE SOUTH SHETLAD ISLANDS OF THE ANTARCTIC OCEAN BETWEEN DECEMBER 1990 AND FEBRUARY 1991: OUTSTANDING COASTAL UPWELLING?
M. Naganobu, T. Katayama, T. Ichii, H. Ishii and K. Nasu (Japan)

WG-KRILL-92/25 HYDROGRAPHIC FLUX IN THE WHOLE OF STATISTICAL AREA 48 IN THE ANTARCTIC OCEAN
M. Naganobu (Japan)

WG-KRILL-92/26 ABUNDANCE, SIZE AND MATURITY OF KRILL (*EUPHAUSIA SUPERBA*) IN THE KRILL FISHING GROUND OF SUBAREA 48.1 DURING 1990/91 AUSTRAL SUMMER
T. Ichii, H. Ishii and M. Naganobu (Japan)

WG-KRILL-92/27 DIFFERENCES IN DISTRIBUTION AND POPULATION STRUCTURE OF KRILL (*EUPHAUSIA SUPERBA*) BETWEEN PENGUIN AND FUR SEAL FORAGING AREAS NEAR SEAL ISLAND
T. Ichii, H. Ishii (Japan), J.L. Bengtson, P. Boveng, J.K. Jansen (USA) and M. Naganobu (Japan)

WG-KRILL-92/33 KRILL POPULATION BIOLOGY DURING THE 1991 CHILEAN ANTARCTIC KRILL FISHERY
Armando Mujica R., Enzo Acuña S. and Alberto Rivera O. (Chile)

SC-CAMLR-XI/4 REPORT OF THE FOURTH MEETING OF THE WORKING GROUP ON KRILL
(Punta Arenas, Chile, 27 July to 3 August, 1992)

SC-CAMLR-XI/5 JOINT MEETING OF THE WORKING GROUP ON KRILL AND THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM
(Viña del Mar, Chile, 5 and 6 August, 1992)
(Convener’s and Rapporteurs’ Summary)

REPORTS OF MEMBERS' ACTIVITIES WITH REGARD TO CEMP

This appendix contains descriptions of Members' activities in relation to CEMP that were submitted to this meeting by participants (Argentina, Australia, Chile, Italy, Japan, Norway, Russia, UK and USA).

2. In 1991/92 Argentina continued to conduct monitoring of several parameters of predators using CEMP Standard Methods at King George Island (Stranger Point), Laurie Island (Mossman Peninsula) and Antarctic Peninsula (Esperanza Station). Studies were primarily focused on Adélie penguins. A video film "Penguins and Man" has been prepared on basic aspects of the Adélie penguin biology and CEMP studies by the scientists of Argentina (WG-CEMP-92/43 and 44).

3. Results of environmental effects on predator parameters measured are presented in WG-CEMP-92/6, 45 and 46. Paper WG-CEMP-92/6 describes the comparison between population trends of elephant seals, breeding success of Adélie penguins and CPUE krill fisheries in Subarea 48.1. The relationship between breeding success of Adélie penguins and the trend of female elephant seals has been found.

4. Australia has two major programs that concern CEMP. The first, the "Prydz Bay Adélie penguin/prey stock interaction program", investigates the predator-prey interaction in the Adélie penguin population of Magnetic Island, Princess Elizabeth Land, and its food sources in Prydz Bay. The following parameters are being studied: A1, A2, A3, A5, A6, A7 and A8. In addition nest-specific survival, chick growth rates, energy budgets, diving behaviour and foraging location are being investigated. Data for some parameters have been collected at the site since 1980/81 and the data are expected to be made available to CEMP at the completion of the current research project (1992/93).

5. The second Australian project is the deployment at Béchervaise Island near Mawson Station of an automated system for weighing and recording tagged birds within breeding colonies. The system is being used to monitor Adélie penguins, in accordance with CEMP Standard Methods.

6. The program has the following elements: operation of the existing automated monitoring system; development of methods for determining sex of birds of all ages but particularly chicks; evaluation of the performance of the birds when carrying various accoutrement associated with the program including flipper bands, electronic tags glued to feathers, radio or satellite tracking devices

etc.; evaluation of the results obtained by the automated system by comparison with similar data gathered by manual means as described in the CEMP Standard Methods; studies on the food and foraging area by satellite tracking of the birds in the monitored colony; evaluation of new tagging systems including implanted tags for ease of operation, for least trauma to the birds and least effect on the monitored parameter; and installation of the full monitoring system at a number of additional sites along the coast.

7. In the 1991/92 season Chile had carried out the following scientific programs at the Cape Shirreff site:

(i) census and population structure of the Antarctic fur seal population including tagging of seals;

(ii) reproductive performance and mother-pup interaction in the Antarctic fur seal population;

(iii) census of penguins and flying birds during breeding season; and

(iv) collection of cartographic and environmental data.

In addition, a census of populations of the Southern elephant seal and the Weddell seal was conducted.

8. The Instituto Antártico Chileno has installed on the east side of Cape Shirreff a fibreglass module as a modern facility for scientists conducting CEMP studies.

9. On Ardley Island, studies of seabird populations were carried out in 1991/92 and will be continue in 1992/93. Observations of birds during the early nesting period were conducted in October 1991 and will be repeated in October 1992. Banding of penguins and storm petrels was also continued. These studies had been done by scientists of the Facultad de Ciencias, Universidad de Chile, with the support of the Instituto Antártico Chileno.

10. In cooperation with the United States AMLR Program, scientists from the Instituto Antártico Chileno took part in the census of Antarctic fur seal colonies on the South Shetland Islands. The Chilean research vessel, *Capitán Luis Alcázar* was used for this purpose.

11. Studies by Italy of interest to CEMP in 1991/92 were directed primarily at genetic variability of zooplankton community in the Straits of Magellan and the Ross Sea. Some studies were also

focused on pelagic species, in particular, on *Euphausia superba* in the Ross Sea by using hydroacoustic methods.

12. Italy also continued to use ‘biomarkers’ for assessing different aspects of human impacts on the Antarctic ecosystem. These studies are aimed at developing non-destructive methods of studying higher vertebrate animals, particularly birds and marine mammals.

13. Japan continues to monitor the annual trends in breeding population size of Adélie penguins near Syowa Station. Studies on Adélie penguins will be conducted in the Indian Ocean Sector in cooperation with Australia in 1992/93.

14. Japan continues to investigate the biology and population size of minke whales through selective catching in Southern Ocean. Studies of krill ecology in relation to hydrological parameters as well as survey design will also continue. Japan intends to continue cooperative work on CEMP monitoring.

15. For the time being Norway has no ongoing program directly related to CEMP. There are, however, proposals for a study of population ecology of seabirds (Antarctic petrel and south polar skua) at Svarthammaren Dronning Maud Land as part of the Norwegian Antarctic Expedition 1992/93. Also, a visit to Bouvet Island will possibly be included in the expedition with a program of direct relevance to CEMP.

16. The Russian Federation did not conduct in 1991/92 any research on parameters of predators in accordance with CEMP Standard Methods. Instead, scientific effort of the Russian scientists was concentrated on studies of prey species, namely krill. Scientists from the Ukraine took part in some of these studies. Two scientific observers conducted observations on board krill fishing vessels in Statistical Area 48.

17. An acoustic survey of krill distribution together with trawl selectivity was carried out in the area to the north of the South Orkney Islands (Subarea 48.2). Krill trawl sampling was also conducted in South Georgia and Shag Rocks waters (Subarea 48.3).

18. Krill movement rates and residential time were studied in a survey which took place in Statistical Area 48 and adjacent waters. Results of these studies were submitted for consideration by WG-CEMP in the following papers: WG-CEMP-92/30, 31, 32, 33, 34 and 35.

19. Plans for the next season include, in particular, an acoustic/trawl survey in Statistical Area 48.

20. The United Kingdom land-based research in support of CEMP is conducted at Signy Island, South Orkney Islands, and Bird Island, South Georgia. At Signy Island, parameters A3 and A6 are monitored for Adélie, chinstrap and gentoo penguins, and breeding success continues to be monitored for Cape (and snow) petrels. At Bird Island, parameters currently monitored are A1, A3, A6, A7, A8 (macaroni penguin), A3, A6, A7, A8 (gentoo penguin), B1 to B3 (black-browed albatross), C1 and C2 (Antarctic fur seal). In addition, comprehensive demographic programs are conducted annually on grey-headed and wandering albatrosses and Antarctic fur seal. Some standardised demographic data are obtained annually for gentoo and macaroni penguins.

21. A three-year program of directed research, involving use of implanted recorders to measure heart-rate (and other parameters) in free-ranging gentoo penguins, black-browed albatrosses and Antarctic fur seals, to estimate activity-specific energy budgets both on land and at sea, was started in 1990/91. At-sea activity budgets and foraging trip durations of albatrosses were derived from data on foraging patterns (using satellite transmitters) and chick growth rates during a pilot study in 1991/92 for a three-year program starting in 1992/93. The research cruise planned to investigate predator-krill interactions in detail has been postponed to 1993/94.

22. Of papers tabled last year, WG-CEMP-91/18, (*J. Zool.* (1992) 227:211-230), WG-CEMP-91/19 (*Acta XX Cong. Int. Orn.* (1991): 1393-1401, WG-CEMP-91/20 (*Condor* (1992) 94: 636-645), WG-CEMP-91/21 (*Can. J. Zool.* (1990) 68: 2209-2213), WG-CEMP-91/22 (*J. Mammal.* (1991) 72: 202-206) and WG-CEMP-91/24 (*J. Anim. Ecol.* (1991) 60: 577-592) have all been published. Paper WG-CEMP-91/23 is still in press in *Can. J. Zool.*. Papers tabled this year relate to the completion of current work on diving pattern and performance in gentoo and macaroni penguins (WG-CEMP-92/37: *Auk*, in press; WG-CEMP-92/38: *J. Zool.*, in press), to the recent survey of the distribution and abundance of Antarctic fur seals at South Georgia (WG-CEMP-92/39; *Antarct. Sci.* in press), to the effect of maternal age on birth date and perinatal period in Antarctic fur seals (WG-CEMP-92/40; *J. Zool.*, in press) to the relative influences of maternal and environmental characteristics on fur seal pup size and growth (WG-CEMP-92/41; *Symp. Zool. Soc. Lond.*, in press) and to an overview of environmental change in relation to seabird, seal and whale populations (WG-CEMP-92/42; *Phil. Trans. Roy. Soc. Lond.*, in press).

23. Although there has been no UK research aimed directly at CEMP prey monitoring, a fish stock assessment survey around South Georgia in January 1992 provided some observations that give an indication of the status of krill in this area. Acoustic survey tracks between the randomly located fishing stations over the South Georgia shelf indicated that krill were widespread over much of the area. The standing stock of krill appeared to be substantially higher than at the same time in 1991.

24. Analysis of the stomach contents of the mackerel icefish, *Champsocephalus gunnari*, indicated that a larger proportion of the fish were feeding on krill than in 1991. The proportion of fish stomachs that contained krill was similar to that observed on previous surveys, prior to 1991, when krill had been plentiful. A further analysis of these results will be presented to the 1992 meeting of the Working Group on Fish Stock Assessment (WG-FSA).

25. United States CEMP related activities in 1991/92 consisted of three components:

(i) land-based predator studies at Seal Island, near Elephant Island and at Palmer Station, Anvers Island;

(ii) repeated surveys of hydrographic conditions, phytoplankton production, and krill abundance and distribution in the waters surrounding Elephant Island; and

(iii) census of Antarctic fur seal colonies of the South Shetland Islands.

26. At Seal Island, directed research and monitoring activities were conducted on fur seals, chinstrap penguins, and macaroni penguins. The following parameters were monitored; A5, A6a and c, A7, A8, A9, C1, and C2. In addition, directed research was completed on automated weighing of nesting penguins to determine food load delivered to chicks.

27. At Palmer Station, parameters A3, A5, A6a,b and c, A7, A8, and A9 were monitored for Adélie penguins. This was conducted in conjunction with the National Science Foundation's long-term ecological research project.

28. Two 30-day cruises were conducted aboard the NOAA Ship *Surveyor* from mid-January to mid-March, 1992. Chlorophyll-*a* concentrations, primary production rates, organic carbon concentrations, phytoplankton species compositions, nutrient concentrations, and solar irradiance were measured and mapped around Elephant Island. In addition, the distribution and abundance of krill were measured using sampling nets and acoustic instrumentation.

29. Census of fur seals were conducted at Elephant, King George and Livingston Islands on 19 January 1992 and 21 to 25 February 1992. The objectives were to count seals at known rookery sites and to identify newly-established and previously unknown colonies. Counts were made by investigators walking along the periphery of the colonies. A total of eight colonies had been previously identified and were counted during this census. Two additional sites, where evidence of fur seal breeding had been reported earlier, were also surveyed.

30. Anticipated field work in 1992/93 will include penguin and fur seal monitoring and directed research at Seal Island and penguin monitoring at Palmer Station. Shipboard surveys of hydrographic conditions, phytoplankton production, krill distribution and abundance, krill demography will be conducted around Elephant Island.

JOINT MEETING OF THE WORKING GROUP ON KRILL AND THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM

(Viña del Mar, Chile, 5 and 6 August, 1992)

(Convener’s and Rapporteurs’ Summary)

JOINT MEETING OF THE WORKING GROUP ON KRILL AND THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM

(Viña del Mar, 5 to 6 August, 1992)

(Convener's and Rapporteurs' Summary)

INTRODUCTION

The following report was prepared by the Convener of the Joint Meeting, Mr O. Østvedt (Scientific Committee Chairman) and by the Conveners of the Working Group on Krill (WG-Krill) and the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP), Mr D.G.M. Miller (South Africa) and Dr J.L. Bengtson (USA) respectively. It provides a summary of the meeting's discussions and agreed conclusions.

MEETING OBJECTIVES

The major objective of the Joint Meeting was to facilitate interaction between WG-Krill and WG-CEMP on matters of common concern.

INFORMATION REVIEW AND EVALUATION

Krill Requirement of Predators

1. Krill Escapement

In the past there has been some confusion concerning the meaning of the term "krill escapement". This appears to have arisen primarily from the use by WG-Krill of the *ad hoc* discount factor **d** in its calculation of krill yield which, by implication, takes some account of the amount of krill needed to escape from the fishery in order to meet predator demands. WG-Krill has noted that such demands would to a large extent be implicitly assumed in the krill natural mortality function **M** also used in the calculation of potential yield. WG-Krill had effectively done away with **d** by refining the estimation procedure. Consequently it was felt that it would be helpful to provide the following explanation of what is specifically meant by "escapement" (based on the definition provided by WG-Krill at its most recent meeting) in the context of accounting for the krill requirements of predators and with a view to improving understanding of information required from WG-CEMP.

A schematic representation of the concepts considered are given in Figure 1. The distribution of krill biomass in the absence of fishing is depicted by the solid curve. Biomass (**B**) is expressed as proportional escapement (**B**/**K**), where **K** is the average biomass in the absence of fishing. Natural fluctuations in recruitment from year to year lead in turn to fluctuations in biomass and hence account for the distribution in **B**/**K** shown, rather than **B** being exactly equal to **K**.

Once fishing occurs, this biomass distribution shifts to the left and its shape may broaden (see dashed curve). The heavier the level of fishing, the greater the shift and the broadening. When considering the effect of fishing on predators, it is not the extent of the shift (related to the average proportional escapement, $\mathbf{B_f}/\mathbf{K}$) which is the most important. Rather, it is the lower tail of the distribution, since it is occurrences of especially low biomass that are the most likely to impact on the health of predator populations. It must be noted for the example illustrated, that if the "critical" level below which predators are deleteriously affected is as shown, there is a much greater likelihood of this occurring in the presence of fishing because a much greater fraction of the area under the dashed curve lies below this "critical" level than is the case for the solid (no fishing) curve.

The explanation presented above emphasises the need to consider critical levels of predator performance in relation to escapement of krill from the fishery in the development of operational definitions to address the requirements of Article II.

2. Functional Relationships Between Krill and Predators

Following on from (1) above, an initial approach to improve information on functional relationships between krill availability (i.e., abundance plus distribution) and predator performance was developed. This is attached as Appendix 1. It was emphasised that the assumptions underlying the approach are by necessity simplistic and an important component of the modelling exercise would be to test their validity.

Action: Initiation of modelling in accordance with suggestions contained in Appendix 1.

3. Krill Biomass Versus Availability

In considering krill biomass (abundance) and availability (abundance plus distribution) in relation to interactions with predators, krill availability is likely to be the more important. This distinction needs to be taken into account in the development of models relating krill yield to functional relationships between krill and its predators (see also (2) above and Appendix 1). In the interests of simplicity, however, the development of models of functional relationships between predators and krill should focus initially on krill abundance in relation to predator consumption alone. Models addressing the problem of krill availability specifically would constitute a subsequent refinement to the initial approach.

Action: Existing data should be analysed as an initial step in addressing the problem of krill abundance versus availability
Predator-prey surveys should be implemented.
The problem should be considered in subsequent refinements of the modelling approach identified in (2) above.

4. Refining Functional Relationships

It was agreed that the natural variability in predator performance and krill availability, caused by fluctuating environmental conditions, offered "natural experiments" within CEMP. Viewing these natural experiments in a predictive context could assist in understanding inter- and intra-annual patterns in interactions among predators, prey, and environmental conditions. Ways to evaluate the impact of natural experiments should be considered.

It was also agreed that large variability in predator performance and environmental stochasticity complicate the task of differentiating between changes caused by natural phenomena and those attributable to fishing. For example, the physical environment (e.g., sea-ice) affects predators directly as well as indirectly through their prey. Although some form of experimental harvesting regime may constitute the only way whereby functional relationships between krill, predators, environment and fishery could be determined, such a regime would have to be carried out over a number of years to take full account of the high levels of variability alluded to above. Such experiments may form part of a more general approach to the question of separating natural from fishery induced changes. There may, however, be other methods for refining functional relationships which do not require elaborate experimental designs.

If such experiments are to be conducted, their design must be carefully evaluated in advance. This would require some form of modelling approach which should attempt to evaluate the statistical precision necessary to quantify the detection of harvest induced changes in addition to provide some assessment of associated practical considerations.

Conclusions: The role of experimental harvesting regimes to establish functional links between krill, predators, environment and fishery should be thoroughly examined.

Action: Detailed descriptions of possible experimental harvesting regimes should be provided and their efficacy evaluated.
Strategic modelling should be developed to evaluate the statistical performance and cost-effectiveness of possible experimental harvesting regimes and in refining estimates of functional relationships between krill availability and predator performance.

Potential Overlap of Krill Fishing and Predators

5. Considering Predator Demands in Subarea Allocation of Catch Limits

In developing an approach to the possible future allocation of the precautionary catch limit of 1.5 million tonnes of krill to areas within Statistical Area 48, one option considered by WG-Krill focused on the need to take explicit account of predator demands. Doubts not only surround the possibility of obtaining gross estimates of the krill demand for important predators in various parts of Statistical Area 48, the inclusion of land-based predators alone in such estimates was questioned. Similarly, although localised situations could be used, their relationship to whole statistical subareas may be difficult to evaluate. Consequently, WG-CEMP was requested to give careful consideration to the matter as a whole with a view to evaluating the overall applicability of incorporating information on predator demands into the allocation of krill catch limits within statistical subareas.

Action: Some crude estimates of the krill demands of predators by Subarea should be provided.
The feasibility of utilising such information in the allocation of precautionary catch limits should be investigated.

6. Timing and Location of Fishery

The value of haul-by-haul data in determining the location of krill fishing activities was emphasised, particularly with respect to identifying areas of overlap between the fishery and land-based predators. Reports from the Chilean and Russian fisheries were welcomed. The submission of such data to CCAMLR, where possible, was encouraged. Problems experienced by some fishing countries in supplying such data were noted.

Action: The submission of haul-by-haul data from the krill fishery from all areas fished should be encouraged.

7. Dialogue on Operational Characteristics of the Krill Fishery

The ongoing dialogue between fishermen, fishing operators and scientists involved with issues pertaining to the krill fishery was found to be extremely useful in improving current understanding of the fishery's dynamics and its operational characteristics. This enhanced understanding is likely to facilitate consideration of various approaches to management in the future and would ensure that such approaches take explicit account of the needs of both the commercial fishery and predator requirements.

8. Krill "Surplus"

The continued use of the term "krill surplus" is not encouraged since it refers specifically to the dated concept that krill formerly eaten by baleen whales are now available to the rest of the system, including the fishery. Current thinking on ecosystem dynamics suggests that this concept is simplistic and, given other priorities in the work of WG-CEMP in particular, it was felt that it would be inappropriate to assign a high priority to undertaking further analyses of essentially historic krill-whale interactions. It was noted, however, that individual scientists may find some utility in using historic estimates of krill by whales in a simple accounting exercise to evaluate the possible reconciliation of such gross limits of krill production with more recent estimates of krill abundance.

Action: Individual scientists should undertake simple accounting exercises to compare historic whale consumption figures with recent estimates of krill abundance.

Development of Approaches for Feedback Management

9. CEMP Experimental Approach

Although the experimental approach has been integral in the development of CEMP, it was agreed that it would be useful to formulate a more formal statement of how this approach might be implemented in practice. The establishment of some form of experimental fishing regime (see (4) above), with both treatment and control areas was thought to offer a useful way to demonstrate cause/effect relationships between potential fisheries impacts and predator performance. Even though it is expected that it would be some time before experimental harvesting regimes can be implemented, some consideration should be given to ensuring that CEMP is conducted in such a way as not to preclude the possibility of initiating specific experiments in the future. Furthermore, as the movement of krill between various areas is likely to be a factor in the design of any experiments that may be undertaken, the advice of WG-Krill should be sought in identifying potential treatment and control areas. The initiation of monitoring to establish suitable baselines in such areas requires consideration.

Action: CEMP's experimental approach should be formalised in practical terms.
The development of strategic models should be encouraged in order to evaluate the statistical performance and cost-effectiveness of possible experimental harvesting regimes designed to distinguish between natural variation in predator performance and effects due to fishing.

10. Feedback Mechanisms for Management Advice

Indices of various measures of predator performance are being calculated annually by CEMP. It was agreed that it would be helpful for CEMP to consider criteria that might be used to specify levels of change or the magnitude of trends to be used in the initiation of management measures (see also discussion under (1) above). There is also a need to develop an appropriate mechanism to include information forthcoming from CEMP in the formulation of management advice on the krill fishery. It was noted that measures could be proposed regardless of whether changes in predator performance could reasonably be attributed to the fishery or whether such measures were deemed necessary to avoid having the fishery exacerbate a situation induced by factors independent of the fishery (e.g., by natural environmental fluctuations).

WG-CEMP was also requested to consider the feasibility of using a dynamic allocation scheme to allocate krill catch limits in various areas. Such allocation would be based on various measures of predator performance within such areas. The scheme would contrast with more static approaches, such as outlined in (5) above, where catches would be limited on the basis of the prey requirements of predators in each statistical subarea. Dynamic allocation of catch levels is likely only to be possible *post hoc* rather than anticipatory.

Action: The possible use and predictive applicability of employing dynamic allocation of krill catch levels based on predator performance should be investigated.

Simulation approaches should be developed to investigate the performance of and the decision rules underlying the incorporation of CEMP information into the formulation of management advice.

11. Precautionary Management Measures

It was noted that although attempts should be made to undertake the best scientific evaluations possible at this time, the information necessary to make such evaluations varies from a total lack of relevant data to data exhibiting considerable inherent variability. This range of information renders it necessary at times to formulate management advice based on a limited understanding of the status of, and interactions between various ecosystem components. In addition, in certain instances when the necessary data are available the decision rules necessary for their inclusion into management advice are lacking. It was therefore agreed that WG-CEMP should consider a precautionary approach to management along with an accompanying mixture of measures which could be applied in zones where, or for critical times when, there is significant overlap between the fishery and land-based predators (particularly during foraging). Such consideration should take account of:

(i) the needs of the fishery;
(ii) historical catch levels;
(iii) potential impacts of fishing on predators;
(iv) potential control/experimental sites for an experimental fishing regime;
(v) uncertainty in knowledge concerning functional relationships between predators, prey, and the environment; and

(vi) minimising the possibility that adverse impacts on the ecosystem occur.

Action: Additional measures to minimise potentially deleterious effects of fishing confined within the foraging ranges of vulnerable land-based predators should be formulated and evaluated.

Information Required from WG-Krill

12. Fishery Data

The continued submission of haul-by-haul data from areas within 100 km of land-based predator sites was again encouraged. Similarly, continued dialogue within WG-Krill was encouraged (see (7)). The need for fine-scale reporting of catches from subareas other than those already identified in Statistical Area 48 and the CEMP ISRs was recognised. There is also a need for demographic information (length, sex ratio, maturity stage, etc.) on krill caught in the fishery, particularly close to land-based predator sites (i.e., especially within the ISRs)

Action: Encourage submission of haul-by-haul data from the fishery within at least 100 km of land-based predator sites.
Encourage the deployment of scientific observers aboard fishing vessels to expedite the above.
The fine-scale reporting of fisheries data from statistical areas other than Statistical Area 48 should implemented.

13. Fishery Independent Data

Estimates of krill abundance and distribution in the ISRs should be encouraged and produced on an ongoing basis. In this connection, some time may be required to implement the predator-prey surveys as recommended by WG-Krill's *ad hoc* Subgroup on Survey Design. The importance of krill movement in estimates of abundance and particularly krill availability was reiterated.

Action: Continued updating of krill abundance estimates in the ISRs.
Krill abundance surveys to be carried out to cover complete ISRs.

Predator-prey surveys to be implemented using the recommended procedures.

Coordination of WG-Krill and WG-CEMP Activities

14. Enhanced Coordination

It was agreed that the Joint Meeting of WG-Krill and WG-CEMP had been a useful forum for promoting a dialogue on issues of common interest. In particular, very fruitful discussions had arisen as a result of personal contact between those with knowledge of predator biology, krill biology and the fishery. The meeting also provided an opportunity for modellers to be included in such discussions on, particularly on the costs of developing of, the most fruitful approaches to addressing deficiencies in knowledge on interactions between predators, krill and the fishery. This deployment of a wide range of scientific skills in one place was seen as being particularly beneficial to the ongoing work of both WG-Krill and WG-CEMP.

Action: Possible future opportunities to continue a close dialogue between the two Working Groups should be provided

15. Coordinating the Formulation of Management Advice

As the work of WG-Krill and WG-CEMP has progressed, areas of overlap between the two groups in relation to the formulation of management advice to the Scientific Committee have been increasingly identified.

In particular, the modelling approach outlined in Appendix 1 was seen as an important first step in a process to augment current understanding of interactions between predators, the environment, krill and the fishery. The need for further modelling both as part of, and outside CEMP was highlighted. Such modelling would improve knowledge on functional relationships (see (2)) as well as provide some basis for decision rules to account for the incorporation of information from CEMP into the formulation of management advice.

Action: Both WG-Krill and WG-CEMP should continue to consider the most effective ways of coordinating their management advice.

16. Liaison Between Working Group Conveners

To facilitate communication between the Scientific Committee's three working groups, it is important that the Conveners of the respective groups should be in contact with each other.

Action: The Conveners of the Working Group on Fish Stock Assessment (WG-FSA), WG-Krill and WG-CEMP will meet immediately prior to the 1992 annual meeting (SC-CAMLR-X, paragraph 12.4).

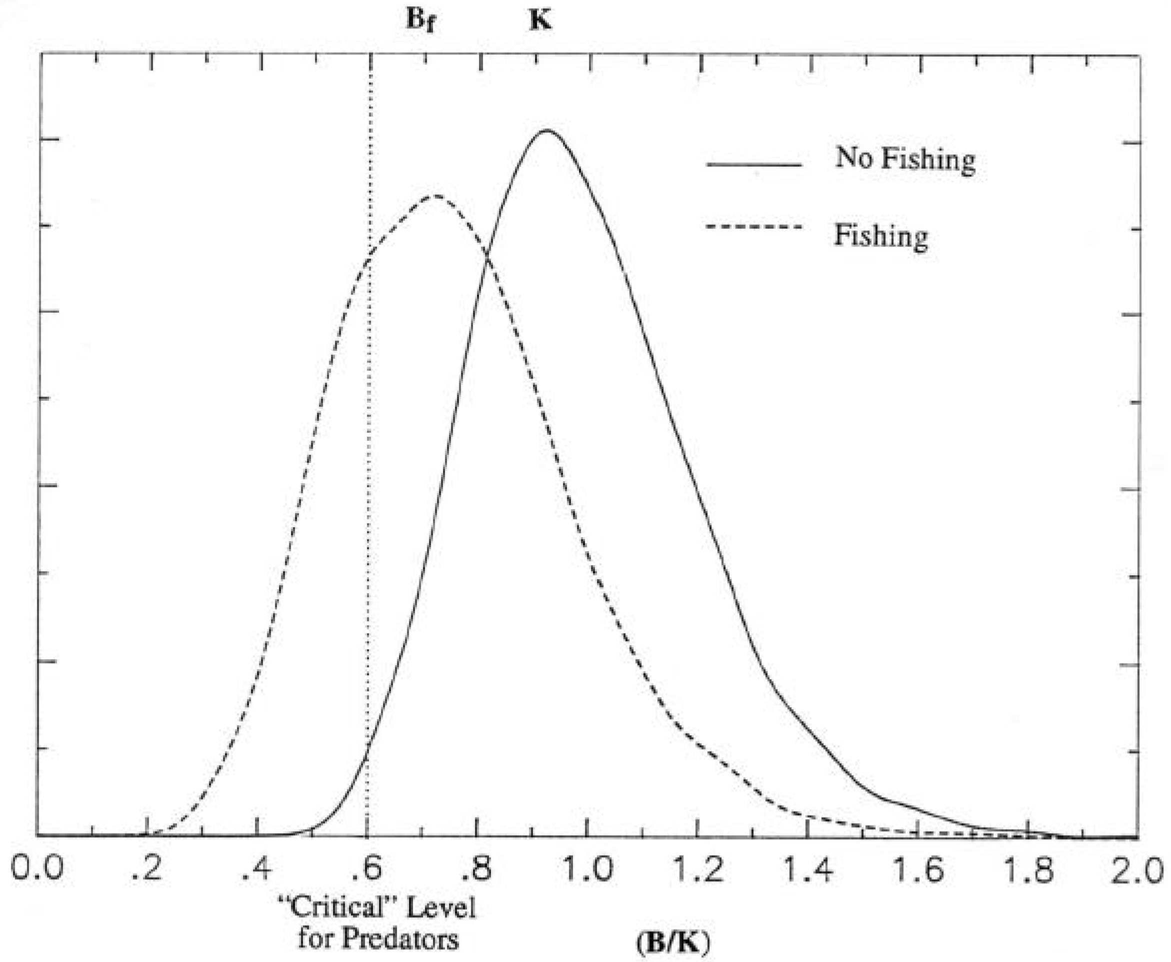

Figure 1: Effect of fishing on the frequency distribution of **B/K**.

AN INITIAL ANALYSIS OF THE EXTENT TO WHICH DIFFERENT LEVELS OF FISHING ON KRILL MAY AFFECT PREDATOR POPULATIONS

SCHEMATIC REPRESENTATION

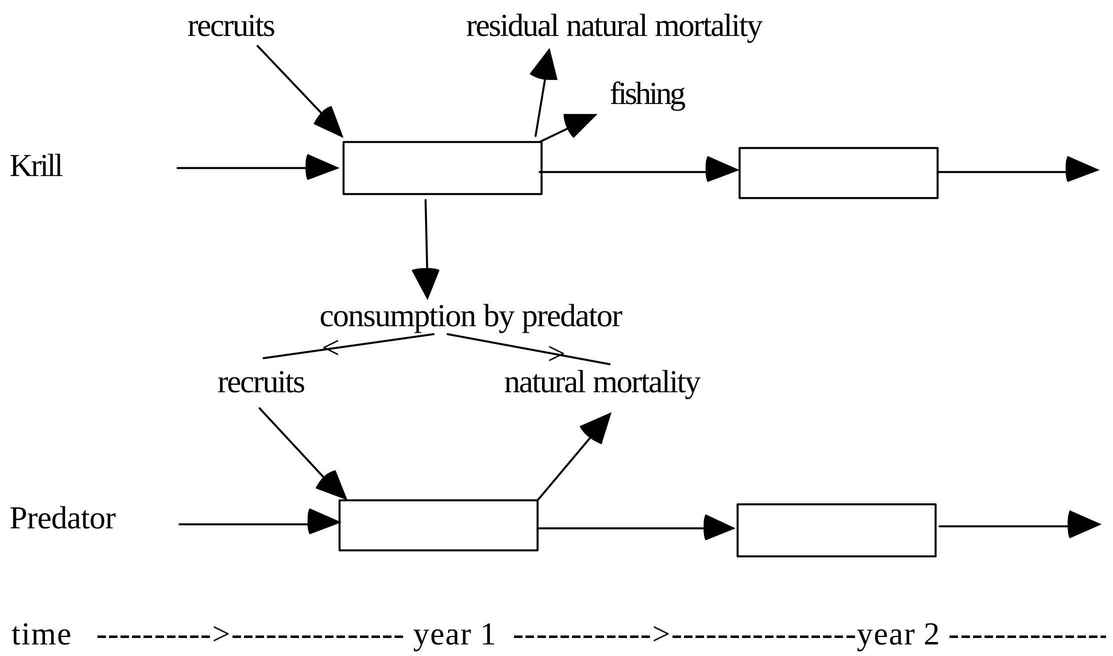

Figure 1

FACTORS TO BE TAKEN INTO ACCOUNT

The diagram in Figure 1 above indicates the inputs and outputs ("births" and "deaths") to be taken into account in modelling the demography of the krill and predator populations and their interaction. The details given below are intended as a broad description (rather than a full specification) of the minimum number of factors which need to be taken into account in the first step in this process. This first step is intended primarily as a learning exercise, following which greater realism can be incorporated into the model.

The Krill Component

The model for the krill population should be a similar but possibly slightly simplified version of that used to explore potential yield possibilities in WG-Krill-92/4. Key elements are that recruitment must include a stochastic component, and that the model must be age-structured. Integration over prior distributions for parameters whose values are uncertain can be ignored for the moment.

Fishing mortality could be modelled as a fixed annual catch. In WG-Krill-92/4, the krill natural mortality rate **M** was considered to be fixed in time. This will now be partitioned into two components: the one, the residual natural mortality (**M**') arising from predators other than the species considered, is to be treated as fixed in time; the other, arising from consumption of krill by the predator under consideration, will vary in time depending on the size of both the predator and the krill population.

The Predator Component

Both the "inputs" and the "outputs" in the model of the predator population (which must also be age-structured) can be considered as survival rates. The relation of the "adult" survival rate to natural deaths is straightforward, but the "juvenile" survival rate should be seen to include the effects of pregnancy rate as well as the higher than average mortality rate early in life.

The key concern is the nature of the functional relationships between these survival rates and krill abundance, which should have the general form indicated in Figure 2, i.e. these rates saturate at high levels of krill abundance (the per capita consumption rate of krill by the predators would also saturate at these levels).

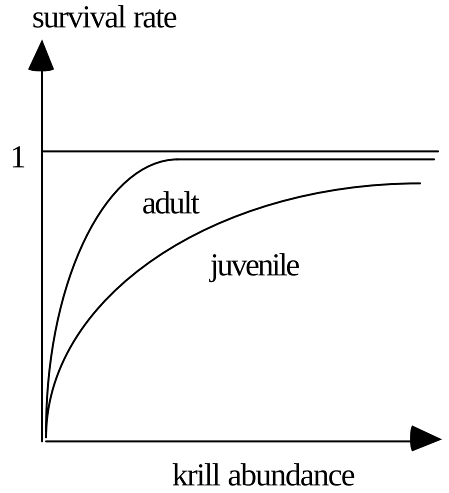

Figure 2

As an initial approach, it may be simplest to specify these relationships as indicated in Figure 3, where **K** is the average krill abundance (i.e., biomass) in the absence of fishing, and a is the fraction of **K** below which the lesser abundance of krill starts to impact on the predators. Two values of a need to be specified: a_J (for the juvenile survival rate) and a_A for the adult survival rate. Because recruitment is likely to be affected before adult mortality as the krill biomass declines, typically $a_A < a_J$. Values of a_J and a_A can be inferred from the distribution of krill biomass in the absence of fishing. For example, given the observed relative frequency of "bad" and "good" years for recruitment, a_J could be chosen so that the ratio of the areas above and below a_J **K** which lie beneath this distribution curve match the observed relative frequency. (Note that although Figure 3 is drawn in a manner which indicates that $\alpha = 1$, circumstances for certain predators may be such as lead to a value of $\alpha > 1$.)

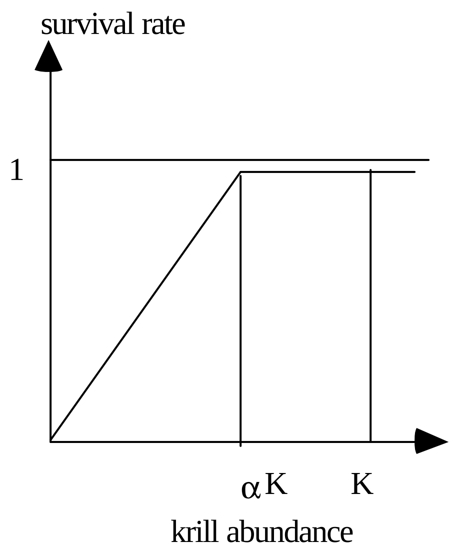

Figure 3

Responses in both adult and juvenile survival rates are seen as necessary components of an initial model. At a later stage, the effect of a stochastic component in these functional response relationships could be investigated; this could provide a means to take account of the fact that land-based predators react to local krill availability, which may not be synonymous with krill abundance in a larger area. Another subsequent refinement of the model might be consideration of breeding space limitations as well as food availability as a limiting factor for the predator population.

INFORMATION REQUESTED FROM WG-CEMP

Rather than attempt to consider some abstract "average predator", models should be developed for two or three choices of an actual predator species. These species should be selected so that their adult survival rates span a reasonably wide range, and information on breeding success and adult mortality variations is available over a reasonable period of time.

The information required for each predator species chosen is as follows:

(i) adult average annual survival rate (i.e. the largest survival rate value in the Figure 3 plot for adults);

(ii) age-at-first breeding;

(iii) categorisation of years with observations across a spectrum from bad to good from the viewpoint of the predator; thus, for example, if three categories are chosen, these might correspond to:

"good" - both breeding success and adult survival good
"poor" - breeding success poor, but adult survival unaffected
"bad" - both breeding success and adult survival poor.

In addition, with future model elaboration to allow for seasonal effects in mind, information on the breeding season for each of the predators selected should be provided.

STATUS AND TRENDS OF ANTARCTIC AND SUB-ANTARCTIC SEABIRDS

(Chairman of the Bird Biology Subcommittee, SCAR)

STATUS AND TRENDS OF ANTARCTIC AND SUB-ANTARCTIC SEABIRDS

Dr J. Croxall, Bird Biology Subcommittee
Working Group on Biology, SCAR

In 1988 at the request of CCAMLR the Subcommittee reviewed the status and trends of Antarctic and sub-Antarctic seabirds and published its conclusions (*Cormorant* 16: 138-158 (1988)). In 1990 CCAMLR indicated that it wished again to consider this topic in detail at its 1992 meeting and invited the Subcommittee to update the 1988 review. The Subcommittee undertook this review at the meeting of XXII SCAR at Bariloche, Argentina in June 1992. Members and observers present are listed at Appendix 1.

2. Three sources of material for this review were available at the meeting. First, data on the forms provided by CCAMLR (listed at Appendix 2). Second, data from the published literature (see reference list) and third, personal communications from scientists present at the meeting.

3. Concern was expressed over the CCAMLR forms in that independently of circulation via the Secretary of the Bird Biology Subcommittee, CCAMLR had also provided these forms to individual researchers, some of whom had replied direct to CCAMLR rather than to the Bird Biology Subcommittee. This had resulted in some submitted data (e.g., for Japan) being unavailable for review at this meeting. The forms themselves were also felt to be too complicated. In particular they seemed to be designed to acquire primary data from research studies, rather than achieving a summary of the conclusions of these. This was felt to be inappropriate and potentially misleading.

4. The main data reviewed by the Subcommittee are summarised in detail, by species and site or area in Table 1 and Appendix 3. The emphasis here is on data newly available since the 1988 review for sites where at least two comparable counts are available. However, many of the more significant longterm datasets are also summarised, whether or not new data are available. It should be noted that, particularly for Antarctic Peninsula penguins, substantial additional relevant historical data can be found in Croxall and Kirkwood (1979) and Poncet and Poncet (1985 and 1987).

5. In its discussion of these data the Subcommittee emphasised that most data, even from exactly the same site, derive from a few counts widely separated in time. Breeding populations of most, if not all, Antarctic and sub-Antarctic seabirds show substantial natural fluctuations. Different apparent 'trends' can be produced by the selection of particular years from a longterm dataset (see e.g., Trivelpiece *et al.*, 1990) and thus interpretations from fewer, more disjunct data can be

misleading. In addition, interpretation of essentially the same data can be substantially different, as for southern giant petrels at Iles Crozet (Voisin, 1988; Bretagnolle *et al.*, 1991; Voisin, 1991). Thus the 'changes' indicated in the tabulation should not necessarily be taken as evidence of systematic population change. The source documents, particularly the published papers, should be consulted in conjunction with this summary.

6. The Subcommittee offered the following general conclusions:

(i) For many species of Antarctic and sub-Antarctic seabirds, data are generally inadequate to make any accurate assessment of population trends at any site in the region. For most other species, adequate data exist for only one or two sites. Only commitments to continuous longterm studies will remedy this situation.

(ii) Of species for which adequate data exist for at least one site, most are currently fluctuating appreciably around a basically stable level, or increasing slightly.

(iii) The king penguin is the only species for which significant population increases are currently taking place at most, if not all, breeding localities. These increases are likely to reflect changes in the species' biological environment, presumably involving their main prey, myctophid fish.

(iv) Adélie penguins have increased steadily in the Ross Sea since 1982. Populations are generally stable elsewhere, including at sites where significant population increases occurred between the l950s and 1970s.

(v) Chinstrap, and possibly macaroni, penguins, which showed substantial local or regional population increases in the 1950s through 1970s are now stable or, at most, slightly increasing.

(vi) There is less evidence than previously that species are continuing to increase in numbers because of increased availability of refuse in the vicinity of stations. Treatment of human refuse, although much improved, still needs attention, especially when the potential main beneficiaries are predatory species whose population increases will be to the likely detriment of other birds.

(vii) The southern giant petrel and nearly all albatrosses for which adequate data are available are decreasing at most or all sub-Antarctic islands. The southern giant petrel has decreased significantly at all breeding sites on the Antarctic continent but the situation in the Antarctic Peninsula area is more complex. The declines are most likely related to incidental mortality associated with fisheries but better data, especially for grey-headed albatrosses and giant petrels, are urgently needed.

(viii) There is less evidence than previously that species are continuing to decrease because of human disturbance, though better data are needed on populations in the vicinity of bases.

(ix) Burrowing seabirds at most sub-Antarctic islands continue to be seriously affected by introduced animals; the example of South Africa in probably having eradicated cats from Marion Island needs to be emulated as widely and as rapidly as possible.

(x) There is still only circumstantial evidence that decreases in any seabird population can be attributed to decreases in food availability at sea. There is no evidence that any population decline reflects effects of commercial fishing.

(xi) There is increasing evidence of the importance of the physical environment in influencing reproductive performance and even population dynamics of Antarctic seabirds, especially species of high latitudes. It is crucial that all seabird monitoring studies should record physical variables as an integral part of the program.

(xii) Despite numerous examples of changes in abundance of seabird populations that correlate with previous or simultaneous changes in characteristics of the biological or physical environment, we have only a very poor knowledge of how such environmental factors operate and interact, or of how seabird populations are regulated. These remain vital fields for enhanced research.

REFERENCES

BAKKEN, V. 1991. Fugle-og selunderøkedser pa Bouvetøya i Desember-Januar 1989/90. *Medd. Norsk. Polarinst.* No. 15, 30 pp.

BRETAGNOLLE, V., H. WEIMERSKIRCH and P. JOUVENTIN. 1991. Have giant petrels *Macronectes spp*. really increased at Iles Crozet. *Mar. Orn. 19*: 73-74.

BROTHERS, N. 1991. Albatross mortality and associated bait loss in the Japanese longline fishery in the Southern Ocean. *Biol. Conserv. 55*: 255-268.

CHASTEL, O., H. WEIMERSKIRCH and P. JOUVENTIN. In press. Annual variability in reproductive success and survival of an Antarctic seabird, the snow petrel *Pagodroma nivea*: a 27 year study. *Ibis*.

COOPER, J. and A. FOURIE. 1992. Improved breeding success of great-winged petrels *Pterodroma macroptera* following control of feral cats at sub-Antarctic Marion Island. *Bird Conservation International 1*: 171-175.

COOPER, W. 1992. Rockhopper penguins at the Auckland Islands. *Notornis 39*: 66-67.

CROXALL, J.P. and E.D. KIRKWOOD. 1979. *The Breeding Distribution on the Antarctic Peninsula and Islands of the Scotia Sea*. Cambridge: British Antarctic Survey.

CROXALL, J.P. and P.A. PRINCE. 1979. Antarctic seabird and seal monitoring studies. *Polar Rec. 19*: 573-595.

CROXALL, J.P. and P.A. PRINCE. 1990. Recoveries of wandering albatrosses *Diomedea exulans* ringed at South Georgia, 1958-1986. *Ringing and Migration 11*: 43-51.

CROXALL J.P., D.M. ROOTES and R. PRICE. 1981. Increases in penguin populations at Signy Island, South Orkney Islands. *Bull. Br. Antarct. Surv. 54*: 47-56.

CROXALL, J.P., P.A. PRINCE, I. HUNTER, S.J. MCINNES and P.G. COPESTAKE. 1984. The seabirds of the Antarctic Peninsula, islands of the Scotia Sea and Antarctic Continent between 80°W and 20°W: their status and conservation. In: CROXALL, J.P., P.G.H. EVANS and R.W. SCHREIBER (Eds). *Status and Conservation of the World's Seabirds*. Cambridge: ICBP. pp. 637-666.

CROXALL, J.P., T.S. MCCAN, P.A. PRINCE and P. ROTHERZ. 1988. Reproductive performance of seabirds and seals at South Georgia and Signy Island, South Orkney Islands, 1976-87: implications for Southern Ocean monitoring studies. In: SAHRHAGE, D. (Ed.). *Antarctic Ocean and Resources Variability*. Berlin: Springer-Verlag. pp. 261-285.

CROXALL, J.P., P. ROTHERY, S.P.C. PICKERING and P.A. PRINCE. 1990. Reproductive performance, recruitment and survival of wandering albatrosses *Diomedea exulans* at Bird Island, South Georgia. *J. Anim. Ecol. 59*: 775-796.

FAVERO, M. and M.P. SILVA. 1991. The status of the breeding birds at Halfmoon Island (Isla Media Luna), South Shetland Islands, Antarctica. *Contr. Inst. Antarct. Argentina* No. 407, 8 pp.

FAVERO, M., P.J. BELLAGAMBA and M. FARENGA. 1991. Abundica y distribucion espacial de las poblaciones de aves de Punta Armonia y Punta Dedo, Isla Nelson, Shetland del Sur. *Riv. Ital. Orn. 61*.

FRASER, W.R., D.G. AINLEY, W.Z. TRIVELPIECE and S.G. TRIVELPIECE. 1992. Increases in Antarctic penguin populations: reduced competition with whales or a loss of sea ice due to environmental warming. *Polar Biol. 11*: 525-531.

GALES, R. and D. PEMBERTON. 1988. Recovery of the king penguin, *Aptenodytes patagonicus*, population on Heard Island. *Aust. Wildl. Res. 15*: 579-585.

HARPER, P.C., G.A. KNOX, E.B. SPURR, R.H. TAYLOR, G.J. WILSON and E.C. YOUNG. 1984. The status and conservation of birds in the Ross Sea sector of Antarctica. In: CROXALL, J.P., P.G.H. EVANS and R.W. SCHREIBER (Eds). *Status and Conservation of the World's Seabirds.* Cambridge: ICBP. pp. 593-608.

HEMMINGS, A.D. 1984. Aspects of the breeding biology of McCormick's skua *Catharacta maccormicki* at Signy Island, South Orkney Islands. *Bull. Br. Antarct. Surv. 65:* 65-79.

JOUVENTIN, P. and H. WEIMERSKIRCH. 1990. Longterm changes in seabird and seal populations in the Southern Ocean. In: KERRY, K.R. and G. HEMPEL (Eds). *Antarctic Ecosystems.Ecological Change and Conservation.* Berlin: Springer-Verlag. pp. 208-213.

JOUVENTIN, P. and H. WEIMERSKIRCH. 1991. Changes in the population size and demography of southern seabirds: the management implications. In: PERRINS, C.M. J.D. LEBRETON and G.J.M. HIRONS (Eds). *Bird Population Studies: Their Relevance to Conservation and Management.* Oxford: Oxford University Press. pp. 297-314.

JOUVENTIN, P., J.C. STAHL, H. WEIMERSKIRCH and J.L. MOUGIN. 1984. The seabirds of the French sub-Antarctic islands and Adélie Land, their status and conservation. In: CROXALL, J.P., P.G.H. EVANS and R.W. SCHREIBER (Eds). *Status and Conservation of the World's Seabirds.* Cambridge: ICBP. pp. 609-625.

MOORS, J.P. 1986. Decline in numbers of rockhopper penguins at Campbell Island. *Polar Rec. 23*: 69-73.

PONCET, S. and J. PONCET. 1985. A survey of penguin breeding populations at the South Orkney Islands. *Bull. Br. Antarct. Surv. 68:* 71-81.

PONCET, S. and J. PONCET. 1987. Censuses of penguin populations of the Antarctic Peninsula, 1983-1987. *Bull. Br. Antarct. Surv. 77*: 109-129.

ROOTES, D.M. 1988. The status of birds at Signy Island, South Orkney Islands. *Bull. Br. Antarct. Surv. 80*: 87-119.

ROUNSEVELL, D. and G.R. COPSON. 1982. Growth rate and recovery of a king penguin *Aptenodytes patagonicus* population after exploitation. *Aust. Wildl. Res. 9*: 519-525.

SHAW, P. 1984. *Factors Affecting the Breeding Performance of the Antarctic Blue-eyed Shag (Phalacrocorax atriceps bransfieldensis*). PhD thesis: Univ. of Durham.

TAYLOR, R.H., P.R. WILSON and B.W. THOMAS. 1990. Status and trends of Adélie penguin populations in the Ross Sea region. *Polar Rec. 26*: 293-304.

TRIVELPIECE, W.Z., S.G. TRIVELPIECE, G.R. GEUPEL, J. KJELMYR and N.J. WOLKMAN. 1990. Adélie and chinstrap penguins: their potential as monitors of the Southern Ocean marine ecosystem. In: KERRY, K.R. and G. HEMPEL (Eds). *Antarctic Ecosystems. Ecological Change and Conservation*. Berlin: Springer-Verlag. pp. 191-202.

VAN FRANEKER, J.A., P.J. BELL and T.L. MONTAGUE. 1990. Birds of Ardery and Odbert Islands, Windmill Islands, Antarctica. *Emu 90*: 74-80.

VOISIN, J. 1988. Breeding biology of the northern giant petrel *Macronectes halli* and the southern giant petrel *M. giganteus* at Ile de La Possession, Iles Crozet, 1966-1980. *Cormorant 16*: 66-95.

VOISIN, J. 1991. Giant petrels increased at Iles Crozet between 1966 and 1980. *Mar. Orn. 19*: 75-77.

WEIMERSKIRCH, H. 1990. The influence of age and experience on breeding performance of the Antarctic fulmar *Fulmaus glacialoides*. *J. Anim. Ecol. 59*: 867-875.

WEIMERSKIRCH, H. and P. JOUVENTIN. 1987. Population dynamics of the wandering albatross (*Diomedea exulans*) of the Crozet Islands: causes and consequences of the population decline. *Oikos 49*: 315-322.

WILSON, K.J. 1990. Fluctuations in the Adélie penguin populations at Cape Bird, Antarctica. *Polar Rec. 26*: 305-308.

WOEHLER, E.J. 1991. Status and conservation of the seabirds of Heard Island and the McDonald Islands. In: CROXALL, J.P. (Ed.). *Seabird Status and Conservation: a Supplement*. Cambridge: ICBP. pp. 263-277.

WOEHLER, E.J. and G.W. JOHNSTONE. 1991. Status and conservation of the seabirds of the Australian Antarctic territory. In: CROXALL, J.P. (Ed.). *Seabird Status and Conservation: a Supplement*. Cambridge: ICBP. pp. 279-308.

WOEHLER, E.J., D.J. SLIP, L.M. ROBERTSON, P.J. FULLAGAR and H.R. BURTON. 1991. The distribution, abundance and status of Adélie penguins *Pygoscelis adeliae* at the Windmill Islands, Wilkes Land, Antarctica. *Marine Ornithology 19*: 1-18.

Table 1: Changes in populations of Antarctic and sub-Antarctic seabirds.

Species	Site	Years of Data	Mean Annual Change Year	%	Reference
Emperor penguin	Pointe Geologie	1952, 1958, 1962-1986	1975-86	-7.5	Jouventin and Weimerskirch, 1990
King penguin	Crozet	1962, 1965, 1981, 1986	1962-86	-0.4*	Jouventin and Weimerskirch, 1990
		1962, 1967, 1981, 1986	1962-86	+7.3	Jouventin and Weimerskirch, 1990
		1967, 1981, 1986	1967-86	+10.4	Jouventin and Weimerskirch, 1990
	Kerguelen	1962, 1985	1962-85	+6.3	Jouventin and Weimerskirch, 1990
		1962, 1985	1962-85	+7.2	Jouventin and Weimerskirch, 1990
		1974, 1985	1974-85	+19.6	Jouventin and Weimerskirch, 1990
	Heard (Spit Bay)	8y 1963-1988	1963-88	+25.5	Gales and Pemberton, 1988
	Macquarie	1930, 1980	1930-80	+6.9	Rounsevell and Brothers, 1984
	South Georgia	1914, 1946, 1976, 1986	1976-86	+5.0	Croxall *et al*., 1988
Adélie penguin	Cape Bird	1965-70, 1974-87	1982-88	+10.1	Wilson, 1990
	Cape Hallett	1981-87	1981-82	+9.9	Taylor *et al*., 1990
	Beaufort I	1981, 1983-1987	1981-87	+6.1	Taylor *et al*., 1990
	Franklin I West	1981, 1983-1987	1981-82	+8.5	Taylor *et al*., 1990
	Pointe Geologie	1958, 1984	1958-84	+2.1	Jouventin and Weimerskirch, 1990
	Windmill Is	1961, 1971, 1989	1961-71	+9.6	Woehler *et al*., 1991
			1971-89	+0.8	Woehler *et al*., 1991
	Signy Island	4y 1948-1979	1948-79	+3.6	Croxall *et al*., 1981
		1979-1992	1979-92	+0.4	Croxall *et al*., 1988 and unpubl.
	Admiralty Bay	7y 1977-1986	1977-86	+0.2	Trivelpiece *et al*., 1990
Chinstrap penguin	Admiralty Bay	7y 1977-1986	1977-86	-3.1	Trivelpiece *et al*., 1990
	Signy Island	4y 1948-1979	1948-79	+7.3	Croxall *et al*., 1981
		1979-92	1979-92	-0.1	Croxall *et al*., 1988 and unpubl.
	Bouvetoya	4y 1958-1978	1958-78	+14.6	Bakken, 1991
		1979, 1990	1978-90	-7.6	Bakken, 1991
	Half Moon Is	1965, 1990	1965-90	+1.5	Favero and Silva, 1991
	Harmony Pt	4y 1964-1988	1964-88	+5.5	Favero *et al*., 1991

Table 1 continued

Species	Site	Years of Data	Mean Annual Change Year	%	Reference
Gentoo penguin	Crozet	1970, 1985, 1986	1970-86	-2.0	Jouventin and Weimerskirch, 1990
	Heard I	1952, 1987	1952-87	+2.5	Woehler, 1991
	Signy I	1979-1992	1979-92	+2.1	Croxall *et al*., unpubl.
	Harmony Pt	6y 1903-1988	1903-88	+5.4	Favero *et al*., 1991
Macaroni penguin	Kerguelen	1962, 1985	1962-85	+0.7	Jouventin and Weimerskirch, 1990
	Bird I, South Georgia	1958, 1977	1958-77	+9.7	Croxall and Prince, 1990
		1977-1992	1976-92	-0.7	Croxall *et al*., unpubl.
	Bouvetoya	5y 1958-81	1958-81	+17.1	Bakken, 1991
		1979-1990	1979-90	-0.9	Bakken, 1991
Wandering albatross	Bird I, South Georgia	1976-1992	1976-92	-1.0	Croxall *et al*., 1990 and unpubl.
	Possession I, Crozets	5y 1960-85	1960-85	-2.4	Jouventin and Weimerskirch, 1990
	Cochon I, Crozets	3y 1964-1981	1964-81	-2.0	Jouventin and Weimerskirch, 1990
	Kerguelen	1971, 1985	1971-85	-5.7	Jouventin and Weimerskirch, 1990
	Marion I	7y 1974-89	1974-91	-0.7	J. Cooper, unpubl.
Black-browed albatross	Crozet	1978, 1986, 1987	1978-87	-3.1	Jouventin and Weimerskirch, 1990
	Bird I, South Georgia	1976-1989	1976-89	+0.8	P.A. Prince *et al*., unpubl.
Grey-headed albatross	Bird I, South Georgia	1977-1990	1977-90	-1.8	P.A. Prince *et al*., unpubl.
Southern giant petrel	Pointe Geologie	1956-1984	1956-84	-5.5	Jouventin and Weimerskirch, 1990
	Giganteus I	1956, 1985	1956-85	-8.2	Woehler and Johnstone, 1991
	Hawker I	1970, 1988	1970-88	-7.8	Woehler and Johnstone, 1991
	Frazier Is	1956, 1983	1956-83	-2.1	Woehler and Johnstone, 1991
	Signy I	4y 1937-1985	1937-85	-6.5	Rootes, 1988
	Anvers I	?-1992	19?-92	+?	W.R. Fraser, unpubl.
	Harmony Pt	1965, 1989	1965-89	+0.7	Favero *et al*., 1991
	Marion I	6y 1985-1992	1985-92	-2.2	J. Cooper, unpubl.
	Heard I	1951, 1988	1951-88	-1.9	Woehler, 1991

Table 1 continued

Species	Site	Years of Data	Mean Annual Change Year	%	Reference
Northern giant petrel	Bird I, South Georgia	1980-1985	1980-85	-7.0	Jouventin and Weimersksirch, 1990
	Crozet	6y 1973-1982	1973-82	+4.3	Hunter, 1984
	Marion I	6y 1985-1992	1985-92	+4.1	J. Cooper, unpubl.
Antarctic fulmar	Haswell I	1963, 1979	1963-79	-1.8	Woehler and Johnstone, 1991
	Rauer I	1981, 1985	1981-85	+10.7	Woehler and Johnstone, 1991
	Windmill Is	1962, 1985	1962-84	+3.5	van Franeker *et al*., 1990
Antarctic petrel	Haswell I	1962, 1979	1962-79	-8.1	Woehler and Johnstone, 1991
	Tauer I	1981, 1985	1981-85	-2.4	Woehler and Johnstone, 1991
	Windmill I	1962, 1984	1962-84	+6.0	van Franeker *et al*., 1990
Cape petrel	Haswell I	4y 1957-1975	1957-79	-0.6	Woehler and Johnstone, 1991
	Windmill I	1962, 1978, 1984	1962-84	+10.0	van Franeker *et al*., 1990
	Harmony Pt	1965, 1989	1965-89	+7.6	Favero *et al*., 1991
Sub-Antarctic skua	Bird I, South Georgia	1959, 1977, 1981	1959-81	+3.8	Prince and Croxall, 1983
	Signy I	1959-1966, 1983	1959-83	+3.8	Hemmings, 1984
Antarctic skua	Anvers I	1974-1990	1974-90	+6.6	W.R. Fraser, unpubl.
Kelp gull	Half Moon I	1966, 1991	1966-91	+2.5	Favero and Silva, 1991
	Harmony Pt	1965, 1989	1965-89	+8.1	Favero *et al*., 1991
Blue-eyed shag	Signy I	20y 1948-1981	1948-81	+6.0	Shaw, 1984
	Half Moon I	1953, 1991	1953-91	+7.2	Favero and Silva, 1991
	Harmony Pt	1965, 1989	1965-89	+3.4	Favero *et al*., 1991

* Colony by permanent station.

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ANTARCTIC SEABIRD POPULATION STATUS:
SUMMARY OF REPLIES RECEIVED

Nation	Locality	Species	Reviewer
Argentina	King George Island	Southern giant petrel	N.R. Coria
Argentina	Hope Bay	Greater sheathbill	N.R. Coria
Argentina	Harmony Point, Nelson I	Gentoo penguin	M. Favero
Argentina	Harmony Point, Nelson I	Chinstrap penguin	M. Favero
Argentina	Harmony Point, Nelson I	Southern giant petrel	M. Favero
Argentina	Harmony Point, Nelson I	Cape petrel	M. Favero
Argentina	Harmony Point, Nelson I	Blue-eyed shag	M. Favero
Argentina	Harmony Point, Nelson I	Kelp gull	M. Favero
Argentina	Harmony Point, Nelson I	Antarctic tern	M. Favero
Argentina	Harmony Point, Nelson I	Greater sheathbill	M. Favero
Argentina	Potter Pen, King George I	Southern giant petrel	M. Favero
Argentina	Potter Pen, King George I	Wilson’s storm petrel	M. Favero
Argentina	Potter Pen, King George I	Kelp gull	M. Favero
Argentina	Potter Pen, King George I	Antarctic tern	M. Favero
Argentina	Potter Pen, King George I	Sub-Antarctic skua	M. Favero
Argentina	Potter Pen, King George I	South polar skua	M. Favero
Argentina	Potter Pen, King George I	Greater sheathbill	M. Favero
Argentina	Half Moon Is	Chinstrap penguin	M. Favero
Argentina	Half Moon Is	Cape petrel	M. Favero
Argentina	Half Moon Is	Wilson’s storm petrel	M. Favero
Argentina	Half Moon Is	Blue-eyed shag	M. Favero
Argentina	Half Moon Is	Kelp gull	M. Favero
Argentina	Half Moon Is	Antarctic tern	M. Favero
Argentina	Half Moon Is	Greater sheathbill	M. Favero
Australia	Amanda Bay	Emperor penguin	E.J. Woehler
Australia	Auster Island	Emperor penguin	E.J. Woehler
Australia	Fold Island	Emperor penguin	E.J. Woehler
Australia	Frazier Islands, Wilkes Land	Southern giant petrel	E.J. Woehler
Australia	Kloa Point	Emperor penguin	E.J. Woehler
Australia	Mawson Region	Adélie penguin	E.J. Woehler
Australia	Mount Biscoe	Adélie penguin	E.J. Woehler
Australia	Proclamation Island	Adélie penguin	E.J. Woehler
Australia	Prydz Bay	Adélie penguin	E.J. Woehler
Australia	Rauer Island	Adélie penguin	E.J. Woehler
Australia	Rookery Islands	Adélie penguin	E.J. Woehler
Australia	Taylor Glacier	Emperor penguin	E.J. Woehler
Australia	Vestfold Hills	Adélie penguin	E.J. Woehler
Australia	Windmill Islands	Adélie penguin	E.J. Woehler
France	Adélie Land	Emperor penguin	H. Weimerskirch
France	Adélie Land	Antarctic fulmar	H. Weimerskirch
France	Adélie Land	Adélie penguin	H. Weimerskirch
France	Adélie Land	Snow petrel	H. Weimerskirch
France	Adélie Land	Southern giant petrel	H. Weimerskirch

Nation	Locality	Species	Reviewer
France	Amsterdam Island	Amsterdam albatross	H. Weimerskirch
France	Amsterdam Island	Yellow-nosed albatross	H. Weimerskirch
France	Crozet Islands	Gentoo penguin	H. Weimerskirch
France	Possession Island	King penguin	H. Weimerskirch
France	Possession Island	Wandering albatross	H. Weimerskirch
France	Possession Island	Northern giant petrel	H. Weimerskirch
France	Possession Island	Southern giant petrel	H. Weimerskirch
France	Kerguelen	Balck-browed albatross	H. Weimerskirch
New Zealand	Cape Bird	Adélie penguin	K.-J. Wilson
Norway	Bouvetoya	Adélie penguin	V. Bakken
Norway	Bouvetoya	Chinstrap penguin	V. Bakken
Norway	Bouvetoya	Macaroni penguin	V. Bakken
South Africa	Gough Island	Rockhopper penguin	J. Cooper
South Africa	Gough Island	Wandering albatross	J. Cooper
South Africa	Gough Island	Yellow-nosed albatross	J. Cooper
South Africa	Gough Island	Southern giant petrel	J. Cooper
South Africa	Gough Island	Sub-Antarctic skua	J. Cooper
South Africa	Marion Island	King penguin	J. Cooper
South Africa	Marion Island	Macaroni penguin	J. Cooper
South Africa	Marion Island	Rockhopper penguin	J. Cooper
South Africa	Marion Island	Wandering albatross	J. Cooper
South Africa	Marion Island	Grey-headed albatross	J. Cooper
South Africa	Marion Island	Northern giant petrel	J. Cooper
South Africa	Marion Island	Southern giant petrel	J. Cooper
South Africa	Tristan da Cunha	Yellow-nosed albatross	J. Cooper
Spain	Deception Island	Chinstrap penguin	J. Moreno
United Kingdom	South Georgia	King penuin	J.P. Croxall
United Kingdom	Signy Island	Adélie penguin	J.P. Croxall
United Kingdom	Signy Island	Chinstrap penguin	J.P. Croxall
United Kingdom	Signy Island	Gentoo penguin	J.P. Croxall
United Kingdom	Bird Island, South Georgia	Gentoo penguin	J.P. Croxall
United Kingdom	Bird Island, South Georgia	Macaroni penguin	J.P. Croxall
United Kingdom	Bird Island, South Georgia	Wandering albatross	J.P. Croxall
United Kingdom	Bird Island, South Georgia	Black-browed albatross	J.P. Croxall
United Kingdom	Bird Island, South Georgia	Grey-headed albatross	J.P. Croxall

SUMMARY OF THE STATUS AND TRENDS OF ANTARCTIC AND SUB-ANTARCTIC SEABIRDS BY SPECIES

Emperor penguin (*Aptenodytes forsteri)*

The significant population decline at Pointe Geologie does not seem to be matched by the (very limited) data available for other breeding sites. The Pointe Geologie decline has usually been attributed to changing physical environmental conditions relating to the local environment of the colony and/or to the extent of ice cover and date of ice breakout (Jouventin *et al*., 1984; Jouventin and Weimerskirch, 1991). Longterm studies, with annual counts, of other breeding populations are obviously desirable; it was noted that Australia had recently commenced such work.

King penguin (*Aptenodytes patagonicus*)

Populations continue to increase very substantially at all breeding sites where data exist (South Georgia, Crozet, Kerguelen, Heard, Macquarie). Increases are least at Marion Island. Reasons for the increases are uncertain. Whereas initial increases at some sites may have represented response to human exploitation in the l9th and early 20th centuries, it is most unlikely that populations are still ‘recovering’ today. In addition, evidence for actual human exploitation at several sites is very weak or non-existent. Increases are thus most likely to reflect enhanced levels of availability of food, especially myctophid fish.

Adélie penguin (*Pygoscelis adeliae*)

The most extensive data are for the Ross Sea (and especially Cape Bird). Here, colonies may have declined pre-1970, remained stable through the next decade and have certainly increased significantly since 1982-83. Elsewhere on the Antarctic continent the limited data broadly suggest population stability, at least in the 1980s, or increases between the late l950s to mid 1980s (e.g., Woehler *et al*., 1991), or in the late 1980s. At sites on the Antarctic Peninsula and nearby island groups, the evidence of increases between the 1950s to late 1970s is unequivocal. Thereafter, depending on site, populations have either fluctuated substantially but remained generally stable overall, or decreased locally. Some decreases may have been due to human disturbance but declines at many sites (e.g., Anvers Island area) cannot have been caused in this way. At Bouvet, Adélie penguins appear to breed only sporadically (on three of five visits; Bakken, 1991). Adélie penguin population changes may be especially closely linked to changes in the physical environment, particularly ice cover (Croxall *et al*., 1988; Fraser *et al*., 1992), but these relationships are not necessarily on an immediate or proximate basis.

Chinstrap penguin (*Pygoscelis antarctica*)

Major population increases (at faster rates than for Adélie penguins) were generally characteristic of the l950s to mid 1970 period. Since then most of the few data indicate substantial fluctuations or, at most, a very reduced rate of continued increase. There is no longer evidence of colonisation of new sites nor of significant increases at the edge of the species breeding range. Decreases at some sites are perhaps attributable to human disturbance, though the data for Bouvet cannot be explained in this way. Chinstrap penguin fluctuations are also undoubtedly influenced by changes in the physical environment (Croxall *et al.*, 1988; Fraser *et al.*, 1992) but possibly to a lesser extent than Adélies and with even less obvious simple correlations.

Gentoo penguin (*Pygoscelis papua*)

This species shows the largest interannual population fluctuations (influenced to some (considerable?) extent by its early age of first breeding) in the genus Pygoscelis. Few data are adequate to demonstrate any systematic trend. Generally, therefore, populations are believed to be stable or, perhaps, increasing (currently or in the past) at a few localities (e.g., Nelson Island, Ardley Island, Signy Island and Heard Island).

Macaroni penguin (*Eudyptes chrysolophus*)

Data from South Georgia and Bouvet suggest that populations are currently fairly stable after substantial increases prior to the 1970s - and a possible decline at South Georgia in the early 1980s. Marion Island populations appear relatively stable.

Rockhopper penguin (*Eudyptes chrysocome*)

No relevant data within the CCAMLR Convention Area of a species very difficult to census accurately. Substantial population declines for the Campbell and Auckland Islands have been reported by Moors (1986) and Cooper (1992) but the causes of these remain entirely speculative.

Wandering albatross (*Diomedea exulans*)

Population decreases have been reported for all breeding sites where sufficient data exist. There is some suggestion of slower rates of decrease/stabilisation at Crozet but not at South Georgia. Incidental mortality associated with longline fisheries is probably the most significant cause of the population decline (Croxall *et al.*, 1984; Jouventin *et al.*, 1984; Weimerskirch and Jouventin, 1987; Croxall and Prince, 1990; Croxall *et al.*, 1990; Brothers, 1991).

Amsterdam albatross (*Diomedea amsterdamensis*)

Stable or perhaps slightly increasing from very low population levels (Jouventin *et al.*, 1989), partly due to removal of cattle and consequent restoration of breeding habitat.

Black-browed albatross (*Diomedea melanophris*)

Decreasing at the Crozet Islands, possibly increasing at Heard between the 1950s and 1980s and essentially stable at Bird Island, South Georgia, where decreases in some colonies are balanced by increases in others (Prince *et al.*, unpublished data). It is difficult to interpret the status of this species because local fishing activities could contribute to population increase (through enhanced opportunities for scavenging food) and also to decreases (through incidental mortality).

Grey-headed albatross (*Diomedea chrysostoma*)

A significant decrease at Bird Island since 1975 across all colonies (Prince *et al.*, unpublished data). The causes are unknown but less likely to be fishery-related than for the other species of albatross at South Georgia because the grey-headed albatross is not typically associated with fishing boats. Populations at Marion Island, and censussed in seven years between 1974-91, have fluctuated considerably but without any clear trend (J. Cooper, pers. comm.).

Southern giant petrel (*Macronectes giganteus*)

There have been decreases in breeding populations at South Georgia, Marion and Heard Islands. The situation at Crozet is controversial (Voisin, 1988; Bretagnolle *et al.*, 1991; Voisin, 1991). Populations at all continental sites are declining. In the Antarctic Peninsula the situation is more complicated. The species appears to be stable at some sites (e.g., Nelson Island, (Favero *et al.*, 1991), Laurie Island since 1981/82 (D. Vergani, pers. comm.), Potter Cove, King George Island, (N. Coria, pers. comm.)). There have been substantial declines at some other sites (e.g., Signy Island (Rootes 1988)) but the population at Anvers Island has increased substantially over the last two decades (W.R. Fraser, pers. comm.). Human disturbance can have an undoubted influence on this species but the declines include several sites where this is unlikely to have been a factor. Incidental mortality is also likely to influence this ship-associated species, especially in sub-Antarctic areas.

Northern giant petrel (*Macronectes halli*)

No clear pattern exists for this species with populations decreasing at Crozet and apparently increasing at South Georgia (though no data available since the mid 1980s) and Marion Island.

Smaller fulmarine petrels

Longterm data on Antarctic fulmar *Fulmarus glacialoides* and snow petrel *Pagodroma nivea* from Pointe Geologie, Adélie Land (Weimerskirch, 1990; Jouventin and Weimerskirch, 1991; Chastel *et al.*, in press) show substantial interannual fluctuations in populations but no clear trend over the last 30 years. Data for these species at other sites and all data for Cape and Antarctic petrels, *Daption capense* and *Thalassoica antarctica*, are insufficiently detailed, when viewed against this background, to indicate clearly any significant population change. Furthermore, counts of breeding populations of fulmarine petrels are particularly significantly affected by the timing of counts (J. van Franeker, pers. comm.). Most data do not have this information and so an additional source of variation is present. Increases of all four species at the Windmill Islands between the 1960s and 1984 simply reflect improved coverage and accuracy of censuses and do not indicate any population change (van Franeker *et al.*, 1990).

Burrow-dwelling petrels (Procellaridae, Hydrobatidae, Pelecanoididae)

The conclusions of the previous review still pertain. That is, despite lack of precise data, populations of species in these groups have been greatly reduced at sub-Antarctic island localities where feral animals are present. In this context, the apparent removal by South Africa of feral cats from Marion Island ranks as of one of the most significant recent achievements in the field of sub-Antarctic island conservation. It has lead to increases in breeding success for at least three species of burrowing petrels (Cooper and Fourie, 1992; J. Cooper, pers. comm.). Other nations should be strongly encouraged to follow this lead.

Local decreases in populations of burrowing petrels (especially blue petrel *Halobaena caerulea* and Antarctic prion *Pachyptila desolata*) at South Georgia have been caused by destruction of breeding habitat by Antarctic fur seals *Arctocephalus gazella* (P.A. Prince *et al.*, unpublished data).

Blue-eyed shag (*Phalacrocorax atriceps*)

This species characteristically shows considerable interannual variation in timing of breeding and population size, making assessment of population trends very difficult. Nevertheless there are clear indications of gradual longterm increases at Half Moon Island, Nelson Island and Signy Island, which may generally be typical of the species in this region.

Sub-Antarctic skua (*Catharacta lonnbergi*)

Increases on King George Island and at Nelson Island may have been facilitated by availability of refuse from nearby bases. Populations at Admiralty Bay, King George Island, away from the base area, are stable (W.R. Fraser, pers. comm.). Otherwise there are no new data since the last review.

Antarctic skua (Catharacta maccormicki)

There are few new data, either on changes in populations at continental sites associated with bases (decreases at Cape Hallett (Harper *et al.*, 1964), increases at Pointe Geologie (Jouventin *et al.*, 1984)) or on increases and range extension in the Antarctic Peninsula (Hemmings 1984). Although some changes may be attributable to more opportunities for scavenging at bases, this cannot explain the large increase at Anvers Island where no refuse has been available since 1979 (W.R. Fraser, pers. comm.). Numbers have increased substantially in the Admiralty Bay area since the first censuses in 1976. The potential influence of refuse cannot be totally discounted, although at sites where both skua species co-occur, Antarctic skuas are usually excluded from the food source by their larger congener. Thus the increases probably reflect natural, rather than man-induced, changes (W.Z. Trivelpiece, pers. comm.).

Kelp gull (Larus dominicanus)

Increases at Nelson Island, King George Island may relate to increased availability of garbage. Populations in the Anvers Island area, where no refuse is available, have remained stable (W.R. Fraser, pers. comm).

Antarctic and Kerguelen tern (*Sterna vittata* and *S. virgata*)

No new data exist for these potentially vulnerable species which, because of their tendency regularly to move breeding sites, are very difficult to census.

Greater sheathbill (*Chionis alba*)

Populations have remained stable over the last decade at Hope Bay (N.R. Coria, pers. comm.), the only site for which any quantitative data exist for this species.

ABUNDANCE AND TRENDS OF ANTARCTIC PINNIPED POPULATIONS

(Report to the CCAMLR Scientific Committee
from the SCAR Group of Specialists on Seals)

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June 1992

In response to a request from the CCAMLR Scientific Committee, the SCAR Group of Specialists on Seals reported in 1988 on the abundance and trends of Antarctic pinniped populations (SC-CAMLR-VII/9 and SC-CAMLR-VII/12). The Scientific Committee had requested that SCAR continue to review available information and to update its report on the status and trends of pinnipeds every five years. The SCAR Group of Specialists on Seals met in Bariloche, Argentina, from 8 to 12 June 1992. The following paragraphs and tables are excerpted from the report of the Group's meeting.

Five-Year Update of Abundance and Trends Report to CCAMLR

3.25 The Group considered the most appropriate way to respond to the request from CCAMLR for assistance in providing an updated report on the abundance and population trends of Antarctic pinnipeds. The Group's previous summary report to CCAMLR on this topic was developed by the Group in 1988. The CCAMLR Scientific Committee had thanked the Group for its help at that time, and requested that the Group provide updated reviews to CCAMLR every five years.

3.26 In anticipation of the 1992 review of pinniped status and trends, the CCAMLR Secretariat had prepared and distributed to individual pinniped researchers standardised forms for reporting abundance data to CCAMLR. In reviewing these forms, the Group agreed that it would be difficult to enter into a database the judgements necessary to estimate population trends. For example, census data for many sites were incomplete, survey methods varied among sites, and assumptions or conditions peculiar to individual censuses were not available on the standardised forms. Thus, some of the resulting descriptions of increasing or decreasing trends were based on professional judgements arising from combined technical expertise. In the Group's view, the CCAMLR Scientific Committee would be assisted most effectively in considering pinniped population trends by the Group providing it with analyses and interpreted judgements.

3.27 The Group therefore agreed that it would probably be most helpful to CCAMLR to provide summaries of the available population data. The updated reviews of population status and trends for

Antarctic pinniped populations are given in Tables 2, 3, 4 and 5. The Convener was requested to convey this information through SCAR to the CCAMLR Scientific Committee for its consideration.

Recent Population Abundance Estimates

3.12 Antarctic fur seal (*Arctocephalus gazella*) populations continue to increase in most areas. Fur seal abundance in the South Shetland, Macquarie, Heard, and Marion Islands appears to be increasing, while the breeding population in the South Orkney Islands has been relatively stable since about 1973 (Table 2).

3.13 A census of Antarctic fur seal pup production at South Georgia in 1990/91 yielded an estimated total of 269 000 (95% confidence limits 198 000 to 340 000) pups born in that year. However, several indicators suggested that pup production was low that year. Pup production in 1990/91 was lower than predicted (378 000) based on longterm monitoring of population size at Bird Island. The average annual increase of the population was 9.8% between 1976/77 and 1990/91. Knowledge of the age structure of the population is insufficient to provide an accurate estimate of total population size, but a conservative estimate would be 1.5 million. Population expansion at South Georgia has occurred mainly through the progressive colonisation of coastline from west to east and most fur seals (>90% of pup production) are still located at the west end of the island, west of Tawny Gap. This means that the fur seal breeding population at South Georgia remains concentrated close to the original center of recolonisation at Bird Island.

3.14 Numbers of Antarctic fur seals at other breeding sites are generally increasing. The average annual rate of increase in pup production at Marion Island has slowed somewhat in recent years compared with estimates made between 1974 and 1981, but this could have been caused by undercounts made in 1974. This may have caused the early estimate of the average annual increase to be inflated.

3.15 Dr Bengtson described the results of a recent census (1992) of the nine known Antarctic fur seal pupping locations identified during a 1986/87 census in the South Shetland Islands. Including pup counts at Cape Shirreff (2 973) supplied by Dr Torres, at least 6 781 pups were born in the South Shetland Islands during the 1991/92 season. This represents a significant increase over the number of pups born in 1986/87 (3 821). At individual sites in the South Shetland Islands there were large variations in the levels of change over the five years between censuses (from -15% to +300%).

3.16 Sub-Antarctic fur seal (*A. tropicalis*) populations are increasing rapidly, and a small population appears to be establishing itself at Macquarie Island together with Antarctic fur seals and New Zealand fur seals (Table 3). The first record of sub-Antarctic fur seals breeding south of the Antarctic Polar Front suggests that a similar situation may be developing at Heard Island as at Marion Island, lle de la Possession, and Macquarie Island, where land-breeding populations of the Antarctic and sub-Antarctic fur seal occur together.

3.17 The recent status of the three stocks of southern elephant seals was considered in detail by the Workshop on Southern Elephant Seals held in 1991 (Table 4). Southern elephant seal populations are declining in the Indian and Pacific Ocean sectors of the Antarctic, while the status of the South Georgia stock is uncertain.

3.18 Despite doubts about the status of possible population fluctuations at South Georgia due to the fact that the apparent stability of the population is based upon two censuses of pup production made 35 years apart, it does not show the longterm population decline illustrated by most other stocks. The uncertainty is mainly due to the long period between censuses and their limited number. However, there is no indication that the South Georgia population has experienced either a large decline or a large increase in recent years.

3.19 The elephant seal populations in the Indian Ocean sector are continuing to decline, especially at Marion and Heard Islands. However, at lles Kerguelen, which represents the largest component of this stock, pup production appears to be stable.

3.20 Although stocks of elephant seals at Macquarie Island were classified as being in decline in the Workshop Report, Mr Burton reported that, after a long period of declining numbers, pup production has been stable for the past four years.

3.21 At Peninsula Valdez, Argentina, the population of southern elephant seals has been increasing since at least 1975.

3.22 Thus, although declines in the numbers of southern elephant seals are continuing at some localities, on the basis of stocks in all regions, there is a suggestion of a trend towards population stability.

3.23 In contrast to the land-breeding Antarctic pinnipeds, there are relatively few data available for estimating the size or trends of ice-breeding seal populations. The dramatic changes in seasonal ice coverage, coupled with the logistic difficulties of operating ships and aircraft in the sea ice zone, present special challenges to obtaining census data.

3.24 Since 1983, there has been only one major survey (conducted early in 1992). The 1992 census data have been incorporated into Table 5, which updates the Group's 1988 compilation of ice seal census data. The Group felt it was unable to make meaningful assessments of potential trends in population abundance based on these limited data. The importance of acquiring additional census data for the pack ice seals was once again emphasized (see paragraphs 5.1 to 5.10).

Table 2: Population estimates of Antarctic fur seals (*A. gazella*).

Area	Numbers		Year	Trend	Reference
	Pups	Total			
South Georgia	378 000	1 500 000	1990/91	–	Boyd, 1992
South Orkney Is	7	---[1]	?	---	
South Sandwich Is	0	400	1960	---	O'Gorman, 1961
South Shetland Is	6 781	27 802[2]	1991/92	–	Bengtson and Torres, unpubl. Aguayo *et al*., 1992
Bouvet Is	2 000	> 9 501	1989/90	–	Bakken, 1991
Heard Is	248	---[3]	1987/88	–	Shaughnessy and Goldsworthy, 1990
McDonald Is	100	300[1]	1979/80	–	Johnstone, 1982
Iles Kerguelen (Ile de Croy)	1 693	3 935[1]	1984/85	–	Stonehouse, 1988
Iles Crozet (Possession)	20	---	?	–––	Jouventin *et al*., 1982
Marion Is	91	335[2]	1988/89	–	Wilkinson and Bester, 1990
Prince Edward Is	--	200	1981/82	–	Kerley, 1983
Macquarie Is	60	---	1991/92	–	Shaughnessy and Goldsworth, 1992

[1] Number in broad age and sex classes counted

[2] Total numbers estimated from pup counts only

[3] Large influxes of non-breeding animals reported in late summer at South Orkney Islands (Boyd, 1992; Vergani, unpublished) and Heard Island (Shaughnessy and Goldsworthy, 1990)

Table 3: Population estimates of sub-Antarctic fur seals (*A. tropicalis*).

Area	Numbers		Year	Trend	Reference
	Pups	Total			
Gough Is	> 53 076	> 200 000[1]	1977/78 (1988/89)[3]	–	Bester, 1987, 1990
Tristan da Cunha Group	> 20	> 1 200	?	–	Holdgate and Wace, 1976
Marion Is	9 338	44 822	1988/89	–	Wilkinson and Bester, 1990
Prince Edward Is	5 372	25 786 14 761[1]	1987/88	–	Wilkinson and Bester, 1990
Iles Crozet (Possession)	758	300	?	–	Jouventin *et al.*, 1982
Amsterdam Is	10 898	> 35 000[1,2]	1981/82	–	Hes and Roux, 1983
St Paul Is	66	---	1984/85	–	Roux, 1987
Macquarie Is	19	---	1991/92	–	Shaughnessy and Goldsworthy, 1992
Heard Is	1	10	1987/88	–	Shaughnessy and Goldsworthy, 1992

1 Numbers in broad age and sex classes counted
2 Excludes yearlings
3 Trends determined from censuses on parts of coastline

Table 4: Size and status of southern elephant seal populations within the three stocks of the Southern Ocean. Pup production estimates for 1990 were extrapolated from the most recent census figures using the rates of change in pup numbers shown below.

Stock	Locality	Year	Pup Production		Annual Rate of Change	Period	Status	Reference
			Observed	1990				
South Georgia	South Georgia	1985	102000	102000	?	1951-1985	Uncertain	McCann and Rothery, 1988
	South Orkney Islands	1985	<100	-	?	1948-1985	Uncertain	McCann, 1985
		1980s	5-10	approx. 5	?	1970s-1980s	Declining	Boyd, pers. comm.
	Falkland Islands	1960	approx. 1000	approx. 1000	?	-	Uncertain	Laws, 1960
	Gough Island	1989	28	28	0.0	1973-1989	Stable	Bester, 1990
	King George Island	1980	708	560	-0.05	1980-1990	Declining	Vergani, pers. comm.
	Nelson Island	1985	106	106	?	-	Uncertain	Vergani *et al.*, 1987
	Valdes Peninsula	1982	6737	-	+5.1	1975-1982	Increasing	Vergani *et al.*, 1987
		1990	9636	9636	+3.2	1982-1990	Increasing	Campagna and Lewis, pers. comm.
Iles Kerguelen	Marion Island	1989	585	540	-4.8	1951-1989	Declining	Wilkinson and Bester, in prep.
	Heard Island	1985	1300	11530	-2.4	1949-1985	Declining	Burton, 1986
	Iles Kerguelen	1977	45000	-	-4.1	1970-1977	Declining	Van Aarde, 1980
	(Courbet)	1989	41000	41000	0.0	1984-1989	Stable	Guinet *et al.*, in press
	Iles Crozet	1976	approx. 3000	-	-5.8	1966-1976	Declining	Barret and Mougin, 1978
	(Possession)	1989	612	578	-5.7	1980-1989	Declining	Guinet *et al.*, in press
Macquarie Island	Macquarie Island	1985	24000	-	-2.1	1949-1985	Declining	Hindell and Burton, 1987
		1990	22068	22068	-1.6	1985-1990	Declining	Slip, pers. comm.
	Campbell Island	1986	5	4	-8.6	1947-1986	Declining	Taylor and Taylor, 1989
	Antipodes Island	1978	113	113	?	-	Uncertain	Taylor and Taylor, 1989
World total		1990		189168				

Table 5: Population densities of lobodontine seals observed in six regions of Antarctic pelagic pack ice (Erickson and Hanson, 1988).

Region	Data Set*	Census			Crabeater			Weddell			Leopard			Ross		
		Method	Date	Total Area (nm^2)	No. Obs.	Corrected No.	Corrected Dens. (nm^2)	No. Obs.	Corrected No.	Corrected Dens. (nm^2)	No. Obs.	Corrected No.	Corrected Dens. (nm^2)	No. Obs.	Corrected No.	Corrected Dens. (nm^2)
Amundsen and	3,4	Aerial	1/23-2/15/72	1076.4	6118	6449	5.99	181	188.1	0.175	285	301.5	0.280	109	116.4	0.108
Bellingshausen	3	Shipb'd	1/23-2/15/72	184.4	1931	2972	16.12	8	12.5	0.068	74	131.8	0.715	13	15.8	0.085
Seas 60°W-130°W																
West, Ross Sea	3,4	Aerial	2/06-2/14/72	163.7	717	768	4.69	4	4.2	0.058	12	12.9	0.079	2	2.1	0.013
East, Ross Sea	3,5	Aerial	1/16-1/16/73	164.2	633	672	4.09	38	40.5	0.247	35	37.1	0.226	14	14.9	0.091
130°W-160°E																
Southern Pacific	3,6	Aerial	1/16-1/26/73	452.0	1438	1508	3.33	34	35.5	0.078	110	114.6	0.253	44	46.7	0.103
Ocean	6	Aerial	1/18-1/28/74	254.7	1682	1974	7.75	183	204.5	0.803	104	121.6	0.478	100	134.2	0.527
90°E-160°E	6	Shipb'd	1/18-1/28/74	50.3	530	1036	20.61	8	9.8	0.194	20	28.3	0.563	12	15.7	0.313
	7	Aerial	1/30/83	48.1	53	64	1.33	42	47.6	0.989	23	27.6	0.575	6	6.8	0.142
	7	Shipb'd	1/24-2/02/83	50.1	109	128	2.55	3	3.3	0.067	15	18.9	0.377	5	6.0	0.120
Southern	7	Aerial	2/03-2/09/83	95.2	543	637	6.69	241	360.6	3.788	13	16.5	0.174	3	9.3	0.098
Indian Ocean	7	Shipb'd	2/03-2/11/83	55.8	119	233	4.18	14	27.3	0.490	3	6.6	0.118	8	11.7	0.210
20°E-90°E																
Eastern	7	Aerial	2/12-2/16/83	90.9	1102	1222	13.44	23	26.0	0.286	38	43.6	0.479	24	25.5	0.292
Weddell Sea	7	Shipb'd	2/12-2/16/83	30.8	206	359	11.64	6	8.0	0.259	11	19.8	0.643	2	2.9	0.094
20°E-20°W																
0°-5°W	8	Aerial	12/18-30/92	228.1	438		1.92	8		0.035	0		0	13		0.057
		Aerial	1/31-2/04/92	139.4	559		4.01	4		0.029	14		0.100	17		0.122
Western	1,2	Shipb'd	1/30-3/13/68	110.5	773	1145	10.38	5	8.3	0.075	11	15.0	0.136	1	1.0	0.009
Weddell Sea	2	Shipb'd	2/18-3/24/69	132.7	1130	1622	12.22	10	16.0	0.120	22	28.1	0.211	3	3.5	0.026
20°W-60°W	7	Aerial	2/17-3/03/83	331.9	423	473	1.42	201	308.5	0.930	13	16.5	0.050	5	5.4	0.016
		Shipb'd	2/17-3/03/83	185.1	1248	1741	9.41	31	51.7	0.280	114	180.3	0.974	2	2.4	0.013

*1 = Siniff *et al.*, 1970
2 = Erickson *et al.*, 1971
3 = Erickson *et al.*, 1972
4 = Gilbert and Erickson, 1977
5 = Erickson *et al.*, 1973
6 = Erickson *et al.*, 1974
7 = Erickson *et al.*, 1983
8 = Erickson and Bester, in prep.

References Cited in Tables 2, 3, 4 and 5

AGUAYO, A., J. CAPELLA, H. TORRES, R. JAÑA, and D. TORRES. 1992. Progresso en el estudio ecologico del lobo fino antarctico, *Arctocephalus gazella*, en Cabo Shirreff, Isla Livingston, Antarctica. *Bol. Antarct. Chileno 11*(1): 12-14.

BAKKEN, V. 1991. Fulge-og- selundersøkelser pa Bouvetøya a Desember/Januar 1989/90. *Meddelelser Nr. 115*. Nortsk Polarinstitutt: Oslo.

BARRAT, A., and J.L. MOUGIN. 1978. L'éléphant de mer *Mirounga leonina* de l'île de la Possession, Archipel Crozet. *Mammalia 42*: 143-147.

BESTER, M.N. 1987. The sub-Antarctic fur seal (*Arctocephalus tropicalis*) at Gough Island (Tristan da Cunha Group). *NOAA Technical Report NMFS 5*: 57-60.

BESTER, M.N. 1990. Population trends of sub-Antarctic fur seals and southern elephant seals at Gough Island. *S. Afr. J. Antarct. Res., 20*: 9-12.

BOYD, I. 1992. Pup production and distribution of breeding Antarctic fur seals (*Arctocephalus gazella*) at South Georgia. *Antarct. Sci.* (in press).

BURTON, H.R. 1986. A substantial decline in the numbers of the southern elephant seal at Heard Island. *Tasmanian Naturalist, 86*: 4-8.

ERICKSON, A.W., D.B. SINIFF, D.R. CLINE and R.J. HOFMAN. 1971. Distributional ecoloy of Antarctic seals. In: DEACON, G. (Ed.) *Symposium of Antarctic Ice and Water Masses (Tokyo, 1970), SCAR*. pp. 55-76.

ERICKSON, A.W., J.R. GILBERT, G.A. PETRIDES, R.J. OEHLENSCHLAGER, A.A. SINHA and J. OTIS. 1972. Populations of seals, whales and birds in the Bellingshausen and Amundsen Seas. *Antarct. J. US, 7*: 70-72.

ERICKSON, A.W., J.R. GILBERT and J. OTIS. 1973. Census of pelagic seals of the Oates and George V coasts, Antarctica. *Antarct. J. US, 8*: 191-194.

ERICKSON, A.W., R.N. DENNEY, J.J. BRUEGGEMAN, A.A. SINHA, M.N. BRYDEN and J. OTIS. 1974. Seal and bird populations off Adélie, Claire and Banzare Coasts. *Antarct. J. US, 9*: 292-296.

ERICKSON, A.W., M.B. HANSON and D.M. KEHOE. 1983. Population densities of seals, birds and whales observed during the 1983 circumnavigation of Antarctica by the USCGC *Polar Star*. *Antarctic J. US., 18*.

ERICKSON, A.W. and M.B. HANSON. 1988. Continental estimates and population trends of Antarctic ice seals. In: *Proceedings of the 5th SCAR Symposium on Antarctic Biology, Hobart, August, 1988.*

ERICKSON, A.W. and M.N. BESTER. In prep. Census of seals in the pack ice off Prince Martha Coast, Antarctica, 1991-92.

GILBERT, J.R. and A.W. ERICKSON. 1977. Distribution and abundance of seals in the pack ice of the Pacific sector of the Southern Ocean. In: LLANO, G. (Ed.). *Adaptations within Antarctic Ecosystems.* pp. 703-740.

GUINET, C., P. JOUVENTIN and H. WEIMERSKIRCH. In press. Population changes, haul out pattern and movement of southern elephant seals on Crozet and Kerguelen Archipelagos. *Polar Biol.*

HES, A.D. and J.P. ROUX. 1983. Population increase in the sub-Antarctic fur seal (*Arctocephalus tropicalis*) at Amsterdam Island. *S. Afr. J. Antarct. Res., 13*: 29-34.

HINDELL, M.R. and H.R. BURTON. 1987. Past and adult status of the southern elephant seal (*Mirounga leonina*) at Macquarie Island. *J. Zool. (Lond.), 21*: 365-380.

JOHNSTONE, F.W. 1982. Zoology. In: Expedition to the Australian Territory of Heard Island and the McDonald Islands, 1980. Division of National Mapping Australia. *Technical Report 31*.

JOUVENTIN, P., J.C. STAHL and H. WEIMERSKIRCH. 1982. La recolonisation des Iles Crozet par les otaries (*Arctocephalus tropicalis* et *A. gazella*). *Mammalia, 46*: 505-514.

KERLEY, G.I.H. 1983. Relative population sizes and trends, and hybridization of fur seals (*Arctocephalus tropicalis* and *A. gazella*) at the Prince Edward Islands, Southern Ocean. *S. Afr. J. Zool., 18*: 388-392.

LAWS, R.M. 1960. The southern elephant seal (*Mirounga leonina*) at South Georgia. *Norsk. Hvalfansttid Tidd., 49*: 466-476, 20-542.

MCCANN, T.S. 1985. Size, status and demography of southern elephant seals (*Mirounga leonina*) populations. In: LING, J.K. and M.M. BRYDEN (Eds). *Studies of Sea Mammals in Southern Latitudes*. South Australian Museum, Adelaide.

MCCANN, T.S. and P. ROTHERY. 1988. Population size and status of the southern elephant seal (*Mirounga leonina*) at South Georgia, 1951-1985. *Polar Biology, 8*: 305-309.

O'GORMAN, R.A. 1961. Fur seals breeding in Falkland Island Dependencies. *Nature, 192*: 914-916.

ROUX, J.P. 1987. Sub-Antarctic fur seal (*Arctocephalus tropicalis*) in French sub-Antarctic territories. *NOAA Technical Report, NMFS, 51*: 79-81.

SHAUGHNESSY, P.D. and S.D. GOLDSWORTHY. 1990. Population size and breeding season of the Antarctic fur seal (*Arctocephalus gazella*) at Heard Island. *Mar. Mamm. Sci. 6*: 292-304.

SHAUGHNESSY, P.D. and S.D. GOLDSWORTHY. 1992. Feeding ecology of fur seals and their management at Macquarie and Heard Islands. Fourteenth Symposium on Polar Biology. National Institute of Polar Research, Japan, Extended Abstract.

SINIFF, D.B., D.R. CLINE and A.W. ERICKSON. 1970. Population densities of seals in the Weddell Sea, Antarctica, in 1968. *Antarctic Ecology, Vol 1*: 377-394. Academic Press: London.

STONEHOUSE, B. 1988. Southern fur seals (*Arctocephalus gazella*) return to breed on Iles Kerguelen. *Polar Rec., 2*.

TAYLOR, R.H. and S.A. TAYLOR. 1989. Reassessment of the status of southern elephant seals (*Mirounga leonina*) in New Zealand. *NZ J. Mar. Greshaut Res. 23*: 201-213.

VERGANI, D.R., M.N. LEWIS and Z.B. STANGANELLI. 1987. Observation on haul out patterns of the breeding populations of southern elephant seals at Peninsula Valdes (Patagonia) and Stranger Point (25 de Mayo - King George Island). Document *SC-CAMLR-VI/36*: 1-39. CCAMLR, Hobart Australia.

VAN AARDE, R.J. 1980. Fluctuations in the population of southern elephant seals at Kerguelen Is. *S. Afr. J. Zool., 15*: 99-106.

WACE, N.M. and M.W. HOLDGATE. 1976. Man and nature in the Tristan de Cunha Islands. IUCN Publications News Series, Supplementary Papers.

WILKINSON, I.S. and M.N. BESTER. 1990. Continued population increase in fur seals, *Arctocephalus tropicalis* and *A. gazella*, at the Prince Edward Islands. *S. Afr. J. Res., 20*: 58-63.

WILKINSON, I.S. and M.N. BESTER. In press. Population parameters of a declining southern elephant seal population at Marion Island.

SCIENTIFIC COMMITTEE BUDGET FOR 1993 AND FORECAST BUDGET FOR 1994

SCIENTIFIC COMMITEE BUDGET FOR 1993
AND FORECAST BUDGET FOR 1994

1993		1994
	Working Group on Krill	
20 600	Meeting	21 500
3 000	BIOMASS database activation	0
	Ecosystem Monitoring Program	
20 100	Meeting	20 900
5 500	Sea-Ice Monitoring	9 400
2 000	Sea-Ice Seals Planning Workshop	0
	Fish Stock Assessment	
27 200	Meeting	28 400
7 400	Crab Workshop	0
34 500	Travel for Scientific Committee Program	35 900
	Ad Hoc workshops (projection)	1 500
3 900	Secretariat representation at ICES	4 100
	Secretariat representation at SCAR symposium	4 000
3 000	Contingency	6 600
127 200	Subtotal	132 300
8 100	Less drawings from the Norwegian Contribution Special Fund	0
A$119 100	Total from Commission Budget	A$132 300

ANNEX 12

CCAMLR GLOSSARY OF TERMS

CCAMLR GLOSSARY OF TERMS

Abundance:	Number of animals in a given geographical area, usually expressed as an index of abundance, e.g., as a catch-per-unit time, numbers or weight-per-unit volume.
Age at recruitment, age at first capture:	The age at which fish are first caught in the fishery.
Age/length key:	A table relating age of fish to their length, used to construct catch-at-age data from length frequencies derived from the fishery.
Age groups:	Animals of the same age in a stock.
Benthic:	Associated with the sea floor on or in the sub-stratum.
Biological data:	Data on individual fish sampled from a catch or research trawl, e.g., length, weight, sexual maturity and age.
Biomass, standing stock:	The weight of living matter present, usually expressed in terms of a given area or volume of the habitat.
By-catch:	The catch in numbers or in weight of non-target species taken in a directed fishery.
Catch:	The quantity by weight or number of fish taken in a specific period.
Catchability (**q**):	The fraction of a fish stock which is caught by a defined unit of fishing effort.
Catch-at-age data:	Numbers or weight of fish of each year-class in a catch.
Catch/effort, catch-per-unit-effort (CPUE):	The catch of fish in numbers or in weight taken by a defined unit of fishing effort.
Codend:	The part of the trawl net which contains the catch.
Coefficient of variance (CV):	The ratio of the standard deviation of a distribution to its arithmetic mean.
Cohort:	Animals of the same age in a stock.

Cohort analysis, virtual population analysis (VPA):	Age-based analytical technique that estimates retrospective stock size from catch and other data.
Demersal:	Living at or near the bottom of the sea.
Directed fishery:	A fishery aimed at catching a single species.
Fine-scale data:	Catch and effort data submitted to CCAMLR each year. The data is submitted for particular fisheries agreed by the commission and is presented as aggregated summaries for areas 1° longitude by 0.5° latitude (approx. 30 miles square) and 10-day periods.
Fishery:	A comprehensive term to include all aspects of harvesting a particular species or group of species, e.g., as in "the krill fishery around South Georgia".
Fishing - Trawl:	A fishery using towed nets.
Longline:	A fishery using longlines with baited hooks.
Mixed:	A fishery aimed at catching several species occurring in the same area
Fishing effort:	A unit of effort expended in obtaining a catch, e.g., days fished by a standard vessel using a standard net or number of hooks of a standard type set on a longline.
Growth overfishing:	Occurs when, although increased fishing increases the number of fish caught, the average weight of individual fish in the catch is steadily decreasing and so ultimately is the total weight of the catch, because the fish are caught before they reach near full size. In growth overfishing the number of older fish in the stock is decreasing, thereby increasing the chance of recruitment failure.
Growth curve:	An equation describing the average length of fish for a given age.
Haul-by-haul data:	Data pertaining to individual hauls of either nets or longlines. A haul is a single setting and retrieval of a net or line.
Knife-edge recruitment:	An approximation which assumes that fish are all recruited to the fishery when they reach a certain age c.f. partial recruitment.

Krill escapement:	In a fisheries management context, escapement is the average level of biomass of the exploited stock for a given level of fishing. Proportional escapement is the ratio of this exploited biomass to the average biomass of the stock before the start of the fishery (pristine biomass).
Lengths-at-age:	The distribution of lengths of fish of the same age.
Length-at-age:	Average of lengths-at-age.
Length frequency, length distribution:	The numbers of fish in selected length ranges in a sample.
Length composition:	An estimate of the distribution of lengths of fish in a catch based on a number of samples.
Length-weight relationship:	An equation describing the average weight of fish of a given length.
Maximum sustainable yield:	The maximum catch which can be taken indefinitely.
Mesh size:	The diagonal dimension of the mesh in a net.
Mortality - Natural mortality (**M**):	Death rate in a population attributable to all causes except fishing.
Fishing mortality (**F**):	Death rate in a population attributable to fishing.
F_{max}:	The value of fishing mortality corresponding to the maximum yield per recruit.
$\mathbf{F_{0.1}}$:	The value of fishing mortality at which the marginal yield per recruit from an additional unit of effort is 0.1 the marginal yield per recruit at very low levels of fishing (a point at which there is little reward for increased fishing effort).
Total mortality (**Z**):	An index representing all deaths in a population, usually expressed per year.
Parameter:	A measurable or quantifiable characteristic or feature.
Partial Recruitment:	When only part of a particular year-class enters the fishery.
Pelagic:	Pertaining to the open ocean, living in the water-column seaward of the shelf/slope break.

Population:	A group of animals of one species occupying a geographical area.
Potential yield:	The yield that may be sustainable from a stock that is not yet fully exploited.
Pre-recruits:	Juvenile animals that have yet to recruit to the fishery.
Proportional escapement:	The proportion of a stock that escapes capture.
Recruitment:	The addition of new fish to the exploitable part of the population by growth from among smaller size categories.
Recruitment failure:	Occurs when the normal pattern of recruitment fails to produce the expected addition of recruits to the stock in a given year.
Recruitment overfishing:	Occurs when as a result of heavy fishing the spawning stock is reduced to too low a level to ensure adequate production of young fish.
Season, fishing season:	Unless defined otherwise in a particular context (e.g., in the text of a conservation measure) a CCAMLR season is the split-year, the period from 1 July in any year to 30 June of the following year.
Shelf break:	Diagram.
Spawning stock, spawning biomass:	The biomass of sexually mature fish in a stock.
Split-year:	The period from 1 July to 30 June of the following year.
STATLANT data:	Data from all fisheries submitted each year in a format designed at FAO. The data includes catch and catch and effort by species and is presented as aggregated summaries for specified statistical areas for each month of the year.
Stock:	The part of a population under consideration for actual or potential harvesting.
Stock assessment:	An estimate of the status of a stock with respect to management objectives.

Stratification:	The analysis of data to allow for known variations in an environmental parameter affecting fish concentration, e.g., strata may be different depth ranges within an area being surveyed.
Trawl:	A net towed through the water away from the bottom.
Trawl - Pelagic trawl, Midwater trawl:	Fishing with a trawl net.
Bottom trawl:	Fishing with a trawl net on the bottom
Semi-pelagic trawl, Off-bottom trawl:	Fishing with a net in the near bottom layer.
Unexploited biomass, pristine biomass, unexploited stock:	Biomass which occurs without exploitation - usually synonymous with longterm biomass.
VPA, virtual population analysis, cohort analysis:	An analytical technique that calculates the stock size required to yield the observed catches based on age structure of those catches.
Weights-at-age:	The distribution of weights of fish in each year-class in a stock.
Weight-at-age:	Average of weights-at-age.
Year-class, cohort:	Animals born, spawned or hatched in a given year.
Year-class strength:	Numbers of animals in a year-class or cohort.
Yield-per-recruit:	The potential catch from the age-class most recently recruited to the stock. It is normally expressed as a function of fishing mortality (**F**) keeping the age at first capture constant or as a function of size at first capture for various values of fishing mortality.