Abstract

This document presents the adopted record of the Sixth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, 1987. Major topics discussed at this meeting include: krill resources, fish resources, squid resources, ecosystem monitoring and management, marine mammal and bird population assessment, data collection and handling, co-operation with other organisations, the long-term program of work for the Scientific Committee, and publication policy and procedures. Reports of meetings of subsidiary bodies of the Scientific Committee, including groups for the CCAMLR Ecosystem Monitoring Program, for Fish Stock Assessment, and for the Long-Term Program of Work for the Scientific Committee, are appended.

TABLE OF CONTENTS

Page

REPORT OF THE SIXTH MEETING OF THE SCIENTIFIC COMMITTEE

OPENING OF THE MEETING

1.1 The Scientific Committee for the Conservation of Antarctic Marine Living Resources met under the Chairmanship of Dr Inigo Everson (UK) from 26 October to 3 November 1987 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, German Democratic Republic, Federal Republic of Germany, India, Japan, Republic of Korea, New Zealand, Norway, Poland, South Africa, Spain, Union of Soviet Socialist Republics, United Kingdom and United States of America.

1.3 At the invitation of the Scientific Committee, representatives from the Intergovernmental Oceanographic Commission (IOC), the International Union for the Conservation of Nature and Natural Resources (IUCN), International Whaling Commission (IWC), the Scientific Committee on Antarctic Research (SCAR) and the Scientific Committee on Oceanic Research (SCOR) attended the meeting as observers. Observers from the acceding states of Greece, Sweden and Uruguay as well as an observer from Peru also participated by invitation.

1.4 The Chairman welcomed delegates, and extended a special welcome to Spain as a new member of the Scientific Committee. Observers were also welcomed and encouraged to participate, as appropriate, in discussion of agenda items 4 through 11.

1.5 A list of participants is at Annex 1. A list of documents considered during the session is at Annex 2.

1.6 Responsibility for the preparation of the Scientific Committee's report was assigned to the following rapporteurs: Mr D. Miller (South Africa) krill resources, Dr J. Gulland (EEC) fish resources, Dr R. Williams (Australia) squid resources, Dr J. Croxall (UK) ecosystem monitoring and management, Dr J. Bengtson (USA) marine mammal and bird population assessment, Dr L. Jacobson (Secretariat) data collection and handling,

Dr D. Robertson (New Zealand) budget for 1988 and Dr E. Sabourenkov (Secretariat) all other items.

1.7 A timetable for the meeting was adopted. The Chairman drew Member's attention to the problem of late submission of papers for consideration at the meeting. It was suggested and agreed that due to the limited time available to the Scientific Committee, only papers received by the Secretariat before the start of the meeting would be discussed.

ADOPTION OF THE AGENDA

2.1 The Chairman noted that since the preparation and distribution of the Preliminary Agenda an additional Item 'Squid Resources' (Item 6) had been proposed by himself after consultation with several members of the Scientific Committee. An explanatory note was distributed to Members as SC-CAMLR-VI/BG/10.

2.2 The Provisional Agenda for the meeting had been circulated to Members in accordance with the Rules of Procedure. In presenting the Provisional Agenda, the Chairman mentioned two requests addressed to the Scientific Committee by the Commission at its 1986 meeting – one concerning conservation measures for Subarea 48.3 (South Georgia) and the other concerning co-ordination of national fish surveys in the forthcoming seasons (CCAMLR-V, paragraphs 52 and 58).

2.3 No amendments to the Provisional Agenda were proposed and the agenda was adopted (Annex 3).

REPORT OF THE CHAIRMAN

3.1 The Chairman noted that members of the Scientific Committee had continued their work during the intersessional period with several meetings taking place. He thanked the conveners, rapporteurs, participants, host countries and the Secretariat for contributing to the success of these meetings.

3.2 The jointly sponsored CCAMLR/IOC Scientific Seminar on Antarctic Ocean Variability and Its Influence on Marine Living Resources, Particularly Krill, was held in Paris from 2 to 6 June 1987. A report by the Convener of the meeting, Dr D. Sahrhage, was distributed as SC-CAMLR-VI/BG/3. Proceedings of the Seminar will be published soon.

3.3 The Working Group for the CCAMLR Ecosystem Monitoring Program met in Dammarie-les-Lys, France, from 10 to 16 June, 1987 by invitation of Dr J.-C. Hureau (France) and was chaired by Dr K. Kerry (Australia). A report of the meeting was distributed as SC-CAMLR-VI/4, and is attached as Annex 4.

3.4 The Ad Hoc Working Group on Fish Stock Assessment met in Hobart, Australia from 19 to 23 October, 1987, convener Dr K.-H. Kock (Federal Republic of Germany). A report of the meeting was distributed as SC-CAMLR-VI/3, and is attached as Annex 5.

3.5 An Informal Group on the Long-Term Program of Work for the Scientific Committee, chaired by Dr K. Sherman (USA) met in Hobart, Australia on Sunday, 25 October, 1987. The group plans to meet for the second time immediately after the Scientific Committee meeting. A report of the group will be attached as Annex 6.

3.6 The Working Group for the Development of a Conservation Strategy for Antarctic Marine Living Resources, established by the Commission, was held in Hobart, Australia on 25 October 1987 and chaired by Australia. The development of a framework for management of Antarctic marine living resources is of direct relevance to the Scientific Committee and will facilitate the Committee's role in formulating advice to the Commission.

3.7 Ten Members only had submitted reports on their fisheries and research activities undertaken during the past year in time to meet the deadline for receipt of 30 days prior to the meeting. An additional seven Members submitted their reports after the deadline or at the start of the meeting. The Chairman urged the remaining Members to submit their reports to the meeting as soon as possible.

3.8 The Chairman noted that the USA report contains reports of scientific fishing using commercial gear, but that no catch had been reported. He felt that this was an incorrect interpretation of the Commission's conclusions in 1986 and that all catches using commercial gear needed to be reported on Stalant forms. The US delegate accepted the Chairman's comment and advised the Committee that the catch data had been made available to the meeting of the Ad Hoc Working Group on Fish Stock Assessment.

3.9 In closing his report, the Chairman noted that the workload of the Scientific Committee was being continually increased, and emphasised the need for close cooperation between Members to accomplish the tasks of the meeting efficiently.

KRILL RESOURCES

Fishery Status and Trends

4.1 There has been a slight decrease in the total krill catch in 1986/87 compared with 1985/86. A synopsis of national krill landings (in tonnes) since 1982/83 is as follows:

Table 4.1: National krill landings (in tonnes) since 1982/83

Member	1982/83	1983/84	1984/85	1985/86	1986/87*
Chile	3 752	1 649	2 598	3 264	4 063
GDR	0	0	50	0	0
Japan	42 282	49 531	38 274	61 074	78 360
Republic of Korea	1 959	2 657	0	0	1 527
Poland	360	0	0	2 065	1 726
Spain	0	0	0	0	450
USSR	180 290	74 381	150 538	379 270	290 401
Total	228 643	128 218	191 460	445 673	376 527

* Preliminary figures

4.2 The total krill catch by statistical area and year since 1973 is illustrated in Figure 1.

4.3 In analysing the breakdown of 1986/87 krill landings by area, the Chairman drew attention to the reduction of the catches from Area 48 as a whole. There was also a major shift in the Soviet catch within this statistical area from Subarea 48.2 to 48.3 and 29 tonnes were taken by Japan from outside the Convention Area in Division 41.3.2 (Tierra del Fuego).

4.4 In contrast, catch from Subarea 58.4 has almost doubled (15 910 tonnes in 1985/86 and 29 557 tonnes in 1986/87).

4.5 The catch reported by Chile has increased slightly during the past year, which is consistent with the fishery having expanded (SC-CAMLR-V, paragraph 5.2).

4.6 The Spanish delegate reported that the 450 tonnes catch of *Euphausia* spp. reported for 1986/87 was in fact *E. superba* and that this had been taken in the South Orkney/Elephant Island region (Subareas 48.2 and 48.3).

4.7 Dr Y. Komaki (Japan) reported that the increase in the overall Japanese krill catch could be attributed to both an increased market demand and better fishing conditions in the 1986/87 season than in the previous season. In response to queries about Japanese fisheries activities reported in CCAMLR-VI/MA/9 Rev. 1 and SC-CAMLR-VI/BG/35, Dr Komaki

indicated that Japanese fishermen preferred to catch 'non-green' krill, i.e. krill which had not recently been feeding. Dr Lubimova (USSR) also reported that the Soviet fishery preferred to catch non-green krill.

4.8 Dr T. Lubimova indicated that the slight decrease in the overall Soviet krill catch for 1986/87 was a result of an areal redirection of the fishery.

4.9 In 1986/87, the total USSR catch of krill (290 401 tonnes) was made up as follows:

Subarea 48.1	319	tonnes	(0 t in 1985/86)
Subarea 48.2	9 731	tonnes	(224 744 t in 1985/86)
Subarea 48.3	254 480	tonnes	(141 994 t in 1985/86)
Area 88	288	tonnes	(1 884 t in 1985/86)
Area 58	25 583	tonnes	(10 648 t in 1985/86)

4.10 The great variation in the proportion of the catch taken in different areas will add to the complexities of studying the impact of the fisheries. However, a wide-ranging fishery would be valuable in improving knowledge of the processes affecting the circumpolar distribution of krill. It would be interesting to know to what extent the change in fleet distribution was a matter of choice and how much it was imposed by the need to find the localities of high krill densities.

4.11 Dr D. Vergani (Argentina) drew attention to SC-CAMLR-VI/BG/42 in which it was reported that there had been an increase in the number of fur seals around the South Orkney Islands during recent years. The Committee recognised that further research was required on the possible interactions between krill availability, predator dynamics, and fisheries.

Further Data Requirements

4.12 Concern was expressed by a number of delegates that a large proportion of the catch taken in Subarea 58.4 was reported as having come from 'area unknown'. It was emphasised that past and future data should be reported in accordance with existing decisions, by Stalant sub-area and division.

4.13 The reporting of catch data in the past year has improved to some extent. Chile and Spain submitted fine-scale catch and effort data in accordance with last year's decision of the

Commission (CCAMLR-V, paragraph 66). The Soviet Union submitted fine-scale catch and effort data during the present meeting.

4.14 It was further noted that fine-scale catch and effort data were essential for the Ecosystem Monitoring Program. It was therefore recommended that wherever possible these data be reported for all CCAMLR Ecosystem Monitoring Program integrated study areas on an annual basis.

4.15 It was noted that the acquisition of additional fine-scale data (particularly in Area 48) could also be of use in the Krill Simulation Study.

Aspects of Krill Biology Relevant to Stock Assessment

4.16 Last year's meeting of the Scientific Committee recognised the following biological topics as being relevant to stock assessment of krill: stock separation, microscale density (swarming versus dispersed krill), near-surface distribution, acoustic target strength, age determination and growth (SC-CAMLR-V, paragraph 5.10).

4.17 National representatives reported on recent research on krill stock separation being conducted in their countries. Dr K. Sherman (USA) indicated that results form a study in which mitochondrial DNA was used as a genetic tracer had been promising (SC-CAMLR-VI/BG/44), and he proposed that collaborative development of such techniques with Soviet scientists could be productive. In supporting Dr Sherman's proposal, Dr T.G. Lubimova (USSR) drew attention to the forthcoming publication of a comprehensive collection of Soviet research papers on krill distribution and abundance. She also presented the Scientific Committee with two compilations of Soviet papers dealing with aspects of krill biology and distribution. The contents page and abstracts of some of the papers included in these documents are contained in SC-CAMLR-VI/BG/50.

4.18 The meeting agreed that there would be considerable value in consolidating the analytical skills related to krill stock separation and that the exchange and co-operative analysis of samples by Members should be encouraged.

4.19 Accurate estimation of krill abundance (particularly by acoustic surveys) is heavily dependent on a knowledge of the proportion of the total krill population that is dispersed as opposed to aggregated in swarms.

4.20 Similarly, the importance of detecting and quantifying krill at, or near, the surface was emphasised. The Chairman drew attention to a recent publication describing a study in which an upward-directed echo-sounder system was employed. He also highlighted on-going research being undertaken by British Antarctic Survey.

4.21 The Chairman introduced a paper dealing with the determination of acoustic target strength of krill (SC-CAMLR-VI/BG/9). It appears that little progress on this subject has been reported since the 1984 Meeting of the BIOMASS Acoustic Working Party (BIOMASS Report Series No. 40). Theoretical studies are underway in Norway and the USA, and some results from these studies are to be reported in the proceedings of the International Symposium on Fisheries Acoustics (ISFA) held in Seattle in June 1987.

4.22 Several acoustic target strength studies are being planned for the forthcoming Antarctic summer season. These include a joint British/Norwegian field investigation at South Georgia, an Australian study using an anechoic tank, and a Japanese study involving *in situ* target strength measurements in the Antarctic Peninsula region. The estimation of acoustic target strength of plankton in general, and of krill in particular, will be included on the agenda for the 1988 Meeting of the ICES Fisheries Acoustic Science and Technology Working Group.

4.23 Factors to convert length to weight are important for biomass estimation. A large number of such equations have been published and consideration needs to be given to the most appropriate ones to employ (SC-CAMLR-VI/BG/33).

4.24 The meeting agreed that given the degree of uncertainty associated with the application of suitable acoustic target strength values to krill survey data, this topic should remain a priority item for the Scientific Committee. In addition, calibration of acoustic equipment and good survey design were recognised as being important considerations in the development of fisheries-independent assessments of krill stock abundance. In this connection, the Committee noted with pleasure the joint USA/Polish/Japanese acoustic inter-calibration program planned for early 1988.

4.25 The Chairman drew attention to the recently published ICES Manual on Calibration of Acoustic Instruments (ICES Co-operative Research Report No 144, February 1987) and suggested that this might be used to standardise calibration procedures.

4.26 Research on krill growth and age determination continues in many countries and includes studies on the age pigment, lipofuscin (SC-CAMLR-VI/BG/48 USA, and Australia),

the use of polymodal length compositions to estimate age and growth in five species of Antarctic euphausiids (SC-CAMLR-VI/BG/24 Federal Republic of Germany), and the effect of environmental variability on krill growth and age determination (USSR). An urgent need to co-ordinate the studies on krill growth and age determination was recognised, and the Committee agreed that inter-calibration of techniques between national laboratories (involving the exchange of samples) should be encouraged.

4.27 Prof. J.-C. Hureau (France) stated that many of the topics discussed above would be included in the jointly sponsored BIOMASS/CCAMLR paper 'Review of the biology of the Antarctic krill, *Euphausia superba* Dana' by Mr D. Miller and Mr I. Hampton (BIOMASS Scientific Series (in press)). Dr J. Croxall (UK) also indicated that some of the above topics would be addressed during the SCAR (BIOMASS) Workshop on Krill Biology and Ecology being planned for 1990/91.

4.28 Taking the above into account, the Committee acknowledged the extensive research being undertaken by Member countries and organisations (e.g. SCAR) on krill biology and ecology in general. At present, there is no forum within CCAMLR for the in-depth review of such research or the evaluation of its application in meeting the Convention's objectives.

4.29 The Scientific Committee therefore decided to establish, subject to the approval by the Commission, an Ad Hoc Working Group on Krill. The Group would be convened by Mr D. Miller (South Africa). The principal objectives of this Group would be to review and evaluate research on krill biology and ecology relevant to the work of the Scientific Committee, and to advise the Scientific Committee on the potential applications of this research to stock assessment and ecosystem monitoring.

4.30 The Group would have the following terms of reference:

- review and evaluate the results of recent studies on krill population structure, abundance estimation and stock separation;

- review and evaluate the results of krill growth and age determination studies;

- review and evaluate estimates of reproductive and mortality rates in krill;

- review and evaluate the results of studies on behaviour, distribution, and reproduction in relation to krill swarming and dispersal;

- review and evaluate existing data on the size, distribution and composition of catches of krill;

- report to the Scientific Committee on results of the Group's activities, and as appropriate, recommend actions to be taken by the Committee with respect to krill stock assessment and ecosystem monitoring.

4.31 It was recommended that the Ad Hoc Working Group on Krill communicate by correspondence during the intercessional period, and that the Convener present a report of activities to the 1988 Meeting of the Scientific Committee.

4.32 The Scientific Committee noted that the Group would need to take into account the influence of both biotic and abiotic factors. In this connection, the Committee agreed that there would be considerable value in the Group liaising with scientists involved in national research programs and programs co-ordinated by SCAR (e.g. see paragraph 4.27).

4.33 In reviewing krill catch data, it will be important to maintain close liaison with the Krill CPUE Simulation Study.

Krill CPUE Simulation Study

4.34 Dr J. Beddington briefly reported the progress made on the Krill CPUE Simulation Study during the past year. He drew attention to the documents which had been circulated to Members which described work undertaken by the two consultants appointed to the study (Dr M. Mangel, University of California at Davis and Dr D.S. Butterworth, University of Cape Town). The results of discussions held during visits by Dr Mangel to British Antarctic Survey, by Dr Butterworth to Japan, and by Drs Beddington and Everson to the USSR were summarised in a paper tabled by Dr Beddington (SC-CAMLR-VI/BG/4).

4.35 The consultant's reports were tabled as documents SC-CAMLR-VI/BG/22 (Dr Mangel) and SC-CAMLR-VI/BG/38 (Dr Butterworth). In order to review and evaluate the contents of these reports, a small task group was formed under the convenership of Dr E. Marschoff (Argentina).

4.36 The task group noted that the consultants had compared changes in several CPUE indices to a reduction in the simulated abundance of krill. The performance of each index depended on the nature of the simulated changes in krill distribution and behaviour and in

fleet behaviour. However, these results are preliminary. Their similarity to alternative model parameters and configurations needs to be examined.

4.37 There was a clearly defined need to extend the studies and refine the models by:

(i) providing a better model of behaviour, movement and distribution of krill,
(ii) providing a better model of the operations of different fishing fleets,
(iii) allowing for sources of variation.

4.38 The Group recommended that work on the study should proceed along the above lines, but emphasised that it was important that data already available should be utilised to the fullest possible extent.

4.39 Data pertaining to (i) above primarily comprise information on krill distribution from research surveys.

4.40 Some data relevant to (ii) above were presented in a paper on the Japanese krill fishery tabled at the meeting (SC-CAMLR-VI/BG/35). A similar paper on Soviet operations is expected to be published during the forthcoming year.

4.41 The Committee accepted the recommendations of the Group and agreed on the following timetable for continuation of the study:

1988	September	Consultants present completed report which will be circulated to all Members.
	October	SC-CAMLR-VII. Preliminary review of consultants' report and commencement of planning for an evaluation Workshop.
1989	March/April	Workshop to evaluate study and formulate further recommendations.

4.42 It was recognised that budgetary provision should be made for the visit of the consultants to meetings concerned with evaluating the simulation.

4.43 The Chairman reported on activities that had been undertaken in connection with the decision by last year's meeting of the Scientific Committee to hold a joint

CCAMLR/BIOMASS workshop (SC-CAMLR-V, paragraphs 5.27–5.31). The primary objective of the Workshop was to investigate the relationship between local estimates of krill abundance using CPUE, and more direct assessments of abundance over a wide area. Attention was drawn to Dr Everson's paper presented at the joint CCAMLR/IOC Seminar on Antarctic Ocean Variability, (June 1987) and entitled 'Can we satisfactorily estimate variations in krill abundance?' (SC-CAMLR-VI/BG/13).

4.44 On the basis of the Chairman's report, the Committee agreed that there was little to be gained by continuing with the workshop in the format in which it had been originally planned. However, it was noted that the commercial fisheries data available from Japan and research data from the USSR could be used as a basis for continuing work on the problem of relating local estimates of krill abundance using CPUE to assessments over wider geographical areas.

Advice to the Commission

4.45 The Scientific Committee noted the various trends apparent from the reports on krill fisheries activities. The Committee agreed that it should continue to attach high priority to gathering the types of information necessary for detecting the effects of fishing on krill stocks (paragraph 4.7). To this end, countries engaged in krill fishing should collect and submit detailed catch and effort data according to agreed procedures (paragraphs 4.12 and 9.5).

FISH RESOURCES

5.1 The Report of the Ad Hoc Working Group on Fish Stock Assessment, which had met in the CCAMLR Headquarters 19–23 October, was presented by the Convener, Dr K.-H. Kock (Federal Republic of Germany). The text of the report is given in Annex 5. The Chairman thanked the Group, and especially its convener, Dr K.-H. Kock (Federal Republic of Germany), and rapporteur, Dr J. Gulland (EEC), for their thorough work. He noted that the work of the Group had been considerably facilitated by the preparation and preliminary analyses of data carried out by the Secretariat.

Stock Assessment

General

5.2 Despite the progress made by the Secretariat in processing data in advance of the meeting, there is also much information that has been submitted to the Commission, e.g. effort data, length and/or age data (other than those aspects included in VPA) and survey data, that remains in other forms e.g. extensive data sheets existing in a limited number of copies. It is not easy for a large group to use data in these forms in an effective way. Partly because of time constraints, it was not possible to review these data as thoroughly as other data, and therefore the stocks to which these data apply may have been assessed with less accuracy than might, under other circumstances, have been possible. Ways in which the presentation of data, and other aspects of the Group's work, might be more effective are discussed later (paragraphs 5.70–5.74).

5.3 Some of the estimates had been derived from data collected on a Spanish survey during the 1986/87 season. While the Working Group had been able to obtain the relevant information through informal channels, no formal presentation of data had been made to the Working Group. This was an unsatisfactory procedure, but had probably arisen because Spain had only very recently joined the Commission and the invitation to participate had only been received two days before the start of the meeting. The information had now been formally deposited with the Secretariat, and relevant extracts from the report have been appended as an attachment to the Working Group's Report.

Notothenia rossii

South Georgia Subarea (48.3)

5.4 The total reported catch in the 1986/87 season was 216 tonnes mostly taken by the Soviet Union. This is approximately what would be expected from compliance with the Resolutions and Conservation Measures approved by the Commission at its 1985 and 1986 meetings concerning the cessation of a directed fishery, and the avoidance of by-catch, though as already noted, this is not consistent with the stated intention of not catching more than in 1985/86.

5.5 Information on biomass is available from surveys carried out in 1986/87, though not all the data from those surveys have been fully analysed and reported to the Commission.

Each estimate for biomass is subject to considerable variance, and it is difficult to detect small changes in biomass. Thus while the observations are consistent with the recent restrictions having the expected effect, and beginning to allow the stock to rebuild, they are also consistent with there being no effect. It would be valuable to carry out some simulations or similar studies to determine how soon the effect of the restrictions could be detected, at different levels of survey effort.

5.6 The recent studies confirm that the stock abundance is now very much lower that in 1969, with the biomass being around 5% of the catches in that period. However, there are elements in the records of catches, age-composition etc. that are not wholly consistent.

5.7 These inconsistencies do not alter the immediate need to rebuild the stock, but could alter the expectations of the extent to which the stock could be rebuilt, and therefore decisions on when to re-open the fishery.

Other Atlantic Areas

5.8 No fisheries had been carried out in Subareas 48.1 or 48.2 in the 1985/86 or 1986/87 seasons, and there is no new information on which to modify the conclusions in last year's report, that the stock abundance was well below the levels at the time when fishing began.

Kerguelen Subarea (58.5)

5.9 Directed fishing on the spawning concentration has been prohibited since 1984, and since the 1985/86 season, catches have been limited to by-catch. Catches were 801 tonnes in 1985/86 and 482 tonnes in 1986/87. Both VPAs and catches per unit effort indicate a clear decline in abundance from 1980 to 1984. Since 1984 there seems to have been some recovery of the stock though the catch statistics for the most recent seasons have not been fully analysed.

Notothenia squamifrons and *Patagonotothen brevicauda guntheri*

5.10 The Group noted that extensive biological data from the Soviet fishery for *Notothenia squamifrons* on the Ob and Lena Seamounts (Division 58.4.4) and for *Patagonotothen brevicauda guntheri* in Area 48, as requested last year by the Scientific Committee

(SC-CAMLR-V, paragraph 4.41), had recently been received by the Secretariat. However, it had not been possible in the time available to the Group to make any assessment of these resources.

Champsocephalus gunnari

South Georgia Subarea (48.3)

5.11 Catches in 1986/87 were 71 247 tonnes, the highest since 1983/84. The Soviet scientists reported that their fishing fleets had been advised to restrict their catches, and that their catches could have been larger. It appears that this highly variable stock is at a peak. There were previous peak catches around 1977 and 1983.

5.12 Though trawl surveys have been made in the area in several recent years, the catches of this species during surveys are highly dependent on the type of the gear and its rigging, so that it is difficult to use the available results to estimate recent trends in abundance. It might be possible to derive better indices from commercial catch and effort data in future, because a distinction has been made in the most recent reports between fishing targeted on krill and on fish. Such biomass indices were obtained from Polish commercial data (SC-CAMLR-VI/BG/40), collected in the past ten years by scientific observers, who could assign precisely fishing effort to target species.

5.13 Because of the large natural fluctuations in abundance it is not easy to use the level of abundance as a simple indicator of the effect of exploitation. It is now clear that abundance was high at the beginning of the 1986/87 season, but the available information is inadequate to estimate the current (October 1987) abundance with any precision. Biomass estimates during the 1986/87 season were some 80 000 tonnes (from the Polish commercial data), and 150 000 tonnes (from the Spanish survey in December 1986).. Bearing in mind that many fish could be mid-water and missed by the commercial bottom trawl, and that the Polish estimate covered only part of the area, the Group believed that the true figure at the time of the surveys was nearer to 150 000 tonnes.

5.14 The impact of fishing is better indicated by the mortality rates. When fishing started in 1976, all ages from 3 to 10 appeared in significant quantities in the catch. Current mortality appears to be high, with only one or two age-groups contributing to the fishery. This is adding to the year-to-year variability in the stock (and hence in the catches). The number of year-classes in the spawning stock has also been reduced.

Peninsula Subarea (48.1)

5.15 A very small catch, 76 tonnes, was reported in 1986/87; this is the first reported catch since 1983. Surveys in the Elephant Island area gave low estimates of abundance – 934 tonnes, Federal Republic of Germany in 1985, about 1 000 t Federal Republic of Germany in 1986 and 1 962 t Spain in December 1986.

South Orkney Subarea (48.2)

5.16 Reported catches were only 29 tonnes in 1986/87, compared with a few thousand tonnes in previous years. An estimate of biomass of 1 179 tonnes was obtained from the Spanish survey in 1987. This is similar but rather lower than the estimate from the 1985 Federal Republic of Germany survey (3 669 tonnes). Although commercial catches could be strongly affected by changes in the distribution and availability of the fish, well-designed surveys should be less affected by these factors.

5.17 Current abundance is clearly low, and it appears from the length and age data that the present stock is composed largely of the survivors of a relatively strong year-class (or year-classes) that recruited to the fishery in 1982.

Kerguelen Subarea (58.5)

5.18 Catches in 1986/87 were only 2 625 tonnes, compared with 17 137 tonnes in 1985/86. The major part of the 1986/87 catches was taken outside the Kerguelen continental shelf (on the Skiff Bank), largely from the 1984 cohort. The 1982 cohort on the shelf, which provided the good catches in the 1985 and 1986 seasons on the main shelf is now passing out of the fishery, and the catch rates in numbers of this cohort have fallen from 5.76 in 1984/85 and 3.81 in 1985/86 to only 0.4–0.5 in 1986/87 (the exact figures are not available, pending full analysis of the log-books). As in other areas, the stock is dependent of the recruitment of the occasional good year-class.

5.19 The 1985 cohort, which is currently protected by the 25 cm size limit regulation, should enter the fishery soon, and may be of reasonable strength. The abundance of this cohort will be evaluated by a joint Soviet/French survey during the 1987/88 season prior to exploitation.

5.20 The Committee noted that data concerning the fisheries before 1979 still have not been reported to the Commission. These data are most valuable for studying past trends in the fishery and should be reported as soon as possible.

McDonald and Heard Islands

5.21 A joint Soviet-Australian survey was made in this area, and the results reported in SC-CAMLR-VI/BG/16. Most of the catches were of *C. gunnari*. The fish were taken in two small areas (130.4 km^2 and 205.8 km^2) of relatively high density. The estimated abundances in these areas were 16 580 (±6 913) and 2 079 (±1 558) tonnes respectively.

5.22 It was suggested that these figures, and corresponding estimates of potential yield should be treated with caution because of the non-random distribution of trawl hauls (see Annex 5, Figure 1). There are also strong reasons to believe there is a close relationship between the populations of the Heard and McDonald Islands and those of Kerguelen Island.

Notothenia gibberifrons

South Georgia Subarea (48.3)

5.23 Catches in 1986/87 were 2 842 tonnes. This continues a picture apparent in previous years of relatively stable catches, in contrast to high fluctuations in other species.

5.24 VPA calculations were carried out, but because recruitment appears to occur over a wide range of ages (not being complete until ages 10–12), the results are highly dependent on the assumptions made about recruitment patterns. In particular, the assumption of constant mortality with age can lead to a serious under-estimate of the abundance of the younger fish in the most recent years. It is clear that abundance decreased in the first few years of exploitation, as might be expected with a long-lived fish, but the trends since 1981 are less clear, although they indicate a relatively stable biomass.

5.25 The age-composition and length composition data showed a decrease in the proportion of larger fish when exploitation began, indicating an increase in total mortality and a relatively high fishing rate, but in the most recent years the mean size has increased.

5.26 Biomass estimates are available from the 1984/85 Federal Republic of Germany survey, and the 1986/87 US/Polish survey, which gave 15 762 and 13 394 tonnes respectively. These agree well, and given the variance in both figures, the difference cannot be taken as evidence of any decrease. An estimate of 11 356 tonnes for part of the area is also available from data of Polish commercial vessels.

Peninsula Subarea (48.1)

5.27 Catches in 1986/87 were only 56 tonnes, after several years of zero catch. The Federal Republic of Germany survey in 1985 gave a biomass estimate of 25 000 tonnes around Elephant Island. It appears that this stock remains lightly exploited because it is only taken as a by-catch in the *C. gunnari* fishery.

South Orkney Subarea (48.2)

5.28 Catches in 1986/87 were only 2 tonnes, compared with several thousand tonnes in 1983/84 and 1984/85. The 1984/85 Federal Republic of Germany survey gave a biomass estimate of 12 000 tonnes.

Other Species

5.29 An analysis of information collected by observers on board Polish commercial trawlers fishing around South Georgia (SC-CAMLR-VI/BG/40) enabled the trends in abundance of several species to be followed in the period 1976/77–1986/87. It appears that there has been some increase recently in the abundance of *Chaenocephalus aceratus*. Trends in the biomass density index of *Pseudochaenichthys georgianus* and *Notothenia rossii* are not clear (Annex 5, Figure 2). It is difficult to determine the role of fishing in these changes. In the interpretation of the trends in some seasons, the influence of targeted fishing for *C. gunnari* should also be considered. When this species is abundant, fishing effort on other species is reduced, which might result in low biomass density estimates derived from 'swept-area' methods. The Committee noted the catches of *C. aceratus* and *P. georgianus* as reported in the STALANT forms may understate the true catches of these species because appreciable quantities may be included in the figures for unidentified fish.

Additional Comments by the Scientific Committee

5.30 In thanking the Group for the work that it had managed to do in the time available, the Committee noted that there were other questions which it would be desirable for the Working Group to address. In particular, the Group should examine the impact of decisions taken by the Commission at its previous meetings. It was noted at the 1986 meeting 'Members carrying out fisheries in this area (Subarea 48.3) took the position that any such limitations of catch for the 1986/87 season should be fixed at the level of catch for the 1985/86 season and indicated that they did not intend to exceed these limits' (CCAMLR-V, paragraph 51).

5.31 Despite that statement, catches of several fish species in 1986/87 had greatly exceeded those in 1985/86, as indicated in the following table:

Table 5.1: Fish catches (in tonnes) in Subarea 48.3 (South Georgia)

	1985/86	1986/87	Ratio 86/87:85/86
D. eleginoides	564	1 199	2.1 : 1
N. gibberifrons	1 678	2 842	1.7 : 1
N. rossii	70	216	3.1 : 1
N. squamifrons	41	183	4.5 : 1
C. gunnari	11 107	71 146	6.4 : 1
Unidentified fish	356	1 906	5.3 : 1

This table also shows a significant and increasing quantity of unidentified fish being reported. Recognising that this could include species from stocks that extend beyond the Convention Area, the Committee urged that every effort should be made to provide identification to species in future reports.

5.32 In relation to the high catches of *Champsocephalus gunnari*, the Soviet delegation pointed out that they had informed the Committee at its 1986 session that recruitment to this stock was likely to be high.

5.33 The Committee recognised that in its work, the Group had made extensive use of research vessel trawl surveys to estimate biomass. While such surveys, if carried out in standard fashion, provide reliable measures of relative abundance and changes from year to year, they are less reliable for estimating absolute abundance. Trawl catch data used in abundance estimation are considered to be representative of the abundance of fish in a particular area. The area swept by a trawl is calculated as the product of the distance towed times the distance between the tips of the wings of the trawl. The actual catches also include fish originally outside the path of the net, but herded into the path by the bridles and trawl doors. Conversely, some fish in the path may not be caught because they pass above the

headline or escape in other ways. The estimates of biomass obtained from trawl surveys could therefore differ appreciably from the true value, depending on the rigging of the gear, and the figure could be in error in either direction.

Management Policy

5.34 The Commission requires management advice from the Committee on several specific measures e.g. on catch limits to implement Conservation Measure 7/V regarding catch limits for fishing around South Georgia in 1987/88. However, the Committee has difficulty in providing that advice because the Commission has not made a clear decision over the policy it wishes to pursue, which could be expressed as a quantitative measure such as the fishing mortality, or minimum stock biomass.

5.35 The decision on such a policy would normally be part of a hierarchy of decision, proceeding from the broad principles set out in the Convention to specific tactical decisions for the measures to be recommended in the forthcoming season; an example is set out below.

Possible Decision

General Policies -
- Reactive management: act only when problems arise, and something is clearly needed
- Anticipatory management: act before problems arise
- Experimental management: set measures that will enable more to be learnt about the system
- Other

Specific Policies -
- Ensure that fishing mortality is not more than that giving the maximum yield per recruit
- Ensure that spawning stock biomass does not fall below some specified level
- Ensure that fishing mortality does not exceed replacement level

Strategies
- Set the TAC (for current, and all future years until corrected) equal to 90% of the estimated MSY
- Set a sequence of TACs, to be modified from year to year according to predetermined rules
- Set a limit on fishing effort in terms of numbers and size of vessels
- Other

Tactics
- Set 1988 TAC
- Other (according to strategy adopted).

5.36 The strategy that might be adopted could be more or less complex, according to the situation being faced. For example, for a severely depleted stock, the strategy might be merely to hold catches at the minimum possible level (preferably zero) until research has shown clearly that recovery has occurred. In the case of hitherto unexploited stock, the first step may be to conduct a survey to estimate the stock biomass and distribution, along with the age-structure and age-weight relationship. From these data an appropriate target level of fishing mortality could be estimated. An appropriate fraction of the stock's area could then be opened to fishing, the size of the area being chosen to keep the level of fishing mortality around or below the target level.

5.37 There is bound to be considerable recycling within this hierarchy, with policies or strategies being modified in the light of, for example, changing knowledge of the resource. At the same time, the stages need to be distinguished, and decisions at one stage clearly determined (if only temporarily) before moving on to the next. Often the arguments that arise, especially over tactics (e.g. the level of next year's TAC) have proved difficult or impossible to resolve because there has been no prior decision on the policy or strategy to be followed.

5.38 The decisions at each stage have to be taken by the Commission, but these decisions will be easier if there is appropriate scientific advice.

5.39 If the Commission wishes to adopt a policy in terms of a target fishing mortality there are a variety of targets it might choose. For example, it might choose that fishing mortality rate that could result in the maximum sustained yield. This can be difficult to calculate because the relation between the abundance of the adult stock and subsequent recruitment is often unclear. An alternative might be to aim at achieving the maximum yield per recruit. Often it would be desirable to aim at rather lower fishing mortality rates. They have the advantages of leading to higher catch rates (and hence the likelihood of more profitable

operations) and the presence of more age-classes in the stock, and hence increased stability and less risk of stock collapses. Other values of target fishing mortality, such as the $F_{0.1}$, as explained in the Working Group's Report, might also be chosen.

5.40 The actual value of target F would be expected to vary from stock to stock, taking into account differences in growth rates, potential life-span, variability in recruitment, the age-structure of the catch, etc. It is possible that for stocks with highly variable recruitment, a constant F might not be appropriate.

5.41 Policy targets might also be expressed in terms of spawning stock biomass. Often it might be desirable to combine the two types of target i.e. the fishing mortality could be set at some target F provided the spawning stock was not reduced below a given minimum level.

5.42 In achieving policy targets, the Commission has potentially two types of controls - on the amount of fishing (through catch and effort controls), or on the ages caught. Controls aimed at protecting small fish (e.g. through mesh regulation) were likely to be particularly useful when there were practical problems in implementing controls on the amount of fishing.

5.43 Problems in using catch limits are likely to be particularly serious for fisheries that depend on only a few year classes as occurs when mortality rates are high and recruitment variable. If a catch limit is to come close to achieving the desired level of fishing mortality there must be good estimates of current biomass and of the strength of the incoming recruitment. For example it is now clear that because the recruitment to the *C. gunnari* stock at South Georgia during 1986/87 was very good, the replacement yield of that stock at the time of the 1986 meeting was greater than the few thousand tonnes mentioned in last year's report. If the Commission wishes to use the approach as a general method of controlling the amount of fishing, the Committee will need to examine the research (e.g. pre-recruit surveys) needed to give adequate advice on the catch levels required to achieve the specific target.

Simulations

5.44 The use of simulations, such as those illustrated in Annex 5, Figures 3a, b and c, are very useful in many different situations of interest to the Commission, e.g. in examining the probable impact of developing krill fisheries on associated and dependent species under various assumptions about the food requirements. Members of the Committee, and

especially the members of the Fish Stock Assessment Working Group, were therefore encouraged to use and develop simulation models in their work.

Management Policies for Specific Stocks

Notothenia rossii

South Georgia Subarea (48.3)

5.45 The immediate objective for this stock should be to rebuild the spawning stock as quickly as possible. Preferably no catches should be taken at all, but it was recognised that this would be impracticable if commercial fishing for the other species continues. The measures already taken by the Commission have clearly resulted in a decrease in the reported catch. The available data are not adequate to prove that they are also having the desired effect of rebuilding the stock.

5.46 It would be desirable to have better information on the incidence of by-catch and its variation in space and time. This could lead to modification in the management measures that would further reduce the by-catch. Some of this information should be available on data forms already received, but there has not been time to examine these in detail. For the present, the Committee agreed with the Working Group in seeing no reason to modify the Conservation Measures already in force.

Other Atlantic Areas

5.47 In the absence of new information, the Committee had no new advice to make about these stocks.

Kerguelen Subarea (58.5)

5.48 The immediate objective should be to rebuild the spawning stock. The Conservation Measures currently in force appear to be having this effect, and should be continued.

Champsocephalus gunnari

South Georgia Subarea (48.3)

(a) Protection of Small Fish

5.49 At present, the fishery starts catching the fish when they are relatively young, at 2–3 years old (the onset of sexual maturity). If the fish were afforded protection until they were 3 or 4 years old, there would be some benefits in terms of increased yield per recruit (Y/R) and a greater spawning stock biomass per recruit (SSB/R). This is shown in the following table, for different values of fishing mortality.

Table 5.2: Yield and spawning stock biomass per recruit for *C. gunnari* at different levels of fishing mortality and age at first capture.

Fishing Mortality	Fished From Age 2		Fished From Age 3		Fished From Age 4	
	Y/R	SSB/R	Y/R	SSB/R	Y/R	SSB/R
0.2	.096	.335	.099	.409	.096	.488
0.4	.105	.158	.116	.236	.118	.326
0.6	.103	.089	.118	.162	.124	.251
0.8	.100	.056	.118	.125	.126	.211
1.0	.098	.038	.118	.103	.127	.186

5.50 The benefits are particularly marked in terms of spawning stock biomass and at higher levels of fishing mortality. For example if F = 0.8 (and in peak years the fishing mortality has been well in excess of this value), changing the age at first capture form 2 to 4 would increase the yield per recruit by 25%, and the spawning stock biomass per recruit by four-fold.

5.51 Traditionally an increased age at first capture has been achieved by the use of a larger mesh size. This technique would be useful for *C. gunnari*, but the relation between mesh size of the codend netting used by the commercial trawlers and age at first capture is not clear. Dr Slosarczyk reported that the Polish scientists have made further net selectivity studies. Due to limited ship time available for fishing with 80 mm meshes, these studies were not completed and will be continued in the 1987/88 season.

5.52 Further studies under commercial conditions, and the full reporting of experiments that have already been carried out are needed. In the meantime the Committee was not in a position to advise on the precise consequences of the present 80 mm mesh regulation. However, the Committee noted that Table 5.2 shows that there would be significant benefits in terms of spawning stock, and (except at very low fishing rates) yield per recruit, from

increasing the size of first capture above the present (age 2–3 years), and therefore from increasing mesh size.

5.53 The Committee noted that there were other methods that could protect the small fish. These include the use of regulations governing the minimum sizes of fish that can be landed. Another possibility, not examined in detail by the Working Group, might be to reduce catches at a time when young fish predominate in the population. For example, rough calculations of the balance between growth and natural mortality, suggest that the 70 000 tonnes, mainly of 2–3 year of fish caught during the last season, could have contributed even more to the catches in the 1987/88 and subsequent seasons if they had not been caught in 1986/87.

5.54 The Committee believed it would be useful to give particular attention to determining the effects of changing the mesh size for *C. gunnari*.. This has implications for the Committee's future work, including studies by the Working Group of the immediate and long-term effects of mesh changes and the priorities that should be set for this work. There was in any case desire for further work on mesh selectivity as discussed later (see paragraph 5.79).

(a) Control of the Amount of Fishing

5.55 At present the fishery is characterised by the presence of only a limited number of age-groups, a high year-to-year variability in catches, and a relatively low spawning stock biomass. Reducing the level of fishing would tend to reverse these undesirable features. In any case, Table 5.2 shows that, at the present age at first capture (2 to 3 years), there is little or no gain in yield per recruit at high fishing rates. As noted earlier (paragraph 5.39) and in more detail in paragraph 44 of the Report of the Fish Stock Assessment Working Group, the Committee believes that there are some advantages in lower levels of target fishing mortality, such as $F_{0.1}$. These would result in a level of fishing that would be consistent with objectives such as increasing stability, or increasing spawning stock biomass.

5.56 In the case of *C. gunnari*, $F_{0.1}$ was estimated to correspond to an actual value of fishing mortality of F = 0.21. So that the Commission can contrast the consequences of fishing at various rates, including $F_{0.1}$, simulations were run to compare possible future catches and spawning stock biomass under different policies. Three values of F (0.21, 0.3 and 0.5) were used, and three assumptions made about the current biomass (75 000, 150 000 or 225 000 tonnes) centred about the current estimate (see Annex 5, paragraph 20). To make the projections, a pattern of future recruitment was obtained by drawing a random sequence

of recruitments form the values observed in the past. The same sequence was used for all the simulations at different values of F and current biomass. The simulations therefore illustrate the differences to be expected between policies, but are not predictions of the future. The chosen sequence implies good recruitment around years 3 and 12 and poor recruitment between, but it is unlikely that this precise sequence will occur. What will occur will be a sequence of good and bad years, though their timing is likely to be different from that of the simulation.

5.57 Some results of the simulation concerning catch an spawning stock biomass are shown in Annex 5, Figure 3, a, b, c. For spawning biomass the picture is clear. The curves for the three levels of F are well separated, the spawning biomass being lower and relatively more variable at higher values of F. For all levels of initial biomass, in the last year of simulation the spawning biomass at F = 0.5 is only some 40% of that of F = 0.3. For F = 0.3, the spawning biomass is 75% of that at F = 0.21.

5.58 As regards catch, in the first year the higher the F, the greater the catch. After the initial period, the differences in yield between the three levels of fishing mortality chosen are not large. The ranking is not the same in all years. In years of poor recruitment there are, at the higher levels of F, few survivors from earlier good recruitment to support the fishery. Thus, for example, the predicted catches in year 8 from the population simulated at F = 0.5 are very much less than those from the simulated populations for F = 0.21 of F = 0.3. (It may be noted here that no allowance was made for any influence of spawning stock biomass on subsequent recruitment. If there were any such effect, the catches at lower Fs would be expected to be relatively greater from perhaps year 6 onwards).

5.59 Figure 4 of Annex 5 shows the estimated biomass-at-age at the beginning and end of the simulation period, and indicates that the level of fishing mortality affects the age structure of the population.

5.60 In the absence of more clearly specified goals, the Working Group could not conclude on the basis of this simulation that one or other policy was better than the rest. However, the long-term interests (such as increasing spawning stock biomass) seem to point to the lower levels of F as being more desirable.

5.61 If $F_{0.1}$ were adopted as the target, then the corresponding catch limit for the 1987/88 season can be calculated as 0.21 x mean biomass in 1987/88. This biomass is not known, and for the present purposes (and for similar calculations in respect of other possible target

fishing mortalities or for other stocks) a figure based on an estimate for some recent period has to be used.

5.62 The recent biomass is believed to be around 150 000 tonnes, including fish of age class one not taken by the commercial fishery, and the Working Group used this figure in its calculations of catch levels as set out in paragraph 67 of its Report. Strictly this figure of biomass refers to the period of the Spanish survey, which ended on 18 December 1986. Between the end of December and the end of June some 50 000 tonnes were removed (see Table 5.3 below).

Table 5.3: Monthly catches (in tonnes) of *C. gunnari* in Subarea 48.3 during the 1986/87 season.

1986	Catch	1987	Catch
July	1 756	Jan	17 504
Aug	6 509	Feb	16 104
Sept	229	March	10 272
Oct	1 328	April	2 459
Nov	663	May	1 800
Dec	10 419	June	2 099

The committee believed that the figure for the biomass should be adjusted to correct for these catches, giving a value of some 10 000 tonnes for the biomass at the beginning of the 1987/88 season. Further adjustments should be made to correct for losses due to natural mortality, and gains due to growth and recruitment, but the necessary information on recruitment strength was not available.

5.63 Using these figures of 100 000 tonnes (derived as described above) and 150 000 tonnes (used by the Working Group), and using the simple approximation of catch = F x biomass, the landings corresponding to any desired target F can be readily calculated (see Table 5.4).

Table 5.4: Calculations of landings corresponding to various F values

	Biomass estimates used	
	100 000 tonnes	150 000 tonnes
F values	Landings	
$F_{0.1}$ (= 0.21)	21 000 tonnes	31 500 tonnes
F = 0.3	30 000 tonnes	45 000 tonnes
F = 0.5	50 000 tonnes	75 000 tonnes

5.64 The Committee believed it would have been very useful in providing the Commission with advice on the consequences of different action if the Working Group had calculated how future catches would have been affected if Member countries had in fact complied with their

expressed intention of keeping catches at their 1985/86 level. In particular, it would have been interesting to see the extent to which the catch levels for different target Fs for the 1987/88 seasons given above would have been increased. The yield per recruit calculations indicate that such increases summed over the life span of the cohorts involved, would have exceeded the 1986/87 catches.

Other Atlantic Subareas

5.65 The standing stock in these areas is very low, and cannot sustain significant fishing.

Kerguelen Subarea (58.5)

5.66 The objectives of the Conservations Measures in force are to increase the spawning stock biomass. Because only one age-group is present in the catches, the stocks are very sensitive to exploitation, and depend on the level of recruitment. Surveys of the incoming cohorts are planned for 1987/88. Simulations similar to those done for the South Georgia Subarea could be made for Kerguelen, using estimates of current biomass. Regulations have been set on the size of fish and on the level of catches for the 1987/88 season. The level of catches is based on the mean index of abundance for the two preceding cohorts. These regulations should reduce the impact of fishing on future spawning biomass.

Notothenia gibberifrons

South Georgia (48.3)

5.67 Catches in the last four years have averaged around 2 500 tonnes, and the stock appears to be stable. Replacement yield is probably also at about the same level.

Other Matters

Age Determination

5.68 It was noted that the report of the Age-Determination Workshop held in Moscow in 1986 was not yet available. This was due to delays in communications between Cambridge and Moscow. The Committee was informed that the final corrections had been sent to the rapporteur, and the report should be available soon. The program for exchange of otoliths and scales was in operation (SC-CAMLR-VI/BG/26).

Early Life History

5.69 A key to the identification, and a catalogue of fish larvae was being prepared by Mr A.W. North and Dr A. Kellermann. This represented a considerable expansion on the existing publication by BIOMASS, covering more species and developmental stages as well as information in ecology. Printing this booklet (500 copies in one language) would cost some US$6 000–7 000. The Committee believed it would be appropriate for the Commission to make a contribution to these costs. This contribution might be shared with BIOMASS and the Alfred Wegener Institute of Polar and Marine Research, Bremerhaven, Federal Republic of Germany.

Future Work

Organisation of the Working Group

5.70 The Committee agreed that, following the ideas expressed at its 1987 session, the Ad Hoc Working Group on Fish Stock Assessment should be established as a formal standing Working Group.

5.71 The terms of reference of the Working Group of Fish Stock Assessment should be:

(a) Apply and develop methodologies for fish stock assessment, including:

(i) procedures for monitoring fish stock abundance and population structure

(ii) protocols for the collection and analysis of fishery-related data including the relevant operations of the CCAMLR data base

(iii) analytical procedures for the estimation and projection of fish stock population trajectories;

(b) review and conduct assessments of the status and potential yield of fish stocks in the Convention Area;

(c) evaluate the actual and potential impact on fish stocks and fisheries of past, present and possible future management actions.

5.72 Dr K.-H. Kock (Federal Republic of Germany) was appointed Convener of the Working Group.

5.73 The Group should meet immediately preceding the next session of the Scientific Committee. In accordance with the pattern of work suggested in the Ad Hoc Working Group's report (Annex 5, paragraphs 73–78), the Group should start work on Wednesday, 12 October, probably within small groups, to carry out the work of review and refinement of preliminary analyses ('phase one' of the Working Group's suggestions for the meeting). Starting on Monday, 17 October, it should meet to review the assessments and formulate advice ('phase two' of the Working Group's suggestions).

5.74 Reduction of data and preliminary analyses should be carried out by the Secretariat before the meeting commences. This intersessional work, largely by the Data Manager, should be carried out under the guidance and advice of the Convener of the Working Group and the Chairman of the Scientific Committee. They would be assisted by receiving comments and suggestions from other members of the Working Group.

Data

5.75 The Committee endorsed the proposals made by the Working Group regarding the submission and publication of data. Specifically it recommended:

(a) The following changes should be made in the draft forms for submitting detailed catch and effort data:

- calendar months should be divided into three parts: day 1 to day 10, day 11 to day 20 and the remaining days. It was recognised that the third period would vary depending on the number of days in the month but this could be allowed for in any computations;

- an explanation should be added to the instructions to the effect that searching time has not been requested as a measure of fishing effort for finfish;

- nominal mesh size should be specified, but where available, measured mesh size should also be included;

- to assist in completing the forms, the species list should be included on the back of the form together with species codes. (The species list should be amended to include the following categories: commercially important species; blank spaces for the listing of other species, families, and catches NEI);

- instructions should be included to the effect that catches converted to fish meal should be reported by species if possible.

(b) All Members of the Commission should report the size of ships using the system described in the instructions for the STALANT and fine-scale data forms.

(c) The instructions for completing the forms should be expanded to include a map of the Convention Area and perhaps illustrations of commercially important species. These instructions should be distributed as a bound manual.

(d) The following changes should be made to the draft Statistical Bulletins (SC-CAMLR-VI/6):

- Tables 5 and 6 of SC-CAMLR-VI/6 should be combined in one table;

- a complete bound version should be issued each year rather than pages to be inserted in a loose bound volume;

- the taxonomic listing of species should be retained.

5.76 Potential fishing grounds around Heard and McDonald Islands are in the same statistical subarea as Kerguelen (58.5), and it is important that catches from the two regions should be distinguished in future statistical reports. The Committee therefore recommended the establishment of two new statistical division - Kerguelen Division (58.5.1), and Heard-McDonald Division (58.5.2). (Refer to Figure 2.)

5.77 The Committee recommended that the divisions be defined as described in the Agreement on Maritime Delimitation between France and Australia, signed in Melbourne, Australia on 4 January 1982. Specifically, Subarea 58.5 should be divided by a line drawn from 53°14'S latitude, 60°00'E longitude to 53°14'S latitude, 67°03'E longitude thence to 49°24'S latitude, 76°42'E longitude and thence to 49°24'S latitude, 80°00'E longitude. The northern division would be designated Division 58.5.1 and the southern division would be designated Division 58.5.2. The actual boundaries of the two proposed new divisions would be defined by the rhumb lines joining the above co-ordinates.

5.78 The Committee requested that the Secretariat contact FAO regarding the changes to Subarea 58.5.

Mesh Selectivity

5.79 Better information on mesh selectivity is needed, particularly for *C. gunnari* around South Georgia (see paragraph 5.51). A number of countries including Poland, Japan and USSR reported that they were implementing or planning mesh experiments. Countries were urged to continue this work, especially under commercial conditions, and to report the results to the 1988 session of the Working Group.

Management Advice

5.80 The Committee's report to the Commission relevant to management is set out in paragraphs 5.34 to 5.68. The Commission's attention is drawn in particular to the following points:

(a) General Matters

- The Committee has difficulty in providing advice in the absence of clear decisions over the policy by the Commission wishs to pursue (paragraph 5.34)

- the policy of the Commission may range from reactive to predictive. In order to achieve its policy (or policies) the Commission will need to control fishing mortality and the age at which fish are first captured. In general, by reducing fishing mortality (to $F_{0.1}$, for example) and by increasing age at first capture, variability in yield and biomass can be reduced, there would be a lower risk of recruitment overfishing, with some potential sacrifice in yield.

- because of problems in setting catch limits, especially for fisheries dependent on relatively few year classes, the use of catch limits will require that the Committee carefully evaluate the research (e.g. pre-recruit surveys) necessary for the formulation of adequate advice (paragraph 5.43).

(b) Specific Matters

- The existing measures for *Notothenia rossii* should be maintained (paragraphs 5.47 and 5.49)

- the replacement catch for *Notothenia gibberifrons* at South Georgia is probably at the level of recent catches (2 500 t) (paragraph 5.68)

- the abundance of *Chaenocephalus aceratus* around South Georgia appears to have increased recently (paragraph 5.33), while trends in biomass density indexes of *Pseudochaenichthys georgianus* are not clear (paragraph 5.33)

- high catches of 2–3 year old *Champsocephalus gunnari* taken at South Georgia in 1986/87 have reduced potential long-term yield (paragraphs 5.54 and 5.65) and an increase in size at first capture of *Champsocephalus gunnari* at South Georgia would be beneficial (paragraphs 5.53 and 5.54)

- the catch limits of *Champsocephalus gunnari* corresponding to different target values of F and two levels of biomass are set out in Table 5.4 (paragraph 5.64).

SQUID RESOURCES

6.1 Squid catches in FAO statistical areas adjacent to the Southern Ocean have increased significantly in recent years (SC-CAMLR-VI/BG/10 and SC-CAMLR-VI/BG/11). Given the high levels of squid consumption by large vertebrate predators in the Antarctic, especially in sub-Antarctic areas, it is important that our lack of knowledge of squid standing stock, production and general demography be rectified, so that the consequences of any future commercial exploitation of squid can be properly assessed. Octopods are also common and widespread in some parts of the Convention Area, although little is known of this group either.

6.2 Current reported catches of squid in the CCAMLR area are very low - a total of a few tens of kilograms in recent years, and two tonnes reported from Area 48 in 1979. No Member stated any intention of harvesting squid in the CCAMLR area in the foreseeable future. Dr Lubimova reported that the USSR has done considerable research on Antarctic squids (SC-CAMLR-VI/BG/18), but that few squid are caught in nets in the Convention Area, and many species are unsuitable for human consumption. Studies on the role of squid in the ecosystem are important, however, because of the high levels of consumption of squid by marine mammals and birds.

6.3 Results form UK research show that one of the commonest squid taken from seabird stomachs in Subarea 48.3 (South Georgia) is *Martialia hyadesi*, a species which is fished commercially around the Falklands/Malvinas Islands. Thus it is important to study this species in the Convention Area, both as a potentially harvestable species and for its important ecological role.

6.4 Recent work on the diet of squid, including the results of Japanese research reported to the recent CCAMLR/IOC Seminar on Antarctic Ocean Variability, shows that krill form a substantial fraction of the diet of many species.

6.5 The Scientific Committee encourages Members to conduct research on squid in the Convention Area because of their important ecological role as predators of krill and as food for large vertebrates. Topics such as those detailed in SC-CAMLR-VI/BG/11, namely

species composition and distribution, production and biomass, demography and population dynamics and trophic relations are relevant to such research. The activities of the Cephalopod International Advisory Council (detailed in SC-CAMLR-VI/BG/32) were noted.

ECOSYSTEM MONITORING AND MANAGEMENT

Report of the Working Group for the CCAMLR Ecosystem Monitoring Program

7.1 Dr K. Kerry (Australia), Convener, introduced the report of the second meeting of the Working Group for the CCAMLR Ecosystem Monitoring Program (CEMP) held at Dammarie-les-Lys, France, 10–15 June, 1987 (Annex 4). He thanked the 23 members of the Group for their participation, the three invited experts for their specialist advice, Dr J.-C. Hureau and his staff for organising the meeting and the rapporteurs (Dr D. Ainley, Dr J. Bengtson, Dr I. Everson and Mr D. Miller) and the Secretariat for preparing the report.

7.2 The main aims of this meeting were to develop practical methods for conducting monitoring operations on selected predator and prey species in specific areas. To this end all species, parameters and potential study sites and areas recommended at the previous meeting were reviewed, in particular in order to establish for which parameters:

(i) it was possible to recommend monitoring programs to start now,
(ii) it was necessary to conduct further directed research,
(iii) the development of appropriate technology was an essential requirement.

7.3 The three experts, invited at CCAMLR expense, gave invaluable advice concerning applications of remote sensing and new technology to both specific and general monitoring objectives.

Predator Monitoring

7.4 For predators within each of the three integrated study areas (Antarctic Peninsula region, South Georgia region, Prydz Bay region), sites at which monitoring of specified species should be started now were listed (Annex 4, Table 1). This was accompanied by recommendations for other sites at which complementary monitoring studies should be undertaken (Annex 4, Table 2).

7.5 The predator parameters which were recommended for monitoring starting now (Annex 4, Table 3) were those which were believed to meet the criteria that:

(i) available data on intra- and inter-annual variation are adequate to demonstrate that the parameter has appropriate sensitivity for detecting significant changes, at least in the medium-term (i.e. 5–10 years) and to allow specification of appropriate sample sizes,

(ii) appropriate methods already exist for implementing monitoring at recommended field sites, using the specified sample sizes.

Instruction sheets giving the recommended methods were prepared for each parameter (Annex 4, Appendix 4), to ensure that data collected at different sites and in different seasons are fully comparable.

7.6 Other predator parameters, previously identified as candidates for immediate use in monitoring programs failed to meet the criteria noted in paragraph 7.5. This was because:

(i) existing data were inadequate for critical evaluation, or
(ii) adequate data exist but they have not been evaluated, or
(iii) vital technological and/or methodological developments are required.

Further evaluation and/or directed research on these and other parameters (listed in Annex 4, Tables 4 and 8) was recommended as an equally high priority as starting routine monitoring activities. Such directed research included the development of appropriate equipment to help automate data collection and to facilitate remote-recording of information on predators during their pelagic phase.

Prey Monitoring

7.7 The Meeting focused principally on Antarctic krill, *Euphausia superba*; the utility of monitoring *Pleuragramma antarcticum*, *Eudyptes chrysolophus* and early life stages of fish still requires further research and detailed evaluation.

7.8 There was broad agreement on the type of data required and the general methods that might be used to obtain these (Annex 4, Table 5). It was agreed, however, that until detailed

definition and standardisation of methods had been prepared, it was premature to recommend implementation of any prey monitoring studies.

7.9 It was regarded as crucial to develop appropriate methods for assessing krill abundance and availability to predators, especially within the integrated study areas.

7.10 As a first step towards this, it was agreed that:

(i) Dr K. Sherman (USA) would co-ordinate net-sampling efficiency studies and would summarise current plans for review and comment at the next meeting of the Working Group.

(ii) Dr I. Everson (UK) would co-ordinate the preparation of suitable survey designs for assessing krill distribution and abundance in integrated study areas, and report to the 1987 meeting of the Scientific Committee.

Environmental Background Data

7.11 It was recognised as essential for monitoring studies to have simultaneous information on predators, prey and the marine environment and that these should all be organised on appropriate temporal and spatial scales.

7.12 Environmental data that are needed in order to interpret predator-prey interactions were listed in detail (Annex 4, Table 6). Methods for acquiring such data were indicated only in outline but many involved techniques standard in oceanography and meteorology, and it would be feasible to use these now. For other methods, further research and evaluation is required and in some cases new techniques would need developing.

7.13 It was clear that remote sensing using satellites (e.g. via the coastal zone colour scanner (CSCZ)) will play an increasingly important role in the acquisition of key environmental data. Dr Feldman (USA) was asked to investigate the availability of environmental data of types deemed relevant by the Working Group and how these might be made available to CCAMLR in the most appropriate form for interfacing with the predator and prey studies in the integrated study areas.

Implementation

7.14 The Working Group recommended that monitoring of certain parameters of predators (Annex 4, Table 3) should start now at as many sites as possible in the integrated study areas and associated network sites.

7.15 These monitoring studies should be conducted as specified on the standard method sheets, particularly with respect to sample sizes. It was stressed that programs which did not meet these criteria could not be recognised as part of routine monitoring activities of the CEMP.

7.16 Because other parameters of predators may prove equally, or more, suitable than those already recommended, directed research on such parameters (Annex 4, Tables 4 and 8) should be given high priority.

7.17 It is now important to expedite progress on monitoring of prey. This should be given priority attention at the next meeting of the Working Group (see paragraph 7.39) and in preparation for this, methodologies for standardisation of net, hydroacoustic and hydrographic techniques, and sampling strategies should be developed. Progress towards a standardised system for monitoring krill abundance and distribution is also required.

7.18 Implementation of long-term, shore-based monitoring of predator parameters would be greatly helped if approved sites were accorded some form of protection from human interference. The attention of the Scientific Committee was drawn to the possible suitability for this of:

(i) provisions under Article IX, paragraph 2, sub-paragraph (g) of the Convention and
(ii) the existing systems of site protection under the Antarctic Treaty.

Theoretical Aspects

7.19 A main aim of the CCAMLR Ecosystem Monitoring Program is to distinguish between changes due to harvesting of commercial species and changes due to environmental variability, both physical and biological.

7.20 To start to address this, it will be necessary to devise and conduct appropriate sensitivity analyses on estimates of predator parameters derived from existing data and to plan to undertake case-history studies, particularly of small, defined regions. Members were urged to consider appropriate procedures with a view to making specific recommendations at the next meeting of the Working Group.

Reporting of Monitoring Operations

7.21 In respect of the predator parameters recommended for monitoring and the desired directed research on potentially suitable parameters, all Members were asked to submit reports on current and planned activities before the 1987 Meeting of the Scientific Committee.

7.22 No recommendations were made for the nature of the data to be reported to CCAMLR as a result of monitoring activities. It was recognised that suitable standardised formats would need developing once the type of data to be reported had been defined.

Review of the Report of the Working Group for the CEMP

7.23 The Chairman thanked the Members of the Working Group for their report and noted the considerable progress made towards practical implementation of a monitoring program.

7.24 The Chairman reported that his review of prey monitoring surveys (SC-CAMLR-VI/BG/8) was based only on UK experience, because the two replies to his request for information had arrived too late for incorporation. He urged Members to provide additional information so that a revised review of survey design could be prepared.

7.25 Dr Sherman (USA) reported that the list of experiments on net performance and abundance estimation of krill scheduled for 1987/88 (Annex 4, Table 7) was only preliminary. He asked Members to revise this as appropriate and also to provide new information on experiments planned for 1988/89.

Implementation and Co-ordination of the CEMP

7.26 The Scientific Committee recommended that monitoring of predator parameters as listed in Annex 4, Table 3, using the standard methods detailed in Annex 4, Appendix 4, should proceed immediately.

7.27 It also recommended that the standard method sheets should be circulated as soon as possible, ideally in the form of a booklet which would be easily amended as necessary.

7.28 The Working Group for the CEMP was asked to keep these methodological instructions under regular review and to provide updated versions as required. To help in this, Members conducting monitoring programs were urged to inform the Working Group of any difficulties encountered in using the instructions and to suggest improvements on the basis of their field experience.

7.29 The Scientific Committee recommended that detailed research to evaluate the potential utility of additional monitoring parameters should be given high priority. The results of such research should be reported to the Working Group together with draft methodological protocols where appropriate.

7.30 The Scientific Committee asked all Members, as a matter of urgency, to provide the Secretariat with details of existing and planned monitoring and directed research operations, by completing the appropriate sections of Annex 4, Tables 3, 4 and 8.

7.31 On the basis of the notification of existing and planned monitoring of approved parameters at approved land-based sites, the Convener of the Working Group for the CEMP, in conjunction with the Secretariat, was asked to consider appropriate action in respect of registration and protection of land-based sites, including needs for development of management plans.

7.32 To assist in this, the Scientific Committee requested the Commission to consider how formal protection for these sites might best be achieved, taking account of provisions available within the Convention and the Antarctic Treaty system.

7.33 Now that CCAMLR-approved monitoring studies of predators are recommended to start, it is essential to consider what data should be reported to CCAMLR and the manner in which this should be done. The archiving of existing data, on approved parameters from

approved sites, where these have been collected following the standard methods, should also be considered.

7.34 The Scientific Committee asked the Convener of the Working Group for the CEMP to devise, in conjunction with the CCAMLR Data Manager and taking advice from appropriate specialists on seabirds and seals, appropriate instructions and formats for the submission to CCAMLR of predator monitoring data.

7.35 The Scientific Committee noted that the Working Group for the CEMP had deferred proposals for implementation of prey monitoring until further standardisation of methods had been achieved. The Scientific Committee re-emphasised the importance of acquiring data on prey abundance and availability to predators (and also basic environmental background data) on the same spatial and temporal scales as the predator monitoring program. It recognised, however, the problems inherent in standardisation of survey design and sampling methodology. Consequently the Scientific Committee recommended that initially prey monitoring operations should concentrate on the integrated study areas and focus on sea areas within the foraging range of the predator species being monitored, ideally at the times of year when these foraging ranges are most restricted.

7.36 The development and refinement of standard methods for prey monitoring would be helped by the analysis of existing major data sets on krill. Dr T. Lubimova (USSR) had made available extensive data on the quantitative distribution of krill for 1980/81, 1981/82 and 1983/84 seasons from research vessels operating in all three sectors of the Antarctic and particularly in the areas of the Scotia Sea, Larzarev Sea, Ruser-Larsen and Cosmonaut Seas, Prydz Bay region and the seas between Mawson and Dumont d'Urville stations. Dr K. Sherman (USA) indicated that his group possessed relevant data on krill acoustic and net haul surveys from research in the Elephant Island, South Shetland Islands area during the 1982/83, 1984/85 and 1986/87 seasons (SC-CAMLR-VI/BG/46). Spanish data on krill catches, length distribution and fishing effort for research in 1986/87 in Subareas 48.1 and 48.2 have also been made available. Members possessing relevant data or results were asked to make these available to the CCAMLR Data Manager. Because these data also have considerable relevance to the CPUE studies, Dr J. Beddington (UK) was asked to advise the Secretariat on appropriate analyses taking into account the requirements of both the CPUE studies and those relating to prey monitoring. It was noted that the analysis of the acoustic data on krill abundance collected during the BIOMASS SIBEX program would also be most valuable in terms of designing CCAMLR prey monitoring programs. The Scientific Committee agreed that SCAR should be asked to request the BIOMASS Executive to give

high priority to arranging the analysis and publication of these data, with particular attention to aspects relevant to maximising the efficiency of prey monitoring surveys.

7.37 Meanwhile, the Scientific Committee felt it was imperative to make progress towards standardisation of sampling methods and survey design for prey monitoring. Members who had not already done so were asked to provide Dr Everson with information relevant to the design of surveys to estimate krill abundance and to provide net haul samples of krill on spatial and temporal scales consistent with the predator monitoring operations in the integrated study areas.

7.38 Dr Everson, in conjunction with Dr Sherman, was asked to prepare and circulate a new summary of current survey methodology and if possible to recommend to the next meeting of the Working Group for the CEMP appropriate methods for use in each of the integrated study areas.

7.39 The Scientific Committee decided that it would not be necessary for the Working Group for the CEMP to meet during 1988. The Convener of the Working Group for the CEMP was asked to provide the 1988 meeting of the Scientific Committee with a report on the progress of all activities where actions had been requested. Specifically these would include:

(i) summary of Member's CEMP activities in 1987/88 and those planned for 1988/89 (Members are already requested to provide this as a separate section in their report to the Commission on Member's Activities).

(ii) proposals for data reporting formats for existing approved predator monitoring operations.

(iii) proposals for registration and protection of approved land-based monitoring sites.

(iv) progress towards sensitivity analyses on estimates of predator parameters derived from existing data.

(v) progress towards acquisition of appropriate environmental background data for predator-prey monitoring.

(iv) progress towards standardisation of sampling and survey design for prey monitoring.

International Whaling Commission (IWC) Activities and the CEMP

7.40 As part of the development of the CEMP the Scientific Committee has been corresponding with the IWC Scientific Committee in order to:

(a) determine how the Comprehensive Assessment might contribute to evaluating the nature of and possible means for detecting the effects of krill harvest on Antarctic whale stocks;

(b) explore means for analysing available data and information assembled during the Comprehensive Assessment on physiological condition, stomach contents, and feeding behaviour of minke whales in terms of their utility for indicating changes in the krill/whale system, and

(c) identify what further steps might be taken to co-operatively plan and convene a Workshop on the Feeding Ecology of Southern Baleen Whales. (See SC-CAMLR-V, paragraphs 6.8–6.11).

7.41 Dr W. de la Mare, the CCAMLR Observer at the 1987 meeting of the IWC Scientific Committee, reported on matters of relevance to CCAMLR dealt with at this meeting (SC-CAMLR-VI/BG/29).

7.42 He reported that the Comprehensive Assessment does not have strong relevance to question (a) above. Two aspects of the Comprehensive Assessment - estimation of current abundance and of recent trends in abundance - have obvious relevance to detecting effects of krill harvesting on whale stocks. However, data currently available from shipboard sighting surveys and CPUE indicate that reliable detection of trends is only possible over an extended period.

7.43 With respect to question (b) above, data currently being assembled specifically for the Comprehensive Assessment do not include items relating to the body condition of the animal.

7.44 Concerning question (c) above (the CCAMLR/IWC Workshop on the Feeding Ecology of Southern Baleen Whales), the IWC had requested its members to indicate the

availability of data suitable for such an undertaking. Although only one reply had been received, it was known that there are extensive sets of Japanese data on stomach contents and blubber thickness, some stomach content and oil yield data with the Bureau of International Whaling Statistics, and some stomach content data in Discovery Investigation files at the Sea Mammal Research Unit, Cambridge.

7.45 The IWC drew up a list of proposed topics for inclusion in the Workshop, which they suggested could be held in late 1988. They approved a budget of £13 500; a further contribution of US$ 15 000 was offered by the US Marine Mammal Laboratory. It was also suggested that a small group (consisting of one or two experts on krill distribution and ecology, and one or two whale specialists) should formulate more detailed questions for the Workshop.

7.46 Concern was expressed at the rather broad nature of the topics proposed for the Feeding Ecology Workshop. It was agreed that, to obtain maximum value from the workshop, it was important to refine further the objectives of the Workshop. It was recognised that the identification of suitable data on krill distribution and abundance to complement the existing whale data was required. Accordingly it was agreed that a small joint steering committee of experts from both the IWC and CCAMLR Scientific Committees should be formed to undertake the organisation of the Workshop. It was anticipated that it would be difficult to hold the Workshop before 1989.

7.47 It was agreed that Mr D. Miller (South Africa) and Dr Y. Shimadzu (Japan) should be asked to be the CCAMLR representatives on this steering committee. In the event that one of these were not available, Dr J. Beddington (UK) should be asked to participate. Although it was recognised that the Workshop would deal with all baleen whales, it was hoped that there would be sufficient focus on the mike whale to provide an evaluation of the utility of this species for the CEMP.

7.48 The IWC Scientific Committee had been unable to reach a consensus regarding a submission by Japan, which included reference to questions of interest to CCAMLR, for a Special Permit to take minke and sperm whales for research purposes. It was agreed that it would be inappropriate for the CCAMLR Scientific Committee to comment further on this topic at present.

Advice to the Commission

7.49 The Scientific Committee recommends (SC-CAMLR-VI, paragraph 7.26) that Members should start new programs monitoring approved predator parameters (SC-CAMLR-VI, Annex 4, Table 3) using approved standard methods (SC-CAMLR-VI, Annex 4, Appendix 4) in the integrated study areas and associated network sites (SC-CAMLR-VI, Annex 4, Tables 1 and 2).

7.50 The Scientific Committee further recommends that detailed research be directed towards evaluating the potential utility of the additional monitoring parameters specified in Annex 4, Tables 4 and 8 as of equally high priority (paragraphs 7.6, 7.29).

7.51 The Scientific Committee noted the advice of the Working Group for the CEMP that land-based sites at which approved predator monitoring programs are ongoing or starting should be offered some degree of protection from human interference (SC-CAMLR-VI, Annex 4, paragraph 68). The Commission is requested to advise the Scientific Committee on the appropriate procedure for providing this protection (see paragraph 7.18).

7.52 The Scientific Committee advises that it is unnecessary to hold a meeting of the Working Group for the CEMP during 1988. Progress on six major items of business identified in the report (SC-CAMLR-VI, paragraph 7.39) will be conducted by correspondence and a report presented to the next meeting of the Scientific Committee.

MARINE MAMMAL AND BIRD POPULATION ASSESSMENT

8.1 In fulfilling the provisions of Article II, there are two general categories within which marine mammal and bird issues may arise:

(a) Ecosystem monitoring - which includes the evaluation of natural variation and the numerical and functional relationships between marine mammals, birds, and other components of the ecosystem of which they are a part; and

(b) Population assessment - which includes characterisation, detection, and monitoring of trends in abundance in the populations themselves, especially those which are depleted, declining, or recovering.

8.2 The Scientific Committee has established a process for addressing selected marine mammal and bird issues within the context of its Ecosystem Monitoring Program. To accomplish the goals of this program, a small group of key 'indicator' species was identified for further study. This group includes crabeater seals, Antarctic fur seals, minke whales, adelié, chinstrap, macaroni, and royal penguins, Antarctic and cape petrels, and black-browed albatrosses. Within the context of the Ecosystem Monitoring Program, this limited group of species will be the focus of baseline characterisation studies, monitoring, and directed research efforts designed to detect and quantify changes in the behaviour, reproduction, growth and condition, and demography of these krill predators in relation to changes in their biological and physical environment.

8.3 Whereas most of the marine mammal and bird issues that are currently under discussion within the Scientific Committee relate to the Ecosystem Monitoring Program, it is clear that there are additional marine mammal and bird issues that require attention. Two examples of such issues that have recently been raised within the Scientific Committee are:

a) The request to the IWC Scientific Committee for advice on the methods by which the recovery of depleted whale stocks (e.g., blue, fin, sei, and right whales) might best be assessed (SC-CAMLR-VI, paragraph 7.6); and

b) The apparent decline in southern elephant seal populations in several areas of the Antarctic over the past several decades (SC-CAMLR-VI, paragraph 14.1).

8.4 These topics were raised peripherally within the Scientific Committee under 'ecosystem monitoring' and 'other business'. Although neither topic pertains directly to the Ecosystem Monitoring Program, both are relevant to the Scientific Committee's consideration of issues bearing upon fulfilment of Article II. Therefore, a mechanism is needed outside the context of the Ecosystem Monitoring Program to facilitate discussion of the status of marine mammal and bird populations, particularly for depleted, declining, and recovering populations. The inclusion of a marine mammal and bird item on the Scientific Committee's agenda would provide an orderly forum in which to address such issues.

Population Status

8.5 The Chairman noted that several background papers dealing with the population status of marine mammals and birds had been tabled. These papers pertained to seabirds (SC-CAMLR-VI/BG/15 and SC-CAMLR-VI/BG/19), Antarctic fur seals

(SC-CAMLR-VI/BG/14, SC-CAMLR-VI/BG/15, SC-CAMLR-VI/BG/18, and SC-CAMLR-VI/BG/42) and southern elephant seals (SC-CAMLR-VI/BG/28 and SC-CAMLR-VI/BG/36).

8.6 It was agreed that it would be useful for the Scientific Committee to periodically review the status of all marine mammal and bird populations in the Antarctic, with particular attention to identifying those species whose populations have experienced or are currently experiencing a significant change in abundance. It was agreed that Dr Chittleborough (Australia) should consult with appropriate specialists, particularly the SCAR Group of Specialists on Seals, the Subcommittee on Bird Ecology, and the International Whaling Commission, to produce a list of such species during the intersessional period.

8.7 It was agreed that a comprehensive evaluation and revision of the list described above should be undertaken by the Scientific Committee approximately every 3–5 years. During the interim periods, issues regarding populations of particular concern may be raised under this agenda item.

8.8 Mr D. Miller (South Africa) noted that southern elephant seal populations on Marion and Prince Edward Islands (SC-CAMLR-VI/BG/28), as well as Kerguelen, Possession, and Heard Islands have experienced a clear decline in abundance over the past 12–15 years. It is as yet not known what is causing this decline. Possibilities include inter- or intra-specific competition, interactions with fisheries, habitat changes, or altered movement patterns of the seals. Data on elephant seals during their marine phase should be emphasised as an important research topic.

8.9 Dr J.-C. Hureau (France) noted that the Scientific Committee should be concerned about the declining population of southern elephant seals at Kerguelen Province. It would be desirable to pursue multi-national co-operative research efforts to investigate the reasons for the elephant seal decline. France and South Africa are currently undertaking joint work on this problem.

8.10 Dr R. Chittleborough (Australia) stated that Australian research has shown that southern elephant seal populations are declining at Heard and Macquarie Islands. Ongoing research on this topic will be carried out at Heard Island in 1987/88 and at Macquarie Island in 1988/89.

8.11 The Chairman reported that whereas elephant seal populations were apparently declining in other sectors of the Antarctic, recent surveys at South Georgia indicate a population level similar to the abundance at that island in the 1950's.

8.12 Dr D. Vergani (Argentina) summarised his paper (SC-CAMLR-VI/BG/36) regarding southern elephant Seal abundance at Patagonian and Antarctic research sites. The decline of seals in 1982 and subsequent recovery is thought to have been related to possible El Niño effects that may have produced changes in seal migration patterns. He stressed the importance of attempting to interpret changes in abundance in relation to potential changes in habitat or interactions with fisheries.

8.13 Dr T. Lubimova (USSR) noted that one must exercise caution in inferring causal relationships between elephant seals, the marine environment, and fisheries. The changes identified in Dr Vergani's work had mainly occurred outside the Antarctic.

8.14 Regarding Antarctic fur seals, it was noted that although this species has recovered dramatically from previous commercial exploitation in the South Georgia area, recovery in other areas has been slower. Dr J.L. Bengtson (USA) stated that a recent survey in the South Shetland Islands (SC-CAMLR-VI/BG/18) indicated that although the breeding fur seal population in that area is still below pre-exploitation levels, it is continuing to recover and rookeries are being re-established at some sites.

8.15 Dr J. Croxall (UK) described the status of declining wandering albatross populations throughout the Antarctic. Studies by France in the Indian Ocean, Australia at Macquarie Island, and the United Kingdom at South Georgia indicate a 1–2% annual population decline over the past 20–30 years.

DATA COLLECTION AND HANDLING

Forms and Instructions for Reporting Fine-scale Data

9.1 Members were reminded that the Secretariat, in consultation with the Chairman of the Scientific Committee and in accordance with the Commission's decisions (CCAMLR-V, paragraphs 66–71), had prepared forms and instructions for the submission of fine-scale data. These documents were distributed in each of the official languages on the dates given below:

Fine-scale catch and fishing effort data for finfish	27 June 1987
Fine-scale biological data for finfish	22 August 1987
Fine-scale catch and fishing effort data for krill taken from Subarea 48.2 during 1985/86 and 1986/87	27 June 1987

9.2 The Committee decided that the forms and instructions for submitting fine-scale data for each split-year should be finalised and distributed by the Secretariat on or before 31 March each year.

Forms and Instructions for Catch and Fishing Effort Data

9.3 The decision to report fine-scale data for finfish did not become binding until the 1987/88 fishing season but Members had been requested to report fine-scale data for the 1986/87 season as well. It was hoped that the experience gained from the 1986/87 returns would be useful in revising the forms and instructions prior to their distribution for use in the 1987/88 season. It was noted that for the 1986/87 fishing season, Poland, German Democratic Republic, the Soviet Union and Spain had submitted fine-scale catch and fishing effort data for finfish, Korea had submitted fine-scale biological data for finfish, and Chile, the Soviet Union, and Spain had submitted fine-scale catch and fishing effort data for krill caught in Subarea 48.2.

9.4 The Scientific Committee approved the suggestions for revisions to the forms and instructions for finfish catch and fishing effort data contained in the report of the Working Group on Fish Stock Assessment (Annex 5, paragraph 82) and agreed that these changes should be incorporated into the forms used for the 1987/88 fishing season.

9.5 The Committee agreed that fine-scale catch and fishing effort data should be collected and reported on an annual basis for krill taken from the three integrated study areas described in the Report of the Working Group for the CCAMLR Ecosystem Monitoring Program (Annex 4, Table 1) as well as from Subarea 48.2 (CCAMLR-V, paragraph 71). The study area in the Antarctic Peninsula region is defined as the area west of 54°W longitude, east of

75°W longitude (or the western ice edge, whichever is further east), south to the Antarctic Peninsula and north to 60°S latitude (SC-CAMLR-V, Annex 6, paragraph 48). The study area in the South Georgia region is defined as the area west of 35°W longitude, east of 40°W longitude, south to 56°S latitude and north to 53°S latitude (SC-CAMLR-V, Annex 6, paragraph 60). The study area in the Prydz Bay region is defined as the area west of 85°E longitude, east of 55°E longitude, south to the Antarctic continent and north to 58°S latitude (SC-CAMLR-V, Annex 6, paragraph 70).

Forms and Instructions For Biological Data

9.6 It was noted that there had been insufficient time at the Fish Stock Assessment Meeting to review the forms and instructions for fine-scale biological data. It was agreed that the Secretariat should incorporate the revisions suggested in Annex 5, paragraph 82 where applicable, and that the forms should be reviewed after the 1987/88 fishing season and revised at that time.

Data Collection and Submission for
the CCAMLR Ecosystem Monitoring Program

9.7 After some discussion, it was agreed that it is not feasible to institute a regular system for reporting detailed data from the Ecosystem Monitoring Program until questions about types of data and the level of detail required are resolved. At present, the procedures for reporting data recommended in the Report of the Working Group for the CCAMLR Ecosystem Monitoring Program (Annex 4, paragraph 67) are considered sufficient.

Data Submission – General

9.8 The Data Manager advised the Commission that late submission of data reports was the most significant problem associated with the acquisition of data and its use by working groups. It was noted that the deadline for submission of data refers to the date at which the information should reach the Secretariat and not to the date at which the information should be mailed.

9.9 Members were reminded that 30 September is the deadline for submitting STALANT 08A data, STALANT 08B data, fine-scale catch and fishing effort data for finfish and fine-

scale catch and fishing effort data for krill. Fine-scale biological data for finfish should reach the Secretariat no later that six weeks prior to the meeting of the Working Group on Fish Stock Assessment.

9.10 Members are requested to note the Scientific Committee's decision to establish two new statistical divisions in Subarea 58.5 – Kerguelen Division (58.5.1), and Heard-McDonald Division (58.5.2) (refer to paragraphs 5.86 – 5.78 and Figure 2). All data submitted to the Commission from this subarea should be reported by division.

Advice to the Commission

9.11 The Scientific Committee stressed the need for all data submitted to the Commission to be presented in the proper format and in the appropriate scale, and to reach the Secretariat before the specified deadline.

CO-OPERATION WITH OTHER ORGANISATIONS

10.1 The CCAMLR Scientific Committee was represented at the following meetings during the intersessional period:

XVIII General Assembly of SCOR, Dr K. Kerry
(SC-CAMLR-VI/BG/37)

1987 Annual Meeting of the IWC Scientific Committee,
Dr W. de la Mare
(SC-CAMLR-VI/BG/29)

IOC Regional Committee for the Southern Ocean Meeting,
Dr D. Sahrhage
(SC-CAMLR-VI/BG/7)

75th Statutory Meeting of ICES, Dr K. Sherman
(SC-CAMLR-VI/BG/49)

10.2 The observers presented their reports to the Scientific Committee. Actions required of the Scientific Committee arising from these meetings are reported and discussed under the

relevant agenda item. The Chairman expressed his thanks to the observers for their work on behalf of the Committee.

10.3 A calendar of future meetings was discussed (SC-CAMLR-VI/BG/2) and it was agreed that the Scientific Committee would be represented at the meetings as indicated below:

1988 Annual Meeting of IWC Scientific Committee, USA, 6–19 May 1988
- Dr W. de la Mare

XX Meeting of SCAR, Australia, 5–16 September 1988
- Dr J. Croxall

XIX General Assembly of SCOR, Mexico, August 1988
- (To be nominated)

76th Statutory Meeting of ICES, Norway, 6 – 14 October 1988
- Dr K. Sherman

CCAMLR/IOC Scientific Seminar on Antarctic Ocean Variability and its Influence on Marine Living Resources, Particularly Krill

10.4 The Seminar was held in Paris, 2–6 June 1987. Thirty-two scientific contributions were presented and discussed during the following four main sessions:

meso/large scale variability in the environment
meso/large scale variability in the biota
krill variability in relation to the environment
krill variability detected from predator studies

The report by Dr Sahrhage, the Convener of the Seminar, had been presented to the meeting (SC-CAMLR-VI/BG/3).

10.5 The Seminar called for closer collaboration between meteorological, physical and biological oceanographers at all levels. Recommendations from the Seminar provided

valuable input to the elaboration of the CCAMLR Ecosystem Monitoring Program (SC-CAMLR-VI/4).

CCAMLR/FAO Species Identification Sheets

10.6 Dr J.-C. Hureau reviewed the status of the joint CCAMLR/FAO project on Species Identification Sheets for the Southern Ocean. The English version was published and distributed in 1985. The Identification Sheets proved to be very useful and many scientists around the world continue to request copies. The main stock of the English version is held at FAO, and a smaller stock at the CCAMLR Secretariat. Copies can be obtained on request.

10.7 French and Spanish versions of the Identification Sheets are being prepared. The French manuscript has already been sent to the publisher and both versions are expected to be published by the end of this year. One thousand copies of each language are being produced.

10.8 Both the French and Spanish versions have been amended and updated form the published English version. Changes have been made to the sections on seaweed, fish and marine mammals.

10.9 The decision not to produce a Russian version of the Species Identification Sheets was based mainly on the grounds that FAO do not have the facilities to publish books in cyrillics.

10.10 Each delegation was asked to provide Dr Hureau, or the Secretariat with a list indicating the number of copies in French or Spanish requested, and the name of the person to whom they should be sent for national distribution. A limit of 5–10 copies per delegation was proposed.

REVIEW OF THE LONG-TERM PROGRAM OF WORK
FOR THE SCIENTIFIC COMMITTEE

11.1 Dr K. Sherman (USA) reviewed the draft report of the Informal Group on the Long-term Program of Work for the Scientific Committee. The Group met on 25 October and plans to hold another meeting immediately after the Scientific Committee's meeting.

11.2 This year's agenda of the Group contains two major items: 'Review of the 5 Year Plan of Work of the Scientific Committee' and 'Co-ordination of Future National Surveys'. The latter item includes co-ordination of national surveys for fish stock assessment in the 1987/88 and 1988/89 seasons as recommended by the Commission (CCAMLR-V, paragraph 58).

11.3 The Group drafted and distributed among delegates a request for information on planned national research programs. The request included the following major items to be completed for each program: (1) scientific objectives, (2) study area, (3) period of study, (4) facilities to be used, and (5) other details.

11.4 The information provided by Members has been collated by the Group and will be used as the basis for improving the overall co-ordination and integration of national programs related to the scientific program of CCAMLR.

11.5 In discussing this topic, it was pointed out that there was an apparent lack of effort to integrate various national programs into the future framework of activity of the Scientific Committee. The collated information alone does not provide an adequate means to evaluate the relevance of current or planned research.

11.6 Several proposals were made on possible means for the co-ordination of national research activities, including nomination of national co-ordinators and exchange of cruise information between chief scientists. However, the conclusion was that at present the Scientific Committee does not have any mechanisms for the integration of national research efforts into its long-term program of work, or for co-ordination of such research. Some co-ordination has recently been achieved, but only through bilateral agreements between interested countries (e.g. USA/Poland, and France/USSR).

11.7 It was suggested that some aspects of long-range planning might be better handled in other subsidiary bodies of the Committee. In particular, the Fish Stock Working Group should consider how trawl surveys could best be carried out in order to help the Group achieve its tasks. To this end countries intending to carry out surveys were requested to inform the Convener of the Working Group of their intention as far in advance as possible.

11.8 It was decided that the Informal Group on the Long-term Program of Work for the Scientific Committee should continue its work during the intersessional period, and that the mechanisms for ensuring that the research activities of member countries facilitate the work of the Committee should be reviewed at its 1988 session. The report on the work of the

Group during the 1987 Commission session will be appended as Annex 6. For convenience of reference this report includes material added after the Scientific Committee concluded its substantive discussions.

PUBLICATIONS POLICY AND PROCEDURES FOR THE PREPARATION OF MEETING DOCUMENTS

12.1 The Chairman briefly reviewed the report of the last year's meeting of the Ad Hoc Editorial Board. The Board recommended that the principal criteria for selection of papers for publication in the 'Selected Scientific Papers' should not only be scientific merit but relevance of its subject matter to the work of the Scientific Committee.

12.2 It was suggested and agreed that the selection of papers should rest with the Editorial Board and that acceptance for publication would be accorded by majority vote of the Board. In accordance with last year's decision of the Scientific Committee (SC-CAMLR-V, paragraph 10.12) the Ad Hoc Editorial Board will include the Chairman, Vice-Chairmen, Conveners of the Working Groups, the Executive Secretary, the Science Officer and the Publications Officer. The Ad Hoc Editorial Board will convene after the Scientific Committee meeting and its report will be appended (Annex 7).

12.3 It was also decided that permission for publication should be sought form authors whose papers had been selected for publication. Any revisions of the manuscript should arrive at the Secretariat before 30 December of the current year.

12.4 It was agreed that if a paper had already been accepted for publication elsewhere, only the abstract and reference to the full publication should be published by CCAMLR. However, in cases where the distribution or language of publication was likely to limit its availability, consideration may be given to full reproduction of the paper in 'Selected Scientific Papers'. The necessity to observe copyright regulations in these cases was stressed.

12.5 During the intersessional period, a detailed paper describing CCAMLR publications and giving specific guidelines for the preparation and submission of papers had been distributed to all Members by the Secretariat.

12.6 The Secretariat's guidelines for preparation of Working Papers and Background papers were reviewed. An amendment was agreed to incorporate into coversheets of

Working Papers, and if appropriate of Background Papers, the agenda item to which the papers were addressed, as this would greatly facilitate consideration of the papers by the Meeting.

12.7 The dates for submission of meeting documents were reviewed. It was agreed that Working Papers should reach Secretariat no later that 45 days before the meeting, and Background Papers, including abstracts, no later than 30 days before the meeting. Papers submitted after these dates would not be considered until the next meeting of the Scientific Committee. Reports of Members' Activities should reach the Secretariat no later than 30 August each year.

12.8 A revised version of the guidelines will be distributed to all Members by the Secretariat in January 1988. Compliance with the guidelines will assist the Secretariat in improving the presentation of papers and in streamlining their distribution and publication.

1988 BUDGET OF THE SCIENTIFIC COMMITTEE

13.1 A draft budget was prepared with the assistance of the Secretariat setting down the cost of implementing the decisions taken by the Committee at this meeting. The budget approved by the Commission is included at Annex 8.

ELECTION OF VICE-CHAIRMEN OF THE SCIENTIFIC COMMITTEE

14.1 Dr J.-C. Hureau (France) nominated Dr Y. Shimadzu (Japan) and Dr E. Marschoff (Argentina) as Vice-Chairmen of the Scientific Committee. The nomination was seconded by Dr Gong (Korea). The Chairman of the Scientific Committee recalled active participation and valuable contributions by both nominees in the work of the Scientific Committee as well as their considerable experience in Antarctic marine biology.

14.2 Dr Y. Shimadzu and Dr E. Marschoff were unanimously elected as Vice-Chairmen of the Scientific Committee for the period from the end of the Sixth Meeting until the end of the Scientific Committee meeting in 1989, in accordance with Rules 3 and 8 of the Rules of Procedure.

14.3 The Chairman congratulated the new Vice-Chairmen on their election. He also paid tribute to their predecessors, Dr J.-C. Hureau (France) and W. Slosarczyk (Poland), and

thanked them for their continued support and valuable contributions to the work of the Scientific Committee during the past two years.

NEXT MEETING

15.1 In accordance with discussions held during the 1986 Meeting, hotel bookings have been made in Hobart for the Seventh Meeting of the Scientific Committee and Commission for the period 23 October to 5 November 1988.

15.2 It was noted that the Working Group on Fish Stock Assessment Meeting has been planned in association with the Seventh Meeting of the Scientific Committee, and is tentatively scheduled for the period 12 to 20 October 1988.

15.3 The timing and venue of future meetings will be discussed further by the Commission.

OTHER BUSINESS

New Computer Facilities for the Secretariat

16.1 It was agreed that CSIRONET should not be used for data management for the reasons described in CCAMLR-VI/11, paragraph 11. The Scientific Committee recommended that the Commission make alternative arrangements for handling fine-scale catch, fishing effort and biological data.

16.2 Three options for the purchase of computer equipment described in a background paper (SC-CAMLR-VI/BG/51) were reviewed by a small task group and it was agreed that each of the options would meet the basic needs of the Commission. It was recommended that further deliberations of the subject of new computer equipment be based on the options described in this background paper.

16.3 It was emphasised that the new computing system should include facilities for reading and writing magnetic tapes.

Effects of Atmospheric Ozone Layer Depletion
on Antarctic Marine Living Resources

16.4 Dr K. Sherman mentioned that during a joint USA/Polish research cruise aboard the Polish vessel RV *Professor Siedlecki* in the 1986/87 season, some experiments were carried out to test the effects of ultraviolet radiation on Antarctic phytoplankton (SC-CAMLR-VI/BG/17). In the context of recently observed phenomenon of ozone depletion above Antarctica, the preliminary result may be of importance for the Working Group for the CCAMLR Ecosystem Monitoring Program. A more detailed report of the US/Polish cruise will be available soon.

Plankton Sorting Facilities in Poland

16.5 Dr W. Slosarczyk informed the Scientific Committee that the Plankton Sorting and Identification Centre in Szczecin, Poland offers low cost services in sorting and identification of zooplankton samples, including ichthyoplankton, to any interested countries and institutions. The Centre can also arrange for phytoplankton samples in Poland. Interested persons should contact:

Dr Leonard Ejsymont
Plankton Sorting and Identification Center
Szczecin Regional Branch of the Sea Fisheries Institute
4, K. Królewricza Str., Pawilon E
71–550 Szczecin, POLAND

ADOPTION OF THE REPORT

17.1 The Report of the Sixth Meeting of the Scientific Committee was reviewed and adopted.

CLOSE OF THE MEETING

18.1 The Chairman thanked Members and other participants, in particular the Conveners of Working Groups, Rapporteurs and the Secretariat for their co-operation and support. He also extended his thanks to the interpreters and translators, and closed the meeting.

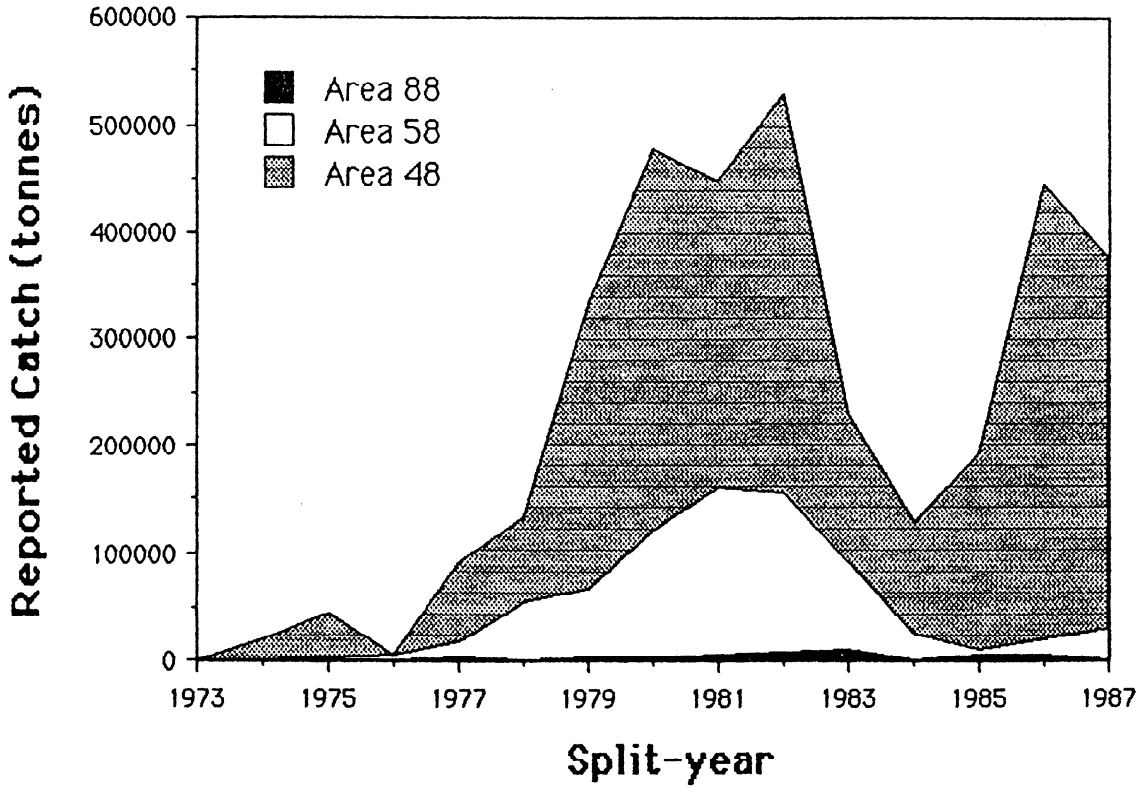
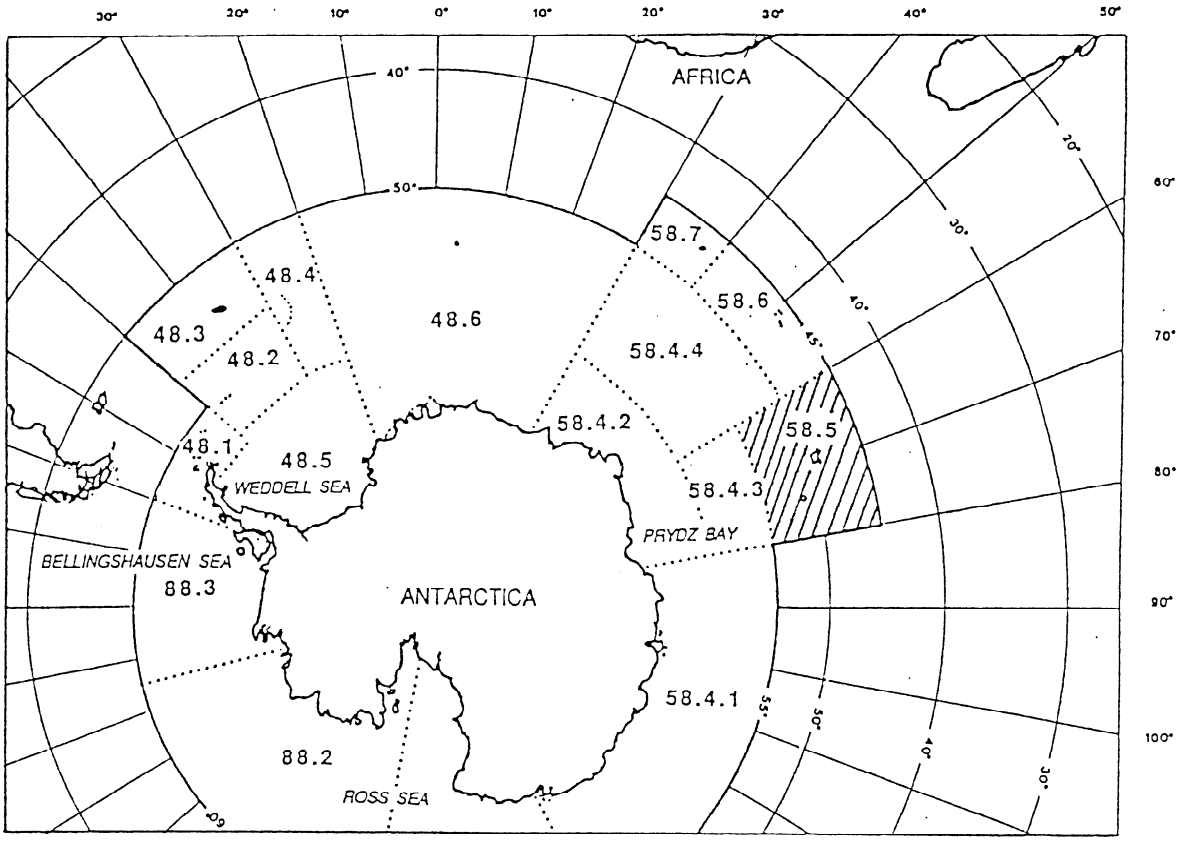


Figure 1: Annual krill catch (in tonnes) by statistical area, 1972/73 – 1986/87.



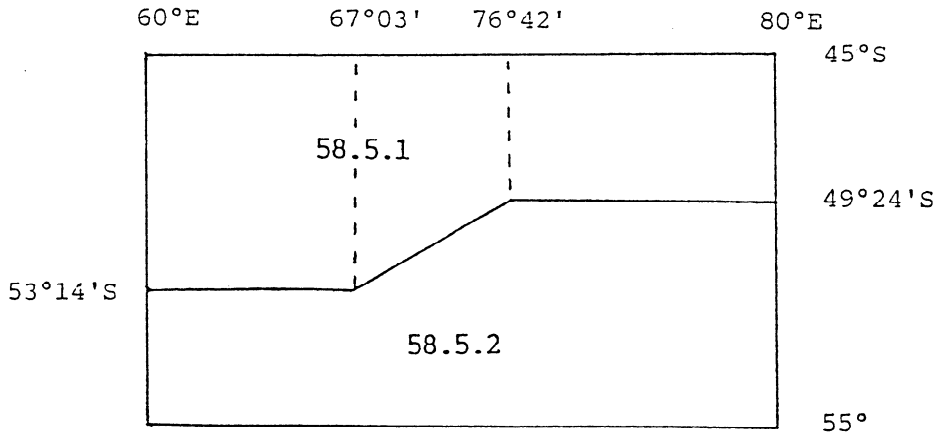


Figure 2: Map showing Subarea 58.5 and boundaries of newly established divisions 58.5.1 (Kerguelen Division) and 58.5.2 (McDonald-Heard Division).

ANNEX 1

LIST OF MEETING PARTICIPANTS

LIST OF PARTICIPANTS

CHAIRMAN

Dr Inigo EVERSON
Section Head
Marine Biology
British Antarctic Survey
Madingley Road
CAMBRIDGE CB3 0ET
United Kingdom

ARGENTINA

Representative:

Consejero Roberto H. MAGNACCA
Subdirector General de Antartida
Ministerio de Relaciones Exteriores y Culto
Buenos Aires

Alternate Representatives:

Dr Enrique MARSCHOFF
Licenciado en Ciencias Biologicas
Instituto Antartico Argentino
Buenos Aires

Sr Angel VILLANUEVA MOURE
Secretario de Embajada
Embajada Argentina en Australia
Canberra

Sta Monica R. CARCI
Secretario de Embajada
Direccion General de Antártida
Ministerio de Relaciones Exteriores y Culto
Buenos Aires

Dr Daniel F. VERGANI
Doctor en Ciencias Naturales
Instituto Antártico Argentino
Direccion Nacional del Antártico
Buenos Aires

Dr Eugenio A. GENEST
Licenciado en Ciencias Politicas
Direccion Nacional del Antártico
Buenos Aires

AUSTRALIA

Representative:	Dr R. Graham CHITTLEBOROUGH Special Adviser Antarctic Division
	Dr Knowles KERRY Antarctic Division
	Dr Patrick QUILTY Antarctic Division
	Mr Allan HAINES Department of the Arts, Sport, the Environment, Tourism & Territories
	Dr William DE LA MARE Special Adviser
	Mr Richard WILLIAMS Antarctic Division
	Dr. Keith SAINSBURY Division of Fisheries Research CSIRO
Advisers:	Mr Gary F. QUINLAN Director Maritime Resoruces Section Department of Foreign Affairs & Trade
	Mr. Roger C. FRANKEL Maritime Resources Section Department of Foreign Affairs & Trade
	Mr Jim KEENAN Department of the Arts, Sport, the Environment, Tourism & Territories
	Dr Stephen NICOL Antarctic Division
	Ms Robyn GRAHAM Antarctic Division
	Mr Andrew J. CONSTABLE Representative of Non-governmental Organisations

BELGIUM

Representative:	Dr Pierre HOVART Director for State Fisheries Station Oostende
Alternate Representative:	Mr Phillippe JOTTARD Counsellor Royal Belgian Embassy
Adviser:	Mr Edmond DE WILDE Counsellor Belgian Ministry for Foreign Affairs Brussels

BRAZIL

Representative:	Antonio José GUERREIRO First Secretary Ministry of External Relations Brasilia
Alternate Representative:	Dr Janice Romaguera TROTTE Adviser Brazilian Interministerial Commission for Resources of the Sea (CIRM) Brasilia
Advisers:	Mr José Borges DOS SANTOS Jr Second Secretary Embassy of Brazil
	Mr Antonio Carlos FRANÇA Third Secretary Ministry of External Relations Brasilia

CHILE

Representative:	Mr Rolando STEIN Consul General of Chile Melbourne
Alternative Representatives:	Mr Antonio MAZZEI Deputy Director Antartic Institute of Chile Santiago

Mrs Lucia RAMIREZ
Antarctic Department
Ministry of Foreign Affairs
Santiago

EEC

Representative:

Dr Guy DUHAMEL
Chargé de Recherche au CNRS
Muséum National d'Histoire Naturelle
Laboratoire d'Ichtyologie Générale et Appliquée
Paris

Advisers:

Dr John A. GULLAND
Research Fellow
Marine Resources Assessment Group
Imperial College
London

Dr Konstantios. VAMVAKAS
Principal Administrator
Commission of EEC
Brussels

Mrs Anna MECKMANN
Principal Administrator
Council of EEC
EC Fisheries Policy Council
Burssels

FRANCE:

Representative:

Dr Jean-Claude HUREAU
Professor, Sous Directeur
Muséum National d'Histoire Naturelle
Paris

Adviser:

Mr Serge GARACHE
Chargé de Mission auprès due Directeur des
Pêche Maritimes
Secrétariat de'Etat à la Mer
Paris

GERMAN DEMOCRATIC REPUBLIC:

Representative:	Dr Walter RANKE Head of Department Fischkombinat Rostock German Democratic Republic

GERMANY, FEDERAL REPUBLIC OF:

Representative:	Dr Karl-Hermann KOCK Federal Research Board for Fisheries Hamburg
Adviser:	Mr Dieter EBERLE Counsellor Federal Ministry for Food, Agriculture and Forestry Bonn

INDIA:

Representative:	Mr Chandra M. BHANDARI Deputy High Commissioner High Commission for India Canberra

JAPAN:

Representative:	Mr Minoru MORIMOTO Counsellor Oceanic Fisheries Department Fisheries Agency
Advisers:	Dr Yasuhiko NAITO National Institute of Polar Research
	Dr Yuzo KOMAKI Far Seas Fisheries Research Laboratory Fisheries Agency
	Mr Masaru OKUNO International Affairs Division Oceanic Fisheries Department Fisheries Agency

Mr Shuichiro KAWAGUCHI
Fisheries Division
Economic Affairs Bureau
Ministry of Foreign Affairs of Japan

Mr Takeo MUROI
Japan Deep Sea Trawlers Association

Mr Kiyoshi MATSUMOTO
Japan Deep Sea Trawlers Association

KOREA, REPUBLIC OF:

Representative: Dr Yeong GONG
Director
Deep Sea Resources Divison
National Fisheries Research and Development Agency

NEW ZEALAND:

Representative: Dr Don ROBERTSON
Ministry of Agriculture & Fisheries

Alternate Representative: Mr Michael DONOGHUE
Senior Conservation Officer
Department of Conservation
Wellington

Advisers: Mr Gerard VAN BOHEMEN
Legal Division
Ministry of Foreign Affairs

Mr Timothy GENTLE
Non-governmental Organisations Representative

NORWAY:

Representative: Mr Ole J. ØSTVEDT
Deputy Director
Institute of Marine Research
Bergen

Adviser: Mr Rolf Trolle ANDERSEN
Minister Plenipotentiary
Ministry of Foreign Affairs
Oslo

POLAND:

Representative:	Dr Wieslaw SLOSARCZYK Sea Fisheries Institute Gdynia

SOUTH AFRICA:

Representative:	Mr Denzil MILLER Sea Fisheries Research Institute Department of Environment Roggebaai
Advisers:	Mr John D. VIALL Chief Legal Adviser Department of Foreign Affairs
	Mr Roger J. BALLARD-TREMEER Consul and Head of Mission South African Consulate Sydney

SPAIN:

Representative:	Mr Eduardo BALGUERIAS Spanish Institute of Oceanography

USSR:

Representative:	Dr Tatiana G. LUBIMOVA Chief Laboratory of Antarctic Research VNIRO Research Institute Moscow
Advisers:	Mr Valeriy I. TSOUKALOV Chief, Department of Fisheries USSR Ministry of Fisheries Moscow

Mr Vladimir I. IKRJANNIKOV
Ministry of Fisheries
Deputy Chief
Department of External Affairs
Moscow

Dr Lev A. POPOV
Chief
Laboratory on Marine Mammal Research
Moscow

Mr Serguei N. KOMOGORTSEV
Science Officer
Laboratory of Antarctic Research
VNIRO Research Institute
Moscow

Dr Rudolf G. BORODIN
Senior Scientist
Department of Catch Prediction
VNIRO Research Institute
Moscow

Ms Natasha K. PRUSOVA
VNIRO Research Institute
Moscow

UK:

Chairman, Scientific Committee:	Dr Inigo EVERSON Section Head Marine Biology British Antarctic Survey Cambridge
Representative:	Dr John BEDDINGTON Director Marine Resources Assessment Group Imperial College London
Advisers:	Dr John P. CROXALL Head Bird and Mammal Section British Antarctic Survey Cambridge

Dr John HEAP
Head, Polar Regions Section
Foreign and Commonwealth Office
London

Mr Michael SNELL
Second Secretary
Polar Regions Section
Foreign and Commonwealth Office
London

USA:

Representative:

Dr Kenneth SHERMAN
Director National Marine Fisheries Laboratory
Narragansett

Advisers:

Dr John L. BENGTSON
National Marine Mammal Laboratory
National Marine Fisheries Service
Seattle

Dr Richard C. HENNEMUTH
Director Woods Hole Laboratory
National Marine Fisheries Service
Woods Hole

Dr Polly PENHALE
Program Manager
Polar Biology and Medicine
National Science Foundation
Washington, D.C.

Mr Bruce S. MANHEIM
Environmental Defense Fund
Washington, D.C.

Dr Michael SISSENWINE
National Marine Fisheries Service
Seattle

OBSERVERS - ACCEDING STATES

GREECE:

Dr Alexis K. PITTAS
Honorary Consul of Greece
Hobart

SWEDEN:

Mr Goran RUDBACK
Research Secretary
Polar Research Secretariat
The Royal Swedish Academy of Sciences
Stockholm

Dr Bo FERNHOLM
Museum of Natural History
Stockholm

URUGUAY:

Mr Mario FONTANOT
Uruguayan Antarctic Institute

Mr Julio GIAMBRUNO
Charge d'Affaires
Embassy of Uruguay

Dr José Pedro DRAGONETTI SAUCERO
Head
Scientific Programmes Division
Uruguayan Antarctic Institute

OBSERVER COUNTRY

PERU:

His Excellency Mr Gonzalo BEDOYA
Ambassador
Embassy of Pery
Canberra

OBSERVERS - INTERNATIONAL ORGANISATIONS

IOC:

Prof. Jean-Claude HUREAU
Professor, Sous-Directeur
Muséum National d'Histoire Naturelle
Paris

IUCN:

Prof. Alexandre KISS
President
Conseil Européen du Droit de l'Environment
University III
Strassbourg

Dr. Justin COOKE
Department of Biology
University of York

IWC:

Dr William DE LA MARE
3 Seymour Avenue
Mount Eliza 3930
Victoria

SCAR:

Professor Jean-Claude HUREAU
Professor, Sous-Directeur
Muséum National d'Histoire Naturelle
Paris

SCOR:

Professor Jean-Claude HUREAU
Professor, Sous-Directeur
Muséum National d'Histoire Naturelle
Paris

SECRETARIAT

EXECUTIVE SECRETARY	Dr Darry POWELL
SCIENCE OFFICER	Dr Eugene SABOURENKOV
DATA MANAGER	Dr Larry JACOBSON
ADMINISTRATIVE/FINANCE OFFICER AND MEETING DOCUMENTS OFFICER	Mr Terry GRUNDY
PUBLICATIONS OFFICER/EDITOR	Ms Glenys JONES
ASSISTANT DOCUMENTS OFFICER	Mrs Rosalie MARAZAS
DOCUMENT PRODUCTION AND DISTRIBUTION	Mrs Leanne BLEATHMAN
	Mrs Debbie FRANKCOMBE
SENIOR SECRETARY	Miss Lisa LARK
SECRETARY	Mrs Genevieve NAYLOR
SECRETARY	Ms Judy GLOCK

ANNEX 2

LIST OF MEETING DOCUMENTS

LIST OF MEETING DOCUMENTS

SCIENTIFIC COMMITTEE DOCUMENTS

SC-CAMLR-VI/1	PROVISIONAL AGENDA FOR THE SIXTH MEETING OF THE SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES
SC-CAMLR-VI/2	ANNOTATION TO THE PROVISIONAL AGENDA OF THE SIXTH MEETING OF THE SCIENTIFIC COMMITTEE Executive Secretary
SC-CAMLR-VI/3	REPORT OF THE AD HOC WORKING GROUP ON FISH STOCK ASSESSMENT - HOBART 19–23 OCTOBER, 1987
SC-CAMLR-VI/4	REPORT OF THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM, FRANCE 10–16 JUNE, 1987
SC-CAMLR-VI/5	CCAMLR/IWC JOINTLY SPONSORED WORKSHOP ON THE FEEDING ECOLOGY OF SOUTHERN BALEEN WHALES Executive Secretary
SC-CAMLR-VI/6	DRAFT OUTLINE OF CCAMLR STATISTICAL BULLETIN Executive Secretary
SC-CAMLR-VI/7	REPORT OF THE SIXTH MEETING OF THE SCIENTIFIC COMMITTEE

****

SC-CAMLR-VI/BG/1	SUMMARY OF KRILL LANDINGS Secretariat
SC-CAMLR-VI/BG/1 Rev. 1	SUMMARY OF KRILL LANDINGS Secretariat
SC-CAMLR-VI/BG/2	CALENDAR OF FORTHCOMING MEETINGS Secretariat

SC-CAMLR-VI/BG/3	REPORT OF THE SCIENTIFIC SEMINAR OF ANTARCTIC OCEAN VARIABILITY AND ITS INFLUENCE ON MARINE LIVING RESOURCES, PARTICULARLY KRILL D. Sahrhage (Federal Republic of Germany)
SC-CAMLR-VI/BG/4	KRILL CPUE SIMULATION STUDY REPORTS OF ACTIVITIES J. Beddington (UK)
SC-CAMLR-VI/BG/5	SUMMARY OF FISHERIES DATA Secretariat
SC-CAMLR-VI/BG/5 Rev. 1	SUMMARY OF FISHERIES DATA Secretariat
SC-CAMLR-VI/BG/6	VACANT
SC-CAMLR-VI/BG/7	IOC REGIONAL COMMITTEE FOR THE SOUTHERN OCEAN Paris, 9–12 June 1987 D. Sahrhage (Federal Republic of Germany)
SC-CAMLR-VI/BG/8	PREY MONITORING SURVEYS I. Everson (UK)
SC-CAMLR-VI/BG/9	KRILL TARGET STRENGTH, CURRENT STATUS I. Everson (UK)
SC-CAMLR-VI/BG/10	SQUID RESOURCES I. Everson (UK)
SC-CAMLR-VI/BG/11	CEPHALOPOD RESEARCH IN THE ANTARCTIC P. Rodhouse (UK)
SC-CAMLR-VI/BG/12	RESULTS OF FISH STOCK ASSESSMENT SURVEY, SOUTH GEORGIA REGION, NOVEMBER–DECEMBER 1986 W. Gabriel (USA)
SC-CAMLR-VI/BG/12 Rev. 1	RESULTS OF FISH STOCK ASSESSMENT SURVEY, SOUTH GEORGIA REGION, NOVEMBER–DECEMBER 1986 W. Gabriel (USA)
SC-CAMLR-VI/BG/13	CAN WE SATISFACTORILY ESTIMATE VARIATION IN KRILL ABUNDANCE? I. Everson (UK)

SC-CAMLR-VI/BG/14	LONG TERM TRENDS IN THE FORAGING PATTERNS OF FEMALE ANTARCTIC FUR SEALS AT SOUTH GEORGIA J.L. Bengtson (USA)
SC-CAMLR-VI/BG/15	VARIATION IN REPRODUCTIVE PERFORMANCE OF SEABIRDS AND SEALS AT SOUTH GEORGIA, 1976–1986 AND ITS IMPLICATIONS FOR SOUTHERN OCEAN MONITORING STUDIES J.P. Croxall et al. (UK)
SC-CAMLR-VI/BG/16	BRIEF REPORT OF THE JOINT SOVIET-AUSTRALIAN EXPEDITION OF THE USSR FRV 'PROFESSOR MESYATSEV' TO THE AUSTRALIAN FISHING ZONE AROUND THE TERRITORY OF HEARD AND MCDONALD ISLANDS, MAY–AUGUST, 1987 V.V. Gerasimchuk et al. (USSR, Australia)
SC-CAMLR-VI/BG/17	U.S. ANTARCTIC MARINE LIVING RESOURCES PROGRAM ECOSYSTEM MONITORING SURVEY 1986–87 CRUISE RESULTS CRUISE NO. SI 86–01 (I–III) Delegation of USA
SC-CAMLR-VI/BG/18	SURVEY OF ANTARCTIC FUR SEALS *ARCTOCEPHALUS GAZELLA* IN THE SOUTH SHETLAND ISLANDS, ANTARCTICA, DURING THE 1987/87 AUSTRAL SUMMER J.L. Bengtson et al. (USA, Sweden)
SC-CAMLR-VI/BG/19	SURVEYS OF BREEDING PENGUINS AND OTHER SEABIRDS IN THE SOUTH SHETLAND ISLANDS, ANTARCTICA, JANUARY – FEBRUARY 1987 W.D. Shuford and L.B. Spear (USA)
SC-CAMLR-VI/BG/20	THE ANTARCTIC SCALLOP, *ADAMUSSIUM COLBECKI* I. MARK-AND-RECAPTURE EXPERIMENTS AND THE POPULATION BIOLOGY OF *ADAMUSSIUM COLBECKI* IN NEW HARBOR, ANTARCTICA P.A. Berkman (USA)
SC-CAMLR-VI/BG/21	PHYTOPLANKTON DATA FROM THE BRANSFIELD STRAIT AND ELEPHANT ISLAND REGION OF THE SOUTHERN OCEAN (R/V PROFESSOR SIEDLECKI CRUISE, 28 DECEMBER – 24 JANUARY 1987) L.H. Weber and S. El-Sayed (USA)
SC-CAMLR-VI/BG/22	SIMULATION OF SOUTHERN OCEAN KRILL FISHERIES M. Mangel (USA)

SC-CAMLR-VI/BG/23	A RATIONALE FOR CONSERVATION AREAS WITHIN ANTARCTIC WATERS R.G. Chittleborough (Australia)
SC-CAMLR-VI/BG/24	AGE AND GROWTH OF ANTARCTIC EUPHAUSIACEA (CRUSTACEA) UNDER NATURAL CONDITIONS V. Siegel (Federal Republic of Germany)
SC-CAMLR-VI/BG/25	INVENTORY OF EXISTING INFORMATION ABOUT EARLY STAGES OF ANTARCTIC FISH J.-C. Hureau (SCAR)
SC-CAMLR-VI/BG/26	CCAMLR ANTARCTIC FISH OTOLITHS/SCALES/BONES EXCHANGE SYSTEM – PROGRESS REPORT K.-H. Kock (Federal Republic of Germany)
SC-CAMLR-VI/BG/27	CCAMLR/BIOMASS WORKSHOP ON KRILL ABUNDANCE I. Everson (UK)
SC-CAMLR-VI/BG/28	SOUTHERN ELEPHANT SEALS AND CCAMLR Delegation of South Africa
SC-CAMLR-VI/BG/29	REPORT OF THE CCAMLR OBSERVER TO THE MEETING OF THE SCIENTIFIC COMMITTEE OF THE INTERNATIONAL WHALING COMMISSION W. de la Mare (Australia)
SC-CAMLR-VI/BG/30	VACANT
SC-CAMLR-VI/BG/31	AREAS OF SEABED WITHIN SELECTED DEPTH RANGES IN THE SOUTH-WEST ATLANTIC AND ANTARCTIC PENINSULA REGIONS OF THE SOUTHERN OCEAN I. Everson (UK)
SC-CAMLR-VI/BG/32	CEPHALOPOD INTERNATIONAL ADVISORY COUNCIL I. Everson (UK)
SC-CAMLR-VI/BG/33	AN ASSESSMENT OF THE MERITS OF LENGTH AND WEIGHT MEASUREMENTS OF ANTARCTIC KRILL *EUPHAUSIA SUPERBA* D.J. Morris et al. (UK, Federal Republic of Germany)
SC-CAMLR-VI/BG/34	FORMAT SPECIFICATIONS FOR KRILL CATCH AND FISHING EFFORT DATA VERSION 1.9 Secretariat

SC-CAMLR-VI/BG/35	OBSERVATION OF FISHING OPERATION AND DISTRIBUTIONAL BEHAVIOUR OF KRILL ON A KRILL TRAWLER OFF WILKES LAND DURING THE 1985/86 SEASON T. Ichii (Japan)
SC-CAMLR-VI/BG/36	OBSERVATION ON HAUL OUT PATTERNS AND TRENDS OF THE BREEDING POPULATIONS OF SOUTHERN ELEPHANT SEAL AT PENINSULA VALDES (PATAGONIA) AND STRANGER POINT (25 DE MAYO – KING GEORGE I.) D.F. Vergani et al. (Argentina)
SC-CAMLR-VI/BG/37	REPORT OF THE EIGHTEENTH GENERAL MEETING OF THE SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH K. Kerry (Australia)
SC-CAMLR-VI/BG/38	A SIMULATION STUDY OF KRILL FISHING BY AN INDIVIDUAL JAPANESE TRAWLER D.S. Butterworth (UK)
SC-CAMLR-VI/BG/39	THE ERROR OF THE BIOMASS ESTIMATE AS A FUNCTION OF SURVEY PARAMETERS AND THE STATISTICS OF A DENSITY FIELD OF KRILL AGGREGATIONS Z. I. Kizner (USSR)
SC-CAMLR-VI/BG/40	ANALYSIS OF CHANGES IN BIOMASS OF FISH STOCKS IN THE SOUTH GEORGIA AREA IN 1976/77 – 1986/87 M. Mucha and W. Slosarczyk (Poland)
SC-CAMLR-VI/BG/41	FISHING EFFORTS AND CPUE OF KRILL FISHING BOATS INTERIM SUMMARY Y. Shimadzu (Japan)
SC-CAMLR-VI/BG/42	OBSERVATIONS ON THE TREND OF THE POPULATION OF *ARCTOCEPHALUS GAZELLA* AT LAURIE ISLAND – SOUTH ORKNEY D.F. Vergani and N.R. Coria (Argentina)
SC-CAMLR-VI/BG/43	AGE DETERMINATION OF THE ANTARCTIC FISHES *CHAMPSOCEPHALUS GUNNARI* AND *NOTOTHENIA ROSSII* FORM SOUTH GEORGIA R. Radtke (USA)
SC-CAMLR-VI/BG/44	KRILL STOCK IDENTIFICATION USING DNA ANALYSES R.W. Chapman (USA)

SC-CAMLR-VI/BG/45	KRILL COMMUNITY STUDIES USING NET AND HYDROACOUSTIC SAMPLING TECHNIQUES J.R. Green et al. (USA)
SC-CAMLR-VI/BG/46	BIOMASS ESTIMATES OF KRILL IN THE BRANSFIELD STRAIT – ELEPHANT ISLAND ECOSYSTEM MONITORING AREA OF CCAMLR, 1987 M.C. Macaulay (USA)
SC-CAMLR-VI/BG/47	MOLT PRODUCTION METHOD OF BIOMASS ESTIMATION OF ANTARCTIC KRILL R. Lasker and S. Butler (USA)
SC-CAMLR-VI/BG/48	AGE DETERMINATION OF ANTARCTIC KRILL USING SIZE, FLUORESCENCE, AND IMAGE ANALYSIS TECHNIQUES M.S. Berman et al. (USA, Australia)
SC-CAMLR-VI/BG/49	ICES ANNUAL MEETING 1987 AND SPECIAL SYMPOSIUM ON ARCTIC AND SUBARCTIC SYSTEMS K. Sherman (USA)
SC-CAMLR-VI/BG/50	INFORMATION OF RECENT USSR PUBLICATIONS ON RESEARCH IN ANTARCTIC MARINE LIVING RESOURCES Delegation of USSR
SC-CAMLR-VI/BG/51	COMPARISON OF THREE OPTIONS FOR PURCHASE OF COMPUTER EQUIPMENT Secretariat

****

COMMISSION DOCUMENTS

CCAMLR-VI/1	PROVISIONAL AGENDA FOR THE SIXTH MEETING OF THE COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES
CCAMLR-VI/2	ANNOTATION TO THE PROVISIONAL AGENDA FOR THE SIXTH MEETING OF THE COMMISSION Executive Secretary
CCAMLR-VI/3	PROVISIONAL AGENDA FOR THE STANDING COMMITTEE ON ADMINISTRATION AND FINANCE
CCAMLR-VI/4	EXAMINATION OF THE AUDITED FINANCIAL STATEMENTS Executive Secretary

CCAMLR-VI/5	REVIEW OF THE 1987 BUDGET AND EXAMINATION OF THE DRAFT 1988 BUDGET AND THE FORECAST 1989 BUDGET Executive Secretary
CCAMLR-VI/6	IMPLEMENTATION OF ARTICLE XIX.3 OF THE CONVENTION (BUDGET CONTRIBUTIONS) Executive Secretary
CCAMLR-VI/7	PROPOSAL TO ESTABLISH A NEW POSITION IN THE SECRETARIAT AND TO AMEND THE STAFF REGULATIONS TO ALLOW EMPLOYMENT OF PERMANENT PART-TIME STAFF Executive Secretary
CCAMLR-VI/7 Rev. 1	PROPOSAL TO ESTABLISH A NEW POSITION IN THE SECRETARIAT AND TO AMEND THE STAFF REGULATIONS TO ALLOW EMPLOYMENT OF PERMANENT PART-TIME STAFF Executive Secretary
CCAMLR-VI/8	PROCEDURES FOR THE APPOINTMENT OF EXECUTIVE SECRETARY TO CCAMLR Executive Secretary
CCAMLR-VI/9	ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY OF ANTARCTIC MARINE LIVING RESOURCES Executive Secretary
CCAMLR-VI/9 Rev. 1	ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY OF ANTARCTIC MARINE LIVING RESOURCES Executive Secretary
CCAMLR-VI/10	VACANT
CCAMLR-VI/11	PROPOSAL FOR PURCHASE OF COMPUTER EQUIPMENT FOR DATA MANAGEMENT AND ANALYSIS Executive Secretary
CCAMLR-VI/12	REPORT OF THE CCAMLR OBSERVER TO THE INTERNATIONAL WHALING COMMISSION Executive Secretary
CCAMLR-VI/13	REPORT ON THE ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY Delegation of the Republic of Korea

CCAMLR-VI/14	REPORT BY AUSTRALIA ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY OF ANTARCTIC MARINE LIVING RESOURCES ASSOCIATED WITH OPERATIONS IN THE CCAMLR AREA Delegation of Australia
CCAMLR-VI/15	COMMENTS OF THE DRAFT BUDGET FOR 1988 AND FORECAST BUDGET FOR 1989 FOR INCLUSION IN THE SCAF REPORT Delegation of USSR
CCAMLR-VI/16	THE EXECUTIVE SECRETARY'S REPORT OF THE MEETING OF THE STANDING COMMITTEE ON ADMINISTRATION AND FINANCE Executive Secretary

****

CCAMLR-VI/BG/1	REGISTER OF PERMANENT RESEARCH VESSELS Secretariat
CCAMLR-VI/BG/2 Rev. 1	LIST OF MEETING DOCUMENTS CCAMLR-VI, SC-CAMLR-VI, 1987
CCAMLR-VI/BG/3	LIST OF MEETING PARTICIPANTS
CCAMLR-VI/BG/3 Rev. 1	LIST OF MEETING PARTICIPANTS
CCAMLR-VI/BG/4	UNITED STATES ACTIVITIES RELATED TO ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY OF ANTARCTIC MARINE LIVING RESOURCES Delegation of USA
CCAMLR-VI/BG/5	STATEMENT FOR THE 1987 MEETING OF THE COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES (IUCN) A. Kiss (IUCN)
CCAMLR-VI/BG/6	ADDRESS TO THE ATCM – XIV MEETING ON BEHALF OF THE CHAIR OF THE CCAMLR – COMMISSION Chairman of the Commission
CCAMLR-VI/BG/7	APPLICATIONS OF ASOC AND GREENPEACE INTERNATIONAL FOR OBSERVER STATUS AT THE 1987 CCAMLR MEETING Secretariat

CCAMLR-VI/BG/8	JAPAN'S REPORT ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY Delegation of Japan
CCAMLR-VI/BG/9	LOSS OF SCIENTIFIC GEAR: REPORT BY THE UNITED KINGDOM Delegation of UK
CCAMLR-VI/BG/10	CONSIDERATION OF A MANAGEMENT STRATEGY FOR ANTARCTIC FISH STOCK RECOVERIES R.C. Hennemuth (USA)
CCAMLR-VI/BG/11	ANTARCTIC SEALS Delegation of Australia
CCAMLR-VI/BG/12	CO-OPERATION WITH FAO Secretariat
CCAMLR-VI/BG/13	THE POTENTIAL EFFECTS OF OZONE DEPLETION OVER ANTARCTICA Delegation of USA
CCAMLR-VI/BG/14	REGULATION OF MARINE DEBRIS UNDER ANNEX V OF THE MARPOL CONVENTION Delegation of USA
CCAMLR-VI/BG/15	ARGENTINA'S ACTIVITIES RELATED TO ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY OF ANTARCTIC MARINE LIVING RESOURCES Delegation of Argentina
CCAMLR-VI/BG/16	STATEMENT BY THE REPRESENTATIVE OF SPAIN Delegation of Spain

****

CCAMLR-VI/MA/1	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 ARGENTINA
CCAMLR-VI/MA/2	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 USSR
CCAMLR-VI/MA/3	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 SOUTH AFRICA

CCAMLR-VI/MA/4	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 FEDERAL REPUBLIC OF GERMANY
CCAMLR-VI/MA/5	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 UNITED KINGDOM
CCAMLR-VI/MA/6	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 INDIA
CCAMLR-VI/MA/7	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 UNITED STATES OF AMERICA
CCAMLR-VI/MA/8	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 CHILE
CCAMLR-VI/MA/9	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 JAPAN
CCAMLR-VI/MA/9 Rev. 1	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 JAPAN
CCAMLR-VI/MA/10	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 REPUBLIC OF KOREA
CCAMLR-VI/MA/11	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 AUSTRALIA
CCAMLR-VI/MA/12	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 POLAND
CCAMLR-VI/MA/13	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 BRAZIL
CCAMLR-VI/MA/14	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 SPAIN

CCAMLR-VI/MA/15	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 NEW ZEALAND
CCAMLR-VI/MA/16	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 BELGIUM
CCAMLR-VI/MA/16 Rev. 1	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 BELGIUM
CCAMLR-VI/MA/17	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 NORWAY
CCAMLR-VI/MA/18	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 GERMAN DEMOCRATIC REPUBLIC
CCAMLR-VI/MA/19	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1986/87 FRANCE

ANNEX 3

AGENDA FOR THE SIXTH MEETING OF THE SCIENTIFIC COMMITTEE

AGENDA FOR THE SIXTH MEETING
OF THE SCIENTIFIC COMMITTEE FOR THE
CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

1. Opening of the Meeting.

2. Adoption of the Agenda.

3. Report by the Chairman.

4. Krill Resources.

   (i) Fishery Status and Trends
   (ii) Biological Aspects Relevant to Stock Assessment
   (iii) Progress Report on Simulation Study
   (iv) Report on Planning of CCAMLR/BIOMASS Workshop on Methods of Estimating Krill Abundance
   (v) Further Data Requirements
   (vi) Advice to the Commission

5. Fish Resources.

   (i) Fish Stock Assessment - Report of the Working Group
   (ii) Further Data Requirements
   (iii) Fish Age Determination
   (iv) Mesh Selectivity
   (v) Establishment of a Permanent Fish Stock Assessment Working Group
   (vi) Advice to the Commission

6. Squid Resources.

7. Ecosystem Monitoring and Management.

   (i) Review of the Report of the Working Group for CCAMLR Ecosystem Monitoring Program
   (ii) Implementation and Coordination of the Ecosystem Monitoring Program
   (iii) IWC Activities and the CCAMLR Ecosystem Monitoring Program
   (iv) Advice to the Commission

8. Marine Mammal and Bird Population Assessment.

9. Data Collection and Handling.

   (i) Formats for Catch and Effort Data
   (ii) Formats for Biological Data
   (iii) Advice to the Commission

10. Cooperation With Other Organisations
   (i) Reports of CCAMLR Representatives at Meetings of Other International Organisations
   (ii) CCAMLR–IOC Scientific Seminar on Antarctic Ocean Variability and its Influence on Marine Living Resources, Particularly Krill
   (iii) CCAMLR/FAO Species Identification Sheet Project
   (iv) Nomination of SC-CAMLR Observers to Meetings of Other International Organisations

11. Review of Long-Term Program of Work of the Scientific Committee.

12. Publications Policy and Procedures for the Preparation of Meeting Documents.

   (i) Report of ad hoc Editorial Board
   (ii) Consideration of a Draft Statistical Bulletin

13. Budget for 1988.

14. Election of Vice-Chairmen of the Scientific Committee.

15. Next Meeting.

16. Other Business.

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

18. Close of the Meeting.

ANNEX 4

REPORT OF THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM

(Dammarie-les-lys, France, 10–15 June, 1987)

(SC-CAMLR-VI/4)

TABLE OF CONTENTS

REPORT OF THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM

Dammarie-les-Lys, France
10–15 June, 1987

INTRODUCTION

At its Fifth Annual Meeting in September 1986, the Scientific Committee of CCAMLR reaffirmed the urgent need to commence the practical implementation of the CCAMLR Ecosystem Monitoring Program (CEMP). The Committee agreed that an intersessional meeting of the Working Group for CEMP should be held during 1987. A draft annotated agenda was prepared and circulated.

2. The Scientific Committee accepted an invitation from the Republic of France to hold the meeting at Chateau des Vives Eaux, Dammarie-les-Lys, France.

3. The Meeting was held from 10–15 June, 1987.

4. Participants were welcomed by Prof. J.-C. Hureau, Muséum National d'Histoire Naturelle, Paris. A list of participants is attached (Appendix 1).

5. The Convener (Dr K. Kerry, Australia) opened the meeting and the agenda (Appendix 2) was adopted.

6. Mr D. Miller (South Africa) was appointed as Rapporteur for the Working Group. Drs J. Bengtson and D. Ainley, both of the USA, were responsible for the sections of the Meeting report dealing with remote sensing technology and predator species respectively.

7. A list of the documents tabled at the meeting is attached as Appendix 3.

8. The Convener tabled a paper prepared by the Secretariat (WG-CEMP-87/4) which outlines the development of the CEMP, and summarises the objectives of the program and agreements reached so far. He drew attention to the wording of the objectives of ecosystem monitoring as agreed at the 1985 meeting in Seattle of the Ad Hoc Working Group on Ecosystem Monitoring (SC-CAMLR-IV, Annex 7, paragraph 11) and subsequently adopted

by the Working Group for CEMP. The Group agreed that the words 'the monitoring system should be designed' were redundant and should be deleted. The objectives of Ecosystem Monitoring are now:

- to detect and record significant changes in critical components of the ecosystem, to serve as a basis for the conservation of Antarctic marine living resources;

- to distinguish between changes due to harvesting of commercial species and changes due to environmental variability, both physical and biological.

9. When necessary the meeting divided into a subgroup on predators (Chairman, Dr J. Bengtson) and a subgroup on prey and environment (Chairman, Dr I. Everson). A workshop on telemetry and remote sensing was convened on 11 June and discussion was led by three invited experts, Drs G. Feldman (satellite remote sensing), R. Hill (systems design) and L. Kuechle (telemetry and tracking). The results of the work of these subgroups and the workshop is presented in the main body of this report.

MONITORING OF PREDATORS

Background

10. A suite of life history and behavioural parameters of predators which potentially could be monitored to provide indices of change in important aspects of structure and processes in the Antarctic marine ecosystem were identified at the 1985 Seattle meeting of the CCAMLR Ad Hoc Working Group on Ecosystem Monitoring (SC-CAMLR-IV, Annex 7). This meeting also received input from the SCAR Group of Specialists on Seals, the BIOMASS Working Party on Bird Ecology (now the Sub-Committee on Bird Biology of the SCAR Working Group on Biology), and the Scientific Committee of the International Whaling Commission.

11. At its 1986 meeting in Hamburg, the Working Group for CEMP defined a number of parameters of potential use in monitoring programs (SC-CAMLR-V, Annex 6, Table 2) and various programs of directed research required to assess the utility of potential monitoring parameters (SC-CAMLR-V, Annex 6, Table 3).

12. Following that meeting, the Scientific Committee requested the SCAR Group of Specialists on Seals and the Subcommittee on Bird Biology to provide advice on the precise

sampling methodology and sample sizes required for the effective monitoring of the identified parameters, including information on the timing of investigations and the minimum time required to establish adequate base-lines of the parameters.

13. Detailed advice including sampling methodology, was provided by the Sub-Committee on Bird Biology (WG-CEMP-87/5). Members of the SCAR Group of Specialists on Seals who attended this meeting provided information on parameters relating to the Antarctic fur seal, *Arctocephalus gazella*. In addition it was noted that during the past year further evaluations had been carried out on some of the predator parameters identified for monitoring in the 1986 Report of the Working Group for CEMP (SC-CAMLR-V, Annex 6, Tables 2 and 3). Relevant papers were tabled at the present meeting regarding seabirds (WG-CEMP-87/13), fur seals (WG-CEMP-87/14) and minke whales (WG-CEMP-87/18).

Objectives

14. The main objectives of the discussion on predators were:

(a) to undertake a critical review of the parameters for which data have been presented and/or analysed and for which standard method sheets have been prepared, and

(b) to make specific recommendations for monitoring activities which could be started now.

Review of Predator Species and Study Sites

15. The species and sites already recommended by the Working Group for monitoring studies were reviewed. The only change to the recommended predator species for monitoring was the addition of the Cape petrel *Daption capense*, a species which is accessible for study on the Antarctic Peninsula and which appears to have s similar ecological role to the Antarctic petrel, *Thalassoica antarctica*, in the Prydz Bay region.

16. The Working Group accepted the monitoring sites identified at the 1986 meeting of the Working Group with some slight modification. Recent information (e.g. WG-CEMP-87/6 and WG-CEMP-87/7) warranted inclusion of additional land-based sites for predator

monitoring within integrated study areas (see Table 1), and accessory network sites (see Table 2).

Review of Parameters

17. In conducting its review of predator parameters, the subgroup felt that in order to recommend that routine monitoring of specific parameters could and should start now, the following criteria had to be satisfied:

(a) existing (and available) data on intra- and inter-annual variation are adequate to demonstrate that the parameter has appropriate sensitivity for detecting significant changes, at least in the medium term (i.e. 5–10 years) and to allow specification of appropriate sample sizes,

(b) appropriate methods already exist for implementing monitoring at recommended filed sites, using the specified sample sizes, and

(c) an agreed, specific, methodology has been (or can be) prepared to ensure that data collected at different sites and between seasons are comparable.

18. Parameters meeting these criteria are presented in Table 3; those requiring further evaluation (directed research) are presented in Table 4. Additional directed research projects needed to provide background information to enable interpretation of variability in monitoring parameters are presented in Table 8. Instances where technological developments are essential to, or would improve, data collection are indicated in Tables 3, 4 and 5. Further comments on the need for automatic data gathering and analysis, telemetry, satellite-linked instrumentation, and remote sensing are reported elsewhere in this report (see paragraphs 40–50). Further consultations with the SCAR Group of Specialists on Seals, Sub-Committee on Bird Biology and Scientific Committee of the International Whaling Commission may be appropriate for some parameters.

19. A number of parameters identified at the 1986 Meeting of the Working Group for potential immediate use in monitoring programs (SC-CAMLR-V, Annex 6, Table 2) failed to meet the criteria for recommending them for routine monitoring at this time. The situation arose because:

(a) existing data were inadequate for critical evaluation, or

(b) adequate data exist but they have not been evaluated, or

(c) vital technological and/or methodological developments are required.

20. The following parameters have now been re-assessed as requiring further evaluation before they can be recommended for routine monitoring:

(a) Demographic parameters for penguins (e.g. adult survival, age of first breeding, cohort strength). Some adequate data exist but they require further analysis to assess their sensitivity and utility for routine monitoring operations;

(b) Penguin weight at fledging and the weight of macaroni penguins before moult. Insufficient data currently exist to evaluate these parameters adequately.

(c) Demographic parameters for crabeater seals (e.g. reproductive rate, age at sexual maturity, and cohort strength). These parameters require further analysis to assess their sensitivity and utility for routine monitoring operations.

(d) Body condition (blubber thickness) of crabeater seals. The potential utility of this parameter requires additional evaluation, particularly in respect of data recently collected on crabeater seals form the Balleny Islands area (as reported by the USSR representative).

(e) Minke whale parameters. The utility and desirability of routinely monitoring these parameters needs to be clarified. To resolve these questions, analyses of existing and possibly new data should be carried out. It was agreed that the Working Group would await the results of further analyses and advice from the IWC Scientific Committee before considering further action.

It was emphasised that directed research on the parameters listed in Table 4 has high priority and should accompany the routine monitoring activities recommended in Table 3.

Conclusions and Recommendations

21. The parameters now meeting the criteria for recommendation for routine monitoring activities are summarised in Table 3; detailed standard method sheets are provided for each of these parameters in Appendix 4. The Working Group noted that where resources and/or

logistics were limiting, priority should be given to monitoring penguins and Antarctic fur seals before flying birds. In addition, certain parameters (indicated in Table 3) should be given priority. Land-based sites within the CCAMLR integrated study areas should be given priority over network sites in the establishment of monitoring programs in the near future. The above priorities reflect the Working Group's desire to initiate integrated predator/prey/environment studies of comparable time series.

22. The Working Group noted the importance of standardising the collection of predator monitoring data by following the approved methodologies. Members must be aware that it is essential for their monitoring activities to address the specified parameters in the manner outlined in the CEMP standard method sheets. It was recognised that some modification of the methodologies may be necessary to adapt them to special circumstances and new developments at certain localities; however, national scientists should not modify the methodologies until the Working Group has been consulted.

23. The Working Group recommended that:

(a) monitoring of the predator parameters listed in Table 3 should start now at as many sites as possible in the three integrated study areas and associated network sites,

(b) this work should be carried out as specified in the standard method sheets, particularly with respect to sample sizes. It was stressed that programs which did not meet these criteria could not be recognised as part of routine monitoring activities of the CEMP, and

(c) in order to determine how much of this work is currently taking place, or is proposed to commence in the future, all Members should be requested, as a matter of the highest priority, to report to the CCAMLR Scientific Committee prior to the 1987 annual meeting on existing monitoring activities (including the dates when activities started) and planned activities (including the proposed commencement dates).

24. The Working Group identified a number of important topics for directed research which would provide essential background information to the interpretation of changes in predator parameters being monitored. These research topics are summarised in Table 8.

25. The Working Group recommended:

(a) that appropriate directed research should be carried out as a matter of priority within national programs to further evaluate the potential utility of identified monitoring parameters,

(b) that Members already undertaking or planning to start such directed research should be requested to report their activities and plans to the CCAMLR Scientific Committee, giving details of the nature, areas, and time-scale of these operations, and

(c) that the results of further evaluations and technological developments should be presented to the Working Group for CEMP as soon as possible and, where appropriate, with draft method sheets.

26. It was noted that rapid technological advances in the electronics and remote sensing fields are likely to provide major benefits to studies of Antarctic predators and their interactions with prey and other environmental features (paragraphs 34–53).

27. Therefore, the Working Group recommended that Members be encouraged to incorporate technological developments (e.g. telemetry, satellite-linked instruments, archival tags, individual identification methods) into their directed research programs (Table 4 and 8) wherever possible, and into routine monitoring activities (Table 3) as recommended in the standard method sheets.

MONITORING OF PREY

28. Taking account of the criteria for selection of parameters outlined in the Report of the Working Group's first meeting in Hamburg (SC-CAMLR-V Annex 6, Paragraphs 28–35), the Group reviewed the various methods and parameters which had been identified at that meeting as being useful for monitoring prey variables, particularly krill (see SC-CAMLR-V Annex 6, Table 5).

29. Some changes were made and the revised table of methods and parameters which could be utilised in monitoring rates of change in abundance and distribution of selected prey species is presented as Table 5. The following important additions were made to the studies that can be implemented immediately:

(a) The inclusion of an additional spatial category to encompass problems associated with the global (greater than 1000 km) distribution of krill. This was considered to be important more for reflecting gross changes in krill distribution than the relative changes in krill abundance.

(b) A separate consideration of relative and absolute changes in krill abundance. For the former, additional estimation methods which could be utilised include monitoring certain properties of predators feeding on krill (e.g. seabirds, WG-CEMP-87/9) and the deployment of moored systems (including sediment traps to monitor faecal pellet and moult fall-out from krill).

(c) The methods which could be utilised in monitoring rates of change in abundance and distribution of *Pleuragramma antarcticum* and early life-history stages of other fish species. Given the relatively poor state of knowledge concerning these groups, it was agreed that all the methods outlined in Table 5 should be considered as requiring further research. Current efforts to relate size to age in *P. antarcticum* should be encouraged.

Studies included in the table but not highlighted for immediate implementation were recognised as requiring further research before effective implementation of field monitoring activities could be undertaken.

30. Net haul and acoustic techniques have been developed to an extent where they could be used in studies monitoring krill. Further research, however, needs to be undertaken on survey design before routine monitoring should commence. Further research is also required on all other techniques of krill sampling before implementation of other field monitoring activities should be considered (see paragraphs 62 and 63).

31. It was agreed that detailed definition and standardisation of methods is essential before any of the methods outlined in Table 5 are implemented.

32. The Group recognised that modelling of important aspects of prey distribution and behaviour may facilitate the definition and standardisation of methods and could be useful in the definition of ecosystem functioning in future.

33. The Group reviewed the environmental variables thought to be important in assessing predator-prey interactions as well as predator and prey dynamics separately (SC-CAMLR-V

Annex 6, Table 6). A revised list of important environmental variables for which monitoring should be commenced as soon as possible is presented in Table 6.

34. Discussion of elements contained in both Table 5 and Table 6 focused on attempts to resolve major questions on monitoring which have been addressed since the Group's last meeting. The Group's attention was drawn to documents WG-CEMP-87/5 (Data and methodological requirements for CEMP: seabird parameters) and WG-CEMP-87/17 (Initiation of United States participation in the CCAMLR Ecosystem Monitoring Program). At the request of the meeting, a further paper was submitted by Dr Sherman entitled 'Some observations on logistics associated with the United States contribution to the CCAMLR Ecosystem Monitoring Program' (WG-CEMP-87/22).

35. Discussion of the USA program drew attention to the importance of ensuring adequate co-ordination and integration of various monitoring programs for prey species in the integrated study areas, and it was agreed that the Group should review such programs annually. Reporting of such activities should be included in the Reports of Members' Activities in the Convention Area.

36. Following the presentation of Dr Feldman's paper in the Workshop on Remote Sensing and Telemetry (see paragraphs 51 to 54) the Group recognised that there exists a vast amount of imagery and data derived from various satellite missions. These could provide valuable information on environmental variability in the Southern Ocean and particularly in the integrated study areas and network sites (see Table 8). It was agreed that the Convener should write to NASA thanking them for Dr Feldman's participation in the Meeting. The letter should also indicate that individual scientists within the group had made arrangements to submit data to Dr Feldman for comparison with relevant satellite derived data sets. The results of this work would be reviewed at the next meeting of the Working Group to further assess the potential contribution of satellite derived data to the CEMP.

WORKSHOP ON TELEMETRY AND REMOTE SENSING

37. The principal objective of the workshop was to obtain a detailed appraisal of currently available techniques as well as pertinent future developments in the field of telemetry and remote sensing.

38. The presentations of Dr R. Hill and L. Kuechle focused on various systems currently being used or being developed for remote monitoring of various animal species. The two

detailed papers (WG-CEMP-87/15 and WG-CEMP-87/16 respectively) were discussed at some length.

39. The Group agreed that the monitoring of several predator parameters identified as key elements and/or potentially valuable elements in the CEMP will require the utilisation of telemetry or other technology. In some cases, the technology will facilitate the collection of data (which could be collected manually if necessary) while in other cases the technology is essential for data collection. Other technological systems will facilitate sample analysis.

Radio Telemetry

40. Radio frequency transmitters used with scanning receivers and data loggers will be necessary to gather information on the duration of foraging trips and attendance cycles of penguins. It would be logistically difficult to gather sufficient data accurately in any other way. These parameters/species have been identified as particularly important in the CEMP (Table 3). The necessary technology for such monitoring has been developed and has been satisfactorily field tested.

41. Telemetry will greatly facilitate and improve the accuracy of measuring the duration of penguin incubation shifts and of fur seal foraging trips and attendance cycles - parameters which otherwise could only be monitored with difficulty. Another parameter - survival of fur seal pups (which requires further research to evaluate its utility) - will likely be greatly facilitated by telemetry. Radio telemetry is also essential for studies of seals' and penguins' foraging areas if this work is carried out from ships. Automatic direction-finding equipment would greatly enhance such tracking studies. Recent developments in programmable transmitters that transmit during specific periods of the season in one or several years (thus saving battery-capacity) may be useful in long term studies of foraging ranges, especially for smaller species.

Archival Tags* and Recorders

42. Time/depth recorders will enhance the ability to investigate the at-sea diving behaviour and activity patterns of predators. Various instruments have been used in the past on seals and penguins, and newly improved and miniaturised units may open new options for

* An archival tag is any recorder which has to be physically retrieved from the animal in order to get the recorded data.

monitoring activities and for directed research. Further development and refinement of digital instruments for use on Antarctic seals and penguins are currently underway.

43. An archival tag currently being developed for tuna in the eastern tropical Pacific Ocean will reportedly be able to record the geographic location of individual fish. Such tags may be useful in studies of Antarctic predators.

Satellite Linked Instruments

44. The use of satellites will likely make it feasible to determine seasonal changes in predator movements, foraging areas and diving/feeding behaviour. Such knowledge will be essential for interpreting patterns in monitored parameters, and for relating these patterns to data on prey availability. At present, studies using prototype satellite-linked instruments on crabeater seals are underway. These studies have indicated promise for this technology. However, additional developmental work is needed, particularly with regard to size, durability and attachment of such instruments to the animals before potential monitoring parameters can be identified and evaluated. It was noted that the size of these instruments may preclude their use on penguins in the foreseeable future.

45. The use of satellite platforms to store and repeat data from transmitters in nearby (20-30 km) areas may be an alternative to direct location by satellite for smaller species. This technique may also be combined with the use of archival tags.

Automatic Data Collection

46. A device to gather and log data automatically would greatly facilitate monitoring three important parameters of penguins - adult weight at arrival, fledging weight and, for macaroni penguins, adult weight at moult. These parameters can currently be measured only through a major field program. The desired automated device will require simultaneous photo-identification of individuals to allow the accurate interpretation of arrival and fledging weight in mixed-species colonies. The required separate pieces of hardware for such an automated device are available but have not been assembled or field tested as a unit.

Automatic Sample Analysis

47. Automatic image analysis may facilitate the sorting and characterisation of prey collected from predators and net-hauls.

48. A digital image analyser may facilitate and increase the accuracy of reading growth layers in whale ear plugs. An accurate evaluation of these samples is critical to interpreting the apparent trends in age at sexual maturity of whales over past decades as indicated by analyses of ear plugs.

Remote Sensing

49. The interpretation of several predator parameters will require information on the location, characteristics and density of pack ice, the location of oceanographic fronts, and shifts in relative productivity of waters within and between years. Data should be made available for areas within 300 km of study sites during the period when predator monitoring and directed research activities are underway (Table 8). Satellite imagery may be able to provide much of this information. The utility of images integrated over a variety of time-scales should be evaluated. It was acknowledged that images integrated over weekly time-scales may be sufficient.

50. The assessment of long-term trends in the size of penguin colonies on a regional scale may be feasible using satellite imagery. Further work is required, and is underway, to evaluate the feasibility of this technique. Regional trends in population size would assist the interpretation of changes in monitored parameters.

51. Dr G. Feldman (NASA, Goddard Space Flight Center, Washington D.C., USA) presented a review of the goals and objectives of NASA's Oceanic Processes Program with specific emphasis on the remote sensing component of the Program (WG-CEMP-87/20). In addition, a summary of the status of current and proposed satellite remote sensing missions by the United States and other nations was given. Several background documents (see Appendix 3) were presented to the Working Group to serve as technical reviews of the methods and applications of satellite remote sensing techniques. Attention was drawn to the applicability of satellite observed sea-ice distribution and characteristics (see background documents 11–13, 15 and 20). Particular emphasis was given to the current efforts to produce global-scale maps of phytoplankton concentration and distribution with data acquired by the

Coastal Zone Colour Scanner (CZCS). The opportunity for using these satellite ocean colour estimates in the proposed Ecosystem Monitoring Program was discussed.

52. It has been demonstrated that near-surface phytoplankton pigment concentrations can be derived from CZCS data with an overall accuracy of 35–50%. Effort to relate these fields to primary productivity of areas are very promising.

53. A full description of the global CZCS processing program and the archiving and availability of this data set is given in background document 28.

54. The potential for fine-scale resolution work in the Southern Ocean using the above technique was highlighted. Dr Feldman stressed that if this was to be effectively achieved, an interactive association between the Working Group and the Goddard Space Flight Center should be developed (see paragraph 36).

THEORETICAL ASPECTS AND PILOT STUDIES IN ESTABLISHING PREDATOR–PREY RELATIONSHIPS

55. Discussions were held to identify problems associated with interpreting the cause of any significant changes detected in parameters of predators. The nature of these problems was illustrated schematically in WG-CEMP-87/21. This scheme concentrates on krill-predator interactions because krill are the only harvested or harvestable prey species for which there are at present predator species suitable for monitoring.

56. It was recognised that from a theoretical point of view, a comprehensive study of the various selected systems should evaluate all their constituent elements. However, for practical reasons, the Group agreed that the CEMP would have to be restricted to trophic interactions in which krill predominates.

57. The steps involved in investigating the key interactions in WG-CEMP-87/21 were discussed. One requirement was to undertake sensitivity analyses of predator parameters both in respect of sample size and in relation to detecting responses to various types and levels of environmental change, including harvesting. Possible data sets for such an investigation include those used to prepare the papers WG-CEMP-87/13, WG-CEMP-87/14 and WG-CEMP-87/18.

58. It was agreed that prior to defining the specific goals of such sensitivity analyses, further detailed discussions were necessary. Members were urged to give consideration to this matter with a view to making further progress at the next meeting of the Scientific Committee.

59. With respect to the initiation of case history studies of suitable existing data sets, the Group noted recent progress in the effective categorisation of other large marine ecosystems. While recognising the potential utility of identifying critical forcing mechanisms to typify certain Antarctic systems, the Group appreciated that this would be difficult because of the present scarcity of data. For this reason, case-history studies in small defined regions may provide useful information. The Group agreed to keep the matter under review.

IMPLEMENTATION AND CO-ORDINATION

60. The Group re-emphasised the importance of standardising methods and procedures used in monitoring. In addition, the Group noted that there would be benefit in co-ordinating the activities of Members monitoring predator-prey interactions in the same integrated study areas or sites. With regard to prey monitoring, it was agreed that little progress would be made unless surveys were undertaken as multi-nation co-ordinated activities. It was noted that progress had been made in the implementation and co-ordination of routine predator monitoring activities by the development of standard methodologies.

61. A variety of sampling techniques for assessing krill distribution and abundance are currently in use, and despite considerable effort in the BIOMASS program towards developing standard techniques, and acknowledgment of their importance by Members, little progress in this area has been achieved.

62. The Group agreed that standardising krill methods for use in the integrated study areas was essential. Dr Everson agreed to co-ordinate the preparation of suitable survey designs focusing of the three integrated study areas with the aim of making drafts available for discussion at the 1987 meeting of the Scientific Committee. The methodologies should then be further developed to include standardisation of net, hydrographic and hydroacoustic sampling techniques so as to form the basis for discussion on the standardisation of data collection as a priority item at the next meeting of the Working Group. In this connection, the Group noted the importance of studies being planned for the forthcoming Antarctic summer in which problems of effective intercalibration of different net types were being addressed.

63. Consideration was given by the Group to experiments designed to identify a suitable sampling system for the standardised monitoring of krill abundance. Several Members have expressed interest in pooling their efforts to conduct experiments quantifying the effect of avoidance and selectivity of different net systems towed at various speeds and under a variety of environmental conditions. The Group reviewed the results of recent studies (BIOMASS 1981; Czubeck 1981; Everson and Bone 1986; Klages and Nast 1981; and Siegel 1986) and concluded that it would be inappropriate to designate an interim standard system. It was agreed, however, to encourage the rapid progress of studies on developing a standardised methodology to measure changes in krill abundance and availability to predators. These studies should be based on an integrated sampling strategy using acoustics, nets and predators. A summary of planned national activities in the forthcoming season is given in Table 1. The Group agreed that this summary should be updated as additional information is received by Members not represented at the Working Group meeting. In an effort to obtain maximum benefit from net sampling efficiency studies, it was agreed that K. Sherman (USA) would co-ordinate such studies through correspondence with the principal scientists identified in Table 7 prior to the implementation of the field operations. Draft plans of net sampling efficiency experiments will be distributed to members of the Working Group for CEMP for review and comment. Appropriate adjustments to sampling schedules will then be made.

64. The Group agreed that an effective system of control and review of monitoring activities will be necessary. In the early stages of the Monitoring Program, such a system would function more in the development of suitable methods and data analysis techniques. As the Program develops, the emphasis would shift to the interpretation of the data accrued as a result of field monitoring activities. It was therefore agreed that the Group will annually review monitoring and directed research activities carried out by Members.

65. It was also agreed that Members will provide data reports and summaries of monitoring activities in advance of the next meeting of the Working Group for CEMP. The development of suitable reporting formats and the effective archiving of such information will have to be developed as activities increase. At present, the format of the Report of Members' Activities in the Convention Area and individual detailed papers on specialist topics appear to be sufficient.

66. In all respects, the Group recognised that reporting of monitoring activities and the submission of field data should be separate. With respect to the submission of field data, a need to develop standardised formats for the presentation of new data may be necessary. The Group did not envisage that such data would have to be archived in one central database. An

informal discussion will be held during the next meeting of the Scientific Committee to advise the CCAMLR Data Manager of requirements of centralised data storage.

67. It was recommended that Members' reports on monitoring activities should contain adequate descriptions, summaries of available data and where such data are housed or can be accessed. This information would be archived by the Secretariat.

Protection of Monitoring Sites

68. The need to provide protection from human interference at monitoring sites was discussed. The Group noted that the CCAMLR Convention (Article IX paragraph 2 subparagraph (g)) provides for the establishment of protected areas for scientific research purposes and conservation and that the Antarctic treaty has established a system for protecting particular sites. The Scientific Committee's attention is drawn to this matter.

Next Meeting

69. It was agreed that the Working Group would need to meet at approximately the same time next year. In addition to reviewing reports of monitoring activities undertaken in the 1987/88 season, matters to be discussed include the following which have been raised at the present meeting:

- review of monitoring programs (paragraph 35) and directed research carried out by Members with emphasis on methods (paragraph 22) and data analysis (paragraphs 64 and 66);

- co-ordination and integration of programs (paragraphs 35 and 60);

- review of utility of case-history studies (paragraph 59).

CLOSE OF MEETING

70. The report was adopted and the meeting concluded at 1730 hours on 15 June, 1987.

71. The Convener thanked the invited experts, the Chairmen of the Sub-Groups and especially the Rapporteurs for their efforts. He also expressed the Group's appreciation to Prof. J.-C. Hureau for hosting the meeting and to the staff of the Muséum National d'Histoire Naturelle for their assistance.

REFERENCES

BIOMASS. 1981. Post-FIBEX Data Interpretation Workshop. *BIOMASS Report Series No. 20.*

CZUBEK, H. 1981. Studies on performance capacity and selectivity of trawls used for Antarctic Krill fisheries. *Polish Polar Research 2*: 131–142.

EVERSON, I. AND D.G. BONE. 1986. Effectiveness of the RMT-8 system for sampling krill (*Euphausia superba*) swarms. *Journal of Plankton Research 1986.*

KLAGES, N. and F. NAST. 1981. Net selection for Antarctic krill by the 1216 meshes krill trawl. *Arch. FischWiss. 34*: 121–144.

SIEGEL, V. 1986. Untersuchungen zur Biologie des antarktischen krill, *Euphausia superba*, im Bereich der Bransfield Strasse und angrenzender Gebiete. *Mitt. Inst. Seefisch. Hamburg 38*: 1–244.

SUMMARY OF RECOMMENDATIONS

The Working Group for the CCAMLR Ecosystem Monitoring Program recommended:

Paragraph 23

(a) monitoring of the predator parameters listed in Table 3 should start now at as many sites as possible in the three integrated study areas and associated network sites, Rec. 1

(b) this work should be carried out as specified in the standard method sheets, particularly with respect to sample sizes. It was stressed that programs which did not meet these criteria could not be recognised as part of routine monitoring activities of the CEMP, Rec. 2

and

(c) in order to determine how much of this work is currently taking place, or is proposed to commence in the future, all Members should be requested, as a matter of the highest priority, to report to the CCAMLR Scientific Committee prior to the 1987 annual meeting on existing monitoring activities (including the dates when activities started) and planned activities (including the proposed commencement dates). Rec. 3

Paragraph 25

(a) that appropriate directed research should be carried out as a matter of priority within national programs to further evaluate the potential utility of identified monitoring parameters, Rec. 4

(b) that Members already undertaking or planning to start such directed research should be requested to report their activities and plans to the CCAMLR Scientific Committee, giving details of the nature, areas, and timescale of these operations,

Rec. 5

and

(c) that the results of further evaluations and technological developments should be presented to the Working Group for CEMP as soon as possible and, where appropriate, with draft methodological protocols.

Rec. 6

Paragraph 27

Members be encouraged to incorporate technological developments (e.g. telemetry, satellite-linked instruments, archival tags, individual identification methods) into their directed research programs (Tables 4 and 8) wherever possible, and into routine monitoring activities (Table 3) as recommended in the standard method sheets Rec. 7

Paragraph 67

Member reports on monitoring activities should contain adequate descriptions, summaries of available data and where such data are housed or can be accessed. This information would be archived by the Secretariat. Rec. 8

Table 1: Sties within the integrated study areas at which land-based monitoring of predators has been or should be initiated now. Parameters to be monitored at each of these sites are given in Table 3.

Site	Species	Critical Period
1. ANTARCTIC PENINSULA REGION		
Anvers Island (south coast)	Adelie penguin	Nov–Jan
Livingston Island		
(north coast)	Chinstrap penguin	Nov–Feb
(north coast)	Antarctic fur seal	Dec–Mar
King George Island		
(north? and south coasts)	Adelie penguin	Oct–Jan
(north and south coasts)	Chinstrap penguin	Nov–Feb
(north coast)	Antarctic fur seal	Dec–Mar
Elephant Island		
	Adelie penguin	Oct–Jan
(west coast)	Chinstrap penguin	Nov–Feb
(west coast)	Macaroni penguin	Dec–Feb
Seal Island	Chinstrap penguin	Nov–Feb
	Macaroni penguin	Dec–Feb
	Antarctic fur seal	Dec–Mar
2. SOUTH GEORGIA REGION		
Bird Island	Fur seal	Dec–Mar
	Macaroni penguin	Dec–Feb
	Black-browed albatross	Oct–Apr
3. PRYDZ BAY REGION		
MacRobertson Land	Adelie penguin	Oct–Jan

Table 2: Sites selected or suggested for monitoring studies to complement the programs in the three main integrated study regions.

Species	Sites
Adelie penguin	NW Ross Sea (Cape Hallett and Cape Adare) Pointe Geologie, Adelie Land
	Budd Coast Syowa Shepard Island* Signy Island, South Orkney Islands Laurie Island, South Orkney Islands
Chinstrap penguin	Signy Island, South Orkney Islands South Sandwich Islands* Bouvet Island*
Macaroni penguin	Bouvet Island* Marion Island* Kerguelen Island* Crozet
Cape petrel	Pointe Geologie, Adelie Land Signy Island, South Orkney Islands
Antarctic fur seal	Bouvet Island* Kerguelen Island
Crabeater seal	Weddell Sea* Amundsen and Bellingshausen Seas*

* Suggested sites

Table 3: Predator parameters for which there have been adequate evaluations to allow preparation of standard method sheets and for which routine monitoring activities are recommended to begin immediately.

PARAMETER	AREA[a] FROM WHICH DATA ARE AVAILABLE TO FORMULATE METHODOLOGIES	STANDARD METHOD SHEETS		TECHNOLOGY		PRIORITY OF EFFORT[g]	MEMBERS UNDERTAKING MONITORING ACTIVITIES[h]	
		Completed	Member Responsible for Drafting	Type	Needs[f]		Programs currently underway (species)	Proposed programs (season of start, species)
PENGUINS[b]								
Adult arrival weight	1,2,8	Yes	–	Auto weighing	I	2	ARG (A), CHL (A,C)	AUS (1989, A)
Macaroni arrival wt.	5	No	AUS	Auto weighing	I	2	CHL (A,C)	–
Breeding popul size	many sites	Yes	–	–	N	1	ARG (A), GBR, CHL (A,C)	AUS (1989, A)
Incubation shift[c]	1,2,3	Yes	–	Passive bands, improved bands	I	2	–	–
Breeding success	many sites	Yes	–	RF Telemetry[e]	I	1	ARG (A), GBR	AUS (1988/89, A)
Foraging trips	1,2,3,4,5,8,9	Yes[d]	–	RF Telemetry	E	1	–	AUS (1989, A)
Fledging weights	1,2,3,4,5	Yes	–	Auto weighing	I	1	GBR (M)	AUS (1989,A)
Prey characteristics/diet	1,2,3,4,6	Yes	–	Auto image analyser	I	2	ARG (A), GBR (M), CHL (A,C)	AUS (1989, A)
BLACK-BROWED ALBATROSS								
Breeding success	4,5	No	GBR	–	N	2	GBR	–
Breeding popul size	4,5	No	GBR	–	N	2	GBR	–

Table 3, continued

PARAMETER	AREA[a] FROM WHICH DATA ARE AVAILABLE TO FORMULATE METHODOLOGIES	STANDARD METHOD SHEETS		TECHNOLOGY		PRIORITY OF EFFORT[g]	MEMBERS UNDERTAKING MONITORING ACTIVITIES[h]	
		Completed	Member Responsible for Drafting	Type	Needs[f]		Programs currently underway (species)	Proposed programs (season of start, species)
FUR SEALS								
Foraging trips/attendance								
- duration at sea	2,4	No	GBR/USA	RF Telemetry	I	1	GBR	–
- duration ashore	2,4	No	GBR/USA	RF Telemetry	I	1	GBR	–
- perinatal period	4	No	GBR/USA	RF Telemetry	I	1	GBR	–
- number of trips	4	No	GBR/USA	RF Telemetry	I	1	–	–
Pup growth/weaning wt.	4	No	GBR/USA	–	N	1	GBR	–

[a] Areas:
1. Ross Island
2. South Shetland Islands
3. South Orkney Islands
4. South Georgia
5. Macquarie Island
6. Davis Station
7. Syowa Station
8. Dumont D'Urville
9. Crozet

[b] Unless otherwise noted, penguin parameters are for Adelie (A), chinstrap (C) and macaroni/royal (M) penguins. [c] Excludes macaroni/royal penguins. [d] Automatic method to be added to standard method sheet [e] RF = radio frequency [f] Needs: N = not needed; I = Improved with technology; E = essential for project [g] Priority: 1 = higher; 2 = lower [h] Member names are represented by International Organisation for Standardisation (ISO) alphabetic codes for countries (ARG = Argentina, AUS = Australia, CHL = Chile, GBR = United Kingdom, USA = United States of America).

Table 4: Directed research programs required to assess the utility of potential predator monitoring parameters. Further evaluations are necessary prior to recommending that these parameters be included in routine monitoring activities. These evaluations should be carried out as a matter of priority within national programs of directed research.

PARAMETER	Areas[a] from which data are available for analysis/evaluation	Further data required?	New methods or technology required?	Members proposing directed research[e]		COMMENTS
				to analyse existing data	to acquire and analyse new data	
PENGUINS[b]						
-Macaroni incubation shift	4,5,14	Yes	RF Telemetry[c]	AUS	GBR	AUS–1988
-Macaroni weight prior to moult	15,14,4,5?	Yes	Auto weighing	AUS	GBR	AUS–1988
-At-sea diving behaviour and activity patterns (A,C,M)	2,4	Yes	Long term TDR'S[c]	–	GBR (M)	–
-Weight recovery during incubation (A,C,M)	2	Yes	(Auto weighing and individual	AUS, CHL	CHL	AUS–1988
-Survival (A,C,M)	1,2	Yes	I.D. improved bands)	AUS, CHL	GBR (M), CHL	AUS–1988
FLIGHTED SEABIRDS						
Black-browed Albatross						
-duration of foraging trips	4	Yes	RF Telemetry	–	GBR	–
-activity budgets at sea	4	Yes	Recorder	GBR	GBR	–
-prey characteristics/diet	4	Yes	No	GBR	–	–
Antarctic/Cape petrel						
-breeding success	3,6,8	Yes	No	AUS, GBR	–	AUS–1988/89, Scullin Monolith
-chick weight at fledging	6,8		No	AUS	–	AUS–1988/89, Scullin Monolith
-prey characteristics/diet	6,8	Yes	No	AUS	–	AUS–1988/89, Scullin Monolith

Table 4, continued

PARAMETER	Areas[a] from which data are available for analysis/evaluation	Further data required?	New methods or technology required?	Members proposing directed research[e]		COMMENTS
				to analyse existing data	to acquire and analyse new data	
FUR SEALS						
-Reproductive success	4	Yes	No	–	GBR	
-Prey characteristics/diet	2,4	Yes	No	–	CHL, ARG	ARG (Laurie I., S. Orkney)
-At-sea diving behaviour and activity patterns	2,4	Yes	Long term TDR'S	GBR	GBR	
-Indices of physiological condition	–	Yes	No	–	GBR	
-Fine structure of teeth	4	Yes	Improved tooth sectioning techniques	–	GBR	
CRABEATER SEALS						
-Reproductive rates	2,3,8,10,11,12	No	No	GBR	–	
-Age at sexual maturity	2,3,8,10,11,12	No	No	GBR	–	
-Cohort strength	2,3,8,10,11,12	No	No	GBR	–	
-Indices of physiological condition	8,10,11,12	Yes	No	–	–	
-Instantaneous growth rate	11,12	Yes	No	–	–	
-Prey characteristics/diet	11,12	Yes	No	–	–	
-At-sea diving behaviour and activity patterns	11,12	Yes	Satellite telemetry	–	–	

Table 4, continued

PARAMETER	Areas[(a)] from which data are available for analysis/evaluation	Further data required?	New methods or technology required?	Members proposing directed research[(e)]		COMMENTS
				to analyse existing data	to acquire and analyse new data	
MINKE WHALES						
-Reproductive rates	13	Yes[(d)]	No	–	–	Historical analyses require additional samples from future collections[(d)]
-Age at sexual maturity	13	No[(d)]	Digital image analyser	–	–	magnitude of reading error for ear plugs requires assessment[(d)]
-Cohort strength	13	Yes[(d)]	No	–	–	estimates of age-dependent mortality schedules require additional samples from future collections[(d)]
-Analysis of existing data:						
-stomach contents	13	Yes[(d)]	No	–	–	Recent analyses presented in WG-CEMP-87/18
-blubber thickness	13	No	No	–	–	
-density/patchiness	13	No	No	–	–	
-school size	13	No	No	–	–	
-Feeding activity patterns	–	Yes	Recorder and/or satellite tags	–	–	

[(a)] Areas:
1. Ross Island
2. South Shetland Isl.
3. South Orkney Isl.
4. South Georgia
5. Macquarie Island
6. Davis Station
7. Syowa Station
8. Dumont d'Urville
9. Crozet Island
10. Balleny Island
11. Antarctic Peninsula
12. Weddell Sea
13. Mainly form the Indian Ocean (IWC Areas III and IV)
14. Marion Island
15. Kerguelen

[(b)] Penguin species: A = Adelie; C = Chinstrap, M = Macaroni/Royal

[(c)] RF = Radio Frequency; TDR = Time Depth Recorder ID = Identification

[(d)] Await results of further analyses and advice from the IWC Scientific Committee

[(e)] Member names are represented by International Organisation for Standardisation (ISO) alphabetic codes for countries (ARG = Argentina, AUS = Australia, CHL = Chile, GBR = United Kingdom)

Table 5: Methods which could be utilised in monitoring rates of change in abundance and distribution of selected prey species.

Species	Krill, *Euphausia superba*				*Pleuragramma antarcticum* [2]			Early life stages of fish			
Scales[1] / Parameters	Global	Macro	Meso	Micro	Macro	Meso	Micro	Global	Macro	Meso	Micro
Abundance changes											
Absolute	A*	A*	A*	A*							
	N*	N*	N*	N*	N	N	N		N	N	N
	(S)	(S)									
Relative		C	C	P	N	N	N		N	N	N
		Pr	Pr	M	C	C	C		C	C	C
			M			Pr	Pr			Pr	Pr
Emigration/ Immigration		A	A		N	N	N	N	N	N	N
		N	N		H	H	H	C	C		
		H	H					H	H	H	H
Aggregation patterns		A*	A*	A*	N	N	N				
		N*	N*	N*	C	C	C				
		H	H	H	H	H	H				
			V	P							
				V							
Demography											
Sex[3]		N*	N*	N*	N	N	N	N	N	N	N
Size/Age		B	B	B	C	C	C	C	C	C	C
Reproductive/ Development stage					B	B					
Community structure							N	N	N	N	
								C	C	C	C

Key:
A - Acoustics
B - Biochemical/genetic tracers
C - Fisheries catch dependent methods
H - Hydrographic measurements
M - Moored systems
N - Net sampling
P - Photography
Pr - Predator dependent methods
(S) - Satellite Imagery (future development)
V - Visual observations
* Techniques are developed but require further research on sampling design prior to implementation.

[1] Definition of scales:
Global : 1000 km
Macro : 100–1000 km
Meso : 1–100 km
Micro : 0.01–1.00 km

[2] Global scales are not applicable for *P. antarcticum*

[3] Sex is not an applicable parameter for early life stages of fish

Table 6: Environmental data requirements to interpret predator–prey interactions.

* Key to Status Indicators: M – Suitable to monitor now
R – Topic currently under research that may ultimately provide a parameter suitable for monitoring
D – New techniques need to be developed to enable research leading to monitoring
U – Relatively unimportant in the context of this Group's studies.

Feature	Scale		Outline of Proposed Methods	Status*	Comments
	Spatial	Temporal			
1. WATER					
1.1 Water movements	Macro & Meso	Interannual Within season	1. Hydrographic grid of stations leading to determination of currents	M	Affects prey flux in region. Location of frontal systems and water bodies affects prey distribution
			2. Direct measurement of currents	M/R	
		Weekly	3. Satellite imagery (e.g. sea surface elevation)	M/R	
1.2 Physical/ chemical properties	Macro, Meso & Micro	Interannual Within season	1. Nutrient estimation/ biogeochemical tracers (e.g. silicate, phosphate, nitrate, trace metals)	M/R	Affects ability of prey to live and survive in the region
			2. Temperature, salinity leading to density estimation	M/R	
		Weekly	3. Satellite imagery (e.g. position of frontal systems)	M/R	
1.3 Biological properties	Meso & Micro	Interannual Within season	1. Determination of chlorophyll distribution, primary production and zooplankton community structure	R	Affects ability of prey to live and survive in the region
		Weekly/Daily	2. Satellite imagery/aircraft	R	
2. ICE					
2.1 Sea Ice Movements and Characteristics: Ice Edge Position % Cover Polynyas	Macro & Meso	Interannual Within season	1. Satellite observation	M	Affects primary production, vulnerability of krill to natural predators and fishing mortality. Accessibility of krill to predators, size of sampling area and ability to sample.

Table 6, continued

Feature	Scale		Outline of Proposed Methods	Status*	Comments
	Spatial	Temporal			
Ice type & thickness Floe size Snow cover			2. Field observation	M/R	Affects vulnerability of krill predators to higher order predators
2.2 Ice Shelf extent	Meso & Micro	Interannual	1. Satellite observations 2. Field observations	U	Affects spawning grounds
3. WEATHER & CLIMATE					
3.1 Sea Condition	Meso & Micro	Daily	Wind and/or wave hight 1. Field observations 2. Satellite tracked buoys 3. Satellite observation	M & D	Surface turbulence affects primary production and thus krill production and distribution. (N.B. Also affects predator energy requirements and commercial fishing success)
3.3.1 Surface irradiance and cloud cover	Meso & Micro	Daily Seasonal	1. Field observations 2. Satellite tracked buoys 3. Satellite observations	M & D	Photo-environment affects primary production and possibly krill distribution
3.2 Atmospheric circulation	Macro & Meso	Interannual Seasonal Daily	1. Analysis of weather Derived from direct observations or satellites	M	Cyclones affect water movement and thus krill distribution
3.3 Climatic change	Macro & Meso	Interannual	Temperature and barometric pressure at fixed stations 1. Field observations 2. Remote observations	M	Mean air temperature gives indication of trends in meso-scale environments. Similarly mean sea temperature also gives some indication of climatic change.

Table 7: Preliminary summary of CCAMLR net performance experiments and associated acoustic abundance estimates on krill scheduled for the 1987–1988 season.

Country	Area	Season	Nets*	Simultaneous Krill Abundance Assessment with Hydroacoustics	Principal Investigator	Space for Visiting Scientists
Argentina	Antarctic Peninsula Integrated Study area and South Orkney area	Spring–Summer	Bongo (0.333 mm mesh) IKMT (0.500 mm mesh) Hensen (0.200 mm mesh) Nansen (0.200 mm mesh)	Yes	E. Marshoff	Yes
Federal Republic of Germany	Antarctic Peninsula Integrated Study area	Spring	RMT–1 RMT–8 Bongos (0.333/0.505 mm) Neuston	No	V. Siegel	No
Japan	Antarctic Peninsula Integrated Study area	Spring–Summer	KYMT-Meter Net and other nets	Yes	Y. Shimadzu	Yes
Poland	Antarctic Peninsula Integrated Study area	Spring	Bongos (0.333/0.505 mm)	Yes	J. Kalinowski	Yes
United States	Antarctic Peninsula Integrated Study area	Spring–Summer	Bongos (0.333/0.505 mm) MOCNESS (9 nets) IYGPT RMT–8 Small krill trawl Neuston	Yes	K. Sherman	Yes

* IKMT – Isaacs Kidd Midwater Trawl; RMT – Rectangular Midwater Trawl; KYMT – Kaiyo/maru Midwater Trawl; IYGPT – International Young Gadoid Pelagic Trawl; MOCNESS – Multiple Opening and Closing Net System

Table 8. Directed research on predator parameters required to provide the essential background information needed to interpret changes in monitored predator parameters.

Research topic	Countries proposing directed research [a]		Comments
	Programs currently underway	Programs proposed to commence (season of initiation)	
PENGUINS			
-Foraging areas	–	GBR (1992)	
-Seasonal movements	–	–	
-Relationships between monitoring parameters and physical environment (e.g. distribution and structure of sea ice and frontal systems)	GBR	AUS (1988)	
FUR SEALS			
-Local abundance/population structure	ARG, CHL, GBR	–	
-Foraging areas	CHL	GBR (1992)	
-Relationships between monitoring parameters and physical environment (e.g. distribution and structure of sea ice and frontal systems)	GBR	CHL	
CRABEATER SEALS			
-Foraging areas	–	–	
-Stock discreteness/seasonal movements	–	–	
-Relationships between monitoring parameters and physical environment (e.g. distribution and structure of sea ice and frontal systems)	–	–	
MINKE WHALES			
-Survey of abundance (IWC/IDCR)[b]	–	–	
-Relationships between monitoring parameters and physical environment (e.g. distribution and structure of sea ice and frontal systems)	–	–	

(a) These columns will be updated as Members indicate their proposed activities.
(b) International Whaling Commission/International Decade of Cetacean Research.

APPENDIX 1

LIST OF PARTICIPANTS

David AINLEY
Point Reyes Bird Observatory
4990 Shoreline Hwy
Stinson Beach, CA 94970
USA
Telephone: (415) 868–1221

Dag L. AKSNES
Institutt for Marinbiologi
Universitet i Bergen
5065 Blomsterdalen
NORWAY
Telephone: 5 226200

John L. BENGTSON
National marine Mammal Laboratory
National marine Fisheries Service
7600 Sand Point Way N.E.
Seattle, Washington 98115
USA
Telephone: (206) 526–4045

John P. CROXALL
British Antarctic Survey
Madingley Road
Cambridge CB3 0ET
UNITED KINGDOM
Telephone : (223) 61188
Telex: 817725 BASCAM G

Patricio EBERHARD
Instituto Antartico Chileno
L. Thayer Ojeda 814
Santiago
CHILE
Telex: 346261 INACH CK

Anatoly ELIZAROV
17, V. Krasnoselskaya.
VNIRO
107140 Moscow
USSR
Telephone: 264 76–22

Inigo EVERSON
British Antarctic Survey
Madingley Road
Cambridge CB3 0ET
UNITED KINGDOM
Telephone: (223) 61188
Telex: 817725 BASCAM G

Gene Carl FELDMAN	NASA Goddard Space Flight Center CODE 636 Greenbelt, Maryland 20771 USA Telephone: (301) 286–9428
Mitsuo FUKUCHI	National Institute of Polar Research 9-10, Kaga 1-chome, Itabashi-ku, Tokyo 173 JAPAN Telephone: 03–962–4711
Roger HILL	Wildlife Computers 20630 NE 150th St Woodinville WA 98072 USA Telephone: (206) 881 3048
Jean-Claude HUREAU	Muséum National d'Histoire Naturelle Ichtyologie Générale et Appliquée 43 rue Cuvier 75231 Paris CEDEX 05 FRANCE Telephone: (1) 43314010
Knowles KERRY	Antarctic Division Department of Science Channel Highway Kingston 7150, Tasmania AUSTRALIA Telephone: (002) 290327 Telex: AA57090 ANARE Facsimile: (002) 29–33–35
Larry KUECHLE	University of Minnesota 2660 Fawn Lake Dr. Bethel, MN 550005 USA Telephone: (612) 434–7361
Per Arne LEMNELL	Swedish National Environmental Protection Board Grimsö Wildlife Research Station 77031 Riddarhyttan SWEDEN Telephone: 46–58192065

Tatjana LUBIMOVA	17, v. Krasnosleskaya VNIRO 107140 Moscow USSR Telephone: 264 94–54
Enrique R. MARSCHOFF	Instituto Antartico Argentino Cerrito 1248 (1010) Buenos Aires ARGENTINA Telephone: 44–1689
Denzil MILLER	Sea Fisheries Research Inst., Private Bag X2 Roggebaai 8012 SOUTH AFRICA Telephone: (021) 211–480 Telex: 526425 SA
Tjelvar ODSJO	Swedish Museum of Natural History Research Department Section for Vertebrates Box 50007 S-104 05 Stockholm SWEDEN Telephone: 46–8150240 or 46–86664113
Darry POWELL	CCAMLR Secretariat 25 Old Wharf Hobart 7000, Tasmania AUSTRALIA Telephone: (002) 31–0366 Telex: AA 57236 Facsimile: (002) 23 2714
Natasha PRUSOVA	17, v. Krasnoselskaya VNIRO 107140 Moscow USSR Telephone: 264 94–54
Eugene SABOURENKOV	CCAMLR Secretariat 25 Old Wharf Hobart 7000, Tasmania AUSTRALIA Telephone: (002) 31–0366 Telex: AA 57236 Facsimile: (002) 23–2714

Kenneth SHERMAN
National Marine Fisheries Service
Antarctic Marine Living Resources Program
Narragansett Laboratory
South Ferry RD
Narragansett, R.I. 02882
USA
Telephone: 401 782 3211
Telex: 927512

Yasuhiko SHIMADZU
Far Seas Fisheries Research Laboratory
7–1, 5-chome, Orido, Shimizu
JAPAN 424
Telephone: 0543–34–0715
Telex: 3965689 FARSEA J

Volker SIEGEL
Sea Fisheries Institute
Palmaille 9
2 Hamburg 50
FEDERAL REPUBLIC OF GERMANY
Telephone: (040) – 38905 177

Daniel F. VERGANI
Instituto Antartico Argentino
Cat. de Genetica
Fac. de Cs Veterinarias
Calle 60 y 118
1900 La Plata
ARGENTINA

Guillermo VISBEEK
Instituto Antartico Argentino
Cerrito 1248
(1010) Buenos Aires
ARGENTINA
Telephone: 44–1689

APPENDIX 2

AGENDA

SECOND MEETING OF THE WORKING GROUP FOR THE
CCAMLR ECOSYSTEM MONITORING PROGRAM
(10–15 June, 1987, Dammarie-les-Lys, France)

1. Data needs for detecting changes in the specified parameters of the selected species.

2. Methods for collecting the data.

3. Workshop on Telemetry and Remote Sensing.

4. Theoretical aspects and pilot studies in establishing predator-prey relationships.

5. Implementation and Co-ordination.

6. Other Business.

APPENDIX 3

LIST OF DOCUMENTS

1. MEETING DOCUMENTS

WG-CEMP-87/1	Agenda
WG-CEMP-87/2	List of Participants
WG-CEMP-87/3	List of Documents
WG-CEMP-87/4	Development of the CCAMLR Ecosystem Monitoring Program, 1982–1986 (submitted by the Secretariat)
WG-CEMP-87/5	Data and methodological requirements for CEMP: seabird parameters.
WG-CEMP-87/6	Survey of breeding penguins and other seabirds in the South Shetland Island, Antarctica, January–February 1987. W.D. Shuford and L.B. Spear
WG-CEMP-87/7	Survey of Antarctic fur seals (*Arctocephalus gazella*) in the South Shetland Islands, Antarctica, during the 1986–87 austral summer. J.L. Bengtson and L.M. Fern
WG-CEMP-87/8	Observations on trends of the population of *Arctocephalus gazella* at Laurie Islands–South Orkney. D.F. Vergani and N.R. Coria
WG-CEMP-87/9	The utilisation of seabird censuses for krill monitoring. E.R. Marschoff, J.G. Visbeek and L.F. Fontana
WG-CEMP-87/10	Micromonitors dive recorder systems. G.L. Kooyman
WG-CEMP-87/11	Poseidon systems dive recorder - Model 1. G.L. Kooyman
WG-CEMP-8712	Designs of a seal datalogger compatible with the service ARGOS satellite location and data collection system. B. McConnell and M. Fedak
WG-CEMP-87/13	Variation or reproductive performance of seabirds and seals at South Georgia, 1976–1986 and its implication for Southern Ocean monitoring studies. J.P. Croxall, T.S. McCann, P.A. Prince and P. Rothery

WG-CEMP-87/14	Long-term trends in the foraging patterns of female Antarctic fur seals at South Georgia (DRAFT). J.L. Bengtson
WG-CEMP-87/15	Archival and satellite-linked data recorders. R.D. Hill
WG-CEMP-87/16	Telemetry monitoring of ecological resources. V.B. Kuechle
WG-CEMP-87/17	Initiation of United States participation in the CCAMLR Ecosystem Monitoring Program in the South Georgia and Antarctic Peninsula integrated study areas, December 1986–February 1987.
WG-CEMP-87/18	An analysis of early change in the blubber thickness of minke whales as an indicator of krill availability. Y. Shimadzu
WG-CEMP-87/19	Can we satisfactorily estimate variation in krill abundance? I. Everson
WG-CEMP-87/20	Overview of NASA's Oceanic Process Program (Excerpt form NASA Annual Report). G.C. Feldman
WG-CEMP-87/21	(Stages in CEMP implementation). Y. Shimadzu
WG-CEMP-87/22	Some observations on logistics associated with the United States Contribution to the CCAMLR Ecosystem Monitoring Program. K. Sherman

2. BACKGROUND DOCUMENTS

1. Opportunities and problems in satellite measurements of the sea. UNESCO Technical papers in marine science, 46 (Report of SCOR Working Group 70).
2. Tracking Grey Seals *Halichoerus grypus* using service ARGOS.
   B. McConnell, Mesagee, 1986, Vol. 46(2), pp.93–94.
3. South African National Antarctic Research.
   Programme-Ocean Sciences (Extract form Programme outline, S.A. Nat. Prog. Rept, 132: 1986).
4. A handbook for the measurement of chlorophyll and primary production.
   BIOMASS, 1987, Scientific Research Series, 8.

5. Seabird responses to fluctuating prey availability in the Eastern Bering Sea.
A.M. Springer *et. al*.. In: Marine Ecology-Progress Series, Mar. Ecol. Prog. Ser., 1986, Vol. 32.
6. The status and conservation of antarctic seals and birds: A review.
J.P. Croxall. In: Environmental International, 1987, Vol. 13.
7. Revised penguin numbers and distribution for Anvers Island, Antarctica.
D.F. Parmelee and J.M. Parmelee. BAS Bulletin, in press.
8. Satellite color observations of the phytoplankton distribution in the Eastern equatorial Pacific during the 1982–1983 El Nino.
G. Feldman, D. Clark and D. Halpern In: Science, 1984, Vol. 226, N° 4678.
9. Patterns of phytoplankton production around the Galapagos.
G.C. Feldman, 1986. In: Lecture notes on coastal and estuarine studies, Vol. 17 'Tidal Mixing and Plankton Dynamics'.
10. Variability of the productive habitat in the Eastern equatorial Pacific.
G.C. Feldman, in OS, 1986, Vol. 67, N° 9.
11. Antarctic sea ice, 1973–1976: Satellite passive-microwave observations.
1983, NASA SP-459.
12. Passive Microwave remote sensing for sea ice research.
Report of the Science Working Group, December 1984.
13. Air Sea interaction with SSM/I and altimeter, Ocean Energy Fluxes Science.
Working Group, 1985, Report NI.
14. The Global Ocean Flux Study (GOFS): Status of the U.S. GOFS program.
P.G. Brewer *et al*. In: EOS, 1986, Vol. 67, N° 44.
15. Satellite Remote Sensing.
Marine Technology Society Journal, 1986, Vol. 20, N° 2.
16. Earth observing system. Instrumental panel report (NASA).
MODUX, 1986, Vol. 26.
17. Assessing marine primary production from space.
M.J. Perry, In Bio-Science, 1986, Vol. 36, N° 7.
18. Changing Climate and the Oceans.
Oceanus, 1986/87, Vol. 29, N° 4.
19. Global ocean flux.
J.M. McCarthy, P.G. Brewer and G. Feldman. In: Oceanus, 1986/87, Vol. 29, N° 4.
20. An overview of the Alaska SAR facility.
J.E. Hilland, 1987. In: Jet propulsion laboratory, NODS, Newsletter, V5, N4.
21. NIMBUS-7 CZCS. Coastal Zone Color Scanner Imagery for selected coastal regions.
NASA publication.
22. Oceanography from space, NASA Information brochure.

23. TOPEX, Observing the Ocean from Space.
NASA Information brochure: Prologue, Sailing ships and early measurements of Ocean circulation.
24. A research strategy for the decade 1985–1995.
NASA Information brochure: 'Oceanography from space' Part 1.
25. A research strategy for the decade 1985–1995.
NASA Information brochure: 'Oceanography from space' Part 2.
26. TOPEX, The Ocean Topography Experiment.
NASA Information brochure: 'Oceanography from space'.
27. OCI, Ocean Color Image.
NASA Information brochure: 'Oceanography from space'.
28. Monthly satellite-derived phytoplankton pigment distribution for the North Atlantic Ocean Basin.
W.E. Esaias et al.. In: EOS. Transaction, American Geophysical Union, 1986, Vol. 67, N° 44.

APPENDIX 4

CCAMLR STANDARD METHODS FOR MONITORING PARAMETERS OF PENGUINS

Working Group for the CCAMLR Ecosystem Monitoring Program

INTRODUCTION

This document is the first of a series which sets out the methodologies to be used in monitoring the predator parameters given priority by the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP), see SC-CAMLR-VI Annex 4, Table 3.

2. The standard method sheets for penguins were compiled by J.P. Croxall and D.G. Ainley. They are based on the original documents prepared by E. Woehler, K.R. Kerry and E. Sabourenkov for the SCAR Subcommittee on Bird Biology and incorporate detailed comments provided by members of that Subcommittee, especially D.G. Ainley, J. Cooper, J.P. Croxall, G.L. Hunt, G.W. Johnstone and W.Z. Trivelpiece.

3. These methodologies have been endorsed by the WG-CEMP. Attention is drawn to paragraph 22 of the report of the 1987 meeting of the Working Group (SC-CAMLR-VI Annex 4) in which it was stressed that work should be carried out as specified in the standard method sheets, particularly in respect to sample sizes.

DESCRIPTION OF STANDARD METHOD SHEETS

4. Unless stated otherwise, the method sheets refer to all three penguin species recommended for monitoring, namely Adelie (*Pygoscelis adeliae*), chinstrap (*Pygoscelis antarctica*) and macaroni (*Eudyptes chrysolophus*). For the purpose of the monitoring program, the common name macaroni penguin is taken to include the royal penguin.

5. Table 1 sets out the parameters of penguin species to be monitored, and cross references the parameters to a perceived relationship with other associated parameters.

6. Each method sheet is complete in itself and includes cited references. It should be noted, however, that one set of observations may provide information for other parameters. Similarly, several parameters may be measured during the breeding season on one colony.

7. Topics listed under 'Ancillary Studies' are provided to complement or focus on a particular aspect of a parameter, and represent starting points from which further investigations can proceed.

8. The use of square brackets [] indicates details in methodology, location, date and sample size, etc., that are either uncertain or have yet to be decided upon. Information is especially sought on this subject matter.

9. Data on critical events in the breeding season which are relevant to the parameter being monitored are presented in each method sheet.

10. The monitoring of several parameters requires particular colonies (or portions of colonies) to be regularly accessed over a long-term period. These monitored colonies need to be protected from disturbance caused by other human activities (e.g. station activities, other research programs, tourists etc.).

11. Excessive disturbance of penguins due to the monitoring activities themselves (e.g. handling and the recording of data) can induce desertion of the nest and so give rise to biased results. Note also that many parameters make use of individually-identifiable (i.e. banded) birds. It is of paramount importance to the monitoring program that the welfare of the birds is maintained.

12. An alpha-numeric coding system has been tentatively proposed for the CCAMLR Standard Method Sheets. According to this system a letter of the alphabet identifies the method sheet series according to the group of organisms for which the series has been prepared, e.g. 'A' represents the method sheet series for penguins; 'B' might represent the method sheet series for seals etc. Immediately following the letter in the code, a number is used to identify the parameter to which the method sheet applies, e.g. for series A, the number '1' identifies the parameter 'adult weight on arrival at breeding colony', '2' identifies the parameter 'length of the first incubation shift' etc. Additional parameters for which method sheets are prepared in the future could be numbered sequentially from the last assigned number for that method sheet series. A period mark (.) separates the parameter number in the code from a second number which is used to identify the version number of the method sheet, e.g. '1.0' represents the first version of the method sheet for parameter 1; '1.1' would

represent the first modification of the method sheet for parameter 1 etc. Such modifications to the original method sheets would be necessary to accommodate changes made to the methodologies, or changes in the applicability of the methodology to the species originally listed as being suitable for monitoring by that methodology.

Table 1: Perceived association between parameters of penguin species. Note: Those marked * have been given highest priority for monitoring. Parameters have been arranged in sequence of breeding events.

Parameter to be Monitored	Method Sheet Number	Associated Parameters								
		Over-winter survival	Arrival weight	Length first incubation shift	Size of breeding population	Foraging trips	Breeding success	Adult weight at fledging	Chick weight at feldging	Adult weight before moult
Penguins (Adelie, chinstrap and macaroni):										
Weight on Arrival at Breeding Colonies	Al.0	+	NA	+	+	-	+	+	+	+
Length of the First Incubation Shift	A2.0	-	+	NA	-	-	+	+	+	
Annual Trends in Breeding Population Size	A3.0	+	+	-	-	-	+	-	-	-
Demography	A4.0	+	+	-	-	-	+	+	-	+
Duration of Foraging Trips*	A5.0	-	-	-	-	NA	+	-	+	+
Breeding Success*	A6.0	+	+	+	+	+	NA	+	+	-
Fledging Weight*	A7.0	+	+	-	-	+	+	+	NA	-
Diet*	A8.0	-	-	-	-	-	-	-	-	-

+ = Association thought to exist between parameters
- = No association known between parameters
NA = Not applicable

Species: Penguins (Adelie, Macaroni and Chinstrap)

Parameter: Adult weight on arrival at breeding colony.

Associated Parameters:

Over-winter survival; length of the first incubation shift; size of breeding population; breeding success; adult weight at chick fledging; chick weight at fledging; adult weight before moult (macaroni penguin only).

Aim: To determine the mean weight of breeding birds of both sexes at first return to the colony.

Method: The following procedure is to be followed on an annual basis:

1. Capture birds on the beach as they leave the sea or pack ice; do not capture those already occupying territories in the colony.

2. Weigh each bird to the nearest 10–25g (depending on accuracy of scale used). Test the scales against a known weight at periodic intervals.

3. Capture 50 birds every five days beginning with 1–5 October as the first five-day interval. If possible attempt to capture 25 birds of each sex (use bill size or cloacal characters to determine sex); do not capture banded birds which are part of other studies. If birds are not sexed, increase sample size to 75 birds per interval. Continue captures until the peak of egg laying has passed (see 4 below).

4. In order to gauge the population breeding effort, determine peak of egg laying as follows. Select three colonies of about 30 pairs each. Determine daily the number of nests in each which do or do not have eggs. When about two-thirds have eggs, the peak has been surpassed.

5. Daily observations should be made of sea-ice cover as viewed from the colony, as well as wind and weather.

Ancillary Studies:

Prey species availability; mate retention; clutch initiation dates for the colony.

A1.0 Table 1: Reported dates of first arrival at nominated breeding areas

Location	Adelie	Chinstrap	Macaroni	References
Prydz Bay	12 Oct	NA	NA	(4)
S. Orkney	2 Oct	31 Oct	X	(5)
S. Georgia	NA	NA	1 Nov	(2) (3)
S. Shetlands	7 Oct	28 Oct	NA	(6) (7)

X = unknown
NA = not applicable; species does not breed at that location

Mandatory Data:

1. Record date of start of observation and date of first arrival(s).
2. Record date, [band number], sex [for macaroni penguins] and weight for each bird on arrival at the colony.

Highly Desirable:

1. Calculate median date of first arrival(s).
2. Record date, sex and weight for each sample on arrival at the colony.

Interpretation of Results:

The mean timing of arrival and weight at arrival after the winter period at sea may provide an index of general condition (fat reserves) and reflect the availability and quality of food through the early spring. Weight on arrival may be affected by the following:

1) Food availability, quality and access
2) Individual variation - age, social status, health and fitness of each bird
3) Distance between open water and colony.

Problems to be considered:

(i) Laying dates correlated with age (experience) with older birds tending to arrive earlier at the colony (1).

(ii) The male birds arrive a few days before the females. This may introduce a sampling bias as the males are heavier; therefore the sampling timetable must allow for this, i.e. sampling must continues past peak of laying every year.

Comment: Automatic data loggers capable of recording most of the data required for this parameter would be helpful. Equipment to record species (photograph), date and weight of each individual would considerably reduce the manual input to data collection and increase the accuracy of data.

References:

(1) AINLEY, D.G., LERSCHE, R.E. and SLADEN, W.J.L., 1983. Breeding Biology of the Adelie Penguin. University of California Press, 240 pp.
(2) CROXALL, J.P., 1984. Seabirds. In LAWS, R.M. (Ed.), Antarctic Ecology, Volume 2. Academic Press, 533–619.
(3) CROXALL, J.P. and PRINCE, P.A., 1980. Food, feeding ecology and ecological segregation of seabirds at South Georgia. Biol.J.Linn.Soc.14, 103–131.
(4) JOHNSTONE, G.W., LUGG, D.J., and BROWN, D.A., 1973. The Biology of the Vestfold Hills, Antarctica. ANARE Sci.Rep.Ser. B(1), 62 pp.
(5) LISHMAN, G.S., 1985. The comparative breeding biology of Adelie and Chinstrap penguins *Pygoscelis adeliae* and *P. antarctica* at Signy Island, South Orkney Islands. Ibis 127, 84–99.
(6) NIELSEN, D.R., 1983. Ecological and behavioural aspects of the sympatric breeding of the South Polar Skua (*Catharacta maccormicki*) and the Brown Skua (*Catharacta lonnbergi*) near the Antarctic Peninsula. Unpubl. MS Thesis, Univer. Minnesota, Minneapolis.
(7) TRIVELPIECE, W.Z., TRIVELPIECE, S.G. and VOLKMAN, N.H., 1987. Ecological segregation of Adelie, Gentoo and Chinstrap penguins at King George Island, Antarctica. Ecology 68: 351–361.

Background Papers:

AINLEY D.G. and EMISON W.B. 1972. Sexual size dimorphism in Adelie penguins. Ibis 114, 267–271.
BIOMASS Report No. 34 Meeting of BIOMASS Working Party on Bird Ecology.
SC-CAMLR-IV, Annex 7. Report of the Ad Hoc Working Group on Ecosystem Monitoring 1985.

Species: Penguins (Adelie, Chinstrap)

Parameters: Length of the fist incubation shift

Associated Parameters:

Weight on arrival at breeding colony; breeding success; adult weight at chick fledging; adult weight before moult (macaroni penguin only).

Aim: To measure the duration of the first incubation shift for each member of the pair and the proportion of nest desertion during the first shift. Nest desertion occurs when one member of a pair leaves before the other returns to relieve incubation.

Method:

1. Use the same 100 nests observed for monitoring breeding success (Method Sheet A6.0); observations, however, must be made daily. Sample must include pairs from early to late in the egg laying period.
2. For each nest, on the first day when a bird is observed alone on the eggs (because mate has gone to sea), squirt dye on the bird's breast; note that date.
3. Check the nest daily, and note the date when a bird with a clean breast appears.
4. For all nests, calculate the mean number of days the dyed bird was alone on its nest incubating eggs.
5. On a daily basis record ice cover and weather in the vicinity of the colony.

Problems to be considered:

(i) Disturbance by visits can induce desertion of the nest. Do not handle any of the birds e.g. do not lift birds off the nest to check for eggs.

(ii) A small percentage of females will incubate the egg first, usually for only a few days ('reverse role' incubation, Ainley et al. (1)). The sample size, however, should be sufficient to identify the 'outlying' data points resulting from these nests; data may best be presented as a frequency distribution of incubation shift durations.

Ancillary Studies:

Prey species availability; clutch initiation dates; energetics of incubation.

A2.0 Table 1: Reported duration of first and second incubation shifts (mean in days ± standard error) and sex of incubating bird.

		Species		
		Adelie	Chinstrap	References
Prydz Bay	First Shift	X	NA	
	Second Shift	X	NA	
S. Orkney	First Shift	13.7±1.7;M	6.0±2.4;F	(2)
	Second Shift	12.7±2.0;F	9.8±2.9;M	

X = unknown
M = male, F = female
NA = not applicable; species does not breed at that location.

Mandatory Data:

1. Date of start of observations for each nest.
2. Nest number, band-number and sex of incubating bird on a [daily] basis.
3. Band numbers of bids which disappear during the observation period and the nest number with which the bird was associated.
4. Record when a change in incubating bird is first observed.

Highly Desirable:

1. Record any data on change in partner (i.e. failure to return; divorce).
2. Record the length of the first incubation shift of each member of the pair in successive years.
3. As for 2. but for birds of known age.
4. Record the content of nest on a regular basis during incubation.

Interpretation of Results:

The duration of the first incubation shift indicates the quality and accessibility of food during the pre-laying period and to the bird taking second shift. It is influenced by breeding experience of the birds incubating and the fat reserves of the individuals.

References:

(1) CROXALL, J.P., 1984. Seabirds. In LAWS, R.M., (Ed.) Antarctic Ecology, Vol.2. Academic Press, 533–619.
(2) LISHMAN, G.S., 1985. The comparative breeding biology of Adelie and Chinstrap penguins *Pygoscelis adeliae* and *P. antarctica* at Signy Island, South Orkney Islands. Ibis 127, 84–99.

Background Papers:

AINLEY, D.G., LERSCHE, R.E. and SLADEN, W.J.L., 1983. Breeding Biology of the Adelie Penguin, University of California Press, 240 pp.

BIOMASS Report No. 34 Meeting of BIOMASS Working Party on Bird Ecology.

BIOMASS Handbook No. 20 Penguin Census Methods. 1982.

SLADEN W.J.L. 1978. Sexing penguins by cloacascope. International Zoo Yearbook 18, 77–80.

TAYLOR, R.H. 1962. The Adelie Penguin at Cape Royds. Ibis 104: 176–204

TRIVELPIECE, W.Z., TRIVELPIECE, S.G. and VOLKMAN, N.J., 1987. Ecological segregation of Adelie, Gentoo and Chinstrap penguins at King George Island, Antarctica. Ecology 68: 351–361.

Species: Penguins (Adelie, Macaroni and Chinstrap)

Parameter: Annual Trend in Size of Breeding Population

Associated Parameters:

Over-winter survival; weight on arrival, breeding success.

Aim: To determine between-year trends in the size of breeding populations.

Methods:

1. For Adelie and chinstrap penguins select a sample of colonies, of about 10% of the total number of colonies (may be same colonies used to assess chick numbers - see Method Sheet A6.0, Breeding Success). For macaroni penguins select a suitable colony or colonies (up to 2000 pairs). These colonies must have the same criteria for selection as those for chick counts, especially no disturbance by human activities (station, research or other). Colonies must be clearly marked and mapped (see Method Sheet A6.0).

2. One week after the peak of egg laying (about 7 November for Adelie and 7 December for Chinstrap penguins on King George Is.; 31 November for Macaroni penguins on South Georgia) count the number of occupied territories in each of the colonies as well as the number of territories on which eggs are being incubated. The date does not have to be exactly the same date each year, but should be nearly the same. The number of territories on which eggs are being monitored can be an estimate based on the number of birds standing versus lying (i.e. incubating eggs) in nests at the time of the count. Physically lifting birds to check underneath them causes too much disturbance especially in larger colonies. Ideally, three separate counts should be made of each colony, and the results be averaged.

Ancillary Studies:

Population structure of colony; mate retention; food availability; clutch initiation dates; weather and ice conditions; energetics.

A3.0 Table 1: Mean laying date of first egg ± standard error (a), range of laying dates (b), and incubation period (mean in days ± standard error) (c).

	Adelie a;b;c	Chinstrap a;b;c	Macaroni a;b;c	References
Prydz Bay	X;X;X	NA	NA	
S. Orkney	3 Nov±6;X;34±1	6 Dec±6;X;34±2	NA	(1)
S. Georgia	NA	NA	23 Nov±3;X;33	Croxall (pers. comm.)
S. Shetlands	X; 20 Oct–5 Dec; X	X; 16 Nov–2 Dec; X	NA	(2) (3)

X = unknown
NA = not applicable; species does not breed at that location

Mandatory Data:

All data listed for the ISAS* Penguin Census Card (BIOMASS Working Party on Bird Ecology, Handbook 20, 1982). An ISAS Penguin Census Card and instructions for completing the card are appended to this method sheet.

Interpretation of Results:

The total number of birds engaged in breeding activity can be influenced by:

1) cohort size at fledging and rate of recruitment of each cohort to the breeding population
2) food supply during pre-laying and incubation periods
3) ages of individual birds (and consequently the age structure of the colony)
3) previous breeding experience of the individuals
4) length of mate-bond
5) presence of mate
6) size and location of colony
7) ice conditions prior to colony occupation.

References: (1) LISHMAN G.S., 1985. The comparative breeding biology of Adelie and Chinstrap penguins *Pygoscelis adeliae* and *P. antarctica* at Signy Island, South Orkney Islands. Ibis 127, 84–99.
(2) NIELSEN, D.R., 1983. Ecological and behavioural aspects of the sympatric breeding of the South Polar Skua (*Catharacta maccormicki*) and the Brown Skua (*Catharacta lonnbergi*) near the Antarctic Peninsula. Unpubl. MS Thesis, Univer. Minnesota, Minneapolis.

*ISAS = International Survey of Antarctic Sea Birds

(3) TRIVELPIECE, W.Z., TRIVELPIECE, S.G. and VOLKMAN, N.J., 1987. Ecological segregation of Adelie, Gentoo and Chinstrap penguins at King George Island, Antarctica. Ecology 68: 351–361.

Background Papers:

AINLEY D.G., LERESCHE R.E. and SLADEN W.J.L., 1983. Breeding Biology of the Adelie Penguin. University of California Press, 240 pp.

BIOMASS Report No. 34 Meeting of BIOMASS Working Party on Bird Ecology.

BIOMASS Handbook No. 19. Monitoring Studies of Seabirds, 1982.

BIOMASS Handbook No. 20. Penguin Census Methods, 1982.

CONROY J.W.H., DARLING O.H.S and SMITH H.G., 1975. The annual cycle of the Chinstrap penguin *Pygoscelis antarctica* on Signy Island, South Orkney Islands. In Stonehouse B. (Ed.), The Biology of Penguins. MacMillan, 555 pp.

CONROY J.W.H., 1975. Recent increases in penguin populations in Antarctica and the Subantarctic. In Stonehouse B. (Ed.) The Biology of Penguins. Macmillan, 555 pp.

CROXALL, J.P., 1984. Seabirds. In Laws R.M. (Ed.), Antarctic Ecology, Volume 2. Academic Press, 533–619.

GWYNN A.M., 1952. Egg Laying and Incubation Periods of Rockhopper, Macaroni and Gentoo penguins. ANARE Rep. Ser. B (1), 29 pp.

JOHNSTONE, G.W., LUGG D.J., and BROWN D.A., 1973. The Biology of the Vestfold Hills, Antarctica. ANARE Sci.Rep.Ser. B(1), 62 pp.

SC-CAMLR-IV, Annex 7. Report of the Ad Hoc Working Group on Ecosystem Monitoring, 1985.

ISAS Census Card for penguins in colonies:

FIELD RECORD FOR CENSUS OF PENGUIN COLONIES						Card No.
1. Observer		2. Species				Office Use Only
3. Locality		4. Lat.° N S	4. Long.° E W	5. Trip No.	6. Date D / M / Y	7. Time
8. Colony Name		9. Topography Beach Slope	Flat Cliff	Other	9. Substrate Sand Shingle	Boulders Cliffs	Ice Others
10. Mode	11. Method	12. Camera Format	13. Focal Length	14. Distance	15. Aspect	16. Photo No.
22. Notes		17. Categories Observed	Count		18. Count	19. % Accuracy
		1. Nests & eggs				
		2. Nests & chicks				
		3. Nests & adults			20. Map No.	20. Map Scale
		4. Chicks				
		5. Breeding adults				
		6. Non-breeding adults			21. Sample Count Numbers	
		7. Moulting adults				
		8. Other			Area Colony	
					Area Sampled	
					Number of Birds	

Instructions for completing ISAS Census Card for penguins in colonies:

1. Observer. Full name and affiliation (institute, country, etc.)

2. Species. Details for one species only per card. If more than one species is present in a colony, complete a separate card for each species. General information may be recorded on the first card only, if the cards are consecutively labelled e.g. 21a, 21b, 21c, etc, and stapled together.

3. Locality. Use the area name. Local or unofficial names must be in inverted commas.

4. Coordinates. Latitude and longitude in degrees and minutes (preferably to the nearest 10 minutes).

5. Trip Number. Assign a consecutive number to each trip on which colonies are observed.

6. Date. Day, month, year.

7. Time. The starting time of each survey period, preferably recorded as Greenwich Mean Time (GMT). If local time is used, note deviation from GMT. Use 24 hour clock notation. Indicate which convention is being used.

8. Colony Name. Allocate a name or number to the colony so that it may be identified on successive visits.

9. Topography and Substrate. Circle all categories occurring in area colonised. Specify any others that occur.

10. Mode. Specify mode of survey, e.g. helicopter, fixed-wing aircraft, ship, ground, other (state).

11. Method. Specify method used, e.g. visual, photographic, other (state).

12. Camera Format. 35 mm, 120 mm, etc. (state).

13. Focal Length/Lens. Record in millimetres (mm).

14. Distance. State whether flight altitude determined from barometer or altimeter. For on-ground observations, state height above and/or distance from colony in metres.

15. Aspect. State whether vertical or oblique.

16. Photograph Serial Number. Record this so that cards may be matched later with photographs.

17. Categories observed. Enter numbers counted for each of the categories listed. If not counted, circle those categories which occurred at time of census.

18. Count. State whether estimate or actual count.

19. Percent Accuracy. Specify estimated accuracy, preferably in 5-percent units.

20. Map. Record map number and scale. Use the reverse of the card to sketch a map of the area showing extent of colony. Indicate direction of photograph or observation.

21. Sample Count Numbers. If census was based on extrapolation of sample counts, state total area of colony, area of subsection sampled and number of birds in area(s) sampled.

22. Notes. Include here any factors which affected census, e.g. weather, topography. Add any other relevant observations.

23. Record negative information e.g. areas surveyed but no birds found. Present this information on a card or map that can be submitted with the cards.

Species: Penguins (Adelie, Chinstrap and Macaroni)

Parameter: Demography: a) annual survivorship, b) age at first reproduction, c) cohort strength.

Associated Parameters:

Size of breeding population; weight on arrival at breeding colony; breeding success; adult weight at chick fledging; adult weight before moult.

Aim: To determine the demographic parameters of the population. Note: This is by far the most labour-intensive parameter. It requires that observations be conducted every year from the beginning of penguin arrival in the spring, through egg laying and into the creche period. The ideal size of the colony is 10,000 to 50,000 pairs. In larger colonies it will be much more difficult to locate banded birds. The procedure requires banding penguins; some mortality is induced by banding. Band loss must also be considered. Two different methodologies are presented; Method A is much less labour-intensive than Method B but only yields an estimate of annual survivorship. Demographic measurements should not be undertaken unless a firm commitment of at least 10 consecutive years is possible. See Ainley et al. (2) for further details of procedures.

Method A: (Less desirable: only yields estimate of annual survivorship).

1. Choose three sites of about 30 nests not on the periphery of the colony; observe them daily during the egg laying period, noting the number of nests which do or do not have eggs. On the day when one third of the nests (i.e. a total of 30 across all three colonies) contain at least one egg, begin the procedures outlined below.

2. Select 50 nests which are not being observed for other purposes, and which have at least one egg and both adults still present. These nests should be near the periphery of colonies (as the days go by, other pairs will likely establish nests to the periphery of these). Mark the nests with a numbered stake or rock (at the end of the season, a permanent marker should be established at each nest). Squirt dye on each bird.

3. Observe both birds of each pair closely. Decide which is the larger and which does not have tread marks on its back (male); confirm sex by incubation schedule in Adelies (male should incubate first).

4. Using a hand net, capture the adult which is not incubating the egg(s) and band it. Check the nest the next day, and every day thereafter until both birds are banded. If on the next day after banding the first bird, the unbanded bird is standing (but the banded one is incubating), capture the unbanded bird with a net and band it. If on the next day, the unbanded bird is alone incubating eggs, it can usually be banded on the nest by placing a hand over its eyes and applying the band with the other hand (this task will become easier if you wait a few days). Note the band numbers of each pair by sex. Do not determine sex by cloacal examination, unless it is possible to capture one of the birds during the creche period.

5. The following year, before and during the laying period, search the colony for these banded birds; most (but not all), if alive, will be found at or near the nest where originally banded. The search effort must be the same every year (same number of people looking for banded birds on the same number of days during the prelaying and laying periods).

6. Each year band a new cohort of 50 pairs as in 1–3 above, and search for them the following year.

7. After 11 years, there will be 10 sets of two consecutive years (year i and year i + 1), in which the survival of adult breeders will be ascertained, year i to year i + 1. In the analysis, do not mix results of penguins banded more than one year previously; analyse cohort by cohort. Determine survival by sex.

Method B: (More desirable).

1. Each year, during the late creche period, but before any chicks have fledged, band a minimum of 1500 large creche-age chicks. Choose several neighbouring colonies in the same part of the colony for the banding. Record the band numbers used each year. Include in the sample, chicks of known-age birds (banded so that parents are known).

2. In subsequent years, search the colony for banded birds; search effort must be the same every year (same number of persons, same number of days spent looking for banded birds). Young birds will appear late in the breeding season, arriving earlier with greater age.

3. When a banded bird establishes a nest site, pairs and lays eggs, mark the nest site and visit that bird/site in later years noting whether or not the bird breeds successfully. Perhaps band its mate.

4. Determine the between-year survival of penguins according to age, sex and breeding status. On an annual basis, determine the average age of first reproduction of birds breeding for the first time (not possible until year 8 of the study; and every year thereafter); in the meantime determine the proportion of each age class which breeds each year. Determine sex by behaviour. Otherwise, during the creche period only, determine sex by cloacal examination.

5. For additional ideas on data analysis see Ainley et al. (2).

Problems to be considered:

(i) Disturbance caused by visits can induce predation of eggs and chicks by skuas. Giant petrels, gulls, wekas and sheathbills may predate eggs and chicks on sub-Antarctic Islands.
(ii) Only stainless steel flipper bands are to be used; these are obtainable from Lambournes Ltd.* Numbering should be co-ordinated among researchers working in the same islands/region.
(iii) Environmental data on weather and extent of ice cover should be recorded daily (see Ainley et al. (1)).

Ancillary Studies:

Ice conditions; predation by Leopard Seals; winter migratory behaviour; prey species availability.

A4.0 Table 1: Reported dates of the first return to and earliest departure from the nominated breeding colony.

	Return			Departure			
	Adelie	Chinstrap	Macaroni	Adelie	Chinstrap	Macaroni	Ref
Prydz Bay	12 Oct	NA	NA	20 Jan	NA	NA	(1) (2) (4) (7)
S. Orkney	2 Oct	31 Oct	NA	20 Jan	20 Jan	20 Feb	(5)
S. Georgia	NA	NA	1 Nov	NA	NA	20 Feb	(3) (6)
S. Shetlands	1 Oct	28 Oct	NA	X	X	X	(8) (9)

X = unknown
NA = not applicable; species does not breed at that location

Mandatory Data:

1. Date of first arrival and band number of arriving birds.
2. Dates of banding and band number of chicks and adults.
3. Date recovered and band number of all dead chicks and adults.

Highly Desirable:

1. Band number of partners.
2. Weights at fledging of banded chicks.
3. Dates of departure of chicks.

Interpretation of Results:

The return of banded birds to the colony following a winter period at sea can be used to calculate the annual survival rate of adults and non-adults. Mortality during winter months can be due to:

(1) prey species availability (quantity, quality and access)
(2) predation by leopard seals, killer whales
(3) weather conditions

* Lambournes Ltd., Coleman House, Station Road, Knowle, West Midlands, B93 OHL, England.

(4) banding activities (banding induced mortalities documented by Ainley et al., (2))
(5) other.

Banding of chicks at pre-fledging allows determination of mortality within the cohort, i.e. age-specific mortality rates can be determined.

Large-scale banding over the lifespan of a cohort provides data on the year-to-year mortality (i.e. an environmental indicator) and if banding takes place in several geographically discrete colonies, the results can indicate if an observed result is local or not. Eventually life tables could be generated from the data collected for each cohort.

Problems to be considered:

(i) Band loss does occur (documented by Ainley et al., (2)); stainless steel bands keep loss to a minimum.
(ii) Non-return of a bird can also indicate some migration has taken place.
(iii) Not all sub-adults return to colonies in all years.

Comment: Automatic data-loggers capable of recording some of the data are needed.

Equipment to record band number (e.g. coded into bar-code), date and weight of individual would reduce the manual input to data collection.

Band numbers should be coded by location using a 3-letter prefix followed by a 5 digit number (advise SCAR Subcommittee on Bird Biology).

References:

(1) AINLEY D.G., WOOD R.C. and SLADEN W.J.L. 1978. Bird life at Cape Crozier, Ross Island. Wilson Bull. 90, 492–510.
(2) AINLEY D.G., LERESCHE R.E. and SLADEN W.J.L., 1983. Breeding Biology of the Adelie Penguin. University of California Press, 240 pp.
(3) CROXALL J.P. and PRINCE P.A., 1980. Food, feeding ecology and ecological segregation of seabirds at South Georgia. Biol.J.Linn.Soc.14,103–131.
(4) WATSON G.E., 1975, Birds of the Antarctic and Sub-Antarctic. American Geophysical Union, 350 pp.
(5) LISHMAN G.S., 1985. The comparative breeding biology of Adelie and Chinstrap penguins *Pygoscelis adeliae* and *P. antarctica* at Signy Island, South Orkney IsIands. IBIS 127, 84–99.
(6) CROXALL J.P., 1984. Seabirds. In LAWS R.M. (Ed.) Antarctic Ecology, Vol. 2 Academic Press, 533–619.
(7) JOHNSTONE G.W., LUGG D.J. and BROWN D.A., 1973. The Biology of the Vestfold Hills, Antarctica. ANARE Sci. Rep. B(l), 62 pp.
(8) NIELSEN, D.R., 1983. Ecological and behavioural aspects of the sympatric breeding of the South Polar Skua (*Catharacta maccormicki*) and the Brown Skua (*Catharacta lonnbergi*) near the Antarctic Peninsula. Unpubl. MS Thesis, Univer. Minnesota, Minneapolis.
(9) TRIVELPIECE, W.Z., TRIVELPIECE, S.G. and VOLKMAN, N.J., 1987. Ecological segregation of Adelie, Gentoo and Chinstrap penguins at King George Island, Antarctica. Ecology 68: 351–361.

Background Papers:

BIOMASS Report No. 34 Meeting of BIOMASS Working Party on Bird Ecology.

CONROY J.W.H., DARLING O.H.S. and SMITH H.G., 1975. The annual cycle of the Chinstrap penguin *Pygoscelis antarctica* on Signy Island, South Orkney Islands. In Stonehouse, B., (Ed.), The Biology of Penguins. Macmillan, 555 pp.

DOWNES M.C., EALEY E.H.M., GWYNN A.M. and YOUNG P.S., 1959. The birds of Heard Island. ANARE Rep.Ser.B (1), 135 pp.

SC-CAMLR-IV, Annex 7. Report of the Ad Hoc Working Group on Ecosystem Monitoring, 1985.

Species: Penguins (Adelie, Chinstrap and Macaroni)

Parameter: Duration of Foraging Trips

Associated Parameters:

Breeding success; chick weight at fledging; diet.

Aim: To determine within-year and between-year differences in the amount of time required to procure food for chicks as an indicator of foraging range, foraging effort and food availability.

Methods This parameter can be measured effectively only with the use of telemetry and automatic data logging instruments. Materials required include 20–40 radio transmitters (battery life 2 months, range 0.5 km, weight less than 25 g), antenna, scanning receiver, and data or strip-chart recorder.

Select 20–40 pairs (depending on number of radios available) guarding 1- to 2-week-old chicks (determine sex of the adults in each pair; male is larger with larger bill). Two people should be involved in placement of radio transmitters. Preferably, upon observing a change in incubation shift, capture the departing member of the pair and affix a transmitter as described below. If capture of the departing member is not possible, capture the other adult of the pair as it guards the chicks. Place chicks in a pocket to keep warm and safe from predation. Just before releasing adult, after affixing transmitter, return chicks to the nest.

Place cloth or glove over adult's eyes to help keep it calm while attaching transmitter. While one person holds the penguin, mix fast-drying epoxy (Devcon or similar product) and apply to back feathers midway between the shoulders using an applicator. Area covered should be 1 cm larger than size of the transmitter. Press epoxy into plumage so that it reaches basal part of feathers. Set transmitter on epoxy (antenna should point toward the head or tail depending on type) and secure using one or two plastic electronic ties; ties should encircle transmitters and the epoxied feathers beneath it. Smooth the upper and lateral edges of the transmitter/epoxy unit with additional epoxy to form a solid, hydrodynamic bond to feathers.

Position scanning receiver in a location protected from the weather, but close enough to the study nests and beach such that all instrumented birds are detected if present. Program each transmitter frequency (each should be different) on the data logger. Transmitted signals are only received when each bird is within range (i.e. ashore), thus providing a continuous record of the at-sea/on-shore intervals. Determine mean at-sea interval for each instrumented bird; determine mean at-sea interval for all transmitters per successive 5-day periods.

Recapture each instrumented adult prior to chicks fledging and remove transmitter. Using a sharp scalpel or surgical scissors, cut feathers at the epoxy boundary. Leave as much of the feathers as possible. Adults should moult in a few weeks following fledging of their chicks.

Ancillary Studies:

Growth rates of chicks; fledging weight; meal size; diet composition and prey species availability; ice and weather conditions; foraging ranges (see Trivelpiece et al., (4)) diving profiles and depths (see Wilson and Bain (5)(6)).

A5.0 Table 1: Reported mean first egg hatching dates ± standard error (a), guard stage duration in days (b) and creche stage duration in (days) (c) respectively.

	Adelie a; b; c	Chinstrap a; b; c	Macaroni a; b; c	References
Prydz Bay	13 Dec ± 3D; 21D; 40D	NA	NA	(2)
S. Orkney	4 Dec. ± 3D; 21D; 40D	1 Jan ± 4; 23D; 53D	X;X;S	(3)
S. Georgia	NA	X;X;X	26 Dec; 23D; 37D	(1); Croxall unpublished
S. Shetlands	23 Nov;X;X;	20 Dec;X;X;	NA	(7) (8)

X = unknown
NA = not applicable; species does not breed at that location

Interpretation of Results:

The duration of foraging trips is exceedingly sensitive to food availability and is of fundamental importance to the (breeding) success of the breeding pairs. Delays in returning to the nest with a meal for the growing chick can cause desertion by the partner as well as starvation in the chick.

Duration of foraging trips may be influenced by the following:

1) sea ice and weather conditions
2) prey species availability, quality and quantity.

References:

(1) CROXALL, J.P., 1984. Seabirds. In Laws, R.M. (Ed.), Antarctic Ecology, Vol.2.
(2) JOHNSTONE, G.W., LUGG, D.J. and BROWN, D.A. 1973. The biology of the Vestfold Hills, Antarctica. ANARE Sci.Rep.Ser. B(1), 62 pp.
(3) LISHMAN, G.S., 1985. The comparative breeding biology of Adelie and Chinstrap penguins *Pygoscelis adeliae* and *P. antarctica* at Signy Island, South Orkneys Islands. Ibis 127, 84–99.
(4) TRIVELPIECE, W.Z., BENGTSON, J.L.; TRIVELPIECE, S.G. and VOLKMAN, N.J., 1986. Foraging behaviour of Gentoo and Chinstrap Penguins as determined by new radiotelemetry techniques. Auk 103, 777–781.
(5) WILSON, R.P. and BAIN, C.A.R., 1984a. An inexpensive depth gauge for penguins. J.Wildl.Manage. 48, 1077–84.
(6) WILSON, R.P. and BAIN, C.A.R., 1984b. An inexpensive speed meter for penguins at sea. J.Wildl.Manage. 48, 1360-64.
(7) TRIVELPIECE, W.Z., TRIVELPIECE, S.G. and VOLKMAN, N.J., 1987. Ecological segregation of Adelie, Gentoo, and Chinstrap penguins at King George Island, Antarctica. Ecology 68: 351–361.
(8) NIELSEN, D.R., 1983. Ecological and behavioural aspects of the sympatric breeding of the South Polar Skua (*Catharacta maccormicki*) and the Brown Skua (*Catharacta lonnbergi*) near the Antarctic Peninsula. Unpubl. MS Thesis, Univer. Minnesota, Minneapolis.

Background Papers:

AINLEY, D.G., LERESCHE, R.E., and SLADEN, W.J.L., 1983. Breeding Biology of the Adelie Penguin. University of California Press, 240 pp.

BIOMASS Report No. 34 Meeting of BIOMASS Working Party on Bird Ecology.

HEATH, R.G.M., 1987. A method for attaching transmitters to penguins. J. Wildl. Manage. 51: 399–401.

SC-CAMLR-IV, Annex 7. Report of the Ad Hoc Working Group on Ecosystem Monitoring, 1985.

WARHAM, J., 1975. The Crested Penguins. In Stonehouse, B. (Ed.), The Biology of Penguins. Macmillan, 555 pp.

WILLIAMS, A.J., 1982. Chick feeding rates of Macaroni and Rockhopper penguins at Marion Island. Ostrich 53: 129–34.

WILSON, R.P., GRANT, W.S. and DUFFY, D.C., 1986. Recording devices on free-ranging marine animals: does measurement affect foraging performance? Ecology 67: 1091–1093.

Species: Penguins (Adelie, Chinstrap, Macaroni)

Parameter: Breeding Success

Aim: To assess productivity. This may be achieved either indirectly by providing an index of relative change in the number of chicks produced one year to the next (Method A), or directly, by actually measuing chick production (Method B).

Note: Method A must be incorporated into monitoring programs at each location; Method B is encouraged as a valuable addition to programs. These procedures must be carried out every year for at least ten years in order to be able to demonstrate trends in breeding success.

The Adelie and chinstrap penguins lay two eggs which often hatch but sometimes only one chick is raised to fledging. In seasons of abundant food close to colonies, more birds raise two chicks than in other seasons. Macaroni penguins often lay two eggs but one of these is always discarded.

Methods: A. Chick Counts

Select at least 20 sites within a colony which will not be affected by other studies or station activities. These sites should be well defined and distributed in various parts of the colony, some in the centre, some far or near to the beach etc. Number these sites and permanently mark them using metal stakes or other means. Map the sites showing position in the colony (perhaps with an aerial photo) and provide this map to the CCAMLR Secretariat; refer to it in all reports. Also, provide this map to station leaders/heads of respective national programs, asking that activities near the various colonies be discouraged/prohibited as they are part of an international monitoring program.

On the same date every year, count the number of chicks and adults present in these colonies. This date should be when about two-thirds of chicks have entered creches; for Adelies, 7 January at 77°S (Ross Island), 2 January at 62°S (King George Island); for chinstrap, 2 February at 62°S; for macaronis, 25 January at 60°S (South Georgia). Record counts by colony. See Ainley et al. (2).

B. Chicks Raised per Breeding Pair.

(1) On the day the first egg is laid in the colony (about 20 October and 20 November, respectively, for Adelies and chinstraps on King George Island; 14 November for macaronis at South Georgia), select 100 contiguous nests along a line which runs through several colonies. Mark every pair of nests with a painted rock or flagged nail driven into the ground between the two; every tenth nest mark with a numbered stake (1, 10, 20, 30 etc.). If possible, squirt dye on the breast of nest occupants (no need for capture). On that first day, and every five days thereafter, note the number of eggs, chicks and adults present. When chicks hatch, squirt dye on their backs. Continue visits until chicks depart for creches. The productivity is determined as the number of chicks reared to creche age per territorial pair of penguins. For a slightly greater level of accuracy

(especially during the period when chicks become mobile) the frequency of observations can be increased (to every other day, for example); however, frequency should not be different from one year to the next (see Ainley et al. (2)).

(2) Select a sample of colonies (at least 5 for Adelies or Chinstrap; one of suitable size for macaronis) and make three counts during the season: 1) on the day when 95% of the nests have eggs, count the number of nests with eggs, 2) when hatching has ended, count the number of nests with chicks, 3) when all chicks have entered the creche, count the number of chicks in creche. Initially, colonies that are relatively isolated should be selected.

Notes on the Method:

Human interference is a major factor in egg loss as any disruption in the colony causes the breakage of eggs or predation by skuas. Interference also dissuades recruitment of subadults into colony and thus over a series of years the number of breeding birds (and chicks) will decline if disturbance is too high. Therefore, walk slowly.

Interpretation of Results:

Season-to-season variation in breeding success can be considerable. For example, Yeates (1) reports the breeding success in Adelie penguins at Cape Royds as 26, 47, and 68 percent in three seasons.

Breeding success may be influenced by:

[colony size – large colonies tend to have better success;] ice conditions – [daily maps of ice cover desirable].

Frequency of Observation:

This will need to be annual (initially for 10 years) in order to establish a time trend.

Dates of Observation:

A6.0 Table 1: Mean laying date of first egg ± standard error (a), range of laying dates (b) and mean date of departure of chicks (c).

Location	Species			Reference
	Adelie a; b; c	Chinstrap a; b; c	Macaroni a; b; c	
Prydz Bay	X; X; X	NA	NA	
South Orkney	3 Nov.±6; X; X	6 Dec.±6; X; X	NA	
South Georgia	NA	NA	23 Nov.±3; X; X	

X = unknown
NA = not applicable; species does not breed at that location

References:
(1) YEATES (1968). Studies on the Adelie penguin at Cape Royds 1964–65 and 1965–66. N.Z.J. Mar. Fresh-Wat.Res. 2: 472–496 as cited in BIOMASS Handbook No. 20.
(2) AINLEY, D.G. and SCHLATER, R.P., 1972. Chick raising ability in Adelie penguins. Ark 89; 559–566.

Background Papers:

AINLEY et al. 1983. Breeding biology of the adelie penguin. University of California Press, 240 pp.
BIOMASS Handbook No. 19 Monitoring Studies of Seabirds
BIOMASS Handbook No. 20 Penguin Census Methods
BIOMASS Report No. 8 Antarctic Bird Biology
BIOMASS Report No. 34 Meeting of BIOMASS Working Party on Bird Ecology
EMISON, W.B. 1968. Feeding preferences of the Adelie penguin at Cape Crozier, Ross Island. Antarct. Res. Series 12, 191–212.
SC-CAMLR-IV, Annex 7. Report of the Ad Hoc Working Group on Ecosystem Monitoring, 1985.

Species: Penguins (Adelie, Chinstrap and Macaroni)

Parameter: Chick weight at fledging

Associated Parameters:

Foraging trips [duration]; breeding success.

Aim: To determine [the year to year differences in the mean] weights of chicks at fledging.

Method:

1. Using the five-day periods in sequence from those established for assessment of breeding success (see Method Sheet A6.0) weigh 100 chicks per five-day period, beginning and ending, respectively, in the periods when the first and last fledglings appear on the beach. At King George Island, for Adelies, periods would extend from about 21–25 January to 31 January–4 February, and for chinstraps, from about 19–24 February to 1–5 March; for macaronis at South Georgia, approximately same periods as for chinstraps at King George.

2. Chicks should be captured on the beach as they await departure for sea; capture should be done using a hand net. Put a spot of dye on chicks which have been weighed so that they will not be weighed again. If a banding study is underway, include weighed fledglings in the banding sample (record band number and weight).

3. Weigh chicks to nearest 10–25 grams (depending on scale available). Calculate mean weight per five-day period.

Ancillary Studies:

Meal sizes; prey species availability; diet.

A7.0 Table 1: Reported fledging dates at nominated breeding areas

Location	Adelie	Chinstrap	Macaroni	References
Prydz Bay	X	NA	NA	
S. Orkney	6 Feb±4	2 Mar±2	X	(2)
S. Georgia	NA	X	25 Feb±3	(1)
S. Shetlands	25 Jan (first fledging)	25 Feb (first fledging)	X	(3) (4)

X = unknown
NA = not applicable; species does not breed at that location

Mandatory Data:

1. Dates of samples.
2. Date, [band-number] and weight (to nearest 25g) of chicks measured during the specified period.

Highly Desirable:

1. Daily counts of chicks in creches and on water's edge.
2. Observed dates of departure, range of departure dates.
3. Date, weight, band-number (if banded) and age of chicks that die during creche stage.
4. Causes of mortality where possible.

Interpretation of Results:

The weight of chicks at fledging will give an indication of the likelihood of survival over the winter period at sea, with lighter chicks less likely to survive than heavier chicks. Chick weights at fledging can reflect prey species availability as well as parent breeding experience.

Chick weight at fledging may be affected by:

1) breeding experience and age of parents
2) prey species availability
3) individual variation
4) variation in timing of breeding events.

References

(1) CROXALL, J.P., 1984. Seabirds. In Laws, R.M. (Ed.), Antarctic Ecology, Volume 2. Academic Press 878 pp.
(2) LISHMAN, G.S., 1985. The comparative breeding biology of Adelie and Chinstrap penguins *Pygoscelis adeliae* and *P. antarctica* at Signy Island, South Orkney Islands. Ibis 127, 84–99.
(3) NIELSEN, D.R., 1983. Ecological and behavioural aspects of the sympatric breeding of the South Polar Skua (*Catharacta maccormicki*) and the Brown Skua (*Catharacta lonnbergi*) near the Antarctic Peninsula. Unpubl. MS Thesis, Univers. Minnesota, Minneapolis.
(4) TRIVELPIECE, W.Z., TRIVELPIECE, S.G. and VOLKMAN, N.J., 1987. Ecological segregation of Adelie, Gentoo and Chinstrap penguins at King George Island, Antarctica. Ecology 68: 351–361.

Background Papers:

AINLEY, D.G. and BOCKELHEIDE (in press) Seabirds of the Farallon Islands.

HARRIS, 1984. The Puffin. Poyser.

JOHNSTONE, G.W., LUGG, D.J. and BROWN, D.A., 1973. The Biology of the Vestfold Hills, Antarctica. ANARE Sci.Rep.Ser. B(l), 62 pp.

RICKLEFS et al., 1984. Ornis scandinavica 15, 162–66.

SLADEN, W.J.L., 1978. Sexing penguins by cloacascope. Int. Zoo Yearbook 18, 77–80.

Species: Penguins (Adelie, Chinstrap and Macaroni)

Parameter: Chick diet

Aim: To gather information on diet composition and meal size to help interpretation of other parameters.

Method:

1. Use same five day periods used to assess proportion of two-chick broods. For example, in South Shetlands begin observations of Adelies in period 22–26 December; of Chinstraps and Macaronis in period 26–30 January.

2. During each five day period, capture 10 adults on the beach as they leave the sea. Use a hand-held net for the capture. Do not include marked individuals being used in other studies. Observe each adult before capture, to be sure that it is a breeding bird.

3. Using a stomach pump, collect the stomach contents of the birds (see Wilson, (1)). Contents may separate by layers related to degree of digestion; keep these layers separate for analysis. Drain each sample, then determine its wet weight or volume.

4. Sort through each sample and remove all otoliths then preserve in buffered 10% formalin. If whole fish are present, remove at least one otolith from each before preservation.

5. In the laboratory, determine species composition and size class frequency by prey species for each sample. Counts can be made of krill based on pairs of eyes. Krill length can be determined by a regression with eye diameter; the same is true for fish length and otoliths. However, weigh whole specimens as a first priority (100 per sample).

Reference:

(1) WILSON, R.P. 1984. An improved stomach pump for penguins and other seabirds. J. Field Ornithol. 55, 109–112.

ANNEX 5

REPORT OF THE AD HOC WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 19–23 October, 1987)

(SC-CAMLR-VI/3)

TABLE OF CONTENTS

REPORT OF THE AD HOC WORKIGN GROUP ON FISH STOCKASSESSMENT

(Hobart, Australia, 19–23 October, 1987)

INTRODUCTION

The meeting of the Working Group was held at the CCAMLR Headquarters, Hobart Australia from 19–23 October, 1987. Dr K.-H. Kock was in the chair. A list of those attending is given in Appendix A. Dr J.A. Gulland was appointed rapporteur. A list of documents presented at the meeting is given in Appendix B. The agenda, as adpoted by the Group, is given in Appendix C.

GENERAL MATTERS

Basic Data

2. There had continued to be improvements in the reporting of basic data to the Commission. However, some countries had failed to meet the deadlines for the reporting of 1986/87 STATLANT data (30 September), and had only submitted their data at the beginning of the meeting. This had made it impossible for the Secretariat to complete the basic data summaries (as contained in SC-CAMLR-VI/BG/5) in advance of the meeting. The Group stressed the importance of countries complying with the agreed deadlines for data submission (six weeks in advance of the meeting in the case of biological data).

Age Determination

3. The Group noted with regret that the report of the Age Determination Workshop held in Moscow in 1986 was not yet available. The Chairman reported on the arrangements being made for the exchange of material used for age determination (SC-CAMLR-VI/BG/26). This exchange program should help to resolve the outstanding doubts and inconsistencies between countries about the interpretation of such material (otoliths, scales etc.).

Early Life-History of Fishes

4. Information was presented concerning the Post-SIBEX Fish Data Evaluation Workshop held in Cambridge, UK in August 1987 (WG-FSA-87/14). The Group noted that an inventory of information and a bibliography on the early life-history of Antarctic fishes was being prepared by Drs Slosarczyk and Kellermann (SC-CAMLR-VI/BG/25). A key to the identification and a catalogue of fish larvae was being prepared by A.W. North and A. Kellermann (see WG-FSA-87/11). Printing this booklet (500 copies in one language) would cost some US$6000–7000. This booklet would be useful in larval and pre-recruit surveys, which may be used for the estimation of adult stock size, or of the strength of year-classes in advance of their recruitment to the commercial fishery. Therefore the Group urged that the Commission help meet the costs of printing. This contribution might be shared with BIOMASS and the Alfred Wegener Institute of Polar and marine Research, Bremerhaven, FRG.

5. It was noted that in many of the cases examined by the Post-SIBEX Workshop, there was little or no correlation between the abundance of fish larvae and that of the adults, or with subsequent recruitment. Many plankton nets were highly selective in terms of the sizes and species of larvae caught. On the other hand, in the case of *C. gunnari* off S. Georgia and other chaenichthids in the Peninsula area, it appeared that mid-water trawls with small mesh liners were very efficient in catching late-stage larvae (over 50 mm in length). Surveys for these stages could be one way of obtaining the early estimates of recruitment which are likely to be of considerable importance if stocks of these species are to be managed by catch limits.

6. The Group believed that it would be valuable to give further and more detailed consideration (possibly at a small workshop) to the potential use of early life-history information in stock assessment.

New Research

7. The results of various surveys carried out in recent years were reported. These included analyses for the South Georgia area by Polish scientists (WG-FSA-87/10); the results of the joint US/Polish survey in South Georgia in November–December 1986 (SC-CAMLR-VI/BG/12); and of the joint Soviet-Australian survey of Heard and McDonald, 1987 (SC-CAMLR-VI/BG/16). The results of simulation studies of the trends in future catches at South Georgia and Kerguelen were presented in WG-FSA-87/8 and 15. The implications of these studies, and of the other documents listed in Appendix B, for the

assessments and advice provided by the Working Group are discussed in the appropriate sections of this report.

Presentation of Data

8. The Secretariat had prepared two main working documents (SC-CAMLR-VI/BG/5 and WG-FSA-87/4) summarising the catch statistics until 1986, and certain routine analyses (yield-per-recruit and VPAs for some major stocks) respectively. These reports facilitated the Group's work and enabled it to concentrate on its proper scientific tasks. However, it was noted that because some data were reported after the required deadline, the statistical summary had to be revised manually during the meeting. Experience suggested that some modifications should be made to the procedures used for the VPA analyses:

(a) an age-specific terminal F should be used, with the terminal F on the older fish being adjusted by the mean selectivity pattern of the previous years;

(b) the print-out should make a clearer distinction between the results for the current and previous years, and the projection for the next year;

(c) consideration should be given to using alternative terminal F, especially when the information available for setting the terminal F is scarce;

(d) the print-out of input data should make clear which figures of catch-at-age are actual observations and which are interpolations from other years;

(e) clearer specifications should be given of how interpolations were done;

(f) the mean selectivity pattern should be used to calculate exploitable biomass as well as total biomass. This is likely to be particularly important when relating VPAs to estimates of biomass obtained from surveys.

ASSESSMENTS

General

9. As noted in the previous section, the Secretariat has made considerable progress in summarizing the basic catch data, in carrying out routine and pre-determined analyses (e.g. VPA), and in presenting the results in a form that can be easily used by the Group. This has greatly facilitated the work of the Group.

10. At the same time there is also much information that has been submitted to the Commission e.g. effort data, length and/or age data (other than those aspects included in VPA) and survey data, that remains in other forms e.g. extensive data sheets existing in a limited number of copies. It is not easy for a large group to use data in these forms in an effective way. The Group is aware that, partly because of time constraints, it was not possible to review these data as thoroughly as other data, and that therefore the stocks to which these data apply may have been assessed with less accuracy than might, under other circumstances, have been possible. This point, and the ways in which the presentation of data, and other aspects of the Group's work, might be more effective are discussed in a later section.

Notothenia rossii

South Georgia Subarea (48.3)

11. The total reported catch in the 1986/87 season was only 216 tomes, mostly taken by the Soviet union. This is approximately what would be expected since the fishermen comply with the resolutions and conservation measures approved by the Commission at its 1985 and 1986 meetings concerning the cessation of a directed fishery, and the avoidance of by-catch.

12. Information on biomass is available from surveys carried out in 1986/87, though not all the data from those surveys have been fully analysed and reported to the Commission. Each estimate for biomass is subject to considerable variance, and it is difficult to detect small changes in biomass. Thus while the observations are consistent with the recent restrictions having the expected effect, and beginning to allow the stock to rebuild, they are also consistent with there being no effect. It would be valuable to carry out some simulations or similar studies to determine how soon the effect of the restrictions could be detected, at different levels of survey effort.

13. The recent studies confirm that the stock abundance is now very much lower than in 1969, with the biomass being around 5% of the catches in that period. However, there are elements in the records of catches, age-composition etc. that are not wholly consistent. For example, it might have been expected that in 1970 there would have been some year-classes of juvenile fish in the inshore areas that would have entered the exploitable stock in the next few years, but there seems little sign of them in the age-composition of later years.

14. Bearing in mind that few natural populations remain exactly in equilibrium, there may have been other factors that exacerbated the impact of the heavy fishing in 1969/70. For example the fishery may have started at a time when the population was reaching the end of a period of unusually high abundance. These alternative hypotheses would not alter the immediate need to rebuild the stock, but could alter the expectations of the extent to which the stock could be rebuilt, and therefore decisions on when to re-open the fishery.

Other Atlantic Areas

15. No catches were reported from Subareas 48.1 or 48.2 in the 1985/86 or 1986/87 seasons, and there is no information on which to modify the conclusions in last year's report that the stock abundance was well below the levels at the times when fishing began.

Kerguelen Subarea (58.5)

16. Directed fishing on the spawning concentration has been prohibited since 1984, and since the 1985/86 season, catches have been limited to by-catch. Catches were 801 tonnes in 1985/86 and 482 tons in 1986/87. Both VPAs and catches per unit effort indicate a clear decline in abundance from 1980 to 1984. Since 1984 there seems to have been some recovery, though the catch statistics for the most recent seasons have not been fully analysed.

Notothenia squamifrons

17. The Group noted that extensive biological data from the Soviet fishery on the Ob and Lena Seamounts (Division 58.4.4) as requested last year by the Scientific Committee (SC-CAMLR-V, paragraph 4.41) had recently been received by the Secretariat. However, it had not been possible in the time available to process these data and to present them in a form

suitable for consideration by the Group. It was therefore not possible for the Group to make any assessment of these resources at this meeting.

Champsocephalus gunnari

South Georgia Subarea (48.3)

18. Catches in 1986/87 were 71 247 tomes, the highest since 1983/84. The Soviet scientists reported that their fishing fleets had been advised to restrict their catches, and these catches could have been larger. It appears that this highly variable stock is at a peak. There were previous peak catches around 1977 and 1983.

19. Though trawl surveys have been made in the area in several recent years, the catches of this species in surveys are highly dependent on the rigging of the survey gear, so that it is difficult to use the available results to estimate recent trends in abundance. Though it should be possible to derive better indices from commercial catch and effort data, this has not been possible because no distinction was made between fishing targeted on krill and on fish before 1986. This distinction has been made in the most recent reports, and this may enable better indices to be provided in future.

20. Because of the large natural fluctuations in abundance it is not easy to use the level of abundance as a simple indicator of the effect of exploitation. It is now clear that abundance was high at the beginning of the 1986/87 season, but the available information is inadequate to estimate the current (October 1987) abundance with any precision. Survey estimates of the biomass during the 1986/87 season were some 80 000 tomes (from the Polish survey), and 150 000 tomes (from the Spanish survey). Bearing in mind that many fish could be mid-water and missed by the bottom trawl, and that the Polish survey covered only part of the area, the Group believed that the true figure was nearer to 150 000 tomes.

21. The impact of fishing is better indicated by the mortality rates. These appear now to be high, with only one or two age-groups contributing to the fishery. In contrast, when fishing started in 1976, all ages from 3 to 10 appeared in significant quantities in the catch. This is adding to the year-to-year variability in the stock (and hence in the catches). The number of year-classes in the spawning stock has also been reduced.

Peninsula Subarea (48.1)

22. A very small catch, 76 tomes, was reported in 1986/87; this is the first reported catch since 1983. Surveys in the Elephant Island area gave estimates of 934 tonnes (FRG in 1985), about 1 000 (FRG in 1986) and 1 962 tomes (Spain in 1987). The stock abundance is clearly low.

South Orkney Subarea (48.2)

23. Reported catches were only 29 tomes in 1986/87, compared with a few thousand tonnes in previous years. An estimate of biomass of 1 179 tomes was obtained from the Spanish survey in 1987. This is similar but rather lower than the estimate from the 1985 German survey (3 669 tonnes). Although commercial catches could be strongly affected by changes in the distribution and availability of the fish, well-designed surveys should be less affected by these factors.

24. Current abundance is clearly low, and it appears from the length and age data that the present stock is composed largely of the survivors of a relatively strong year-class (or year-classes) that recruited to the fishery in 1982.

25. There are considerable doubts about the inter-relations of the *C. gunnari* stocks found in different parts of the Atlantic, and it was felt that it would be useful, in order to get a better understanding of the dynamics of the fisheries, to run a VPA for the whole Atlantic sector combined. Analysis of infestation patterns with parasitic copepods, and discriminant analysis based on morphological and meristic characters carried out in Poland, GDR and FRG indicate that the population is separate from other populations in the Peninsula and South Georgia areas. Large fluctuations in length compositions without any apparent trend may, however, indicate immigration from or emigration to other areas at irregular intervals.

Kerguelen Subarea (58.5)

26. Catches in 1986/87 were only 2 625 tonnes. As in other areas, the stock is dependent on the recruitment of the occasional good year-class. The 1982 cohort, which provided the good catches in the 1985 and 1986 seasons on the main shelf is now passing out of the fishery, and the catch rates in numbers of this cohort have fallen from 5.76 in 1984/85 and 3.81 in 1985/86 to only 0.4–0.5 in the 1986/87 (the exact figures are not available, pending

full analysis of the log-books). The major part of the 1986/87 catches was taken on the Skiff Bank, largely from the 1984 cohort.

27. The 1985 cohort, which is currently protected by the 25 cm size limit, should enter the fishery soon, and may be of reasonable strength. The abundance of this cohort will be evaluated by a joint Soviet/French survey during the 1987/88 season prior to exploitation.

McDonald and Heard Islands

28. A joint Soviet–Australian survey was made in this area, and the results reported in SC-CAMLR-VI/BG/16. Most of the catches were of *C. gunnari*. The fish were taken in two small areas of relatively high density of 40 and 60 nm^2. The estimated abundances in these areas were around 16 580 and 2 079 tomes respectively.

29. It was suggested that these figures, and corresponding estimates of potential yield should be treated with caution because of the non-random distribution of trawl hauls (see Figure 1), and also because of the likelihood that there is considerable natural variation in the stock. There are also uncertainties about the relationship of these fish to those around Kerguelen.

30. This region lies in the same statistical subarea as Kerguelen. It is important for the future work that the catch statistics and other information from any commercial fishery should be kept separate from those relating to Kerguelen.

Notothenia gibberifrons

South Georgia Subarea (48.3)

31. Catches in 1986/87 were 2 842 tonnes. This continues a picture apparent in previous years of relatively stable catches, in contrast to high fluctuations in other species.

32. VPA calculations were carried out, but because recruitment appears to occur over a wide range of ages (not being complete until ages 10–12), the results are highly dependent on the assumptions made about the recruitment patterns. In particular, the assumption of constant mortality with age can lead to a serious under-estimate of the abundance of the younger fish in the most recent years. It is clear that abundance decreased in the first few

years of exploitation, as might be expected with a long-lived fish, but the trends since 1981 are less clear, although they indicate a relatively stable biomass.

33. The age-composition and length composition data showed a decrease in the proportion of larger fish when exploitation began, indicating an increase in total mortality and a relatively high fishing rate, but in the most recent years the mean size has increased.

34. Biomass estimates are available from the 1984/85 German survey, and the 1986/87 US/Polish survey, which gave 15 762 and 13 394 tomes respectively. These agree well, and given the variance in both figures, the difference cannot be taken as evidence of any decrease. An estimate of 11 356 tomes for part of the area is also available from data of Polish commercial vessels.

Peninsula Subarea (48.1)

35. Catches in 1986/87 were only 56 tonnes, after several years of zero catch. The German survey in 1985 gave a biomass estimate of 25 000 tomes around Elephant Island. It appears that this stock remains lightly exploited because it is only taken as a by-catch in the *C. gunnari* fishery and there is insignificant *C. gunnari* fishing to support the fleets.

South Orkney Subarea (48.2)

36. Catches in 1986/87 were only 2 tomes, compared with several thousand tomes in 1983/84 and 1984/85. The 1984/85 German survey gave a biomass estimate of 12 000 tomes.

Other Species

37. An analysis of information collected by observers on board Polish commercial trawlers fishing around South Georgia (WG-FSA-87/10) enabled the trends in abundance of several species to be followed in the period 1976/77-1986/87. It appears that there has been some increase recently in the abundance of *Chaenocephalus aceratus*. Trends in the biomass density index of *Pseudochaenichthys georgianus* and *Notothenia rossii* are not clear (Figure 2). It is difficult to determine the role of fishing in these changes. In the interpretation of the trends in some seasons, the influence of targeted fishing for *C. gunnari* should also be

considered. When this species is abundant, fishing effort on other species is reduced, which might result in low biomass density estimates derived from 'swept-area' methods.

MANAGEMENT ADVICE

General Observations

38. Management involves a sequence of decisions, proceeding from the very general statements of principles, as set out in the Convention, to matters of specific measures, such as setting a TAC (total allowable catch) for a particular species in a particular area for a particular year. This sequence can be arranged in a number of ways; an example is illustrated below.

Possible Decisions

General Policies	– Reactive management : act only when problems arise, and something is clearly needed.
	– Anticipatory management: act before problems arise.
	– Experimental management: set measures that will enable more to be learnt about the system.
	– Other.
Specific Policies	– Ensure that fishing mortality is not more than $F_{0.1}$ (see below).
	– Ensure that spawning stock biomass does not fall below some specified level.
	– Ensure that fishing mortality does exceed replacement level.
Strategies	– Set the TAC (for current, and all future years until corrected) equal to 90% of the estimated MSY.
	– Set a sequence of TACs, to be modified from year to year according to predetermined rules.
	– Set a limit on fishing effort in terms of numbers and sizes of vessels.
	– Other.
Tactics	– Set 1988 TAC.
	– Other (according to strategy adopted)

39. The strategy that might be adopted could be more or less complex, according to the situation being faced. For example, for a severely depleted stock, the strategy might be merely to hold catches at the minimum possible level (preferably zero) until research has shown clearly that recovery has occurred. In the case of a hitherto unexploited stock, the first step may be to conduct a survey to estimate the stock biomass and distribution, along with the age-structure and age-weight relationship. From these data an appropriate target level of fishing mortality could be estimated. An appropriate fraction of the stock's area could then be opened to fishing, the size of the area being chosen to keep the level of fishing mortality around or below the target level.

40. There is bound to be considerable recycling within this hierarchy, with policies or strategies being modified in the light of, for example, changing knowledge of the resource. At the same time, the stages need to be distinguished, and decisions at one stage clearly determined (if only temporarily) before moving on to the next. often the arguments that arise, especially over tactics (e.g. the level of next year's TAC) have proved difficult or impossible to resolve because there has been no prior decision on the policy or strategy to be followed.

41. The decisions at each stage have to be taken by the Commission, but these decisions will be easier if there is appropriate scientific advice.

42. Up to the present, the Commission has made few clear decisions on the policies or strategies it wishes to adopt. At the same time, it is clear (e.g. from Conservation Measure 7/V regarding catch limits for fishing round South Georgia in 1987/88) that it will require advice on tactical measures at its 1987 session.

43. The Working Group therefore found it necessary to make some working hypotheses about policies and strategies that the Commission might decide upon, particularly regarding a target level of F.

44. In a similar situation, a number of other Commission or regulatory bodies have found it convenient to adopt as the target what has been called $F_{0.1}$. This is the value of fishing mortality at which the marginal yield per recruit (i.e. the increase in yield per recruit resulting from a small increase in fishing mortality) is 10% of that when fishing starts. This value of F has a number of advantages:

- it is easily calculated from values of growth, natural mortality and age at recruitment, which are available for most stocks;

– it is likely to make economic sense, being around the level at which the value of any increase in catch arising from increased fishing is likely to be significantly less than the increase in costs;

– as compared with higher Fs that might be adopted as target, it will give rise to a higher spawning biomass, and lead to catches and population sizes that vary less from year to year.

$F_{0.1}$ may also turn out to be close to alternative, but less easily calculable, target Fs. For example, though $F_{0.1}$ will always be less than F_{MAX}, the value of F that gives the maximum yield per recruit, it may, when the effect of reduced spawning stock on recruitment is taken into account, be close to F_{MSY}, the value of F that gives the maximum sustainable yield.

45. The Working Group recognised that the Commission may wish to adopt other target Fs - perhaps smaller if it places emphasis on stability or large spawning stock, or larger, if it places emphasis on high short-term catches. The point to be stressed is that the absence of clear decisions on target Fs or other policies has raised problems for the Group in providing advice on TACs, or other tactical measures.

46. It was also assumed, for the purposes of providing tactical advice, especially in the light of Conservation Measure 7/V, that the strategy would be one in which the controls would be expressed as catch limits. This may be a less reasonable assumption. Experience elsewhere indicates that management by catch limits requires a highly sophisticated management apparatus. Unless the stock is long-lived, and recruitment reasonably constant, the setting of sufficiently accurate TACs will usually require extensive research to give up-to-date estimates of current stock abundance, and of the strength of the incoming recruitment. Enforcement of the regulations may also raise questions, and cause uncertainties in the reported catch statistics.

47. Before a definitive decision is taken on the strategy to be adopted, it would seem desirable to make a careful examination of such questions as the current ability of the Scientific Committee to provide accurate estimates of the TAC required to meet specified targets; the research required to improve this accuracy; and the ability of countries to enforce catch limits, and to assure other countries of this ability.

Simulations

48. An increasingly valuable approach for providing scientific advice in taking these management decisions is simulation. This allows the scientists to advise the Commission on the consequences of each of a set of alternative decisions, and also of the degree to which these consequences (and especially the relative performance of different decisions) are sensitive to uncertainties e.g. in the current biomass, or the strength of incoming recruitment.

49. Examples of simulations are contained in documents WG-FSA-87/8 and 15, and later in this report in relation to the management of a *Champsocephalus gunnari* stock. Simulations enable answers to be provided to many of the questions that those making decisions might ask - for example, how would the series of annual catches of *C. gunnari* differ under various levels of fishing mortality? Potentially a very wide range of questions can be examined. However, the questions and the inputs fed into the simulation need to be carefully determined. For example it is interesting to see how the relative performance of different TACs is affected by uncertainties about the current biomass. However, to answer this question in a meaningful way requires the specification of the management strategy for future years. After the initial year of management, would the TAC be maintained at the same level, or would it be adjusted in the light of improved knowledge of current biomass? If so, how quickly would the revised estimates be available, and how accurate would they be?

50. Productive use of the simulation approach is therefore complex, requiring repeated iterations between the user and the computer. Running simulations is not an operation that is efficiently done in a large working group. This is confirmed by the experience during the present meeting.

51. The Working Group believed that it would be extremely useful to examine further the use of simulation models in the provision of scientific advice. Some points that might be considered include (a) examination of the general ways in which simulation models might be of use to the Commission; (b) the identification of the sort of questions that might most usefully be addressed by simulation; (c) simulation to answer some representative questions; (d) determination of the requirements (data inputs, more specific framing of questions, computer hardware and software) for more effective use of simulation. Recognizing that this approach should be valuable in answering other questions of interest to the Commission (e.g. the impact of developing krill fisheries on associated or dependent species under various assumptions about the food requirements) the Group believed that this activity might well be one that should be sponsored by the Scientific Committee, as well as by the Fish Stock Assessment Working Group.

Notothenia rossii

South Georgia Subarea (48.3)

52. The immediate objective for this stock should be to rebuild the spawning stock as quickly as possible. Preferably no catches should be taken at all, but it was recognized that this would be impracticable if commercial fishing for the other species continues. The measures already taken by the Commission have clearly resulted in a decrease in the reported catch. The available data are not adequate to prove that they are also having the desired effect of rebuilding the stock.

53. It would be desirable to have better information on the incidence of by-catch and its variation in space and time. This could lead to modification in the management measures that would further reduce the by-catch. Some of this information should be available on data forms, but there has not been time to examine these in detail. For the present, the Working Group sees no reason to modify the measures already in force.

Other Atlantic Areas

54. In the absence of new information, the Group has no new advice to make about these stocks.

Kerguelen Subarea (58.5)

55. The immediate objective should be to rebuild the spawning stock. The measures currently in force appear to be having this effect, and should be continued.

Champsocephalus gunnari

South Georgia Subarea (48.3)

(a) Protection of Small Fish

56. At present, the fishery starts catching the fish when they are relatively young, at 2–3 years old (the onset of sexual maturity). If the fish were afforded protection until they were 3 or 4 years old, there would be some benefits in terms of increased yield per recruit (Y/R) and a greater spawning stock biomass per recruit (SSB/R). This is shown in the following table, for different values of fishing mortality.

Fishing Mortality	Fished From Age 2		Fished From Age 3		Fished From Age 4	
	Y/R	SSB/R	Y/R	SSB/R	Y/R	SSB/R
0.2	.096	.335	.099	.409	.096	.488
0.4	.105	.158	.116	.236	.118	.326
0.6	.103	.089	.118	.162	.124	.251
0.8	.100	.056	.118	.125	.126	.211
1.0	.098	.038	.118	.103	.127	.186

57. The benefits are particularly marked in terms of spawning stock biomass and at higher levels of fishing mortality. For example if F = 0.8 (and in peak years the fishing mortality has been well in excess of this value), changing the age at first capture from 2 to 4 would increase the yield per recruit by 25%, and the spawning stock biomass per recruit by four-fold.

58. Traditionally an increased age at first capture has been achieved by the use of a larger mesh size. This technique would be useful for *C. gunnari*, but the relation between mesh size of the codend netting used by the commercial trawlers and age at first capture is not clear. Dr Slosarczyk reported that the Polish scientists have made further selectivity studies. Due to limited ship time available for fishing with 80 mm meshes, these studies were not completed and will be continued in the 1987/88 season.

59. Further studies under commercial conditions and the full reporting of experiments that have already been carried out are needed. In the meantime the Group was not in a position to advise on the consequences of changing from the present 80 mm mesh.

(b) Control of the Amount of Fishing

60. At present the fishery is characterized by the presence of only a limited number of age-groups, a high year-to-year variability in catches, and a relatively low spawner biomass. Reducing the level of fishing would tend to reverse these undesirable features. As noted earlier, the Group believed that, in many circumstances, setting a target F equal to $F_{0.1}$ would result in a level of fishing that would be consistent with objectives such as increasing stability, or increasing spawner biomass.

61. In the case of *C. gunnari*, $F_{0.1}$ was estimated to correspond to an actual value of fishing mortality of F = 0.21. So that the Commission can contrast the consequences of fishing at various rates, including $F_{0.1}$, simulations were run to compare possible future catches and spawner biomass under different policies. Three values of F (0.21, 0.3 and 0.5) were used, and three assumptions made about the current biomass (75 000, 150 000 or 225 000 tomes) centred about the current estimate (see paragraph 20). To make the projections, a pattern of future recruitment was obtained by drawing a random sequence of recruitments from the values observed in the past. The same sequence was used for all the runs at different values of F and current biomass. The simulations therefore illustrate the differences to be expected between policies, but are <u>not</u> predictions of the future. The chosen sequence implies good recruitment around years 3 and 12 and poor recruitment between, but it is unlikely that this precise sequence will occur. What will occur will be a sequence of good and bad years, though their timing is likely to be different from that of the simulation.

62. Some results of the simulation concerning catch and spawning stock biomass are shown in Figure 3, a,b,c. For spawning biomass the picture is clear. The curves for the three levels of F are well separated, the spawning biomass being lower and relatively more variable at higher values of F. For all levels of initial biomass, in the last year of simulation the spawning biomass at F = 0.5 is only some 40% of that of F = 0.3. For F = 0.3, the spawning biomass is 75% of that at F = 0.21.

63. As regards catch, in the first year the higher the F the greater the catch. After the initial period, the differences in yield between the three levels of fishing mortality chosen are not large. The ranking is not the same in all years. In years of poor recruitment there are, at the higher levels of F, few survivors from earlier good recruitment to support the fishery. Thus, for example, the predicted catches in year 8 from the population simulated at F = 0.5 are very much less than those from the simulated populations for F = 0.21 or F = 0.3. (It may be noted here that no allowance was made for any influence of spawning stock biomass on

subsequent recruitment. If there were any such effect, the catches at lower Fs would be expected to be relatively greater from perhaps year 6 onwards).

64. Figure 4 shows the estimated biomass at age at the beginning and end of the simulation period, and indicates that the level of fishing mortality affects the age structure of the population.

65. In the absence of more clearly specified goals, the working Group could not conclude on the basis of this simulation, that one or other policy was better than the rest. However, the long-term interests (such as increasing spawning stock biomass) seem to point to the lower levels of F as being more desirable.

66. If F = 0.21 (i.e. $F_{0.1}$) were adopted as the target, then the corresponding catch limit for the 1987/88 season can be readily calculated as 0.21 x mean biomass in 1987/88. This biomass is not known, and for the present purposes (and for similar calculations in respect of other stocks) the biomass for the most recent period for which estimates are available is used.

67. The recent biomass is believed to be around 150 000 tomes (paragraph 20). If the biomass in the 1987/88 season remains at this level (which is a different assumption from that used in the simulation), the catch quotas corresponding to any desired target F can be readily calculated. The values are:

$F_{0.1}$	(= 0.21)	31 500 tonnes
F	= 0.3	45 000 tonnes
F	= 0.5	75 000 tonnes

68. The current biomass is not well known, and even less is known about the abundance of incoming recruits. A catch of 31 500 tomes in 1987/88 may therefore result in an F that is different from 0.21. If the Commission wishes to use catch limits as a reliable method of managing this stock, arrangements would have to be made for getting better estimates of current biomass, and of the recruitment strength (perhaps from surveys of 0-group fish with mid-water trawls).

Other Atlantic Sub-areas

69. The standing stock in these areas is very low, and cannot sustain significant fishing.

Kerguelen Subarea (58.5)

70. The objectives of the measures in force are to increase the spawning stock biomass. Because only one age-group is present in the catches, the stocks are very sensitive to exploitation, and depend on the level of recruitment. Surveys of the incoming cohorts are planned for 1987/88. Simulations similar to those done for South Georgia could be made for Kerguelen, using estimates of current biomass. Regulations have been set on the size of fish and on the level of catches for the 1987/88 season. The level of catches is based on the mean index of abundance for the two preceding cohorts. These regulations should reduce the impact of fishing on future spawning biomass.

Notothenia gibberifrons

South Georgia Subarea (48.3)

71. Recent catches in the last four years have averaged around 2 500 tonnes, and the stock appears to be stable. Replacement yield is probably also at about the same level.

FUTURE WORK

Organisation of Working Group

72. It was noted that the Scientific Committee, at its 1987 session, would consider a proposal to establish the Ad Hoc Working Group on Fish Stock Assessment as a formal standing Working Group (SC-CAMLR-V, paragraph 9.5). To assist the Scientific Committee, the Group prepared draft terms of reference for the Committee's consideration (Appendix D).

73. There was discussion on ways to improve the efficiency of the Group and it was agreed that there would be advantages in structuring the meeting into two sequential phases: one in which analyses (including actual computation) would be carried out, and a second period during which the analyses would be reviewed and interpreted.

74. In developing this idea, the Group noted that the assessments could be conveniently divided into four parts:

(a) Reduction of data and preliminary analyses (paragraph 75).

(b) Review and refinement of preliminary analyses (paragraph 76).

(c) Assessments and formulation of advice (paragraph 77)

(d) Developmental work (paragraph 78).

75. Reduction of data and preliminary analyses should be carried out by the Data Manager before the Fish Stock Assessment Meeting commences according to agreed procedures and with advice from the Convener of the Working Group and the Chairman of the Scientific Committee. It was agreed that this system would be improved if a small steering group, including the Convener and Chairman, was formed to provide this advice.

76. Review and refinement of the preliminary analyses should be undertaken by the working Group in the first few days of the meeting. During this time, additional computations could be undertaken by participants assisted by the Secretariat. The objective would be to complete the necessary additional computations prior to the commencement of the second phase.

77. The second phase of the meeting would involve the actual assessment of the status of the stocks and the preparation of advice for the Scientific Committee.

78. The Working Group would identify priorities for the developmental work included in part (d) which could be undertaken by Members in the intersession period. This work would be reviewed by a sub-group of specialists. This sub-group could also meet during the first phase of the meeting.

79. Taking the above into consideration, it was therefore recommended that future meetings should be longer, and that next year the Group should meet for a period of seven working days.

80. In discussing the organisation of the work, the Group commented on the good job the Secretariat had done this year in preparing for the meeting. In spite of this preparation, however, it had been difficult to complete certain tasks set down for the present meeting. Furthermore, it was felt that the future workload was likely to increase with the analysis of additional data.

81. The Working Group noted that the Secretariat was submitting a proposal to the Commission this year for the purchase of computing equipment. The Working Group did not discuss the proposal in detail, but confirmed the requirement for efficient, timely support for its work and that appropriate computing, printing and graphics capabilities were essential in providing such support.

Fine-scale Data Formats

82. In accordance with the Commission's decision at its last meeting (CCAMLR-V, paragraph 66), the Secretariat had prepared and distributed forms for the submission of fine-scale catch and fishing effort and biological data for finfish stocks. The Working Group made the following suggestions for improving the form for catch and effort data:

- calendar months should be divided into three parts day 1 to day 10, day 11 to day 20 and the remaining days. It was recognised that the third period would vary depending on the number of days in the month but this could be allowed for in any computations;

- an explanation should be added to the instructions to the effect that searching time has not been requested as a measure of fishing effort for finfish;

- nominal mesh size should be specified, but where available, measured mesh size should also be included;

- to assist in completing the forms, the species list should be included on the back of the form together with species codes. (The species list should be amended to include the following categories: commercially important species; blank spaces for the listing of other species, families, and catches NEI.)

- instructions should be included to the effect that catches converted to fish meal should be reported by species if possible.

83. In the past, the codes for ship size groups specified for use on STATLANT fine-scale data forms have not been used by some countries in their national data reports. It was recommended that all Members of the Commission report the size of ships using the system described in the instructions for the STATLANT and fine-scale data forms.

84. It was suggested that some data errors might be eliminated at source if the Secretariat were to provide a data entry program to all Members. It was agreed that the form in which data were submitted be discussed further at the next meeting of the Group.

85. It was also suggested that the instructions for completing the forms should be expanded to include a map of the Convention Area and perhaps illustrations of commercially important species. These instructions should be distributed as a bound manual.

Statistical Bulletin

86. A draft Statistical Bulletin had been prepared by the Secretariat in response to the request made during the 1986 Meeting of the Scientific Committee (SC-CAMLR-V, paragraph 7.9). It was noted that the Statistical Bulletin was designed to serve several purposes. It was a means of providing data for analysis by Members, and a means of providing general information on the state of the fishery and current fishing and survey activities of Member countries.

87. The Group agreed that because of the different types of data and the different purposes for publishing catch/effort data as compared with biological data, these data should be published in separate volumes. It also agreed that the Group's comments on the contents and structure of the Bulletin should be limited to aspects affecting its use as a data source. Specific comments were:

- Tables 5 and 6 of SC-CAMLR-VI/6 should be combined in one table;
- a complete bound version should be issued each year rather than pages to be inserted in a loose bound volume;
- the taxonomic listing of species should be retained;
- the Bulletin of Biological Data should include input data to the VPA used in the Stock Assessment of the previous year, and age/length composition data by each country submitting data.

Mesh Selectivity

88. It was noted that several experiments were conducted last season and that others were in the planning stage. In particular, attention was drawn to the Polish experiment (paragraph 20).

89. The Group noted that the USSR had completed an experiment, but the results were not yet available. Spain conducted extensive survey work last year, which was reported in its submission for membership of the Commission. The Group agreed that these two completed experiments could provide valuable data for assessments and asked that the members provide the relevant information and analyses as soon as possible.

90. Once again the Working Group emphasized the necessity for mesh selectivity experiments to be conducted using the same type of gear as that used in commercial fishing.

Biomass Estimates of *Champsocephalus gunnari*

91. Some differences in estimates of the biomass from surveys of *Champsocephalus gunnari* have been attributed to the use of nets with different heights in the net openings, and to the depths at which the nets were trawled. This situation clearly points to the need to carry out experiments aimed at determining the distribution of fish in the water column in order to improve the interpretation of the trawl survey results. The possibility of using acoustic methods and pre-recruit surveys to provide further independent estimates of biomass was also suggested.

Trawl Survey

92. Members of the Group commented on the reliability of trawl survey data and drew attention to the general need to provide for the adequate design of surveys being planned for future seasons. The value of co-ordinating surveys was also discussed and particular mention was made of the contribution this would make to knowledge of spatial distribution of stocks. In this context, the Working Group noted the decision of the last Scientific Committee Meeting (SC-CAMLR-V, paragraph 9.4), which established a group under the Convenership of Dr Sherman (USA) to co-ordinate plans for surveys in the 1987/88 season and the Commission's general support for this activity (CCAMLR-V, paragraph 58). The Group agreed that it should make a strong input into the work of Dr Sherman's group.

Simulation Studies

93. It was agreed that further work on the development of simulation models and risk analysis methods should be undertaken for the investigation of the effects of particular management options.

Collaboration with Other Organisations

94. Since its establishment, CCAMLR has benefitted from several studies undertaken as part of the SCAR BIOMASS Program. Examples are the review on the biology and status of exploited Antarctic fish stockss (BIOMASS Scientific Series No. 6) and the forthcoming review on krill and its biology and fisheries compiled by D. Miller and I. Hampton. Studies undertaken during the two Post-SIBEX Fish Data Evaluation Workshops resulted in a key to and catalogue of early life stages of Antarctic fish, which was of direct benefit to pre-recruit surveys planned under CCAMLR auspices in the near future. During the Post-SIBEX Fish Data Evaluation Workshops it was proposed to SCAR via the SCAR Group of Specialists on Southern Ocean Ecology to establish a new Antarctic Fish Ecology Working Party. To co-ordinate and closely liaise work undertaken by this group and the CCAMLR Fish Stock Assessment Working Group, it was recommended that the Chairman of the CCAMLR Fish Stock Assessment Working Group should be invited to the meetings of the SCAR Fish Ecology Working Party to ensure that the work of both groups is complementary.

95. The Data Manager reported that work had been undertaken during the year in collaboration with FAO to improve the STATLANT data from the Southern oceans held in the FAO data bank.

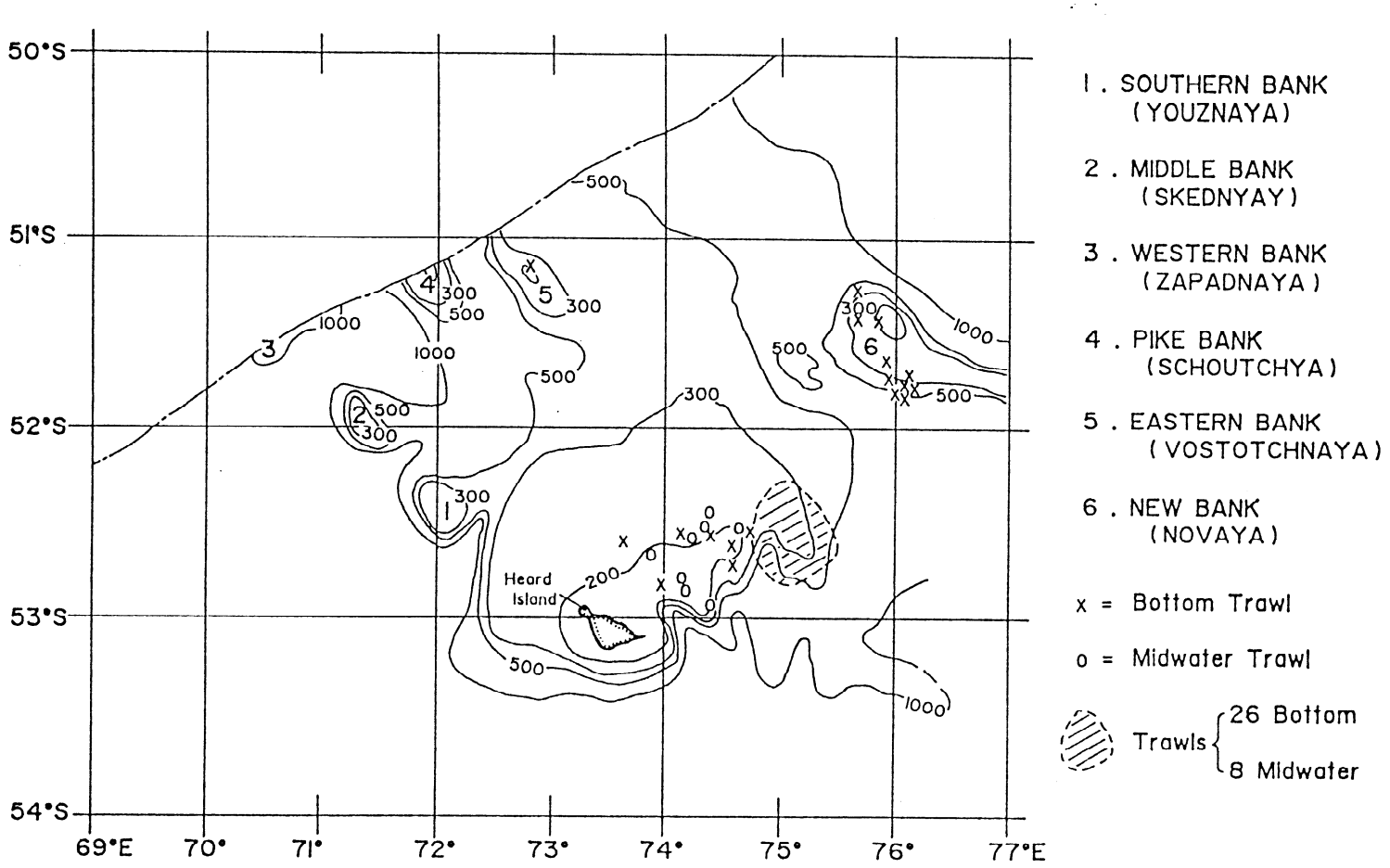


Figure 1: Distribution of research vessel survey trawls around Heard Island during the joint Soviet/Australian survey.

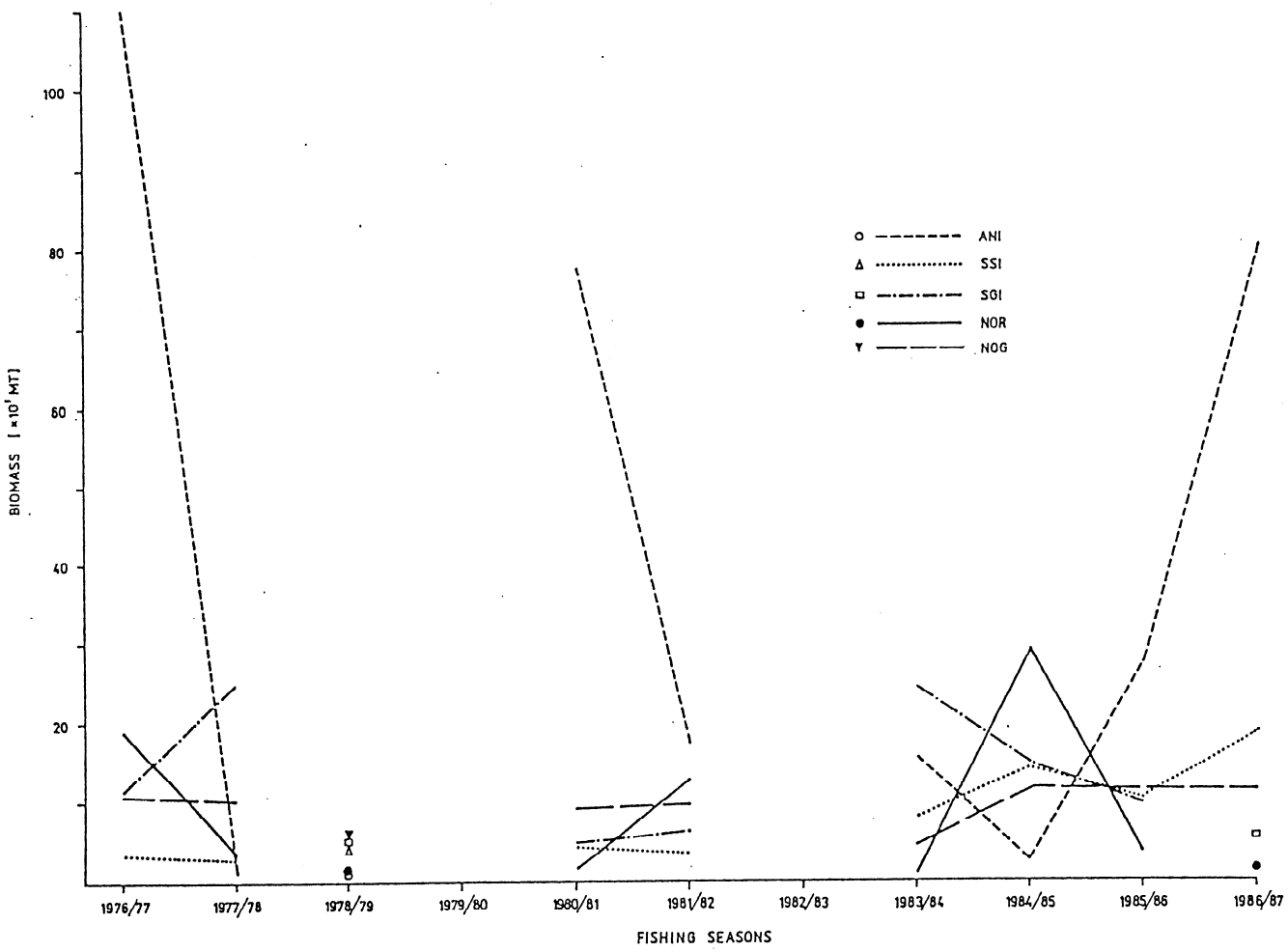


Figure 2: Changes in biomass of fish stocks around South Georgia, as estimated from catch rates of Polish trawlers. Symbols represent estimates based on catches by RV Professor Siedlecki.

ANI = *Champsocephalus gunnari* NOR = *Notothenia rossii* marmorata
SSI = *Chaenocephalus aceratus* NOG = *Notothenia gibberifrons*
SGI = *Pseudochaenichthys georgianus*

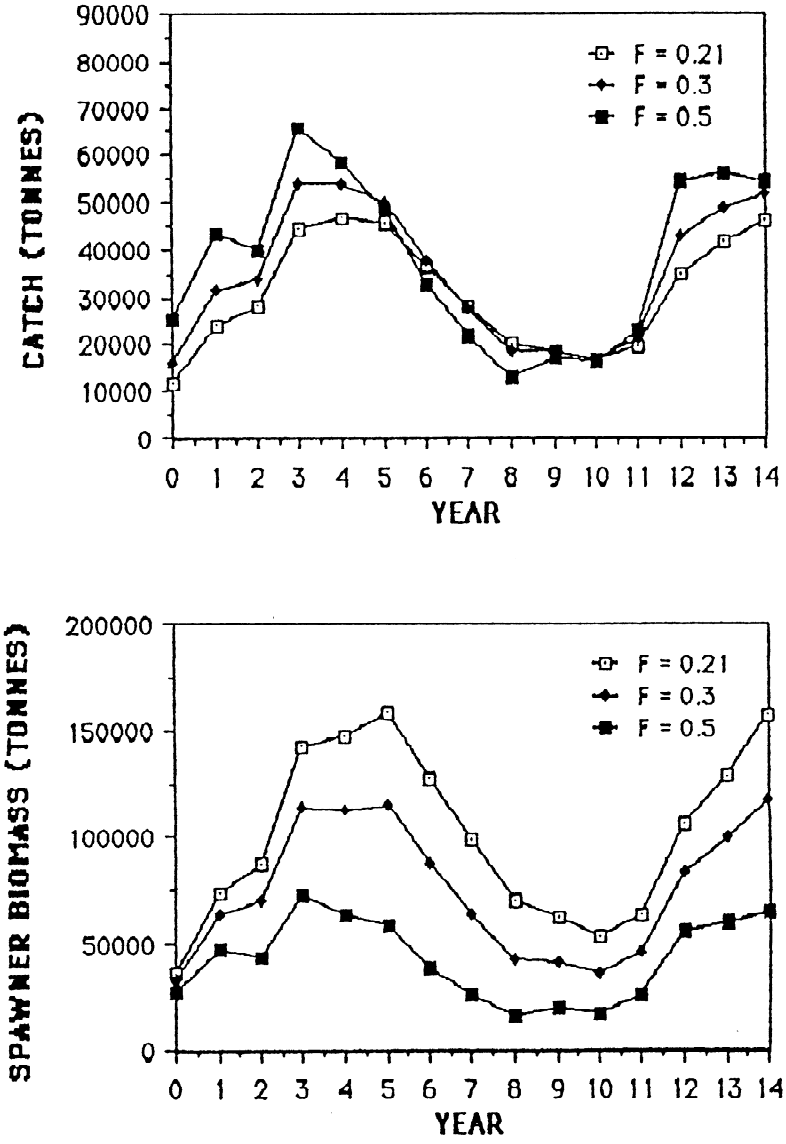


Figure 3a: Projected catches (top panel) and spawner biomass levels (bottom panel) for three different levels of fishing mortality (F = 0.21, 0.3 and 0.5) and an initial biomass of 75 000 tonnes.

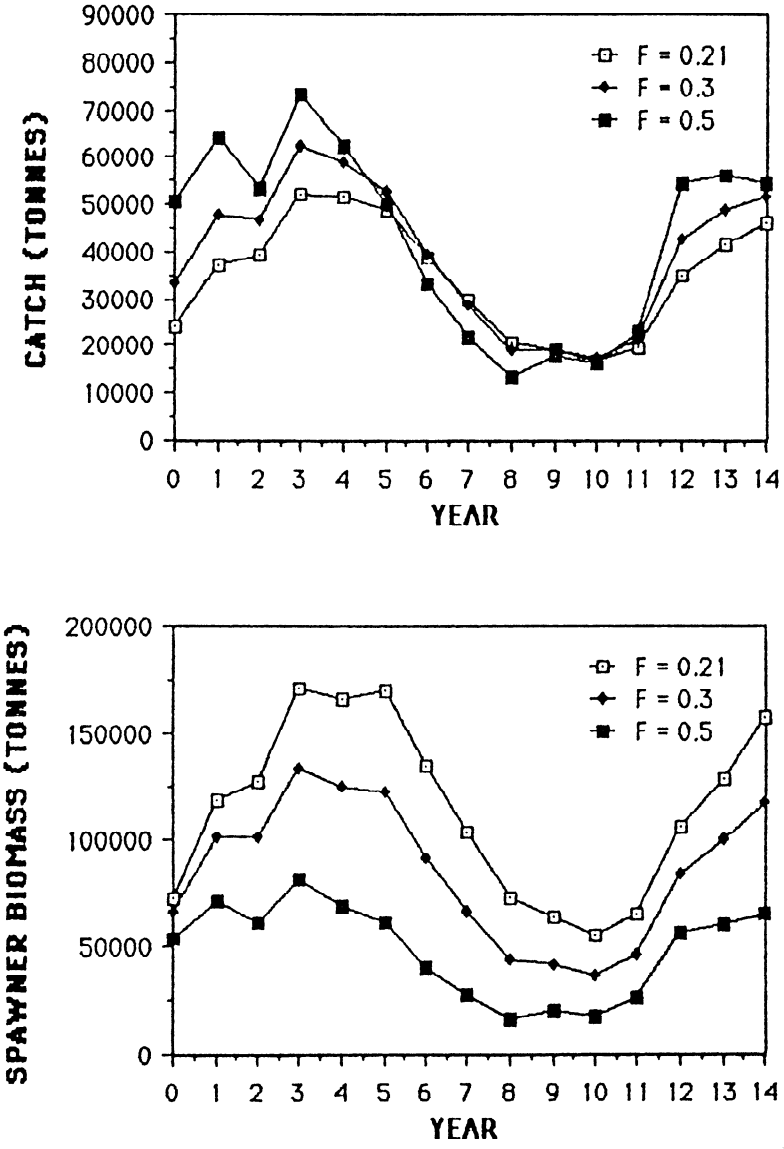


Figure 3b: Projected catches (top panel) and spawner biomass levels (bottom panel) for three different levels of fishing mortality (F = 0.21, 0.3 and 0.5) and an initial biomass of 150 000 tonnes.

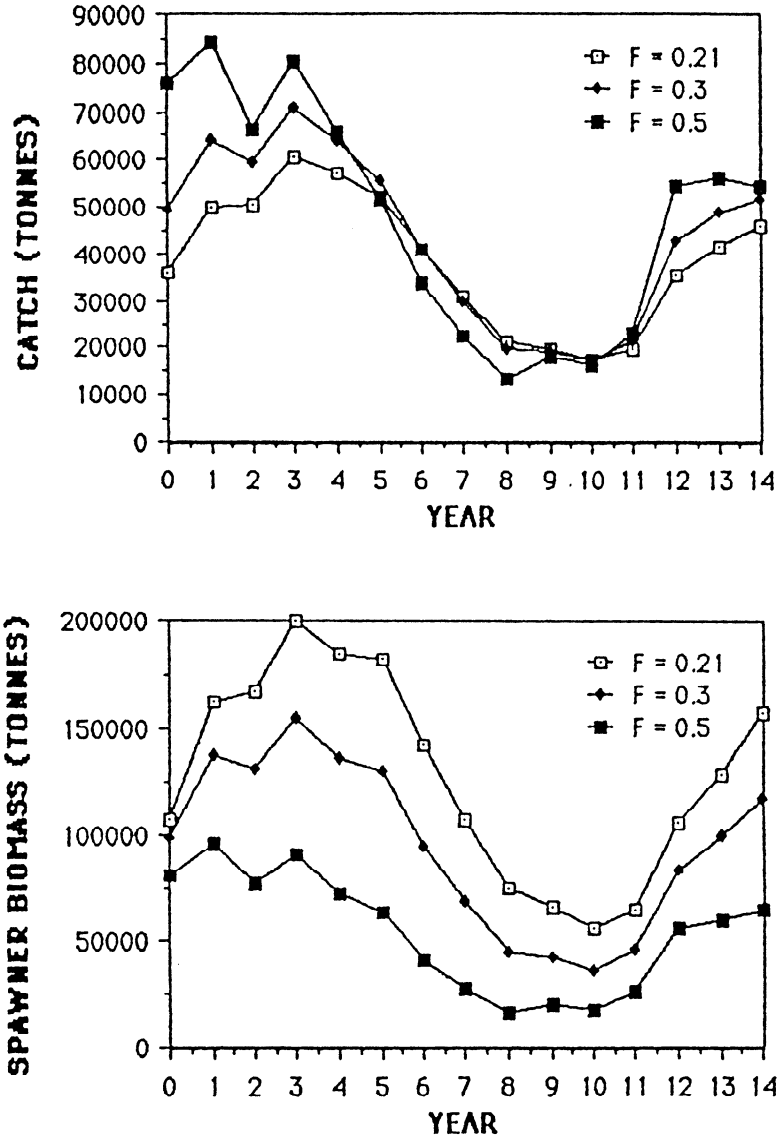


Figure 3c: Projected catches (top panel) and spawner biomass levels (bottom panel) for three different levels of fishing mortality (F = 0.21, 0.3 and 0.5) and an initial biomass of 225 000 tonnes.

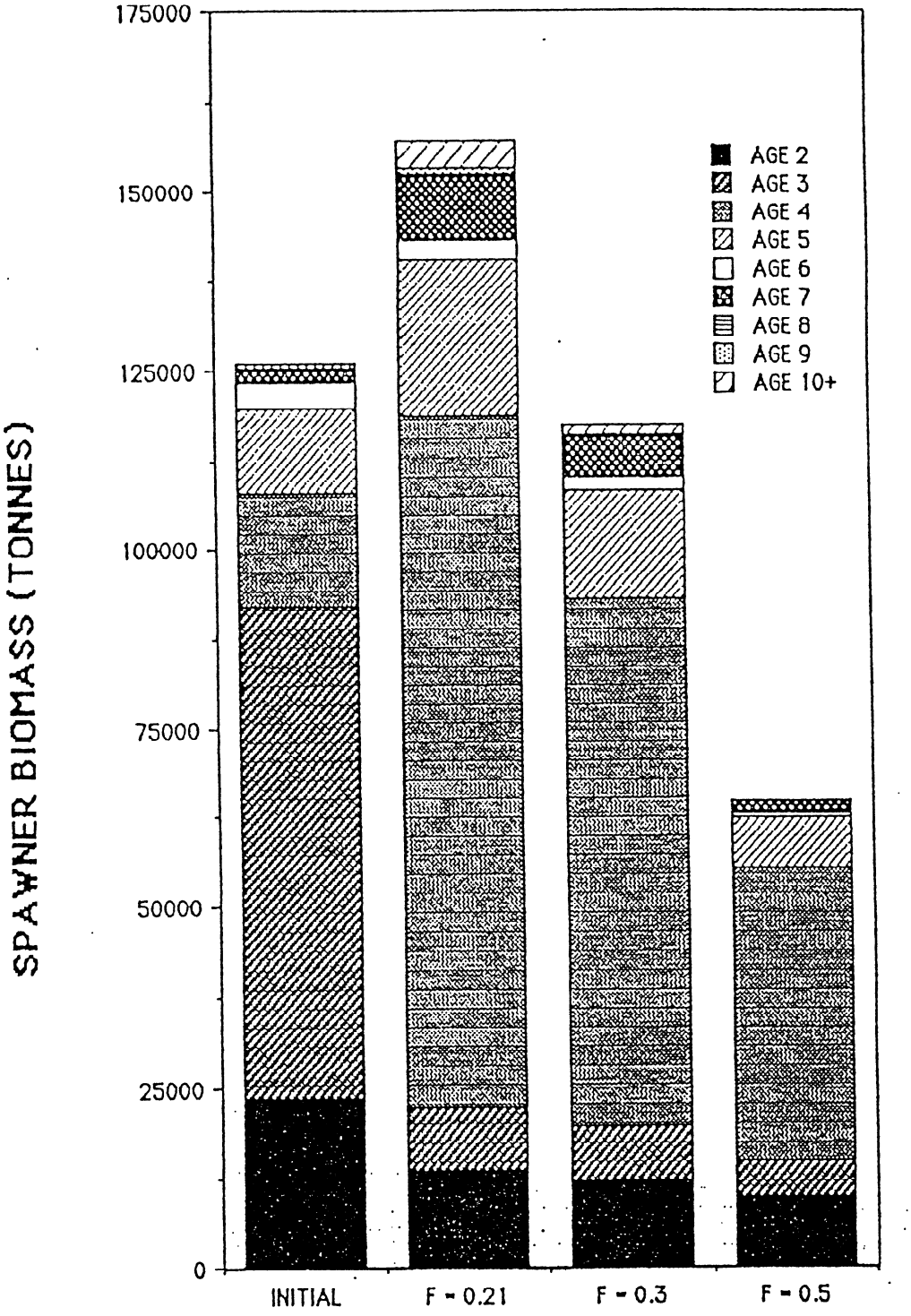


Figure 4: Projected spawner biomass for ages 2–9 and 10+ at the beginning (year 0) and end (year 14) of simulations involving three different levels of fishing mortality (F = 0.21, 0.3 and 0.5). The first column gives the initial values (note that identical initial values were used in each simulation). The second column gives values at the end of the simulation with F = 0.21. The third column gives values at the end of the simulation with F = 0.3. The fourth column gives values at the end of the simulation with F = 0.5. The shading on the columns indicates the values for each age class.

APPENDIX A

LIST OF PARTICIPANTS

Ad Hoc Working Group on Fish Stock Assessment
(Hobart, 19–23 October, 1987)

Dr K.-H. Kock (Convener, FRG)

Dr I. EVERSON (S.C. Chairman, UK)

Dr R. BORODIN (USSR)

Dr J. COOKE (IUCN)

Dr W. DE LA MARE (Australia)

Dr G. DUHAMEL (EEC)

Dr W. GABRIEL (USA)

Dr Y. GONG (Korea)

Dr J. GULLAND (EEC)

Dr R. HENNEMUTH (USA)

Prof. J.-C. HUREAU (France)

Dr P. MACE (New Zealand)

Mr A. MAZZEI (Chile)

Mr D. MILLER (South Africa)

Dr K. SAINSBURY (Australia)

Dr W. SLOSARCZYK (Poland)

Dr R. WILLIAMS (Australia)

Dr D. POWELL (CCAMLR Secretariat)

Dr. L. JACOBSEN (CCAMLR Secretariat)

Dr. E. SABOURENKOV (CCAMLR Secretariat)

APPENDIX B

LIST OF DOCUMENTS

Ad Hoc Working Group on Fish Stock Assessment
(Hobart, Australia, 19–23 October, 1987)

Meeting Documents:

WG-FSA-87/1	Draft Agenda
WG-FSA-87/2	List of Documents
WG-FSA-87/3	List of Participants
WG-FSA-87/4	Data and stock assessments for fish stocks in the Convention Area. (Secretariat)
WG-FSA-87/5	Key biological parameters of antarctic fish target speices in ccamlr areas 48.1, 48.2, 48.3, 58.4.2, 58.4.4. (K. Shust, A. Kozlov, V. Boronin, V. Shlibanov, V. Gerasimchuk and A. Zaitsev, USSR)
WG-FSA-87/6	Availability of catch, effort and biological data. (Secretariat)
WG-FSA-87/7	F_{rep} – An example calculation for *Notothenia rossii* in Subarea 48.3. (Secretariat)
WG-FSA-87/8	Simulation of recovery rates fo fish stocks in the South Georgia Island area (Subarea 48.3). (R.C. Hennemuth and K.D. Bisack, USA)
WG-FSA-87/9	Re-analysis of some published data on *Notothenia rossii* from the South Georgia region of Antarctica. (USA).
WG-FSA-87/10	Analysis of changes in biomass of fish stocks in the South Georgia Area in 1976/77 – 1986/87. (M. Mucha and W. Slosarczyk, Poland).
WG-FSA-87/11	Identification key to the early life stages of Antarctic fishes. (A.W. North, UK)

WG-FSA-87/12	Antarctic fish species which are currently exploited or have been harvested in the past on various fishing grounds or statistical areas and subareas. (Convener of the Ad Hoc Working Group on Fish Stock Assessment)
WG-FSA-87/13	Figures showing the length composition of commercially important species taken from Subarea 48.3 during the 1986/87 fishing season. (Secretariat)
WG-FSA-87/14	Report on Post SIBEX Fish Data Evaluation Workshop in Cambridge in October 1986 and August 1987. (Convener of the Ad Hoc Working Group on Fish Stock Assessment)
WG-FSA-87/15	Simulation of Recovery Rates of Fish Stocks in the Kerguelen Island Area. (R.C. Hennemuth and K.D. Bisack (USA) and G. Duhamel, France)
WG-FSA-87/16	Distribution of fish larvae at South Georgia: Horizontal, Vertical, and Temporal distribution and early life history relevant to monitoring year-class strength and recruitment. (A.W. North, UK)
WG-FSA-87/17	Projected catches for *Champsocephalus gunnari* from Subarea 48.3 under a variety of assumptions concerning recruitment, fishing mortality and initial biomass. (Secretariat)
WG-FSA-87/18	Format specifications for summaries of fine-scale catch and fishing effort data submitted to the CCAMLR Secretariat. (Secretariat)
WG-FSA-87/19	Format specifications for reporting fine-scale biological data to the CCAMLR Secretariat. (Secretariat)
WG-FSA-87/20	Length composition data for *Patagonotothen brevicauda guntheri* taken from Subarea 48.3. (Secretariat)

2. Other Documents

SC-CAMLR-VI/6	Draft outline of CCAMLR Statistical Bulletin. (Secretariat)

SC-CAMLR-VI/BG/5	Summary of fisheries data. (Secretariat)
SC-CAMLR-VI/BG/12 Rev. 1	Results of Fish Stock Assessment Survey, South Georgia region, November–December 1986. (W. Gabriel, USA)
SC-CAMLR-VI/BG/16	Brief report of the joint Soviet-Australian expedition of the USSR-FRV 'Professor Mesyatsev' to the Australian fishing zone around the territory of Heard and McDonald Islands, May–August 1987. (USSR)
SC-CAMLR-VI/BG/17	US Antarctic marine living resources program ecosystem monitoring survey 1986-87 Cruise results. Cruise No. SI 86-01 (1-111). (USA)
WG-CSD-87/12	Beyond MSY: a consideration of definitions of management objectives. (J.A. Gulland)
CCAMLR-VI/11	Proposal for purchase of computer equipment for data management and analysis. (Secretariat)
SC-CAMLR-VI/BG/23	A rationale for Conservation areas within Antarctic waters. (Australia)
SC-CAMLR-VI/BG/25	Inventory of existing information about early stages of Antarctic fish. (Observer for SCAR)
SC-CAMLR-VI/BG/26	CCAMLR Antarctic fish otoliths/scales/bones exchange system – Progress Report. (Convener of the Ad Hoc Fish Stock Assessment Working Group).

APPENDIX C

AGENDA FOR THE MEETING

Ad Hoc Working Group on Fish Stock Assessment
(Hobart, 19–23 October, 1987)

1. Opening of meeting.

2. Adoption of Agenda.

3. Review of Data and Presentation of Documents:
   - Review of data submitted to CCAMLR prior to 30 September, 1987 and also in previous years.
   - Presentation of documents.
   - Report of the Fish Age Determination Workshop, July, 1986.
   - Present status of the otolith/scale/bones exchange scheme established under the auspices of CCAMLR. (Report of the Chairman of the Ad Hoc Working Group.)
   - Results of Post-SIBEX Fish Data Evaluation Workshop, Cambridge, August, 1987, that are of direct relevance to the Ad Hoc Working Group.

4. Trends in abundance of exploited Antarctic fish stocks derived from VPA and CPUE analyses and also from surveys of early life history stages and by trawling.

5. Review of values of estimated parameters. (This is to obtain agreement on the input data values, particularly M and Z, for subsequent analyses, e.g. yield per recruit.)

6. Trends in Recruitment
   - Year to year variability
   - Stock recruitment relationships

7. Assessment
   - Yield per recruit analysis
   - Production models

8. Consideration of Management Actions
   - Mesh size limitations
   - Target fishing mortalities
   - Estimation of minimum spawning stock biomass
   - Total allowable catches

9. Future Work
   - Organisation of Working Group
   - Data requirements
   - Data analyses required prior to future meetings
   - Future research
   - Collaboration with other organisations

10. Any Other Business

11. Adoption of Report.

APPENDIX D

SUGGESTED TERMS OF REFERENCE FOR THE WORKING GROUP ON FISH STOCK ASSESSMENT

(a) Apply and develop methodologies for fish stock assessment, including:

  (i) procedures for monitoring fish stock abundance and population structure

  (ii) protocols for the collection and analysis of fishery-related data including the relevant operations of the CCAMLR data base

  (iii) analytical procedures for the estimation and projection of fish stock population trajectories;

(b) review and conduct assessments of the status and potential yield of fish stocks in the Convention area;

(c) evaluate the potential impact on fish stocks of possible management actions.

ATTACHMENT 1

BIOMASS ESTIMATES AROUND SOUTH GEORGIA OBTAINED BY THE 'ANTARTIDA 8611' SPANISH SURVEY

[from 'Informe de Resultados Antártida 8611 Pescas Científicas'
(Report of Results Antartida 8611 Scientific Fisheries) MAPA, SGPM, IEO.]

Method

Biomass

The target species biomass calculation by archipelago and by depth stratum was done by the swept area method (Saville 1978), which is obtained by multiplying the distance travelled by the gear (from the moment it is tense until it is turned around) by the horizontal opening. The horizontal opening was estimated by means of the following equation (De La Cueva Sanz, 1974):

$$JK = (((CD-AB)*AE+AB)*JO)/(JO+GJ+EG)$$

JK = Fishing gear's horizontal opening

CD = Distance between the cables at 1 meter from the snatch blocks

AB = Distance between the snatch blocks

AE = Length of the paid out rope

JO = Size of the net

GJ = Length of the sweep wires

EG = Length of the bridles

The lengths of sweep wires and bridles were kept constant at values of 50 m and 15 m respectively throughout the survey.

Using to our advantage the accuracy in location afforded by the satellite tracking system GPS, the distance travelled was calculated according to the following formula:

$$\text{distance} = \cos^{-1} (\sin(LATi)*\sin(LATf)+\cos(LATi)*$$

$$*\cos(LATf)*\cos(LONf-LONi))*60$$

whereas:

LATi and LONi: initial latitude and longitude

LATf and LONf: final latitude and longitude

In the final calculation of the mean swept area, all values that had been found to be clearly erroneous were excluded.

Within each archipelago the mean catch by haul and its corresponding standard deviations as well as variation coefficients were established for the various depth strata being studied.

The mean density by stratum was calculated extrapolating the mean catch by haul, expressed in tonnes, over an area of one square nautical mile.

The stratified mean for the whole area and its variance were obtained by applying the following formulae (Saville, 1978):

$$\bar{x}st = \sum \frac{\bar{x}n * area(n)}{\text{total area}} ; \text{var}\,\bar{x}st = \sum \text{var}\,\bar{x}n * \left[\frac{area(n)}{\text{total area}}\right]^2$$

The biomass estimates by stratum and for the total area were done by inferring the corresponding mean densities for the total surface of every area.

RESULTS OBTAINED AND COMMENTS

Swept Area

Mean values estimated for the distance travelled and the horizontal opening of the fishing gear are shown in Table VI.

For the travelled distance, a mean value of 2.221 nautical miles was obtained with a moderate variation coefficient of 24.09%, which indicated the accuracy of the estimate.

However, we can observe that considerable variability occurs in the opening of the fishing gear with a standard deviation greater than the mean.

Calculations of this parameter have always conflicted. Various tests carried out in test channels, have established an approximate ratio of 1/3 between the mean opening of the fishing gear and the length of the floats line.

Pauly (1983) obtained different values for this ratio in South western Asian waters. These varied between 0.4 and 0.6 and it was believed that the best answer would be the intermediate value equal to 0.5.

Estimates of 0.254, 0.30 and 0.56 were obtained for shellfish, cephalopod and cramp ray trawling gears respectively, at Surveys carried out by the Canary Islands Oceanographic Center of the Spanish Institute of Oceanography (Delgado and Santana, 1985; López Abellán, pers. com.).

The ratio of 0.37 observed in the fishing gear used during the 'ANTARTIDA 8611' survey falls within the range considered to be acceptable. The position close to the lower end can be accounted for as corresponding to a semi midwater gear, which has a greater structural tendency to a vertical opening, rather than to a horiaontal one.

Table IV: Mean, standard deviation and variation coefficient obtained in the calculation of distance travelled (DR), horizontal opening of the fishing gear (AB) and swept area (AR), druing the 'ANTARTIDA 8611' survey.

	DR (nm)	AB (nm)	AR (nm^2)
No OF OBSERVATIONS	298	282	-
MEAN	2.221	0.007	0.016
STANDARD DEVIATION	47.21	252.00	0.020
VARIATION COEFF. (%)	24.09	128.57	125.00

Table XX: Mean catch per haul (X), mean biomass catchable by trawl (BME), standard deviation (SD), variation coefficient (CV) and mean densitiy (DM) of some species captured around South Georgia during the 'ANTARTIDA 8611' survey. Limits of reliability (LC) = 95%.

SPECIES		*N. rossii*	*N. gibberifrons*	*D. eleginoides*
0-150 m	NUMBER OF HAULS	18	18	18
	X (kg/0.016 nm2)	0.19	1.67	0.003
	SD	0.14	1.00	0.003
	Cv (%)	73.68	58.88	100.00
	DM (t/nm2)	0.01	0.10	0.00019
	BME (t)	25	250	0.47
150-250 m	NUMBER OF HAULS	51	51	51
	X (kg/0.016 nm2)	4.35	6.61	0.17
	SD	2.83	1.04	0.09
	Cv (%)	65.06	15.73	52.94
	DM (t/run2)	0.27	0.41	0.01
	BME (t)	1 425	2163	53
250-500 m	NUMBER OF HAULS	29	29	29
	X (kg/0.016 nm2)	51.86	4.36	3.53
	SD	49.58	1.42	2.04
	Cv (%)	95.60	32.57	57.79
	DM (t/nm2)	3.24	0.28	0.22
	BME (t)	10 021	866	680
TOTAL	NUMBER OF HAULS	98	98	98
	X (kg/0.016 nm2)	16.91	4.83	1.09
	SD	14.17	0.69	0.58
	Cv (%)	83.80	14.29	53.21
	LC	166.59	28.40	105.78
	DM (t/nm2)	1.06	0.30	0.07
	BME (t)	11 471	3 252	733

SPECIES		*Ch. gunnari*	*Ch. aceratus*	*Ps. georgianus*
0-150 m	NUMBER OF HAULS	18	18	18
	X (kg/0.016 nm2)	21.72	0.92	0.79
	SD	17.44	0.34	0.34
	Cv (%)	80.29	36.96	43.04
	DM (t/nm2)	1.36	0.06	0.05
	BME (t)	3 405	150	125
150-250 m	NUMBER OF HAULS	51	51	51
	X (kg/0.016 nm2)	436.48	5.85	3.76
	SD	220.20	1.08	1.20
	Cv (%)	50.45	18.46	31.91
	DM (t/nm2)	27.28	0.37	0.24
	BME (t)	143 929	1 952	1 266
250-500 m	NUMBER OF HAULS	29	29	29
	X (kg/0.016 nm2)	20.42	2.88	3.22
	SD	7.30	0.97	1.54
	CV (%)	35.75	33.68	47.83
	DM (t/nm2)	1.28	0.18	0.20
	BME (t)	3 959	557	619
TOTAL	NUMBER OF HAULS	98	98	98
	X (kg/0.016 nm2)	222.61	3.87	2.92
	SD	106.94	0.66	0.74
	Cv *(%)*	48.04	15.50	25.34
	LC (%)	95.50	30.82	50.38
	DM (t/nm2)	13.91	0.24	0.18
	BME (t)	151 293	2 659	2 010

ANNEX 6

REPORT OF THE INFORMAL GROUP ON THE LONG-TERM PROGRAM OF WORK FOR THE SCIENTIFIC COMMITTEE

REPORT OF THE INFORMAL GROUP ON THE LONG-TERM PROGRAM OF WORK FOR THE SCIENTIFIC COMMITTEE

The Informal Group on the Long-Term Program of Work for the Scientific Committee met on 25 October 1987 in association with the Sixth Meeting of the CCAMLR Scientific Committee in Hobart, Australia.

2. At its first meeting the Convener of the Group, Dr K. Sherman (USA), presented a draft agenda which had been circulated in advance and outlined two major tasks to be addressed by the Group: improving the level of co-ordination of various national scientific programs and updating the long-term program of work for the Scientific Committee.

3. Two papers prepared by the Convener were available for discussion at the meeting: 'Proposed Activities for the Long-Term Program of the Work of the Scientific Committee of the Commission for the Conservation of Antarctic Marine Living Resources' (WG-LTP-87/4) and 'Framework for the Co-ordination of the Long-Term Program of Work for the Scientific Committee' (WG-LTP-87/5).

4. It was proposed that the level of co-ordination of various national scientific programs might be improved if, in addition to plans for the forthcoming season, plans for future seasons would also be reported by members.

5. Proposed formats for reporting pertinent program activities were considered. The merit of using reporting systems of other relevant international organisations and SCAR in particular, were suggested. However, the Group concluded that the SCAR reporting system does not provide the necessary level of detail and that a format designed for the unique ecosystem approach of CCAMLR would be preferable.

6. It was decided to draft a request form for information on planned national research programs. The form, kindly drafted by Dr John Heap (UK) includes the following major topics for each program: (1) scientific objectives, (2) study area, (3) period of study, (4) facilities to be used, and (5) other details.

7. Members were asked to complete the prepared research program inventory form regarding 1987/1988 programs and provide an indication of planned programs over the next two Antarctic seasons (1988/89 and 1989/90). A summary of this information for 1987/88 is found in Appendix A. Information such as this would be used as the basis for improving overall co-ordination and integration of national programs in support of the scientific program

of CCAMLR. A draft set of the research program inventory forms was compiled during the meeting; Members were invited to provide additions or revisions to these forms to the Secretariat by 7 December 1987. The revised set of forms will be placed as an annex to the Members' Activities Reports (CCAMLR-MA/4-1986/87).

8. It was agreed that the Long-Term Program of Work approved by the Scientific Committee during the Fifth Meeting of the Scientific Committee provided a useful framework for focusing activities of the Scientific Committee. The Committee requested that this Program of Work should be updated annually, following the conclusion of the Scientific Committee deliberations so as to include pertinent activities endorsed by the Scientific Committee. The updated plan will appear as an annex to the report of the Scientific Committee.

9. At present, information which is being collected by the Group indicates only the level and scope of Members' activities for the forthcoming season. It is impossible at such short notice to co-ordinate them or to introduce changes to program designs in spite of some spacial and temporal coincidence between national research programs.

10. A suggestion was made that some level of co-ordination might be achieved if information on national research programs were known at least 2 or 3 years in advance. In this case the timing and survey areas of national programs could be adjusted to gain the maximum benefit from effective use of ship-time, compatable methods of sampling, possibility of obtaining larger samples over a wider area, exchange of field information etc.

11. During the past two years, the Group has made several attempts to collect information regarding future research plans. However, the level of details in replies was not adequate for co-ordination purposes. It became evident that any further request for information should cover future research (at least for 3 years) and contain a list of specific questions.

12. To assist Members, the Group decided that such a list, the same as used this year, should be included into next year's Guidelines for preparation of Member's Activities Reports. The Secretariat should collate information on the research program inventory form before the next meeting of the Group. Such information should be requested and updated annually.

13. The process of gathering and integrating information on future research plans is complex. A first step is a simple compilation of research plans to obtain an idea of the topics,

timing, and location of planned investigations. This is being done now by the Group through the forms submitted by Members.

14. The next step involves the assistance of the various Working Groups of the Scientific Committee. They should come forward with suggestions for specific integrated studies. Such suggestions should be accompanied by sampling procedures, proposed areas and timings of multinational studies. The last step is for the Informal Group on the Long-Term Program of Work to co-ordinate implementation of actual programs.

15. In connection with this a question was raised on the status of the Group. It is not clear whether the Group should take over duties of other working Groups in the co-ordination of integrated research or if it should return to its initial task of simple compilation of information on current and planned Members' research activities.

16. In light of the discussions at the 3 November 1987 meeting of the Informal Group on the Long-Term Program of Work for the Scientific Committee, it was agreed that those countries indicating planned survey activities for the 1987/88 and 1988/89 seasons should proceed with bilateral and multilateral planning to advance the work of the Scientific Committee.

17. For example, for the 1987/88 field season, planning includes the co-ordination of the following joint surveys and studies in support of fish stock assessment, krill ecology, and predator studies. Assessments of demersal fish are planned for the Kerguelen shelf area by France/USSR; a US/Polish bottom trawl and experimental fish recruitment index survey will be conducted in the South Georgia shelf area. Based on needs identified during the Scientific Committee discussions, the USSR is exploring the possibility of redirecting a fish stock assessment survey to the South Georgia area during the mid to late portion of the 1987/88 season. Preliminary plans for the 1987/88 season have been developed for complementary studies on krill ecology (age and growth/stock separation), oceanography, and acoustic/net biomass assessments in the Antarctic Peninsula integrated study area by US/Poland/USSR/Japan. Further joint studies on krill target strength are planned by the UK and Norway for the South Georgia area. Joint investigations of predators will be conducted by the US, Chile and Sweden. In addition, a collaborative study on the analysis of specimen material from recent crabeater seal collections will be carried out by the USSR and us within the framework of the Ecosystem Monitoring Program.

18. Consistent with the long-term plan, multinational studies on fish stock assessment, krill ecology, and predators will also be conducted during the 1988/89 field season. A joint

US/Polish bottom trawl survey and fish recruitment index survey around South Georgia is scheduled for the December–January period. Also, the GDR is planning a bottom trawl survey on the shelf of South Georgia. Krill assessment surveys including oceanographic net sampling and hydroacoustic methodologies are planned by US/Poland within the Scotia Sea/Antarctic Peninsula area. Studies of ecosystem structure, including krill, water column productivity, and environmental conditions, within the areas of the Antarctic Peninsula, South Orkney Islands, and Weddell Sea will be conducted during the European Polarstern Study (EPOS) by Belgium, Federal Republic of Germany, France, Norway, Spain, Sweden and United Kingdom. Efforts are underway to link the EPOS activities with other CCAMLR surveys. Joint studies on the ecology, behaviour, and population structure of pinnipeds and seabirds will be conducted by the US, Chile, and Sweden. Plans for co-ordinated studies of pinniped ecology among other CCAMLR members, including the USSR, will be developed during the intersessional period.

19. A matrix outlining the long-term program of work for the Scientific Committee is shown in Appendix B. The long-term plan of work will be reviewed, evaluated, and updated at the 1988 meeting of the Scientific Committee (SC-CAMLR-VI, paragraph 11.8).

APPENDIX A

SUMMARY OF NATIONAL RESEARCH PROGRAMS FOR 1987/88

Table A.1: Fish stock assessment surveys and related studies to be conducted during the 1987/88 Antarctic field season.

Area	Country	Dates	Sampling strategy
South Georgia	US/Poland	Dec–Jan	Stratified random with commercial bottom trawls (120 stations), recruitment index/ichthyoplankton survey.
Scotia Sea Ant. Peninsula South Shetlands Commonwealth Bay	USSR	Dec–Apr	Commercial bottom trawl, including fish selectivity.
Elephant Island	FRG	Oct–Dec	Stratified random with commercial bottom trawls, ichthyoplankton.
Gerlache Strait	Chile	Jan–Feb	Small boat, fish ecology
Kerguelen EEZ	France/USSR	Feb–Apr	Stratified random with commercial bottom trawl.
	France/USSR	Jul–Aug	Ichthyoplankton survey.
	France	Oct–Sep	Observer program on board commercial trawlers, nearshore ichthyoplankton
Crozet	France	Oct–Nov	Exploratory survey

Table A.2: Krill relative abundance and related studies to be conductedduring the 1987/88 Antarctic field season.

Area	Country	Dates	Research Objectives and Sampling Strategy
Prydz Bay	Australia	Jan–Feb	Acoustic estimation of krill.
Admiralty Bay, Bransfield Strait and Elephant Island	Brazil	Dec–April	Krill distribution population structure.
Bransfield Strait	Chile	Feb	Identification of krill stocks.
Elephant Island to Adelaide Island	FRG	Oct–Dec	Abundance estimates of krill, RMT 1+8.
Elephant Island or South Orkneys	Japan	Dec	Acoustic and net estimates of krill, patch studies with commercial vessel, intercalibration with US/Polish acoustic systems.
Antarctic Pen. area, South Shetland Island	Poland/US	Jan–Feb	Acoustic and net estimates of krill abundance, patch study in co-operation with Japan.
South Georgia	UK/Norway	Jan–Mar	Krill target strength.
Scotia Sea	Korea, Republic of	Dec–Feb	Environmental effects on krill distribution and abundance.
Scotia Sea (45°–60°S)	USSR	Jan–Mar	oceanographic research of krill ecology, trawl survey on krill concentrations using commercial trawl and Issacs-Kidd trawl under control of hydroacoustic devices.
Atlantic Sector 52–62°S between 20–55°W	USSR	Dec–April	Integrated studies on Antarctic krill resources

Table A.3: Marine mammal and bird studies to be conducted during the 1987/88 Antarctic field season.

Area	Country	Dates	Research objectives and Sampling Strategy
King George Island S. Orkney Island	Argentina	Oct–Apr	Ecology of fur seals, elephant seals, and Adelie penguins.
Prydz Bay, Mawson, Davis, and Heard and Macquarie Is.	Australia	Oct–Mar	Census, behaviour, diet, metabolism of crabeater and elephant seals, Adelie and emperor penguins.
South Shetlands	Brazil	Dec–Apr	Census, ecology, and physiology of seabirds.
King George Is., Livingston Island	Chile	Dec–Feb	Monitoring and ecology of penguins and fur seals.
Elephant Island	Chile/US	Feb	Penguin and fur seal foraging areas.
Ross Sea	New Zealand	Nov–Feb	Census, feeding ecology, and physiology of Adelie penguins.
South Georgia	UK	all year	Bird and seal ecology.
Scotia Sea	Sweden/US	Jun	Contaminants in ice-dwellig seals.
South Shetlands, Anvers Island, and Antarctic Pen.	US	Dec–Feb	monitoring and directed ecological research on fur seals and penguins.
Scotia Sea	US	Jun	Feeding ecology and movements of crabeater seals.
Lützow-Holm Bay	Japan	Oct–Feb	Penguin and seal ecology.

Table A.4: Environmental measurements and related studies to be conducted during the 1987/88 Antarctic field season.

Area	Country	Dates	Research Objectives and Sampling Strategy
Prydz Bay Hobart/Commonwealth Bay	Australia	Nov–Feb	Current meters, CTD transects.
Kerguelen	France/USSR	Feb–Apr Jul–Aug	XBTs
Elephant Island to Adelaide Island	FRG	Oct–Dec	Long-term variability of water masses, time series since 1983, CTD transects.
Elephant Island to S. Orkney Island	Japan	Dec	Temperature, salinity, chlorophyll, chemistry.
E. Drake Passage Elephant Island area	Japan	Jan	Temperature, salinity, chlorophyll, chemistry.
Bransfield Strait and Scotia Sea	UK	Jan–Feb	Frontal systems and Antarctic Circumpolar Current.
South Georgia and Bransfield Strait	UK	Jan–Feb	Nutrient flux and net primary production.
Scotia Sea, Ant. Peninsula, South Shetland Is., Commonwealth Bay	USSR	Dec–Apr	oceanographic research.
South Georgia	US/Poland	Dec-Jan	Hydrography, XBTs.
South Shetland Is., Bransfield Strait	US/Poland	Jan-Feb	Primary productivity, effects of ozone depletion. XBTs, CTD, C^{14}

APPENDIX B

LONG-TERM PROGRAM OF WORK FOR ME SCIENTIFIC COMMITTEE

B/1

		1987/88	1988/89	1989/90	1990/91	1991/92
1.	ADVICE TO THE COMMISSION	Formulate immediate and practical objectives	———	———	———	——>
		Provide best scientific information available on changes in the status of the living resources and the ecosystem	———	———	———	——>
		Provide management advice	———	———	———	——>
		Review effectiveness of conservation measures	———	———	———	——>
2.	FISHERY STOCK ASSESSMENTS					
	2.1 FINFISH:	Implement routine reporting of commercial fish data and establish CCAMLR data base by establishing formal requirements for reporting age and length data from commercial fisheries	———	———	———	——>
		Update stock assessments	———	———	———	——>

	1987/88	1988/89	1989/90	1990/91	1991/92
FINFISH (Continued)	Define spatial distribution of stocks	Review results of stock identity studies	——————————>		
	Obtain available historic fish data for data base	——————————>			
	Develop requirements for future data from research vessel fish surveys, mans of coordinating program among countries, and specific objectives	Conduct co-ordinated research vessel fish surveys	Review the results from co-ordinated research vessel fish surveys	——————————>	
	Conduct scientific research surveys for stock assessment and mesh selectivity studies	Conduct experimental studies on mesh selectivity	Review and evaluate results of experimental mesh selectivity studies	——————————>	
	Implement preliminary recruitment index surveys	Review results of recruitment index surveys	Implement routine recruitment index surveys	——————————>	
	Conduct ichthyoplankton surveys	Review and evaluate results of ichthyoplankton surveys	Implement routine ichthyoplankton surveys	——————————>	
		Refine estimates of abundance and evaluate year to year variations and trends	——————————>		
	Develop long-term sampling protocol	Refine estimates of recruitment year to year	——————————>		

	1987/88	1988/89	1989/90	1990/91	1991/92
2.2 KRILL:	Consider interim report of krill CPUE simulation study	Consider final report of krill CPUE simulation study	——————>		
		Review potential of stock assessment surveys and baseline studies	Initiate stock assessment surveys and baseline studies	——————>	
	Conduct acoustic target strength measurements on krill	——————>			
	Evaluate statistical bias in gear types	——————>			
		Review results and improve co-ordinated small-scale studies on patch and swarm structure and their effects on population dynamics	——————>		
		Review krill fishery data collection and reporting requirements as appropriate			
	Initiate exploratory krill surveys	Review results and applicability of exploratory krill surveys	Implement routine reporting of commercial krill data and establish CCAMLR data base as necessary	——————>	

	1987/88	1988/89	1989/90	1990/91	1991/92
KRILL (Continued)		Initiate procedure to procure available historic krill fishery data	——>		
		Review estimates of abundance and evaluate year to year trends	——————————>		
		Review and evaluate techniques of size and acoustic target observations	——————————>		
3. ECOSYSTEM MONITORING:	Initiate monitoring program for predators	Further develop predator monitoring	——————————>		
		Develop monitoring program for prey	Initiate monitoring program for prey	——>	
	Develop methods for additional predator parameters	Review predator parameters and update additional methods	——————————>		
	Develop predator data reporting formats	Develop and review data reporting and archiving formats	——————————>		
	Develop proposals for registration of land-based monitoring sites	Review status of land-based monitoring sites	——————————>		

	1987/88	1988/89	1989/90	1990/91	1991/92
ECOSYSTEM MONITORING (Continued)	Initiate preliminary sensitivity analyses of existing data				
	Identify requirements for appropriate data	Recommend methods for acquiring environmental data	——————————>		
	Evaluate possible sampling and survey designs for prey monitoring	Recommend standard methods including development of data formats			
	Analyse CZCS* remote sensing data	——————————>			
4. MARINE MAMMAL AND BIRD POPULATION ASSESSMENTS					
4.1 WHALES	Review the current status of cetacean populations			Update evaluation of the status of whale populations	
			Review the results of the IWC Comprehensive Assessment		
	Evaluate potential utility of sightings data for investigating stock recovery, abundance and distribution	——————————>			

* CZCS = Coastal Zone Color Scanner

	1987/88	1988/89	1989/90	1990/91	1991/92
WHALES (Continued)	Assess feasibility of using photogrammetry and satellite telemetry to assess distribution, movements, and behaviour	——————>	Develop experimental protocol for deploying satellite-linked telemetry	——————>	
4.2 SEALS:	Review the current status of pinniped populations			Update evaluation of the status of seal populations	
	Refine population estimates for pack ice seals	——————>	——————>	——————>	——————>
	Investigate the cause of the populations decline of southern elephant seals	——————>	——————>	——————>	——————>
	Assess the recovery of Antarctic fur seals at selected sites	——————>	——————>	——————>	——————>
4.3 SEABIRDS:	Review the current status of seabird populations			Update evaluation of the status of seabird populations	
	Review the status of wandering albatross populations	——————>	——————>	——————>	——————>

ANNEX 7

REPORT OF THE AD HOC EDITORIAL BOARD MEETING

REPORT OF THE AD HOC EDITORIAL BOARD MEETING

The Ad Hoc Editorial Board met on 4 November 1987 in conjunction with the Sixth Meeting of the Scientific Committee. Two main topics were addressed by the Board: (1) consideration of the Secretariat's paper 'CCAMLR Document Information and Guidelines for Preparation' and (2) selection of papers to be published in the 1987 'Selected Scientific Papers'.

Guidelines for the Preparation of Paper

2. A revision of the Secretariat's guidelines for the preparation of papers (incorporating the Scientific Committee's decisions on dates of submission of papers) will be distributed in early 1988. Suggestions for further modifications to the Guidelines were invited.

3. It was recommended that all Background Papers submitted to the Scientific Committee should relate specifically to an agenda item for the meeting, and that reference to that agenda item should be clearly displayed on the cover page of the document.

4. The Board further recommended that the Guidelines (which are presently available only in English) should be distributed in each of the official languages of the Commission.

Selection of Papers for Publication

5. Papers presented to meetings of the Scientific Committee and its Working Groups were considered for publication. The question of whether scientific papers presented to meetings of Working Groups of the Commission should be considered for publication in this forum was raised and it was agreed that the Chairman of the Scientific Committee would further this matter with the Commission.

6. Papers were selected for publication by consensus of the Board. In accordance with the recommendation of the Scientific Committee, papers which have been accepted elsewhere for publication will have only their abstract and the reference to the full text included in the Selected Papers. Authors of all papers selected for publication will be contacted by the Secretariat for permission to publish. Members are reminded that any alterations or revision of papers by authors must be received by the Secretariat prior to 30 December.

ANNEX 8

SCIENTIFIC COMMITTEE BUDGET FOR 1988
AND FORECAST BUDGET FOR 1989

SCIENTIFIC COMMITTEE BUDGET FOR 1988
AND FORECAST BUDGET FOR 1989

Krill CPUE Simulation Study

1. A revised report from the Krill CPUE Simulation Study will be prepared for consideration at the 1988 CCAMLR Meetings. This will be followed by an Evaluation Workshop in March/April, 1989. The estimated cost for the Workshop in 1989 is A$38 700.

	1988
Costs Computing	A$ 6 000
Consultancy	A$17 600
Travel and per them	A$13 700
	A$37 300

Joint CCAMLR/IWC Workshop on the Feeding
Ecology of Southern Baleen Whales

2. It has been agreed by the Scientific Committee of CCAMLR and IWC to sponsor jointly a Workshop on the Feeding Ecology of Southern Baleen Whales. The Workshop will involve the participation of specialists both in the study of whales and krill. Funds have already been approved by the IWC and the USA has made available US$15 000 towards the cost of the Workshop. A steering group meeting is required to determine the types of data that will be needed, their availability and to specify the analyses to be carried out in preparation for the Workshop. The Scientific Committee has nominated two scientists, Dr Y Shimadzu and Mr D. Miller (with Dr J. Beddington as a reserve) to participate in the Steering Group which may be held at the IWC Headquarters in Cambridge, UK. A sum of A$15 000 has been included in the 1988 Budget for this purpose. The CCAMLR contribution to the Workshop in 1989 is estimated to be A$15 000.

Fish Stock Assessment Working Group

3. The Scientific Committee recommended that the Ad Hoc Working Group on Fish Stock Assessment be established as a permanent Working Group and that an intersessional meeting of this Working Group be held under convenership of Dr K.-H. Kock (Federal Republic Germany) in Hobart during 7 working days prior to the next CCAMLR meetings in 1988. Similar costs are envisaged for the 1989 meeting.

	1988
Costs	
Computing	3 000
Report translation	10 800
Administration	2 000
	A$15 800

4. A key to identification of fish larvae is being prepared by Mr A.W. North and Dr A. Kellermann and published by SCAR. The cost of printing 500 copies in English is estimated to be around A$10 000. The Alfred Wegener Institute of Polar and Marine Research, Bremerhaven, has agreed to contribute to the cost and CCAMLR has been asked to make a contribution. The Scientific Committee agreed that the document was of obvious benefit to CCAMLR and as with similar publications in the past, it would be appropriate to make a contribution in the form of an advance purchase for 100 copies at a total cost of A$3 000.

5. The Fish Stock Assessment Working Group suggested that the instructions for completing the fine scale data entry forms should be expanded to include a map of the Convention Area and illustrations of commercially important species. These should be distributed as a bound manual, in 1989. The representative of Republic of Korea will prepare a report for consideration at the 1988 meeting.

	1989
Cost 40 pages - half text	
Translation: 3 languages	A$ 5 500
Publication/Postage	A$ 5 000
	A$10 500

6. It was recommended that the Chairman of the Fish Stock Assessment Working Group should attend meetings of the SCAR Fish Ecology Working Party to ensure that the work of both groups is complementary. This working party will not be operating until 1989. The estimated cost is A$5 000.

Ad Hoc Krill working Group

7. The Scientific Committee agreed to establish an Ad Hoc Krill Working Group which will communicate by correspondence during 1987–88. A meeting of the Group will be convened for three days in 1989 to address issues agreed to in the Terms of Reference. The venue of the meeting will be determined during the Seventh Meeting of the Scientific Committee.

Costs (for 1989)	
Travel	A$10 000
Report and translation	A$20 000
Administration	A$ 2 000
	A$32 000

CCAMLR/IOC Scientific Seminar

8. As described in the previous report of the Scientific Committee (SC-CAMLR-V, 1986 paragraphs 13–16, p. 269) an amount not exceeding A$3 000 may be required in 1988.

Ecosystem Monitoring Program

9. There will be no intersession meeting of the Working Group for the CCAMLR Ecosystem Monitoring Program in 1988. Further work on the protocols for the monitoring of predator parameters, the preparation of instructions for data collection and data reporting and the preparation of draft management plans for approved sites will be done by the Secretariat under the supervision of the Convener. This work cannot be undertaken completely by the Secretariat staff and assistance will have to be obtained. Funds are required for the employment of a person or persons with appropriate qualifications to undertake the tasks given in paragraph 7.39 particularly as set out in 7.39 (ii) and (iv). Funds are also required for the publication of the manual of methods for monitoring predator parameters. There will be a meeting of the Ad Hoc Working Group for the CCAMLR Ecosystem Monitoring Program in 1989. The estimated cost for the meeting is A$36 000.

Costs 1988	
Secretariat support	A$12 000
Publication of Field manual	A$ 7 000
	A$19 000

Secretariat Travel

10. The Committee agreed that funds should be made available for the Data Manager to visit ICES Headquarters for discussions with his counterparts in the ICES Secretariat, to obtain fish stock analysis software and manuals and to gain experience in their use. If possible the visit will be timed to enable the Data Manager to attend an ICES Working Group meeting. He will also take the opportunity to visit the Convener of the Fish Stock Assessment Working Group to prepare for the 1988 meeting of that group. A sum of A$8 000 has been provided for fares and per diem.

Summary Scientific Committee Budget

	1988	1989
	A$	A$
Krill CPUE Simulation Study	37 300	38 700
Joint CCAMLR/IWC Workshop	15 000	15 000
Fish Stock Assessment Working Group	15 800	15 800
Larval Fish Identification Key	3 000	0
Fine-scale Data Entry Forms, etc.	0	10 500
Attendance of Fish Stock Working Group Convener at SCAR	0	5 000
Ad Hoc Krill Working Group	0	32 000
CCAMLR/IOC	3 000	0
Secretariat support for Ecosystem Monitoring work	19 000	36 000
Secretariat	8 000	10 000
Contingency	7 500	7 500
	108 600	170 500