Abstract

This document presents the adopted record of the Ninth Meeting of the Scientific Committee for the Conservation of Antarctic Marine Living Resources held in Hobart, Australia, from 22 to 29 October 1990. Major topics discussed at this Meeting include: krill resources, fish resources, squid resources, ecosystem monitoring and management, development of approaches to conservation of Antarctic marine living resources, marine mammal and bird populations and cooperation with other organisations. Reports of meetings and intersessional activities of subsidiary bodies of the Scientific Committee, including the Working Groups on Krill, on Fish Stock Assessment and for the CCAMLR Ecosystem Monitoring Program, are appended.

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REPORT OF THE NINTH 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 I. Everson (UK) from 22 to 29 October 1990 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, Germany, Italy, Japan, Republic of Korea, New Zealand, Norway, South Africa, Spain, Sweden, Union of Soviet Socialist Republics, United Kingdom and United States of America.

1.3 The representatives of France, Dr G. Duhamel (a Vice-Chairman of the Scientific Committee), and Poland, Dr W. Slosarczyk, sent their apologies to the Meeting. The Chairman acknowledged their absence with regret and in particular, extended his sympathies to Dr Slosarczyk, wishing him a speedy return to health.

1.4 The Chairman commemorated Dr John Gulland FRS to the Scientific Committee. Dr Gulland, who was an active participant in the work of the Scientific Committee for many years, died on 24 June 1990.

1.5 Observers were welcomed and encouraged to participate, as appropriate, in discussion of Agenda Items 2 through 11.

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

1.7 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. Beddington (UK), fish resources; Dr J. Croxall (UK), squid resources and ecosystem monitoring and management; Dr J. Bengtson (USA), marine mammal and bird populations and incidental mortality; Dr A. Constable (Australia), Development of Approaches to Conservation; and Dr D. Agnew (Secretariat) all other items.

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

Adoption of the Agenda

1.8 The Provisional Agenda for the Meeting had been circulated to Members in accordance with the Rules of Procedure. No amendments to the Provisional Agenda were proposed and the Agenda was adopted (Annex 3).

Report of the Chairman

1.9 The Chairman noted that Members 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.

1.10 The Second Meeting of the Working Group on Krill (WG-Krill) was held in Leningrad, USSR from 27 August to 3 September 1990 (Convener, Mr D. Miller, South Africa). The Report of the WG-Krill Meeting was distributed as SC-CAMLR-IX/4 and a Report on the Meeting by the Convener as SC-CAMLR-IX/5.

1.11 The Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) met in Stockholm, Sweden from 6 to 13 September 1990 (Convener, Dr J. Bengtson, USA). The Report of the WG-CEMP Meeting was distributed as SC-CAMLR-IX/6 and a Summary of the Meeting by the Convener was presented in SC-CAMLR-IX/11.

1.12 The Working Group on Fish Stock Assessment (WG-FSA) met in Hobart, Australia from 9 to 18 October 1990 (Convener Dr K.-H. Kock, Germany). The Report of the WG-FSA Meeting was distributed as SC-CAMLR-IX/7.

1.13 The Chairman reported on documents available for consideration by the Scientific Committee. Fifteen Members' Activities Reports were submitted, three had been received by the Secretariat by the deadline set; 12 Working Papers were submitted, four had been received by the Secretariat by the deadline set; and 22 Background Papers were submitted, seven had been received by the Secretariat by the deadline set. The total number of papers tabled for consideration by the Scientific Committee and its Working Groups was 165, compared to 155 in 1989. There had been a re-organisation of papers this year, most being tabled for working group meetings in contrast to a large number of background papers submitted to the Scientific Committee in 1989.

KRILL RESOURCES

Fishery Status and Trends

2.1 The krill catch for the 1989/90 season was some 5% lower than in 1988/89 and totalled 374 793 tonnes (Table 2.1).

Table 2.1: National krill landings (in tonnes) since 1982/83.

Member	Split-Year*							
	1983	1984	1985	1986	1987	1988	1989	1990
Chile	3 752	1 649	2 598	3 264	4 063	5 938	5 329	4 527**
GDR	0	0	50	0	0	0	0	396
JAPAN	42 282	49 531	38 274	61 074	78 360	73 112	78 928	62 179**
Republic of Korea	1 959	5 314	0	0	1 527	1 525	1 779	4 040
Poland	360	0	0	2 065	1 726	5 215	6 997	1 275
Spain	0	0	0	0	379	0	0	0
USSR	180 290	74 381	150 538	379 270	290 401	284 873	301 498	302 376
TOTAL	228 643	130 875	191 460	445 673	376 456	370 663	394 531	374 793

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

** From catch data tabled during the Meeting

2.2 The total krill catch by subarea and year since 1973 is illustrated in Figure 2.1.

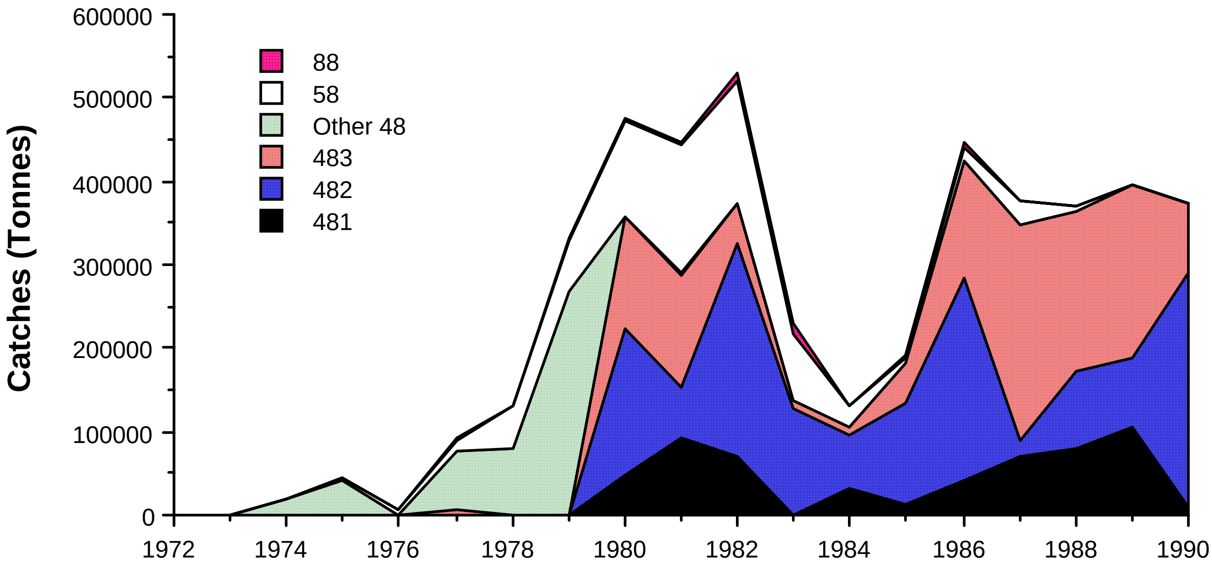

Figure 2.1: Total krill catches from 1973 to 1990. ('Other 48' refers to catches from Statistical Area 48 not allocated to Subareas 48.1, 48.2 or 48.3).

2.3 An analysis of the 1989/90 landings by area and subarea indicated a decrease in total catches from Statistical Area 48 compared with the previous two years. In this regard, Soviet catches in Subarea 48.3 decreased by approximately 125 000 tonnes in 1989/90 compared with 1988/89. In Subarea 48.2, on the other hand, Soviet catches increased by about 145 000 tonnes and no catch was reported from Subarea 48.1 (see paragraph 2.6).

2.4 In contrast to the above, there was an increase of catches (from 217 to 30 510 tonnes) taken in Subarea 58.4. Catches in Statistical Area 88 increased from 0 in 1988/89 to 658 tonnes.

2.5 While the total catch taken by the Soviet Union was essentially similar to that in 1988/89 (showing an increase of about 0.3%), catches by Chile, Japan and Poland decreased between 15 and 82%. The Korean catch was just over double that taken last year.

2.6 The total krill catch in 1989/90 by area and country is shown in Table 2.2.

Table 2.2: Total krill catch in 1989/90 by area and country. The catch for 1988/89 is indicated in brackets.

	Chile		Japan		Korea		Poland		USSR	
Subarea 48.1	4527	(5329)	0	(75912)	4040	(1615)	0	(1823)	0	(20875)
Subarea 48.2	0	(0)	62179	(3016)	0	(164)	0	(2732)	220517	(76494)
Subarea 48.3	0	(0)	0	(0)	0	(0)	1275	(2442)	79698	(203912)
Subarea 58.4	0	(0)	0	(0)	0	(0)	0	(0)	1503	(217)
Statistical Area 88	0	(0)	0	(0)	0	(0)	0	(0)	658	(0)

2.7 Dr K. Shust (USSR) reported that Soviet catches in Subarea 48.2 came predominantly from north to northwest of Coronation Island and were taken between January and May 1990. Catch rates of between 40 and 110 tonnes per day were common during this time. At South Georgia (Subarea 48.3), on the other hand, catches were taken during the period October 1989 to May 1990 while rates of 65 to 87 tonnes per day were normal. Such catches were predominantly from the shelf-slope zone to the north and northwest of the island. Although available research data from Statistical Area 58 indicated an overall increase of krill in the region, unfavourable ice and weather conditions precluded any substantive increase in overall catch levels.

2.8 The bulk of the Soviet catches are used for the onboard production of tinned krill meat. For the first time representatives of the USSR krill fishing industry will be attending the Commission Meeting. The Scientific Committee expressed the hope that these representatives will be able to provide additional information on possible future developments by the Soviet krill fishery.

2.9 Dr M. Naganobu (Japan) reported that the Japanese krill fishery was strongly market related and as such, the decreases in catches during the past year can be attributed to a reduction in demand for krill products by the Japanese domestic market.

2.10 Mr J. Park (Republic of Korea) indicated that Korean catches were taken in the vicinity of Elephant and King George Islands (Subarea 48.1) between early December 1989 and early February 1990. Mr A. Mazzei (Chile) stated that Chilean catches were taken in the Antarctic Peninsula region (Subarea 48.2) and were used for the production of meal and frozen tail meat products.

2.11 Mr Miller suggested that in view of the ongoing need to monitor trends in krill fishing operations and to assess the possible impact of such activity in the Convention Area, the Scientific Committee may find some utility in having information on the number of vessels fishing for krill in any one year available during its annual review of the fishery. The Scientific Committee agreed that such information would be useful and requested the Secretariat to provide the Scientific Committee with summaries of the information supplied by Members on intended vessel operations under the auspices of the Standing Committee on Observation and Inspection (SCOI).

2.12 Papers distributed at the Meeting dealt with the results of a net sampling survey in Subarea 48.1 (SC-CAMLR-IX/BG/9), and catch-per-unit effort and body length composition of Japanese catches north of Livingston Island in the 1988/89 season (SC-CAMLR-IX/BG/10). In this connection, the Scientific Committee reiterated its 1989 decision (SC-CAMLR-VIII, paragraph 2.11) and referred these papers to WG-Krill for detailed consideration.

Report of the Working Group on Krill

2.13 The Second Meeting of WG-Krill was held in Leningrad, USSR from 27 August to 3 September 1990. This meeting was attended by 41 participants from 12 Member countries.

2.14 Having briefly outlined the objectives of this meeting as agreed at last year's meeting of the Scientific Committee (SC-CAMLR-VIII, paragraphs 2.35 and 5.21), the Convener of WG-Krill, Mr D. Miller (South Africa), presented the Report of the Meeting (SC-CAMLR-IX/4) as well as his own summary of its conclusions and recommendations (SC-CAMLR-IX/5).

2.15 The Report of WG-Krill is attached in Annex 4.

2.16 In reviewing the report, the Scientific Committee thanked the Convener of WG-Krill and all the participants for their input. There were some 40 background papers presented to the Working Group and the list of documents considered is given in Annex 4, Appendix C.

2.17 The Scientific Committee endorsed WG-Krill's report and in accepting the report, made use of its findings as a basis for discussion. To avoid unnecessary duplication, only a brief summary of WG-Krill's deliberations is given below. Wherever paragraphs of the Working Group's report were accepted with only little or minor revision, the reader is referred to the relevant paragraphs of the Working Group report (Annex 4). Consequently, the following summary should be read in conjunction with that report.

Development of Approaches to Managing the Krill Fishery

2.18 The Scientific Committee noted that in dealing with the question of developing approaches to management of the krill fishery (CCAMLR-VIII, paragraph 50), WG-Krill had agreed to focus discussion on Subarea 48.3 (the target of the Commission's questions). The Scientific Committee agreed with the Working Group's conclusion that management approaches and considerations developed with respect to that specific subarea would also be pertinent to the krill fishery in other subareas (Annex 4, paragraph 11).

2.19 The Scientific Committee supported the approach adopted by the Working Group (Annex 4, paragraphs 55 and 61 to 62), taking particular note of the Working Group's suggestions concerning four general concepts on which to base operational definitions of Article II with respect to krill (Annex 4, paragraph 61). These:

(i) aim to keep the krill biomass at a level higher than might be the case if only single-species harvesting considerations were of concern;

(ii) given that krill dynamics have a stochastic component, focus on the lowest biomass that might occur over a future period, rather than the mean biomass at the end of that period as might be the case in a single-species context;

(iii) ensure that any reduction of food to predators which may arise because of krill harvesting is not such that land-breeding predators with restricted foraging ranges are disproportionately affected in comparison with predators present in pelagic habitats; and

(iv) examine what level of krill escapement would be sufficient to meet the reasonable requirements of krill predators. It was agreed that WG-CEMP be asked to consider this aspect.

The Scientific Committee supported the Working Group's request that Members provide suggested operational definitions of Article II to the Working Group's next meeting.

2.20 In keeping with the approach adopted by the Working Group, the Scientific Committee agreed that estimation of the potential yield of krill is fundamental to the development of an appropriate operational definition of Article II and the formulation of suitable approaches to management of the resource.

Estimation of Potential Yield

2.21 The Scientific Committee noted that WG-Krill had attempted to estimate the potential yield of krill from Subarea 48.3 in response to the Commission's question on this matter (CCAMLR-VIII, paragraph 50) and as an example to be used to improve definition of the types of data required to carry out such a calculation (Annex 4, paragraphs 63 to 80).

2.22 WG-Krill used the classical and simplified formula applicable to the calculation of potential yield:

$$Y = \lambda M B_0 \qquad (1)$$

where **Y** is the annual yield,
M is the natural mortality,
$\mathbf{B_0}$ is an estimate of the effective total biomass of the population prior to exploitation, and
λ is a numerical factor which depends on age-at-first capture, growth curve parameters, and the extent of recruitment variability.

2.23 The Scientific Committee recognised that in applying the formula to krill, there are likely to be a number of major problems and took note of specific reservations expressed by Members of the Working Group as to the formula's applicability (Annex 4, paragraphs 78 to 80). There was, however, general agreement that the example provided by the Working Group represented a useful first step to addressing the problems associated with the estimation of krill yield.

2.24 In discussion, the Scientific Committee highlighted the following problems.

2.25 The first problem is directly associated with obtaining accurate estimates of krill biomass, in particular $\mathbf{B_0}$.

2.26 The structure of the model underlying formula (1) assumes that the krill stock being considered is 'static' and therefore confined within the area of concern. There are, however, likely to be large scale immigration and emigration (i.e., fluxes) of krill through the area. In addition, the estimate of biomass is assumed to pertain to a single unit stock.

2.27 The second problem is associated with obtaining accurate estimates of λ, which depend on demographic parameters (i.e., age-at-first capture, growth and recruitment variability) and natural mortality (**M**).

2.28 Finally, the formula does not take into consideration the requirement of krill-dependent predators – an important underlying concept identified in the operational definitions of Article II (Annex 4, paragraph 61(iii) and (iv) and paragraph 2.19 above), developed by WG-Krill.

Biomass Estimation

2.29 The Scientific Committee noted that two primary methods are currently used to assess krill spatial distribution and biomass – acoustics and direct net sampling. Acoustics has the principal advantage that a much larger portion of potential krill habitat is sampled per-unit-survey-time. Principal disadvantages include undersampling in the upper 10 or so metres of the water column and possible undersampling of non-aggregated krill (Annex 4, paragraph 18).

2.30 The Scientific Committee noted that the Working Group had expanded and updated the table of the characteristics of nets used to sample krill which was developed at the Working Group's First Meeting (Annex 4, paragraph 24 and Table 1).

2.31 Given the importance of acoustic techniques and in the overall interest of improving krill abundance estimation, the Scientific Committee endorsed the Working Group's conclusions that further development is required to standardise procedures for the conduct of acoustic surveys, including specification of:

- krill acoustic target strength to size relationships used to scale echo integration data in order to obtain biomass estimates;

- statistical procedures to summarise data, prepare distribution maps and estimate total abundance along with its associated variance; and

- guidelines for acoustic survey design and direct sampling requirements.

2.32 The Scientific Committee noted that considerable progress has been made in the last two years to improve available krill target strength information and consequently endorsed paragraphs 20 to 23 of the Working Group's report (Annex 4). In particular, the Scientific Committee emphasised that (in order of priority):

(i) additional experiments should be undertaken to measure krill target strength under controlled conditions; and

(ii) suggestions for appropriate acoustic survey designs, methods for summarising survey data and procedures for estimating biomass and associated variance should be developed and submitted to next meeting of WG-Krill.

2.33 Most present estimates of krill biomass are 'instantaneous' estimates of biomass which, because of immigration and emigration of animals from a region, differ from the 'effective total' biomass. The Scientific Committee noted that estimation of effective total biomass is required for assessment of the potential harvest which can be removed from a particular region (Annex 4, paragraph 34).

2.34 In principal, the Scientific Committee agreed that this problem can be dealt with either by:

- changing the underlying model (or formula) in order to specifically incorporate immigration and emigration rates; or

- adjust estimates of 'instantaneous biomass' obtained from biomass surveys (e.g., via acoustics) to allow for residence times of krill in a particular area.

2.35 In both the above cases, estimates of both immigration and emigration rates as well as possible residence times of krill in a particular area will be required.

2.36 The Scientific Committee noted that WG-Krill had throughout its meeting, attempted to provide suggestions as to how to improve current understanding of krill flux rates in different areas. Such suggestions include further hydrographic studies (Annex 4, paragraphs 109 and 129), the use of satellites to detect gross hydrographic features (Annex 4, paragraphs 107 to 109) and further analyses of commercial fisheries data (particularly haul-by-haul data) to improve definition of areas of possible krill concentration (Annex 4, paragraphs 113 to 115 and 118 to 120).

2.37 It was therefore recommended that a program of work be established whereby additional information on krill movements be collected. Both existing and this new data should be analysed to estimate immigration and emigration rates as well as krill residence times in a particular area.

2.38 The Scientific Committee noted that the effective separation of krill 'stocks' by genetic and other means is yet to yield unequivocal results (Annex 4, paragraphs 13 to 15).

Estimation of Demographic Parameters and Other Problems

2.39 With respect to improving estimates of $\mathbf{M}$ and λ in formula (1), the Scientific Committee agreed that available estimates should be refined by further analyses of existing and newly provided data (Annex 4, paragraphs 44 to 50).

2.40 The Scientific Committee recommended that WG-Krill consider methods for taking account of the needs of krill predators in calculations of the potential yield of krill. It was also noted that local predator needs could require additional consideration in cases where krill catches are predominantly taken in important foraging areas for land-based predators.

2.41 Finally, the Scientific Committee recommended that the approach aimed at estimating the potential yield of krill in Subarea 48.3 (as set out in Annex 4, paragraphs 67 to 80) should also be applied in other subareas (e.g., Subareas 48.1 and 48.2) as far as is possible.

Monitoring of Krill as Prey and the Working Group for the CCAMLR Ecosystem Monitoring Program

2.42 The Scientific Committee noted the Working Group's deliberations on this particular topic in response to the former's request for pertinent information (SC-CAMLR-VIII, paragraph 5.21) (Annex 4, paragraphs 87 to 115).

2.43 The Scientific Committee agreed with WG-Krill's conclusion that initially it will be most practical to develop a krill (i.e., prey) survey strategy to be implemented during a period (the 'integration period') of two to two-and-a-half months (particularly during mid-December to late February) within a radius of approximately 100 km of land-based monitoring sites and to a water depth of 150 m. It was also agreed that acoustic surveys offer the most practical approach to assessing krill variability at the spatial and temporal scales described (Annex 4, paragraph 91).

2.44 The Scientific Committee endorsed the Working Group's view that although absolute estimates of krill biomass are preferred for prey monitoring purposes, relative biomass estimates were still considered valuable. However, the Working Group felt that further consideration in this regard must be given to:

- the degree of precision required in the estimation of krill biomass related to the predator parameters being studied with, and in association with, the integration period identified;
- the compilation of areal data on krill distribution; and
- methods of calculating relationships between survey design, associated survey effort and the expected precision of estimates.

2.45 The Scientific Committee endorsed WG-Krill's recommendation that a small subgroup be tasked with considering matters related to the design of surveys for monitoring krill biomass in relation to predator requirements. The subgroup would also consider the statistical combination of line transect measurements of krill density to estimate biomass over a region in combination with provision of associated estimates of variance (Annex 4, paragraphs 96 to 98).

2.46 In this context, the Scientific Committee felt that many of the tasks being undertaken by the subgroup were also relevant to the estimation of krill biomass over broader spatial and temporal scales (see discussion in paragraphs 2.29 and 2.38) than those considered in terms of predator requirements.

2.47 The Scientific Committee endorsed the Working Group's suggestions for interim guidelines for implementing krill (prey) surveys (Annex 4, paragraph 100).

2.48 The Scientific Committee recognised that additional data are required to improve linkages between prey surveys and key predator parameters being monitored by WG-CEMP (Annex 4, paragraph 104), as well as between krill availability and key environmental processes (Annex 4, paragraphs 106 to 113). The collection of haul-by-haul data from commercial fishing operations was also seen as being an important source of information in this regard (Annex 4, paragraphs 112 to 115).

2.49 The Scientific Committee duly noted that the continued close liaison and exchange of information between WG-Krill and WG-CEMP will be crucial to the future development of prey monitoring.

Effects of Krill Catches for Young and Larval Fish

2.50 The Scientific Committee noted that the Commission has sought WG-Krill's advice on possible measures for the krill fishery in Subarea 48.3 (SC-CAMLR-VIII, paragraph 50) which would contribute to the protection of young and larval fish.

2.51 The Scientific Committee noted that the WG-Krill had considered the problem of quantifying the incidental catch of young fish in krill trawls.

2.52 This problem had also been referred to WG-FSA where it had been considered in some depth (Annex 4, paragraphs 21 to 29) and the results of such discussion are reflected in Annex 5, paragraphs 16 to 29 and 3.16 below.

2.53 In addition to improving information on the incidental by-catch of young fish by the krill fishery, having suitably trained personnel as observers on commercial krill trawlers would substantially improve the flow of information aimed at quantifying krill demographic parameters from the fishery (Annex 4, paragraph 121). The improved supply of data likely to be forthcoming as a result of the deployment of observers aboard commercial fishing vessels was also considered by the Scientific Committee to be an important factor in improving the flow of information from the Antarctic commercial finfish fishery (see paragraphs 3.16 to 3.17).

WG-Krill's Answers to Questions Posed by the Commission

2.54 The Scientific Committee noted that WG-Krill had attempted to answer the three questions conveyed to it from the Commission (SC-CAMLR-VIII, paragraph 50).

2.55 Specifically, these three questions requested advice on:

(i) What is the biomass and potential yield of krill in Subarea 48.3?

(ii) What are the possible management measures, including limits, that might be necessary on krill catches in the subarea which would maintain ecological relationships with dependent and related populations, including:

(a) the protection of dependent predators; and

(b) the protection of young and larval fish?

(iii) If these questions cannot be answered, what new information is required and how soon could it be obtained?

2.56 WG-Krill's answers to these questions were set out in Annex 4, paragraph 139 and are as follows:

(i) some Members considered that a crude range of biomass and potential yield estimates of krill in Subarea 48.3 could be provided. Others expressed reservations concerning such estimates and the formula used to calculate annual yield (Annex 4, paragraphs 63 to 80);

(ii) specific concepts with respect to approaches to the management of krill were developed along with suggestions for operational definitions of Article II of the Convention:

(a) a number of suggestions were made concerning the improvement of information on, and consequently, the protection of krill dependent predators (Annex 4, paragraph 59);

(b) suggestions were made on gear developments to alleviate the potential problem of incidental by-catch of young and larval fish by commercial krill trawling operations (Annex 4, paragraph 81). It was recommended that experiments be carried out on such gear modifications with a view to reducing possible mortality of young fish in trawls and that field data on the extent of the problem should be collected (Annex 4, paragraph 122); and

(iii) requirements for new information were outlined (Annex 4, paragraphs 80, 118 to 120, 122 to 124 and 128 to 129), but it was felt that the determination of the time required to obtain sufficient data to provide satisfactory answers to the questions being posed would be a substantial exercise and one which the Working Group was unable to carry out in the time available to it.

2.57 The Scientific Committee also noted that many of the key issues crucial to answering questions of the type posed by the Commission have been considered by WG-Krill and will constitute a major part of the Working Group's ongoing work.

Future Work of the Working Group on Krill

2.58 The Scientific Committee agreed that discussion at WG-Krill's meeting had identified many areas important to the ongoing assessment of the impact of fishing on krill stocks and krill availability to both the fishery and dependent predators.

2.59 In addition to the ongoing requirement to monitor fisheries activities, review the status of the krill resource and liaise with WG-CEMP, the Scientific Committee agreed that WG-Krill should focus its attention on refining estimates of potential yield. In this connection, further work on estimation of biomass, determination of krill acoustic target strength, estimation of krill advection and the separation of stocks are essential.

2.60 In the interest of improving management advice on krill, the Scientific Committee agreed that WG-Krill should continue to develop approaches to management.

2.61 In order to address these issues which are fundamental to the development of advice on krill, the Scientific Committee recommended the WG-Krill should meet during the intersessional period for approximately one week during 1991.

2.62 Attention was also drawn to the fact that the above meeting will be immediately preceded by a three-day workshop to review results forthcoming from the various tasks assigned to the subgroup on survey design (see Annex 4, paragraph 97).

Data Requirements

2.63 In view of a continued need to monitor fishery activities, the Scientific Committee endorsed WG-Krill's recommendation (Annex 4, paragraph 113) that, if possible, haul-by-haul data should be reported from areas within 10 km of land-based predator colonies. The potential utility of deploying suitably qualified observers aboard commercial vessels to facilitate the collection of such data was recognised.

2.64 The Scientific Committee endorsed WG-Krill's action with respect to developing a form to be used by scientific observers and aimed at collecting data on krill demographic parameters from the krill fishery (Annex 4, paragraph 121).

2.65 Analyses of fine-scale fisheries data should continue (as per SC-CAMLR-VIII, paragraph 2.41) with a view to monitoring fishery activities specifically (Annex 4, paragraph 115). Such data should be reported for Subareas 48.1, 48.2 and 48.3 as well as the Antarctic Peninsula Integrated Study Region.

2.66 As recommended last year (SC-CAMLR-VIII, paragraphs 2.37 and 2.38), Members should report results of analyses of both past and currently available acoustic data on krill as well as on the examination of available echo-charts. Submissions on procedures to access such data should also be provided (Annex 4, paragraph 120).

2.67 The interim measure requiring collection of at least 50 krill per single haul, per vessel, per fishing day for length frequency analyses, should remain until the level of precision to be achieved by such analyses can be properly evaluated. In this regard, the improved definition of the specific use(s) to which krill length frequency data from commercial catches can be put, is required before modification of the interim measure is recommended (Annex 4, paragraph 123).

2.68 Length frequency data from commercial catches already collected should be analysed (either nationally or by the Secretariat) to estimate the level of precision to be expected from implementation of the current sampling regime (Annex 4, paragraph 124).

2.69 Under the current arrangement, data from the krill fishery must be submitted by 30 September. The Scientific Committee considered the deadline in view of WG-Krill's requirement to consider such data from the most recent split-year and the fact that meetings of the Working Group are likely to be scheduled prior to this deadline. The Scientific Committee felt that at this stage, however, there was no need to modify the current deadline of 30 September.

Advice to the Commission

2.70 WG-Krill should hold an intersessional meeting and workshop during 1991 in order to review commercial fishing activities, attempt estimates of potential yield and sustain momentum in the development of approaches to structuring advice on krill resources. The WG-Krill should also develop advice on survey design for, and continue liaison with, WG-CEMP.

2.71 The continued collection of haul-by-haul catch and effort data (including relevant operational details) should continue.

2.72 The interim guidelines for the conduct of krill (prey) surveys in the vicinity of land-breeding colonies should be adhered to until such time as suitable prey survey designs have been developed.

2.73 The Commission had posed a number of questions concerning krill resources in Subarea 48.3. The first question concerned the estimation of the total biomass and the potential yield of krill. WG-Krill indicated that they were unable to estimate biomass reliably because of uncertainty in estimates of acoustic target strength (estimates differed by an order of 10) and uncertainty about the residence times of krill in the area.

2.74 Because of the uncertainty in estimating biomass, WG-Krill was unable to estimate potential yield.

2.75 Regarding the second question posed by the Commission, WG-Krill indicated that is not possible to provide detailed advice on measures aimed at protecting krill dependent predators or young and larval fish, due to a lack of data.

2.76 Finally, WG-Krill was unable to provide any indication of how soon sufficient information to resolve these particular problems could be collected. In the light of the uncertainties outlined above, and in the absence of any reliable estimate of potential yield of krill in Subarea 48.3, the Scientific Committee recommended that the Commission consider imposing precautionary measures for limiting krill fishing in Subarea 48.3.

2.77 At the time the Report of the Scientific Committee was being adopted, the Delegations of Japan and USSR expressed the view that the introduction of precautionary limits on krill fishing in Subarea 48.3 was not yet justified because of the lack of estimates of the total biomass and the potential yield.

FISH RESOURCES

Fish Stock Assessment - Report of the Working Group

3.1 The Convener of the Working Group on Fish Stock Assessment (WG-FSA), Dr K.-H. Kock (Germany), presented a report of the meeting which had been held in Hobart at the offices of the Secretariat from 9 to 18 October 1990.

3.2 The Report of the WG-FSA is attached in Annex 5.

3.3 In reviewing the report, the Scientific Committee thanked the Convener and participants for all their hard work. A large number of background papers were presented to the WG-FSA meeting. A list of these documents is given in Annex 5, Appendix C.

3.4 The Scientific Committee endorsed the report of the WG-FSA and in receiving the report, used its findings as a basis for discussion of the agenda items to be covered under fish resources.

3.5 To avoid unnecessary duplication, where certain sections of the WG-FSA report were accepted with only minor or no comment, this Report refers to the relevant paragraphs in the Working Group report. This should be read in conjunction with that report.

3.6 At the request of the Scientific Committee (SC-CAMLR-VIII, paragraph 3.49) the Convener had prepared a document which analysed the problems of providing stock assessment advice. This was revised and endorsed by the Working Group. The Scientific Committee also endorsed the document which is in Annex 5, Appendix D.

3.7 The main conclusions of this document are as follows:

(i) the quality of stock assessment and management advice by the WG-FSA will be improved by an increase in the number of research surveys and an improvement in the quality of catch and effort statistics; and

(ii) uncertainty arising in the assessment of stocks will continue to be a major problem in the provision of management advice on fisheries resources in the Convention Area and this uncertainty must be taken into account in reaching management decisions.

3.8 The Scientific Committee drew the Commission's attention to the problems identified in this document and pointed out that a large number of the difficulties associated in assessing the state of the stocks documented later in this Report are important examples of the problems identified in this document.

Review of Material for The Meeting

Catch and Effort Statistics (Annex 5, paragraph 8)
Size and Age Composition Data (Annex 5, paragraph 9)

3.9 There was a major problem in assessing many of the stocks as large amounts of relevant data were unavailable or incomplete. The Scientific Committee drew the Commission's attention to the fact that attempts to provide advice on the status of the stocks annually were being regularly and substantially undermined by the failure to provide relevant data in a timely manner.

By-Catch of Fish Larvae and Juvenile Fish in the Krill Fishery (Annex 5, paragraphs 10 to 29)

3.10 The Working Group had reviewed a substantial amount of material which indicated that there was a potential problem of catches of young and larval fish in krill trawls.

3.11 The Scientific Committee endorsed in principle the idea that once nursery grounds for fish had been identified, these areas should be closed to krill fishing for the relevant periods.

3.12 Dr Naganobu expressed his reservations to this view.

3.13 Dr Shust agreed with the principles of operating the krill fishery in a manner that minimised the catch of young and larval fish, but expressed the view that more data needed to be collected on the problem before further action should be contemplated.

3.14 Mr O. Østvedt (Norway) suggested the possibility of dealing with the problem via by-catch regulations. However, this was considered to be problematic as the separation of larval fish from krill in commercial catches is difficult.

3.15 The Scientific Committee agreed that as a matter of priority, nursery grounds for fish should be identified. It was agreed that this should be a topic for the next meeting of the WG-FSA.

3.16 The Scientific Committee endorsed the suggestion of the Working Group (Annex 5, paragraph 27) that a program to monitor the by-catch of young and larval fish by the krill fishery should be initiated as soon as possible.

3.17 It was noted that the WG-FSA had developed a draft field sampling logsheet for the submission of data on this by-catch (Annex 5, Appendix J) and that an observer program would probably need to be implemented to undertake such monitoring (Annex 5, paragraphs 27 to 29).

Other Biological Information (Annex 5, Paragraphs 30 to 40)

3.18 The Scientific Committee noted the report of the Working Group without further comment.

Mesh Selection Experiments
(Annex 5, Paragraphs 41 to 42)

3.19 The Working Group had reviewed further information on mesh selectivity experiments conducted by the USSR. These experiments had produced essentially similar results to previous work on the fishing targeted on *Champsocephalus gunnari*.

3.20 The Scientific Committee noted that its recent advice on the modification of mesh regulations contained in Conservation Measure 2/III (SC-CAMLR-VIII, paragraph 3.18) had not been accepted by the Commission pending the results of these experiments (CCAMLR-VIII, paragraphs 80 to 83).

3.21 In 1989 the WG-FSA considered mesh sizes for *C. gunnari* which would allow some escapement of fish at various stages of development. A nominal mesh of 80 mm selects fish at about the length of 50% maturity, which is well below the length of first spawning. A 90 mm nominal mesh selects fish at about the mean length of first spawning. A nominal mesh of 100 mm would correspond to an age at first capture of 4 years which has been proposed as the optimum under the conditions of high fishing mortality.

3.22 The Scientific Committee agreed that they could now advise the Commission that all analyses supported the position that in Subarea 48.3 the above options for mesh regulation could be considered for the fishery targeted on *C. gunnari*.

Assessments Prepared by Member Countries
(Annex 5, Paragraphs 43 to 59)

3.23 The Scientific Committee noted the Working Group's report on these assessments without comment.

Methodologies Used for Surveys and Assessments
(Annex 5, Paragraphs 60 to 93)

3.24 The Scientific Committee <u>endorsed</u> the recommendation of the Working Group on these results.

Assessment Work (Annex 5, Paragraph 94)

3.25 The Scientific Committee recommended that the assessment summaries contained in Annex 5, Appendix L should be modified to exclude the recommendations of the Working Group. These summaries could then be used directly without the problem of confusion between the recommendation of the Working Group and those of the Scientific Committee. The Scientific Committee believed these summaries were useful and recommended that they should continue.

Statistical Area 48

Subarea 48.3 (South Georgia)

Catches (Annex 5, paragraph 95)

3.26 The Scientific Committee noted the information provided by the Working Group on historical catches without comment.

Assessments of Individual Stocks

Notothenia rossii in Subarea 48.3 (Annex 5, paragraphs 96 to 98)

3.27 The Scientific Committee noted that the report of the Working Group indicated that this stock was still at a very low level.

Management Advice

3.28 The Scientific Committee recommended that all conservation measures for this species should remain in force.

Champsocephalus gunnari in Subarea 48.3
(Annex 5, paragraphs 99 to 141)

3.29 Three surveys had occurred during 1990 to assess the status of the stock. These surveys gave widely different estimates of the biomass of the stock. The estimates obtained by the RV *Akademik Knipovich* (USSR) and the BMRT *Anchar* (USSR) were in excess of two-times (*Akademik Knipovich*) and four-times (*Anchar*) the estimates obtained by the RV *Hill Cove* (UK/Poland).

3.30 Dr Beddington expressed concern about the wide disparity between these results which had not been explained by the Working Group. He believed that there were likely to be operational differences in the conduct of the different surveys.

3.31 Dr Shust stated his view that the results of the different surveys were both comparable and reliable and stated that for the first time, identical randomised survey designs had been used.

3.32 Lic. E. Marschoff (Argentina) expressed his concern about the design of the surveys because at least two of them had no significant difference in fishing density between the depth strata sampled nor between geographical positions of trawls contrary to normal biological expectations.

3.33 The Chairman of the Scientific Committee pointed out that the survey design used by the *Hill Cove* was the same as that used by RV *Professor Siedlecki* and RV *Walter Herwig* in previous years.

3.34 The Working Group had identified a number of sources of uncertainty concerning the status of the stock which the Scientific Committee noted. In addition, no length and age data from the commercial catches had been presented to CCAMLR.

3.35 The Working Group had examined the problem of setting TACs under uncertainty. They indicated that under reasonable statistical assumptions, the use of point estimates (e.g., from a survey) would have a 69% chance of the TAC being too high.

3.36 Dr Shust pointed out that there was a 31% chance of the TAC being too low.

Management Advice

3.37 The Working Group had presented a range of possible TACs based on the point estimates of the *Hill Cove* and *Akademik Knipovich* surveys (44 000 to 64 000 tonnes).

3.38 The Scientific Committee, in considering the uncertainties identified by the Working Group, did not believe that the range of TACs given was appropriate as a basis of management advice to the Commission. The Scientific Committee believed that the range should be extended to lower levels of TAC to reflect the uncertainties in the use of the point estimate and the discrepancy between the surveys in earlier years and those in 1990.

3.39 The USSR Delegation did not agree with these reservations and stated its view that the range given by the Working Group was the appropriate basis for giving management advice to the Commission and might well be conservative.

3.40 The Scientific Committee endorsed the comment of the Working Group that if the biomass is well estimated by the *Hill Cove* survey, setting a TAC on the basis of the *Akademik Knipovich* survey will result in a substantial depletion of the stock. If the biomass is well estimated by the *Akademik Knipovich* survey, setting a TAC on the basis of the *Hill Cove* survey will result in a substantial increase in the stock.

3.41 The Scientific Committee <u>recommended</u> (on the basis of advice of the Working Group) that due to the uncertainties, a conservative TAC be adopted to reduce the probability of over-exploiting the species.

3.42 Lic. E. Barrera-Oro (Argentina) stated that even if a TAC was set from the lowest figure of the range of TAC values (44 000 to 64 000 tonnes), the by-catch limit of 500 tonnes of *Notothenia gibberifrons* would be exceeded. He referred to WG-FSA-90/15 referred to in paragraph 185 of the Working Group report, where the *N. gibberifrons* by-catch in the directed fishery of *C. gunnari* using midwater trawls in Subarea 48.3 was evaluated based on the data submitted for 1987/88 and 1988/89. This evaluation specifies that between 138 and 638 kg of *N. gibberifrons* would be caught for each haul directed at *C. gunnari*. Taking the minimum value (i.e., 138 kg per haul), a TAC of 500 tonnes of *N. gibberifrons* by-catch would be reached with 3 600 hauls, which is equivalent to 14 000 tonnes of *C. gunnari*. This value of 14 000 tonnes is less than half of the minimum TAC proposed for the target species, *C. gunnari* in paragraph 3.37.

3.43 These observations were supported by a number of delegations.

3.44 Mr E. Balguerías (EEC) made the point that the catch of target species may need to be restricted by concerns over the by-catch of depleted species.

3.45 In this context, Dr W. de la Mare (Australia), supported by a number of other delegations, suggested that the figure referred to in paragraph 3.42 (14 000 tonnes) could form the basis for a conservative TAC for *C. gunnari*.

3.46 Dr Shust disagreed with the views expressed in paragraph 3.42. He pointed out that the reported catch of *N. gibberifrons* was only 11 tonnes in the catch of 8 000 tonnes of *C. gunnari* in 1990 when only midwater trawls were used. He pointed out that where a by-catch species exceeded 5% of the haul, the vessel would cease fishing in the area.

3.47 Dr de la Mare drew attention to paragraph 186 of the Working Group report which noted that it cannot be presumed that future fishing with midwater trawls will always result in negligible by-catch.

3.48 Lic. Marschoff stated that the by-catch of *N. gibberifrons* reported to CCAMLR from the last season is highly improbable in view of previously reported by-catches from midwater trawls.

Patagonotothen brevicauda guntheri in Subarea 48.3
(Annex 5, paragraphs 142 to 154)

3.49 Reported catch of this species was 145 tonnes although the TAC was 12 000 tonnes (Conservation Measure 16/VIII). It was stated that this was a result of no fishing being conducted within 12 miles of Shag Rocks.

3.50 There is some confusion in the reported data as catches reported to CCAMLR in 1987 and 1988 were indicated as coming from the South Georgia region. Research surveys have indicated that the species does not occur in this area.

3.51 The Scientific Committee noted that the report of the Working Group indicates considerable uncertainty with respect to current biomass, age structure, recent recruitment and demographic parameters.

Management Advice

3.52 The Working Group had recommended (Annex 5, paragraph 154) that the TAC should be at the lower end of the range (20 000 to 36 000 tonnes).

3.53 The basis of this recommendation was queried by Dr Beddington who pointed out that the previous TAC was 12 000 tonnes which had not been caught. There were major documented uncertainties in all the components of the stock assessment process and the catch data had been shown to be false.

3.54 The Scientific Committee's attention was drawn to paragraph 275 of the Working Group's report in which two views were expressed.

(i) The TAC should be revised upward in the light of the TAC recommendations of the Working Group.

(ii) The fishery should be closed until the major uncertainties identified with fine-scale data and those referred to in paragraphs 3.50 and 3.51 above could be resolved.

The Scientific Committee's discussion of this matter reflected these two views which are presented as alternative approaches to the Commission.

Dissostichus eleginoides in Subarea 48.3
(Annex 5, paragraph 155 to 170)

3.55 Catches in the 1988/89 season were 4 138 tonnes. Reported catches for 1989/90 have doubled to 8 311 tonnes.

3.56 The Scientific Committee noted that the intention of the USSR not to increase the fleet by more than one or two vessels in addition to the six vessels operating in 1988/89 (CCAMLR-VIII, paragraph 130(a)), had not prevented the doubling of catches in 1989/90. Essential information necessary for monitoring fishing power in this fishery has not been provided. The Scientific Committee felt that this information is essential to the management of this fishery. It was also noted that only a small amount of biological information from the fishery has been submitted.

3.57 At its last meeting, the Commission had not set any conservation measures for this stock: in part, as a result of the assertion (CCAMLR-VIII, paragraph 106) that the fishery is targeted on senescent fish. The results of the Working Group's analyses (Annex 5, paragraphs 161 and 162) indicate that this assertion is almost certainly false.

Management Advice

3.58 The Working Group had suggested that a TAC in the range of 1 200 to 8 000 tonnes would be appropriate.

3.59 The Scientific Committee, having reviewed the substantial uncertainties associated with the stock, recommended that a TAC should be set for the stock in the lower part of this range.

3.60 The USSR Delegation expressed the view that a TAC in the middle of the range would be appropriate in the light of its comments in the report of the WG-FSA.

3.61 Dr Kock had expressed concern on a fishery on *Dissostichus eleginoides* developing on a bank west of Shag Rocks just outside the Convention Area (CCAMLR-IX/MA/1) with a potential of extending further to the west. Due to uncertainties in stock boundaries, it is possible that these catches originate from the same stock which is currently exploited around Shag Rocks and South Georgia.

3.62 The Scientific Committee drew the Commission's attention to the fact that this fishery was occurring in all months of the year. Accordingly, there is a potential problem that the catch may have already exceeded a possible TAC.

3.63 Dr Shust reported that he had not received information on the catch of this species since July 1990.

3.64 Catches in the 1989/90 season were 2 501 tonnes from 1 August to 31 October and 3 410 tonnes by the end of November.

3.65 The Scientific Committee recommended that the Commission should consider imposing a closed season on this fishery from the beginning of July until the end of the 1991 Commission meeting.

3.66 The Scientific Committee recommended that in the event of a TAC being set by the Commission for this species, a five-day reporting period for catches should be utilized.

Electrona carlsbergi in Subarea 48.3 (Annex 5, paragraphs 172 to 183)

3.67 The Scientific Committee endorsed the recommendation of the Working Group and recommended that for myctophids caught in the CCAMLR Convention Area, all catches including those from adjacent areas to the north of Statistical Area 48, should be reported in fine-scale format.

Notothenia gibberifrons in Subarea 48.3 (Annex 5, paragraphs 184 to 197)

3.68 The Scientific Committee endorsed the analyses of the Working Group without comment.

Management Advice

3.69 On the basis of the analyses of the Working Group, the Scientific Committee recommended that there should be no directed fishery for this species and catches should be restricted to not more than 500 tonnes.

Chaenocephalus aceratus and *Pseudochaenichthys georgianus* in Subarea 48.3 (Annex 5, paragraphs 198 to 207)

3.70 The Scientific Committee endorsed the analyses of the Working Group without comment.

Management Advice

3.71 On the basis of the Working Group's analyses, the Scientific Committee recommended that there should be no directed fishery for either species and that a TAC of 300 tonnes as a by-catch provision should be set.

Notothenia squamifrons in Subarea 48.3
(Annex 5, paragraphs 208 to 211)

3.72 The Scientific Committee noted the report of the Working Group without comment.

Management Advice

3.73 On the basis of the Working Group's advice, the Scientific Committee recommended that there should be no directed fishery for this species and that the by-catch provision of 300 tonnes should be retained by inclusion of this species in Conservation Measure 13/VIII.

Subarea 48.2 (South Orkney Islands)

3.74 Catches in 1990 were *C. gunnari*, 2 528 tonnes and *N. gibberifrons*, 340 tonnes.

Management Advice

3.75 The Working Group had requested new data at its 1989 Meeting. These data were not presented. Accordingly, the Working Group was not able to provide management advice for either *C. gunnari* or *N. gibberifrons*.

3.76 Lic. Barrera-Oro pointed out that in spite of CCAMLR Resolution 6/VIII the catch of *N. gibberifrons* taken as a by-catch in the directed fishery for *C. gunnari* was high (around 13%). This fishery used bottom trawls. He suggested that there should be a ban on bottom trawling for *C. gunnari* to reduce the by-catch of *N. gibberifrons*. This suggestion received support from a number of delegations.

3.77 Dr Shust did not agree with this suggestion. He believed any such advice should follow a proper assessment of the stock.

Subarea 48.1 (Antarctic Peninsula)
(Annex 5, paragraphs 218 to 220)

3.78 Lic. Marschoff referred to analyses contained in WG-FSA-90/14 and discussed by the Working Group. This indicated a decline in recruitment of *N. rossii* and *N. gibberifrons* in Subarea 48.1.

3.79 There was no commercial fishing in this area and no new information was provided. The Scientific Committee made no recommendations about management advice.

Statistical Area 58

Catches (Annex 5, paragraphs 221 to 223)

3.80 The Scientific Committee noted the report of the Working Group without comment.

Subarea 58.5 (Kerguelen)

Division 58.5.1 (Kerguelen)
(Annex 5, paragraphs 224 to 243)

3.81 The work of the Working Group was seriously hampered by the absence of Dr Duhamel or any scientist with a direct knowledge of the fishery. The Scientific Committee supported the hope expressed by the Working Group that this absence of relevant scientists would not occur at future meetings.

Notothenia rossii in Division 58.5.1
(Annex 5, paragraphs 225 to 228)

3.82 The Scientific Committee endorsed the report of the Working Group.

Management Advice

3.83 The Scientific Committee recommended that there should be no directed fishery for this species and that there should be no resumption of the fishery until a biomass survey had established that the stock had recovered from past over-exploitation.

Notothenia squamifrons in Division 58.5.1
(Annex 5, paragraphs 230 to 233)

3.84 Catches continued at around the level of recent years. No new data were presented.

Management Advice

3.85 The Scientific Committee advised that a continuation of catch at the current levels will prevent recovery of the stock.

Champsocephalus gunnari in Division 58.5.1
(Annex 5, paragraphs 234 to 243)

3.86 Catches were 226 tonnes in 1990.

3.87 The Scientific Committee endorsed the analyses of the Working Group.

Management Advice

3.88 On the basis of the advice of the Working Group, the Scientific Committee noted that the 1985 cohort now appears to be extinct. The Scientific Committee recommended that there be no directed fishery for this species until a survey has established the size of the new cohort.

Dissostichus eleginoides in Division 58.5.1
(Annex 5, paragraphs 240 to 243)

3.89 The Scientific Committee endorsed the work of the Working Group without comment.

Management Advice

3.90 There is an urgent need to assess this stock. No such assessments have been made due to a lack of information. No advice can be given.

Division 58.5.2 (Heard Island)
(Annex 5, paragraph 244)

3.91 The Scientific Committee noted the results without comment.

Subarea 58.4 (Enderby-Wilkes)

3.92 The Scientific Committee noted with concern the major inconsistency of the catch data on *Notothenia squamifrons* reported for Ob and Lena Banks and the catches reported for these two grounds separately.

Division 58.4.4 (Ob and Lena Banks)
(Annex 5, paragraphs 245 to 261)

Notothenia squamifrons (Lena Bank)

3.93 The Scientific Committee endorsed the analyses of the Working Group without comment.

Management Advice

3.94 The Scientific Committee recommended that catches should be limited to 305 tonnes.

Notothenia squamifrons (Ob Bank)

3.95 The Scientific Committee endorsed the analyses of the Working Group without comment.

Management Advice

3.96 The Scientific Committee recommended that catch levels should be below 267 tonnes.

Division 58.4.2 (Enderby-Wilkes Land)
(Annex 5, paragraphs 262 to 265)

3.97 The Scientific Committee endorsed the work of the Working Group without comment.

3.98 The Scientific Committee noted that *Pleuragramma antarcticum* is a prey species of interest to CEMP and that fine-scale data on the species are required to be submitted (SC-CAMLR-IX/7).

Management Advice

3.99 Due to lack of data, no management advice is possible.

General Advice to the Commission
(Annex 5, paragraphs 267 to 279)

3.100 The Scientific Committee endorsed all the conclusions of the Working Group with respect to the Conservation Measures. The Commission's attention is drawn to the relevant paragraphs of the Working Group report, paragraphs 267 to 279.

Submission of Data
(Annex 5, paragraphs 280 to 281)

3.101 The Scientific Committee endorsed the recommendations of the Working Group.

3.102 Prof. Lubimova (USSR) expressed concern about the latter part of paragraph 281, which was not appropriately placed in the Working Group report. This view was shared by several other delegations.

Questions from the Commission
(Annex 5, paragraphs 282 to 294)

3.103 The Scientific Committee endorsed the Working Group's answers to the questions posed by the Commission. The Commission's attention is drawn to the appropriate paragraphs in the report, paragraphs 282 to 294.

Future Work
(Annex 5, paragraphs 295 to 304)

3.104 The Scientific Committee endorsed the data requirements outlined in the report.

3.105 Lic. Marschoff stated a view of a need for corroborative data from independent sources such as the observation program and (in spite of the political problems) the transhipment system in Subarea 48.3 which may give information on the location and species composition of catches.

Data Analyses and Software to be Prepared Prior to Next Meeting
(Annex 5, paragraphs 305 to 311)
Organization of the Next Meeting
(Annex 5, paragraphs 312 to 316)

3.106 The Scientific Committee noted and endorsed the Working Group's report on these matters.

3.107 The Scientific Committee endorsed the report of the task group convened by Dr M. Basson (UK) concerning information requirements of working papers submitted to the Working Group. This report is at Appendix F of the Working Group report.

SQUID RESOURCES

Review of Activities Related to Squid Resources

4.1 No Members reported undertaking any squid fishing within the Convention Area during the past year.

4.2 The United Kingdom reported that seven squid-jigs were trawled up in January 1990 at 54°28’S, 38°13’W during the course of a fish survey around South Georgia. The origin of these jigs was unknown.

4.3 No Members present have reported the loss of any squid fishing gear but the possibility remained that non-Member nations might be involved (e.g., SC-CAMLR-VIII, paragraph 4.3). The Scientific Committee noted that the topic of obtaining data from non-member nations would be discussed at this meeting of the Commission (CCAMLR-VIII, paragraph 54).

4.4 The Secretariat reported that, following the decision of the Commission (CCAMLR-VIII, paragraph 55) to accept the recommendation from the Scientific Committee (SC-CAMLR-VIII, paragraph 4.5) that fine-scale catch and effort data from squid fishing operations in the Convention Area should be submitted to the Commission, it had developed a preliminary format for the reporting of such data (SC-CAMLR-IX/BG/4). The Scientific Committee thanked the Secretariat and their specialist advisers for preparing this and approved its content.

4.5 During last year’s discussion of this Agenda Item it was concluded that, chiefly because of the limited market potential of the most likely target species, the ommastrephid squid *Martialia hyadesi*, it was unlikely that squid fishing in the Convention Area would expand in the near future. However, the view was also expressed that the squid resource was not available in sufficient quantities or with adequate predictability to be of future importance as a commercial resource (SC-CAMLR-VIII, paragraph 4.4).

4.6 However, ommastrephids are one of the two families which form over 70% of the World’s commercial catch of cephalopods and *Martialia* has been a significant element in the current Patagonian shelf/Falkland Islands squid fishery, with annual catches of up to 26 000 tonnes and has contributed a catch of commercial quantity during exploratory fishing within Subarea 48.3 (SC-CAMLR-VIII, paragraph 4.2).

4.7 Furthermore, Dr Croxall introduced a report by Dr P. Rodhouse (SC-CAMLR-IX/BG/13) which provided the first, preliminary, assessment of the stock of *M. hyadesi* in the Convention Area, based on data from its contribution to the squid diet of predators.

4.8 Based on sampling over several years, the proportion of *Martialia* in the squid diet of predators breeding at South Georgia is known for grey-headed albatross (*Diomedea* *chrysostoma*) (69%), black-browed albatross (*Diomedea melanophrys*) (76%), wandering albatross (*Diomedea exulans*) (2%), light-mantled sooty albatross (*Phoebetria palpebrata*) (1%), northern giant petrel (*Macronectes halli)* (1%), southern giant petrel (*Macronectes giganteus)* (15%), and southern elephant seal (*Mirounga leonina*) (12%). The squid diet of a number of other seabirds and seals is insufficiently known to indicate whether or not they eat *Martialia*.

4.9 Based on these quantitative data, the estimated annual consumption of *M. hyadesi* is at least 330 000 tonnes, of which about 94% is due to southern elephant seals. No data are available to estimate the relationship between the biomass of *Martialia* consumed by predators and the total stock.

4.10 The Scientific Committee welcomed this assessment and noted that the paper had important implications. It clearly demonstrated the existence of a substantial population of a squid species of potential commercial significance within the Convention Area and indicated the nature of some of the relationships between this species and its dependent predators. The knowledge that *Martialia* probably has a life-span of two years (rather than one year as in most ommastrephid squid) also has important implications for management of any future commercial exploitation.

Advice to the Commission

4.11 The Scientific Committee recommended that the Commission should adopt the instructions and data reporting form in SC-CAMLR-IX/BG/4 as the standard format for reporting fine-scale catch and effort data from squid-jig fisheries.

ECOSYSTEM MONITORING AND MANAGEMENT

5.1 Dr J. Bengtson (USA), Convener, presented the Report of the Fourth Meeting of the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) held at Stockholm, Sweden, 6 to 13 September 1990 (Annex 6), the highlights of which were summarised in SC-CAMLR-IX/11.

5.2 The Scientific Committee thanked the Working Group for its work during the intersessional period and at the meeting. It reviewed the report, focusing particularly on the current status of the main undertakings, and the implications and requirements for present action and future work.

Relevance of CEMP to the Work of the Commission

5.3 WG-CEMP had responded to the requests from the Scientific Committee and Commission (CCAMLR-VIII, paragraphs 68 and 69) to provide advice on operational definitions of depletion, on the ability of CEMP to detect changes in ecological relations (Annex 6, paragraphs 35 and 36) and to consider approaches to the use of CEMP data as part of CCAMLR fisheries management strategies.

5.4 In respect of the latter topic, the Scientific Committee noted and approved:

(i) that WG-CEMP had identified as a specific priority the development of ways of incorporating the data on monitored predator parameters in the formal management deliberations of CCAMLR by the Scientific Committee and the Commission;

(ii) the agreement to determine annually the magnitude, direction and significance of year-to-year and overall trends in each of the predator parameters being monitored at each site;

(iii) the agreement:

   (a) to evaluate annually these data on species, site and region specific bases;

   (b) to consider the conclusions in the light of a comprehensive range of relevant biological information;

   (c) to formulate, where appropriate, advice to the Scientific Committee; and

(iv) the conclusion that analysis and evaluation of submitted CEMP data and developments of recommendations based thereon did not require, and should not await, the determination of the precise quantitative nature of predator/prey/environmental relationships.

5.5 The Scientific Committee approved the request that both Members and the Secretariat should undertake the work referred to in paragraph 5.4 (ii), encouraged WG-CEMP to develop and agree comprehensive instructions for doing this, and endorsed the request to Members to submit explicit proposals to the next meeting of WG-CEMP.

5.6 In a broader general consideration of these initiatives the Scientific Committee noted that the approach developed would benefit from considering as wide a variety of parameters as possible. WG-CEMP was requested to continue to evaluate additional parameters of potential value and, where appropriate, to develop standard methods (including data collection and reporting formats).

5.7 In this regard, the Scientific Committee noted that WG-CEMP had indicated that to expedite the development of standard methods involving activity (e.g., diving, feeding) budgets of seals and seabirds at sea, a workshop on the use of devices currently employed in such studies was an important requirement. The Scientific Committee endorsed this suggestion and encouraged the Working Group to develop detailed proposals.

Predator Monitoring

5.8 The Scientific Committee noted the potential addition of Esperanza Station (Argentina) as a CEMP Network Site and the suggestion, reinforced by a formal recommendation from SCAR to appropriate national committees, that Admiralty Bay, King George Island (within the Antarctic Peninsula Integrated Study Region) should be reinstated as a CEMP site.

5.9 The change in the eastern and southeastern boundaries of the Antarctic Peninsula Integrated Study Region to make them coincide with the eastern and southeastern boundaries of Subarea 48.1 was approved. The other boundaries of the Antarctic Peninsula Integrated Study Region remain unchanged.

5.10 The Scientific Committee also approved the addition of the gentoo penguin (*Pygoscelis papua*) as a designated CEMP species and urged WG-CEMP to complete appropriate modifications to standard methods and data reporting formats as soon as possible.

5.11 It was noted that WG-CEMP had completed a major revision of the CEMP Standard Methods, including approving the revised data reporting forms and instructions, which were now available for most approved methods.

5.12 The Secretariat would shortly be circulating the version incorporating the revisions agreed at the recent WG-CEMP meeting and the revisions carried out during this Meeting of the Scientific Committee.

5.13 With the completion of the procedure for submission of CEMP data to the CCAMLR Data Centre and the agreement on access procedures to such data (CCAMLR-VIII, paragraph 64), the decision of the Commission (CCAMLR-VIII, paragraph 57) requiring Members monitoring approved parameters of selected species at nominated sites using approved standard methods to submit these data to the Secretariat annually by 30 September, comes into force. Retrospective data conforming to the same criteria are also required as soon as possible.

5.14 A number of Members had already submitted data for 1989/90 to the CCAMLR Data Centre (summarised in SC-CAMLR-IX/BG/5) and other Members were urged to do so as soon as possible.

5.15 WG-CEMP had advised that it would be helpful to have data from the most recent austral summer available for review at the meetings of WG-CEMP, which have usually been held in July/August. A revision of the deadline for annual submission of CEMP data to 30 June had been suggested; this was <u>approved</u> by the Scientific Committee.

5.16 WG-CEMP had addressed the issue of ensuring that field research techniques (e.g., those advocated in the Standard Methods) should be carried out in standard approved fashion and in such a way so as to minimise adverse effects on wildlife.

5.17 The Scientific Committee <u>endorsed</u> the suggestion of WG-CEMP that Members should seek to document the general procedural effects (e.g., effect of investigators presence and activities or effects induced by attaching devices). It also supported the preparation of appropriate documentation (including video tape recording) on field techniques (e.g., banding, stomach pumping, sex determination, etc.), with a view to producing instructional guides and noted the suggestion that a workshop might be helpful in achieving this.

Prey Monitoring

5.18 The Scientific Committee noted the valuable continuing dialogue between WG-CEMP and WG-Krill in respect of the development of guidelines for prey surveys in support of the objectives of WG-CEMP. In particular, Members' attention was drawn to the desirability of their active participation in the work of the subgroup established by WG-Krill to undertake the detailed development of such surveys, and the interim operational guidelines suggested by WG-Krill for such surveys (Annex 4, paragraph 100 and paragraph 2.47 of this Report).

5.19 Essential complements to these surveys were the continuing timely availability of the data on fine-scale distribution of krill within the Integrated Study Regions and data on relative abundance of krill on a subarea scale. The latter is likely to depend on fishery-derived indices and further work on developing the Composite Index of Krill Abundance was urged.

5.20 With respect to the need for data on other prey species of importance to predators, the Scientific Committee:

(i) reiterated the requirement (SC-CAMLR-VIII, Annex 6, paragraph 144) for the submission of fine-scale data for catches of *P. antarcticum* in Subarea 58.4 (and especially in the Prydz Bay Integrated Study Region), particularly including the data from the large catches in 1985 and 1986; and

(ii) drew attention to the recently developed fishery for *E. carlsbergi* in Subarea 48.3 and to the concern about the paucity of data on the role of myctophids in the Antarctic ecosystem and the need to consider the relative importance of these species as prey in the South Georgia region (Annex 5, paragraph 181).

5.21 Members were <u>requested</u> to submit information on the significance of myctophids, and especially *E. carlsbergi*, as prey for predators in the Convention Area, and especially in Subarea 48.3, to the next meeting of WG-CEMP.

Environmental Monitoring

5.22 The Scientific Committee noted the progress made by WG-CEMP in developing ways of collecting data on environmental features likely to have significant indirect or direct effects on predators and prey being monitored in CEMP.

5.23 In respect of environmental data collectable at land-based sites, Members involved in monitoring predator parameters are requested to collect data on meteorology and sea-ice according to the methods outlined in the document on Standard Approaches for Monitoring

Environmental Parameters, which will be appended to the booklet on Standard Methods for Monitoring Parameters of Predatory Species.

Prey Requirements of Predators

5.24 The Commission supported a request of the Scientific Committee (SC-CAMLR-VIII, paragraphs 5.26 and 5.27) for Members to synthesise data on predator population size, diet and energy budgets in order to provide estimates of krill requirements of predators in Integrated Study Regions. Advice on how best to proceed towards this goal had been requested from, and provided, by the SCAR Subcommittee on Bird Biology and Group of Specialists on Seals (SC-CAMLR-IX/BG/18).

5.25 In addition, two papers were prepared describing models of potential value in estimating food consumption of predators in the South Georgia and Antarctic Peninsula Integrated Study Regions (WG-CEMP-90/30 and 31).

5.26 The Scientific Committee endorsed the views of WG-CEMP on the constructive advice provided by the SCAR groups and the substantial potential of the tabled models for providing the information required by the Scientific Committee and Commission.

5.27 It supported the proposals for future action (Annex 6, paragraphs 136 and 137), particularly the development of detailed proposals for a workshop and the request to Members to collect and make available relevant data.

Awareness of CEMP

5.28 In response to requests to promote awareness of CEMP among CCAMLR Members and in the Scientific community generally, the Secretariat had been asked to prepare an article describing the aims, principles and operations of CEMP.

5.29 This document had been reviewed and approved by WG-CEMP which had recommended that the revised version (SC-CAMLR-IX/8) should be published (in the four languages of the Commission) as the text of an information brochure, accompanied by a selection of relevant illustrations. The Scientific Committee endorsed this recommendation.

Designation and Protection of Sites

5.30 WG-CEMP had reviewed proposals for the designation of CEMP Monitoring Sites at Magnetic Island, Cape Shirreff, Livingston Island and Seal Islands. It notified the Scientific Committee that, with certain minor modifications, these conformed to the guidelines suggested by the Scientific Committee (SC-CAMLR-VII, paragraphs 5.19 and 5.20) and endorsed by the Commission (CCAMLR-VII, paragraph 78).

5.31 The Scientific Committee regretted that the revised versions had not been attached to the report of WG-CEMP, nor officially transmitted to Members in advance of this Meeting of the Scientific Committee, thereby preventing examination and discussion by national organisations in some Member countries.

5.32 The Scientific Committee agreed that the revised versions for Magnetic Island and Cape Shirreff conformed to the guidelines referenced in paragraph 5.30 above. The Seal Islands proposal, however, required a modification in the title of the proposal and the production of an accurate map, including geographical coordinates. The Scientific Committee agreed that, subject to the corrections indicated above, all three proposals met the existing guidelines; it agreed to notify the Commission accordingly.

5.33 Further action would await a decision by the Commission as to how it wished to proceed with the formal designation and protection of land-based CEMP sites.

Future Meetings

5.34 The Scientific Committee agreed with the recommendation of the Working Group that an intersessional meeting in 1991 would be desirable.

5.35 The Scientific Committee strongly endorsed (and drew to the Commission's attention) the request by WG-CEMP that more Member countries should be involved in the work of WG-CEMP, especially through participation at its meetings.

Data Requirements

5.36 In the WG-CEMP report, there are several requests for information and data additional to those already identified in previous sections (paragraphs 5.13 to 5.15, 5.17, 5.20, 5.21, 5.23 and 5.27). The attention of Members is drawn particularly to those on:

(i) submission of methodological protocols relating to age-specific annual survival and recruitment (Annex 6, paragraph 60);

(ii) evaluation of whether foraging trip data should be collected for one or both penguin parents (Annex 6, paragraph 63);

(iii) actual and potential effects of monitoring procedures (Annex 6, paragraph 82); and

(iv) the preparation by the Secretariat of a paper on analysis techniques relevant to CEMP for summary data on sea-ice distribution (Annex 6, paragraph 118).

Advice to the Commission

5.37 The Scientific Committee informs the Commission that now the protocols for submission of data to the CCAMLR Data Centre from CEMP predator monitoring programs have been agreed and following the Commission's decision at CCAMLR-VIII (paragraph 57), Members have an obligation under Article IX of the Convention to submit relevant data annually by 30 September.

5.38 For reasons set out in paragraph 5.15, the Scientific Committee requests the Commission to change the above annual reporting date to 30 June.

5.39 In response to the Commission's request for advice and progress in relation to issues identified in conjunction with Working Group for the Development of Approaches to Conservation of Antarctic Marine Living Resources (WG-DAC), WG-CEMP has provided comments on operational definitions of depletion (Annex 6, paragraph 35) and the ability of CEMP to detect and interpret change (Annex 6, paragraph 36). In particular, it has developed explicit procedures for evaluating the CEMP predator data in order to provide advice to the Scientific Committee and Commission. The Commission is requested to endorse these developments.

5.40 In response to the Commission's request that Members synthesise data on population size, diet and energy budgets in order to estimate krill consumption by seabirds and seals in Integrated Study Regions, WG-CEMP had made excellent initial progress. It expects to develop proposals for a workshop, designed to provide specific detailed responses to the Commission's requirements, during the intersessional period.

5.41 The Commission is asked to approve the publication of an information brochure (see paragraph 5.29) on the CEMP based on SC-CAMLR-IX/8.

5.42 The Scientific Committee recommends that a meeting of WG-CEMP during 1991 would be desirable.

5.43 The Scientific Committee draws to the Commission's attention the development, according to the guidelines suggested by the Scientific Committee and endorsed by the Commission at its Seventh Meeting, of management plans for three CEMP Monitoring Sites.

5.44 The Commission is requested to encourage more Member countries to become involved in the work of WG-CEMP and in particular to participate in its meetings.

CCAMLR/IWC Workshop on Feeding Ecology of Southern Baleen Whales

5.45 This Workshop was intended to permit a functional evaluation of the minke whale as a potential indicator of changes likely to result from harvesting of krill.

5.46 In 1988 a Joint CCAMLR/IWC Steering Committee prepared terms of reference and a comprehensive list of workshop topics and pre-workshop tasks (SC-CAMLR-VII/BG/9).

5.47 The CCAMLR Scientific Committee noted this Steering Committee's recommendations for review papers and background documents to be prepared in advance of the meeting and provided detailed instructions for the CCAMLR Co-conveners (Mr D. Miller, South Africa and Dr J. Bengtson, USA) to arrange this (SC-CAMLR-VII, paragraphs 5.48 to 5.51). In correspondence with IWC, a meeting date in September 1989 was agreed.

5.48 In November 1988, the CCAMLR Co-conveners solicited pre-workshop contributions from nine scientists on six topics (SC-CAMLR-VIII/8). In late March 1989, however, the IWC Co-convener informed CCAMLR that IWC contributors would be unable to undertake their allocated tasks. The meeting was deferred until IWC contributions were sufficiently advanced to allow the Workshop to be rescheduled (SC-CAMLR-VIII, paragraph 5.36).

5.49 In August 1990, the IWC Secretary informed CCAMLR 'that the terms of reference and participants for the Joint Workshop on the Feeding Ecology of Southern Baleen Whales should be expanded to cover studies of other major predators of krill, especially those pertinent to estimates of abundance and trends' and that a joint workshop should be planned for 1992 (SC-CAMLR-IX/BG/12).

5.50 The Scientific Committee was surprised that the letter from IWC did not indicate why the original terms of reference and the detailed workshop plans (to which CCAMLR had devoted considerable time and effort) were no longer appropriate.

5.51 The IWC suggestion for a workshop expanded to cover all major predators on krill was, in the Scientific Committee's view, entirely inappropriate for a joint CCAMLR/IWC workshop. The Scientific Committee reaffirmed that the original terms of reference and workshop plans were still entirely appropriate to CCAMLR's interest and recommended that the Executive Secretary write to IWC in these terms.

5.52 As it was clear that even a workshop on the original topic could not now be held until 1993, the Scientific Committee suggested that WG-CEMP should consider an interim review, (perhaps in 1992) of the minke whale as a potential indicator of changes likely to result from harvesting of krill. Essential to such a review, would be contributions (as background papers) along the lines of those originally solicited in SC-CAMLR-VIII/8.

MARINE MAMMAL AND BIRD POPULATIONS

Status and Trends of Populations

6.1 At its Eighth Meeting, the Scientific Committee decided to seek advice from the SCAR Group of Specialists on Seals and the SCAR Bird Biology Subcommittee on the following issues:

(i) guidance on the likely or possible causes of declines in populations of marine mammals and birds, and steps that might be taken to halt these declines (SC-CAMLR-VIII, paragraph 6.6); and

(ii) assistance in compiling data on the population sizes of marine mammals and birds, their diet and energy budgets in order to provide estimates of the krill requirements of these predators in CEMP Integrated Study Regions, at least during their breeding seasons (SC-CAMLR-VIII, paragraph 5.28).

6.2 The two SCAR groups discussed these issues during the SCAR XXI Meetings in July, 1990, in São Paulo, Brazil. The results of their discussions were presented in the Report of the CCAMLR Observer to SCAR (SC-CAMLR-IX/BG/18).

6.3 Both groups provided the Scientific Committee with a review of the status and trends of Antarctic seabird and pinniped populations in 1988, and it is intended that an updated review be undertaken and made available in 1992. The Bird Biology Subcommittee has set such a review in motion, and will report the results to CCAMLR in 1992. The Group of Specialists on Seals is taking similar steps. These reviews would be facilitated if standard formats were agreed for reporting information on status and trends. The Secretariat is therefore requested to:

(i) provide copies of the previous summaries to the specialists conducting the updates on seabird and pinniped status so that they can have the benefit of the previous estimates when preparing their update; and

(ii) provide the specialists with instructions regarding the formats in which the updated population review should be presented to CCAMLR.

6.4 In reviewing the status of the crabeater seal populations, the SCAR Group of Specialists on Seals at its 1990 meeting noted once again that there is an urgent need to obtain new census data for all Antarctic pack ice seals. Aerial surveys in the pack ice zone have not been implemented in recent years because of the lack of opportunities to work aboard icebreaker ships. Survey data are required so that questions raised by previous surveys in the early 1980s can be answered (it has been suggested that crabeater seal populations may have undergone a dramatic decrease in abundance over the past 15 years). At its Seventh Meeting, the Scientific Committee endorsed SCAR’s 1988 recommendation that such surveys should be undertaken (SC-CAMLR-VII, paragraph 6.7). In view of SCAR’s repeated calls for seal surveys in the pack ice zone, the Scientific Committee once again urged Members’ national programs to conduct censuses of seals in pack ice areas when opportunities arise to conduct such surveys from icebreakers.

Proposed Workshop on Southern Elephant Seals

6.5 Populations of southern elephant seals have declined sharply in some areas of the Antarctic over the past 50 years. The reasons for these changes are unclear. There is an urgent need to assess the current status of southern elephant seals and to collect additional information which will help to identify the factors causing the decline in abundance. The Scientific Committee has discussed this issue and expressed its concern over these declining populations at each of its previous four meetings (reviewed in SC-CAMLR-IX/19).

6.6 A Symposium on the Biology of Elephant Seals is being organised to be held in Santa Cruz, California, in May, 1991. Although it is likely that the Symposium will address a wide range of topics, it will not necessarily focus on the specific questions of greatest interest to CCAMLR. Therefore, the SCAR Group of Specialists on Seals has proposed that convening a small workshop to follow the Symposium would be a cost-effective way to address the concerns of CCAMLR (SC-CAMLR-IX/BG/22).

6.7 The Scientific Committee <u>recommended</u> that such a workshop should be convened jointly by CCAMLR and SCAR, and it approved the terms of reference outlined in SC-CAMLR-IX/BG/22.

6.8 To ensure that the workshop has the benefit of input from all of the appropriate experts on southern elephant seals, the Scientific Committee agreed to provide partial funding for the workshop. It was understood that without financial participation by CCAMLR, this workshop would not go ahead. The Scientific Committee <u>recommended</u> that financial support at the level proposed in SC-CAMLR-IX/BG/22 (US$7 000) should be made available for the workshop, subject to overall budget constraints.

ASSESSMENT OF INCIDENTAL MORTALITY

7.1 At its Seventh Meeting, the Commission requested SCAR to provide advice on ways to assess the incidence, causes, and effects of the ingestion of and entanglement in marine debris by Antarctic seals and birds (CCAMLR-VII, paragraph 40 and CCAMLR-VIII, paragraph 28). The responses from SCAR were considered by the Commission in 1989 (CCAMLR-VIII, paragraphs 29 and 30).

7.2 The Commission requested (CCAMLR-VIII, paragraph 31) the Scientific Committee to continue consultations to assist in identifying, designing, and implementing programs to assess and monitor the effects of marine debris and incidental catch on marine mammal and bird populations (SC-CAMLR-IX/BG/11).

Longline Fisheries

7.3 Dr K. Kerry (Australia) summarised a paper describing albatross mortality associated with longline fisheries for tuna outside the Convention Area (CCAMLR-IX/BG/17). A conservative estimate of the number of albatrosses (mostly sub-Antarctic species) killed annually is 44 000, which is sufficiently high to substantiate claims that serious declines in albatross populations within the Convention Area are due to this type of fishing activity (SC-CAMLR-VIII, paragraph 6.7).

7.4 The recent development of a longline fishery on *D. eleginoides* within the Convention Area has raised major concerns about the potential adverse effects on local albatross populations (CCAMLR-VIII, paragraphs 24, 107 and 108), to the extent that the Commission adopted a specific Resolution (5/VIII) concerning this issue.

7.5 The results of a joint Australian/Japanese effort to reduce the mortality of albatross in tuna longline fisheries (CCAMLR-IX/BG/14) were considered. Through the use of streamers on 'bird poles', the catch rate of birds was reduced by 88%. The streamers are trailed behind the ship and deter birds from settling on the water to take baits. In addition to dramatically reducing bird mortality, this technique resulted in an estimated gain of A$7 million for the tuna industry by reducing fish loss. Additional steps to reduce bird mortality have been proposed (CCAMLR-IX/14 Rev. 1).

7.6 Dr Naganobu noted that there are no Japanese longline fisheries in the Convention Area. Outside the Convention Area, in addition to efforts to develop methods to reduce avian by-catch (as described above), Japan is considering requiring 'bird poles' to be fixed to all Japanese longline vessels which operate in areas where albatrosses are encountered.

7.7 Prof. Lubimova stated that because the *D. eleginoides* fishery is a bottom longline fishery, it is different from longline fisheries for tuna. She also noted that there have been no reported cases of incidental catch of birds from Soviet longline fisheries.

7.8 However, Dr Croxall pointed out that:

(i) without full data on the longline fishing methods it was impossible to determine whether or not a bottom longline fishery was different from a pelagic one in respect of its likelihood of causing significant incidental mortality to seabirds; and

(ii) until the time when observers had been placed on Japanese longline tuna fishing boats, there had been no reports of incidental catches of seabirds.

7.9 At its 1989 Meeting, the Commission requested (CCAMLR-VIII, paragraphs 52 and 109) that full information on the fishing methods used in the *D. eleginoides* longline fishery and information on levels of incidental mortality be provided as a matter of urgency.

7.10 No such information had been received and therefore the Scientific Committee has no data available to it upon which to consider the potential impact of this fishery on seabirds in the Convention Area and especially on populations of wandering albatross in Subarea 48.3 which are already known to be declining principally due to incidental mortality from a longline fishery.

7.11 Prof. Lubimova agreed that information on fishing methods and incidental mortality was required to assess the magnitude of any problem. She extended an invitation to Members for observers to come aboard Soviet longline vessels to observe fishing techniques and to monitor any incidental mortality which may occur. It was agreed that cooperative research and observation on longline fisheries vessels should be encouraged.

7.12 It was noted that SCAR has also recommended that CCAMLR place observers on longline vessels in the Convention Area to obtain data as soon as possible on incidental mortality of seabirds (SC-CAMLR-IX/BG/18).

7.13 Dr D. Robertson (New Zealand) drew the attention of Members to a source of incidental seabird mortality associated with the trawl fishery in New Zealand waters. Soviet trawlers use net monitor cables, upon which the wings of seabirds (albatrosses in particular) can become entangled. Entangled birds are swept under the water and drown. There has been an indication from Dr Duhamel that a similar problem may occur around Kerguelen. Members were asked to investigate this issue further and to prepare papers for consideration at the next meeting of the Scientific Committee.

Advice to the Commission

7.14 In view of its concern over the management of longline fishing in the Convention Area, the Scientific Committee recommended that:

(i) the request for information specified in paragraph 52 of CCAMLR-VIII should be reiterated and emphasised;

(ii) the request for information should include the seven points described in paragraph 10 of CCAMLR-IX/14 Rev. 1;

(iii) modifications to the Antarctic longline fishery should be implemented as set out in paragraph 9 of CCAMLR-IX/14 Rev. 1, at least until such time as data specified above in (i) and (ii) have been made available and have demonstrated that such modifications are unnecessary; and

(iv) steps should be taken to place scientific observers on longline fishery vessels.

Driftnet Fisheries

7.15 Mr Miller introduced a paper on penguin mortality associated with driftnet fisheries (CCAMLR-IX/BG/5). There have been several instances of rockhopper penguins being killed by driftnets in the South Atlantic Ocean, and in particular from Gough Island, which is just outside the Convention Area. These reports are cause for concern because:

(i) the activities are taking place very close to the Convention Area;

(ii) data on fishing procedures and the fishery are sparse;

(iii) driftnet fisheries are known to cause significant levels of incidental mortality on a wide variety of marine life; and

(iv) the fishing is being conducted by a country that is not a Member of CCAMLR.

7.16 It was noted that because few data are available regarding the fisheries referred to above, steps should be taken to obtain more information. The Scientific Committee agreed that data pertaining to this fishery should be sought as a matter of priority, possibly through the mechanisms being explored by the Secretariat in relation to the squid fishery within the Convention Area.

7.17 Dr K. Chu (USA) briefly summarised a joint report by the US, Japan, and Canada which described levels of incidental mortality associated with driftnet fisheries in the North Pacific (SC-CAMLR-IX/BG/8). He noted that there has been a significant by-catch of marine mammals, birds, turtles, and non-target fish species in this fishery and that there is therefore reason for serious concern about the impact of driftnet fisheries on ecosystems in the North Pacific.

7.18 The Scientific Committee noted that during 1990, both SCAR and the United Nations passed recommendations or resolutions regarding driftnet fisheries. SCAR Recommendation XXI-BIOL-2 urged CCAMLR to ban the use of driftnets and gillnets within the Convention Area (SC-CAMLR-IX/BG/18). UN Resolution 44/225 imposed a moratorium on existing driftnet fishing in certain areas and prohibited the expansion of driftnet fishing on the high seas (CCAMLR-IX/BG/12).

7.19 A number of delegations expressed their concerns about the possible adverse impacts of driftnets in and near the Convention Area, and stated that driftnets should not be introduced into the Convention Area because of the high abundance of marine mammals, seabirds, and other pelagic species in Antarctic waters. It was also stated that there was a danger of derelict driftnets lost from fisheries outside the Convention Area floating south and causing harm to Antarctic marine living resources.

7.20 The Scientific Committee strongly endorsed UN Resolution 44/225 and recommended that the Commission also express its support of this Resolution.

7.21 All delegations except Japan endorsed the SCAR recommendation and expressed their desire that the Commission ban driftnets in the Convention Area. The Japanese Delegation stated that there is no need to ban driftnet fishing in the Convention Area because:

(i) there is presently no active driftnet fishery in the Convention Area;

(ii) there are no known resources that could effectively be caught by this method; and

(iii) no countries have expressed an intention to develop such fisheries.

7.22 Recognising that at present there are no driftnet fisheries in the Convention Area, and that the inception of such fisheries would constitute an expansion as defined in paragraph 4.c. of United Nations Resolution 44/225, the Scientific Committee expressed its understanding that in accordance with UN Resolution 44/225, the development of any new driftnet fishery in the Convention Area is prohibited.

Impact of Bottom Trawling

7.23 Dr Kock summarised a paper describing the potential adverse impacts of bottom trawling on Antarctic benthic communities (SC-CAMLR-IX/BG/15). Bottom trawling is known to have a substantial impact on benthic organisms in many shelf areas around the world, and long-term shifts in benthic community structure (e.g., in the North Sea) have been attributed to the continuous impact of heavy bottom gear on these communities. Members were encouraged to take note of this matter and, as possible, provide further information to the Scientific Committee in the future.

7.24 This issue also raises the question of whether or not it would have been helpful for CCAMLR to be asked to comment on the proposals to designate marine Sites of Special Scientific Interest (SSSI) under the Antarctic Treaty. Given CCAMLR's expertise in the area of marine living resources, the Scientific Committee expressed its view that, had it been asked, it would have been able to make a useful contribution to SCAR's review of the marine SSSI proposals.

Marine Debris

Entanglement

7.25 Members' reports on assessment and avoidance of incidental mortality in the Convention Area had been received from Australia (CCAMLR-IX/BG/21), Japan (CCAMLR-IX/BG/19), Korea (CCAMLR-IX/BG/22), USA (CCAMLR-IX/BG/9) and USSR (CCAMLR-IX/BG/18). No observations of entanglement of seabirds or seals at sea were reported.

7.26 Australia (SC-CAMLR-IX/BG/20 reporting two seabirds entangled in 1987 and 1989), Chile (SC-CAMLR-IX/BG/21 reporting two Antarctic fur seals entangled in 1988), UK (SC-CAMLR-IX/BG/6 reporting 161 Antarctic fur seals entangled in 1990) and USA

(CCAMLR-IX/BG/9 reporting nine Antarctic fur seals entangled in 1990) had provided reports of seabirds and seals observed ashore entangled in marine debris. The Secretariat had provided a summary of reports submitted to CCAMLR on entanglement and incidental mortality of birds and seals (SC-CAMLR-IX/BG/16).

7.27 The UK study at Bird Island, South Georgia (SC-CAMLR-IX/BG/6) had repeated the survey of the previous year, which derived an estimate of at least 0.4% of the seal population (at least 5 000 seals) entangled. The 1990 study reported an incidence of entanglement of 0.22%, about 60% of the 1989 value. The distribution of entanglement by age and sex of animals was very similar in both years and polypropylene straps (55%) and fishing nets (21%) were again the main source of entanglement. It was intended to repeat this study in 1991.

7.28 The Australian Delegation noted that stricter compliance with regulations prohibiting at-sea dumping could significantly reduce the problem of entanglement in marine debris in Antarctic waters. The Scientific Committee expressed its concerns about disposing of debris at sea, and stated that such dumping should be minimised as a matter of priority.

7.29 Reviews of debris surveys at sea during Southern Hemisphere minke whale surveys (CCAMLR-IX/BG/15) and ashore at Bird Island, South Georgia (CCAMLR-IX/BG/4) had been received.

7.30 The latter study indicated that 20% of plastic packaging bands (the main source of entanglement of Antarctic fur seals) retrieved from beaches had been discarded without being cut. The United Kingdom intends to continue these surveys over the next several years to establish baseline data on the incidence and types of debris found on beaches.

7.31 In respect of the requirement to design programs to monitor the incidence and effects of marine debris (paragraph 7.2 above), the Scientific Committee noted that the SCAR Group of Specialists on Seals (SC-CAMLR-IX/BG/18) had requested its members to consider whether the monitoring procedures for beach debris and seal entanglement in use at South Georgia would be applicable to other areas and therefore suitable as a general method for CCAMLR.

7.32 Dr V. Marín (Chile) introduced SC-CAMLR-IX/BG/21 which addressed the question of attempting to extricate marine mammals and birds from marine debris in which they are entangled. It was noted that care must be taken in avoiding harm to either the wildlife or the person removing the debris. For example, although experienced personnel with appropriate equipment can effectively remove 'neck collars' often found on Antarctic fur seals, this procedure can be dangerous if attempted on fur seal males older than 4 years of age.

7.33 Dr Robertson enquired whether or not there are reports of pinnipeds being caught or entangled in active trawling gear. It was noted that no reports of this nature have been received by the Secretariat.

Ingestion of Plastic by Seabirds

7.34 In following up on its earlier review of the incidence and effects of plastic ingestion by seabirds (SC-CAMLR-VIII/BG/6), the SCAR Bird Biology Subcommittee noted that experimental work on the direct effects of plastic ingestion is being conducted by South Africa (SC-CAMLR-IX/BG/11). In addition, investigators from South Africa and New Zealand are monitoring the incidence of plastic pollutants in beach-cast seabirds. Scientists from the Netherlands are researching the levels of plastics in the diet of Wilson's storm petrels.

Oil Pollution

7.35 Dr P. Penhale (USA) summarised a report on oil spillage in Antarctica (CCAMLR-IX/BG/11). Now that the US Palmer Station has been designated as a site under the National Science Foundation's Long-Term Ecological Research (LTER) Program, there will be a long-term follow-up to monitor environmental conditions after the oil spill that occurred in 1989. The follow-up studies are part of a cooperative effort between the United States and Argentina.

DEVELOPMENT OF APPROACHES TO CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

8.1 Last year, in response to specific questions raised by the Commission, the Scientific Committee identified two broad areas of work in relation to this item on which it intended to concentrate more effort (SC-CAMLR-VIII, paragraph 7.17):

(a) actual work at assessment level in key areas involving coordination and integration of studies which would enable definition of appropriate management options. An example would be investigation of the krill flux in the South Shetlands/Peninsula area combined with determination of the impact of predators on stocks, leading to drawing up a budget of predator prey interactions; and

(b) the wider task of evaluating the effectiveness of approaches to management adopted by the Commission in the light of the objectives of the Convention. It was suggested that the fundamental problem is how to deal with the uncertainty in the assessments.

8.2 Further, the Scientific Committee requested its working groups to continue to consider the Commission's questions from CCAMLR-VII (paragraphs 140 to 141), which were concerned with:

(i) operational definitions of depletion and target levels for recovery of depleted species; and

(ii) the ability of the CCAMLR Ecosystem Monitoring Program to detect changes in ecological relationships and to recognise the effects of simple dependencies between species, including distinguishing between [the effects of] natural fluctuations and those induced by fisheries.

8.3 The Scientific Committee also agreed to ask the Commission for more specific guidance on the strategic issues on which it would like the Scientific Committee to consider and provide advice (SC-CAMLR-VIII, paragraph 7.19). The Commission did not respond directly to this request, but questions on conservation approaches in relation to the management of krill and finfish stocks were referred back to the Scientific Committee (CCAMLR-VIII, paragraphs 74 to 75, 50 (krill) and 123 (finfish)).

8.4 The Conveners of WG-Krill, WG-CEMP and WG-FSA highlighted the aspects of their groups' reports relevant responses to these questions. These have been considered in the respective sections of the Scientific Committee Report.

8.5 The questions concerning krill, such as potential yield in Subarea 48.3 and possible management measures that would maintain ecological relationships in that area, and other issues in the wider context of approaches to conservation of krill stocks, such as operational definitions of the objectives in Article II, are addressed in paragraphs 2.18 to 2.20 and 2.53

to 2.56. The Scientific Committee has agreed that WG-Krill should investigate these questions further at its next meeting.

8.6 WG-CEMP has continued to make progress on assessing the relevance of CEMP to the work of the Commission (paragraphs 5.3 to 5.7). The Scientific Committee endorsed the conclusion that analysis and evaluation of submitted CEMP data and developments of recommendations based thereon did not require, and should not await, the determination of the precise quantitative nature of predator/prey/environmental relationships.

8.7 The questions that the Commission asked the Scientific Committee dealing with developing fisheries (CCAMLR-VIII, paragraph 123) are pertinent to the development of approaches to conservation in new fisheries. These questions were addressed by the WG-FSA (Annex 5, paragraphs 282 to 294) and the approach suggested by the Working Group was endorsed by the Scientific Committee as being necessary for the management of new and developing fisheries (paragraph 3.91). The Scientific Committee recommends that the Commission take account of this approach in its management of those fisheries.

8.8 An approach for obtaining 'operational definitions for depletion and target levels for recovery of depleted species' was also discussed on the basis of SC-CAMLR-IX/BG/14. This paper illustrated a possible approach that provides an objective basis for setting TACs (probably by-catch limits in practice) for depleted stocks so that there is a high probability of achieving the general objectives set out in Article II of the Convention, i.e., if the 'best' estimate of current stock level is substantially below the greatest net annual increment (GNAI) then a stock is deemed to be depleted and hence fishing mortality must be set at levels which should not preclude stock recovery to GNAI (or other target levels) within two or three decades. A 'best' estimate would be the mean or median of a probability density function which incorporates the uncertainty in the quantities estimated.

8.9 The paper illustrated, in principle, how these catch limits could be calculated such that they have specified levels of probability of achieving the requisite stock recovery. The paper used three illustrative operational objectives to determine these fishing mortalities that may achieve the requirements in Article II:

(i) the fishing mortality which results in a specified subjective probability that the stock will not have declined further in 20 years;

(ii) the fishing mortality which results in a subjective probability that the stock is at or above GNAI (or other target level) in 20 years; and

(iii) the fishing mortality which results in a specified subjective probability that the stock is above GNAI (or other target level) in 30 years.

8.10 In these examples, the fishing mortalities were calculated using a stock projection program with inputs on stock size, biological parameters and accounting for uncertainty in stock assessment. The by-catch would be set using whichever of these fishing mortalities was lowest. The assessments would be revised as new data become available. Once the procedure has been put into effect the target years for recovery become fixed at 20 and 30 years after that time when the procedure was first begun. Thus, the fishing mortalities specified above have to be calculated using shorter projections as time progresses. The fishing mortalities would also be revised as more information accrues about the status of the stock.

8.11 The Scientific Committee welcomed this type of study and agreed that this approach should be developed further. It was also agreed that such an approach, with modifications, may be useful for taking into account uncertainty when calculating fishing mortalities appropriate for exploitable stocks at all levels of development.

8.12 The USSR Delegation drew the attention of the Scientific Committee to the fact that Soviet scientists have been carrying out studies based on similar principles derived from Prof. Monastirskiy's theory (1928). The fundamental characteristics of these studies are described in SC-CAMLR-IX/BG/14.

8.13 The Scientific Committee noted that the selection of the probability levels in the operational objectives used in this approach (paragraph 8.9) is not purely a scientific question, and hence guidance from the Commission will be required. However, such guidance will be most easily obtained if further analyses on the properties of these definitions and procedures, or others that are suggested, can be carried out so that the Commission has an objective and quantitative basis for selecting management policy parameters.

8.14 The illustrative calculations showed that uncertainty in stock assessment and the relationship between stock-size and recruitment were both very important in determining by-catch limits. In particular, the Scientific Committee noted that:

(i) the current policy of the Commission to apply $\mathbf{F_{0.1}}$ when calculating fishing mortalities may not be appropriate for ensuring the recovery of depleted stocks to the levels envisaged by the Convention within the required time interval. Such a conclusion was also reached by WG-FSA, which considered that fishing mortality of $\mathbf{F}_{0.1}$ was too high for depleted stocks of *N. squamifrons* at Ob Bank (Division 58.4.4) (Annex 5, paragraph 2.61), and *P. georgianus* and *C. aceratus* around South Georgia (Subarea 48.3) (Annex 5, paragraph 203); and

(ii) the fishing mortality which ensures the recovery of a depleted stock becomes less as uncertainty in stock assessments increase.

8.15 The WG-DAC is also considering this year the ways in which scientific evidence is being used by the Commission to aid its decision making. A paper by Australia (WG-DAC-90/5) on this topic was drawn to the attention of the Scientific Committee for consideration.

8.16 The Scientific Committee recognised that one of the major problems it has been facing is how to deal with uncertainty when providing advice to the Commission. The Scientific Committee drew the attention of the Commission to its endorsement of the document by the WG-FSA (paragraph 3.6 of this Report), which analysed the problems of providing stock assessment advice (Annex 5, Appendix D). The main conclusions of this paper are set out in paragraph 3.7 of this Report.

COOPERATION WITH OTHER ORGANISATIONS

Meetings of Other International Organisations

9.1 The Scientific Committee was represented at the following meetings held during the intersessional period:

1990 Meeting of the International Whaling Commission Scientific Committee (IWC), 10 to 23 June 1990; Dr W. de la Mare (Australia)

XXI Meeting of SCAR, São Paulo, Brazil, 9 to 27 July 1990; Dr J. Croxall (UK)

78th Statutory Meeting of ICES, 4 to 20 October 1990; Mr O. Østvedt (Norway).

9.2 Dr de la Mare presented his report of the IWC Scientific Committee meeting in SC-CAMLR-IX/BG/17. Of particular interest to the Scientific Committee was the IWC work on the development and simulation testing of new management procedures, and the fact that the IWC now recognises two morphological forms of minke whale, *Balaenoptera* *acutorostrata*; the larger form which has been commercially exploited in the Southern Ocean and the dwarf form which occurs mostly to the North of 60°S. The current estimate of stock size from sighting surveys south of 60°S was 760 000 individuals, the catch of these whales now totalling 114 096.

9.3 Dr Croxall presented his report of the XXI SCAR meeting in SC-CAMLR-IX/BG/18. The topics covered at this meeting were wide-ranging. Of particular interest to CCAMLR were proposals for marine SSSIs near Low and Brabant Islands to protect areas of rich benthic communities. A proposal for an SSSI at Ardley Island, near King George Island, was approved; a proposal for the newly created designation of 'multiple-use planning area', made for southwest Anvers Island (including Palmer Station), was referred for revision.

9.4 The SCAR meeting responded to several questions from CCAMLR which are discussed in full in paragraphs 6.1 to 6.4 and Annex 6. The next meeting of SCAR will be in 1992, and in the interim SCAR will convene a conference on Antarctic science at Bremen, Germany, from 23 to 28 September 1991. The objectives of this conference will be to foster public awareness of the importance of Antarctic science, particularly in relation to global problems, and to foster the interaction of Antarctic scientists working in different disciplines.

9.5 It was noted that this would be an important forum for publicising the work of CCAMLR, and it was agreed that the Secretariat should present a poster at the conference describing the work of the Scientific Committee and Commission.

9.6 The 78th Statutory Meeting of ICES was held in Copenhagen from 4 to 12 October 1990 and was attended by nearly 400 scientists from ICES' member states and guests and observers from other international organisations. Of particular interest to CCAMLR was the invited lecture at the opening session by Prof. K. Ronald (Canada) on 'Marine Mammals and Man: Commerce, Competition and Conflicts'. More than 400 scientific papers were presented in the Standing Committees on theme sessions. The theme sessions covered a wide range of topics such as remote sensing, acoustic methods and gear selection. Abstracts of all the papers are published in a special volume. It should be noted, however, that copies of all contributed papers can be purchased from ICES on microfiche.

9.7 The work of ICES' two Advisory Committees (ACFM and ACMP) on Fishery Management and on Marine Pollution was presented at special sessions. The work of ACFM depends on reports from several fish stock assessment working groups handling 60 to 70 fish stocks in the North Atlantic. Increasing awareness of pollution and its effects of living resources has resulted in several requests for regional environmental assessments.

9.8 The following were nominated as observers for meetings taking place in 1991:

79th Statutory Meeting of ICES: Mr O. Østvedt

1991 Meeting of the IWC Scientific Committee: Dr W. de la Mare

UNEP Coordinating Committee on Marine Mammal Action Plan: Dr W. de la Mare

SCAR Antarctic Science Conference, Bremen, Germany, 23 to 28 September 1991: Secretariat.

Application for Observer Status by Asoc and Greenpeace

9.9 On 11 July 1990, the Chairman of the Scientific Committee wrote to Members suggesting that ASOC (the Antarctic and Southern Ocean Coalition, a non-governmental organisation) appeared to satisfy the requirements of Article XXIII, paragraph 3 and that the organisation be invited as an observer to the Ninth Meeting of the Scientific Committee. This decision was deferred until the time of the Meeting. A copy of the correspondence on this matter was provided to the Meeting in SC-CAMLR-IX/9.

9.10 In discussion of this matter, the Japanese Delegation indicated that they could not accept the attendance of ASOC at the Ninth Meeting of the Scientific Committee.

9.11 A number of delegations expressed their regret at Japan being unable to accept ASOC's application to attend the Ninth Meeting of the Scientific Committee as an observer.

9.12 A small group convened by Mr D. Miller (South Africa) was asked to examine the problem of ASOC's attendance at the meetings of the Scientific Committee.

9.13 The group reported that they had identified a number of difficulties and suggested that any letter of invitation to ASOC should include the new conditions that:

- the observer nominated should possess a suitable scientific qualification;

- the invitation would only apply to the meeting stipulated in the letter;

- until such time as the Rules of Procedure of the Scientific Committee were amended, ASOC's participation would be in accordance with the conditions set down in Rules 32 to 34 of the Commission's Rules of Procedure; and

- that the absolute confidentiality of data and results discussed in the meeting of the Scientific Committee be observed where these were not subsequently published in the report of the meeting of the Scientific Committee.

9.14 All delegations except Japan accepted these recommendations as a basis for inviting ASOC to attend the Tenth Meeting.

9.15 The Japanese Delegation expressed the views that:

(i) the Rules of Procedure of the Scientific Committee are not adequate concerning the attendance of observers;

(ii) ASOC's attendance at the Scientific Committee would undermine the confidentiality of data; and

(iii) as ASOC is a 'movement', the Scientific Committee would not benefit from the presence of an ASOC observer at the Committee.

9.16 Greenpeace had also applied for observer status at the Ninth Meeting of the Scientific Committee; a copy of the correspondence was presented in CCAMLR-IX/12 Rev. 1. Some Members thought that the application from Greenpeace should not be considered by the Scientific Committee since this organisation was a member of ASOC and had therefore already been party to an application for observer status. Others expressed the view that each application for observer status should be considered on its individual merit.

9.17 This application was not granted by the Scientific Committee and was not deliberated further.

INFORMATION SUBMITTED BY MEMBERS

10.1 The Secretariat presented a review of the information reported to CCAMLR and the timing of that reporting. The Scientific Committee agreed that the following amendments to the requirements for submitting information should be made:

- the requirement for the submission of updates to the inventory of commercial fishing activities should be withdrawn since this information is submitted elsewhere;
- the timing of the submission of CEMP data should be brought forward from 30 September to 30 June (paragraph 5.15);
- the guidelines for the preparation of the Reports of Members' Activities should be changed to include information on the timing and details of cooperative research plans to assist the coordination of collaborative activities; and
- a common deadline date of 30 August should be introduced for the Reports of Members' Activities, the Reports of National Research Plans and the Reports on the Assessment and Avoidance of Incidental Mortality.

10.2 The Representatives of Spain and the USSR said they would have difficulties in meeting this deadline for Reports of Members' Activities and the Reports of National Research Plans.

10.3 The current submission date for data on the krill fishery falls on 30 September, after the meeting of WG-Krill. It was noted that whilst the work of the Working Group is not seriously obstructed at present by the absence of data from the most recent fishing season at its meetings, this may become a problem in the future and could necessitate changing the current schedule for submission of data on the krill fishery.

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

11.1 The Scientific Committee agreed that all three working groups would meet during the intersessional period, and that in view of the reported benefit to both the WG-Krill and

WG-CEMP of holding these meetings back to back during 1990, the same arrangement should be sought for their meetings in 1991.

11.2 Offers by the USSR and Spain to host the meetings of WG-Krill and WG-CEMP were warmly received by the Scientific Committee.

The WG-Krill will meet from 22 to 30 July, 1991 in Yalta.

The WG-CEMP will meet from 5 to 13 August, 1991 in Santa Cruz de Tenerife.

The WG-FSA will meet from 8 to 18 October, 1991 in Hobart.

11.3 As discussed in paragraphs 6.5 to 6.8 and 9.5, the Scientific Committee agreed that it should sponsor a Southern Elephant Seal Workshop in Santa Cruz, California in May 1991 and that it should be represented by the Secretariat and present a poster at the SCAR Symposium on Antarctic Science in Bremen, Germany in September 1991.

11.4 A summary of research activities planned by Members for the 1990/91 season was distributed as SC-CAMLR-IX/BG/3. It was noted that this summary had been prepared from brief information provided in Reports of Members' Activities and that no Members had submitted information on their research plans in time for the Meeting. Members agreed to improve on this performance in the future.

DRAFT BUDGET FOR 1991 AND FORECAST BUDGET FOR 1992

12.1 The draft budget is given in Annex 8. It includes provision for three working group meetings and two special events, the sponsoring of the Southern Elephant Seal Workshop and participation in a poster demonstration at the SCAR Symposium.

12.2 Some doubts were raised, especially on the part of the USSR Delegation, about the value of CCAMLR contributing to the funding of the Elephant Seal Workshop, but it was pointed out that the problem of the decline in southern elephant seals was a matter of immediate concern to CCAMLR. The Workshop would provide an excellent opportunity for experts on elephant seal biology to meet and establish the reasons for the decline, which may have implications for other Antarctic marine animals. The Workshop will not go ahead without the participation and financial assistance of CCAMLR.

12.3 The Scientific Committee recommended that the budget be adopted.

ELECTION OF THE CHAIRMAN OF THE SCIENTIFIC COMMITTEE

13.1 The Chairman, Dr Everson, informed the Scientific Committee that his term of office would come to an end with the Ninth Meeting of the Scientific Committee.

13.2 Mr Østvedt was nominated for Chairman for the next two meetings of the Scientific Committee by Lic. Marschoff and seconded by Prof. Lubimova. Mr Østvedt has been active in the Scientific Committee of CCAMLR since 1985 and has extensive experience of fisheries and resource management problems. He was until recently Chairman of ICES.

13.3 Mr Østvedt was unanimously elected to the position of Chairman.

13.4 Dr Everson thanked the Scientific Committee for their hard work and cooperation in the four meetings for which he had been Chairman.

13.5 Mr Miller, on behalf of the Scientific Committee, thanked Dr Everson for his work as Chairman, commenting that the significant progress made by the Scientific Committee in all areas of its activity over the last four years had been due largely to his hard work, enthusiasm and expert guidance. The Scientific Committee looked forward to continuing to benefit from his experience and wide knowledge from the floor in future years.

NEXT MEETING

14.1 The Scientific Committee agreed that its next meeting should be held in Hobart, Australia from 21 October to 1 November 1991.

OTHER BUSINESS

Rules of Procedure

15.1 In the course of its deliberations on the application for observer status by ASOC, the Scientific Committee identified several shortcomings in its Rules of Procedure relating to the participation of observers at its meetings (Rules 19 and 20). Specifically, these related to the procedure for inviting observers to be present, and the conditions of their participation.

15.2 A draft set of amendments to the Rules of Procedure was prepared and is presented in Annex 8. It was agreed that these and other amendments to the Rules should be considered in full as early as possible during the deliberations of the Tenth Meeting of the Scientific Committee in 1991.

Scientific Committee - Official Contact

15.3 There is no formally-agreed procedure for communicating official and urgent matters between the Secretariat and Members of the Scientific Committee. Up to now, this form of communication has been achieved either through the Member Contact nominated by the Commission or directly to the Representative at the most recent meeting of the Scientific Committee.

15.4 The Scientific Committee agreed to introduce a similar procedure to that used by the Commission which, under its Rules of Procedure (Rule 3), requires that 'each Member of the Commission shall nominate a correspondent who shall have primary responsibility for liaison with the Executive Secretary between meetings'.

15.5 The Scientific Committee agreed that this decision would take effect immediately and would be included in its Rules of Procedure when next they are revised.

15.6 The Secretariat will contact Members after the Meeting concerning the nomination of their Official Contacts for the Scientific Committee.

Exploratory Crab Fishery

15.7 Dr R. Holt (USA) informed the Scientific Committee that the US Government had issued a permit for the vessel MV *Marlin* to conduct exploratory fishing for king and stone crabs in Subareas 48.1, 48.2, 48.3 and 48.4 during the 1990/91 season. This permit limited the catch to 1 000 tonnes of crabs. The fishery would probably take place from November 1990 through February 1991 using crab pots. The detailed reporting of catch and biological data from this experimental fishery are mandatory.

15.8 Concern was expressed by the Scientific Committee that this fishery had been authorised without prior knowledge of the demographic characteristics of these species. Some Members were concerned about the size of the take allowed by the US permit. It is feared that if the total 1 000-tonne limit is taken in one local area, it is likely to be close to the total biomass of the target species. If successful, this take may put the target species at the brink of extinction in some areas.

15.9 Dr Holt assured the Scientific Committee that full details of this exploratory fishery would be available at the next meeting of the Scientific Committee and that data would be reported to CCAMLR in the usual way.

15.10 In view of this situation, the Scientific Committee agreed to the need for the establishment of an appropriate mechanism to prevent future development of fisheries without sufficient information upon which to base management advice.

Standardised Grid of Oceanographic Stations

15.11 Mr Miller enquired as to the progress of Dr I. Barrett's (USA) offer to prepare a tentative station pattern and suite of methods for a standardised grid of oceanographic stations in the CCAMLR Convention Area (SC-CAMLR-VIII, paragraphs 13.8 to 13.10).

15.12 Dr Holt informed the Scientific Committee that Dr Barrett had investigated the methods available for monitoring oceanographic parameters and had concluded that the limited resources available to researchers in Antarctic waters may be unsuited to the establishment of a standardised grid. Instead he advocated the development of a geographical information system or similar system for analysing data obtained at a wide range of stations, opportunistically sampled, in the CCAMLR region. He indicated the USA will report on the feasibility of this approach at the 1991 WG-Krill and WG-CEMP meetings.

ADOPTION OF THE REPORT

16.1 The Report of the Ninth Meeting of the Scientific Committee was reviewed and adopted.

CLOSE OF THE MEETING

17.1 The Executive Secretary reiterated Mr Miller's earlier expression of thanks on behalf of the Scientific Committee to the outgoing Chairman, Dr Everson, and presented him with a memento as a mark of appreciation for his chairmanship over the past four years.

17.2 Prof. Lubimova also expressed sincere thanks on behalf of the Scientific Committee to Dr Everson for his guidance as Chairman, drawing attention to the manner in which he had led the Committee in its achievements in recent years.

17.3 In reply, Dr Everson thanked participants, working group conveners, rapporteurs and the Secretariat for their support and cooperation. He said that the improvements in the amount and quality of the science that had come out of the Scientific Committee over the years had been achieved through the dedication of all involved. He believed that with this continuing support and commitment to the Commission's goals, the next Chairman, Mr Østvedt, would, at the end of his term, feel an equal sense of gratitude in having been fortunate to have worked with such an enthusiastic, keen and dedicated Scientific Committee.

17.4 Dr Everson then closed the Meeting.

ANNEX 1

LIST OF PARTICIPANTS

LIST OF MEETING PARTICIPANTS

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ADMINISTRATIVE/FINANCE OFFICER AND MEETING DOCUMENTS OFFICER	Mr Terry Grundy
COMPUTER SPECIALIST	Mr Matthew Perchard
PERSONAL ASSISTANT TO THE EXECUTIVE SECRETARY	Ms Geraldine Nicholls
SECRETARY	Mrs Genevieve Naylor
ASSISTANT SECRETARY	Mrs Raewyn Hodges
ASSISTANT DOCUMENTS OFFICER	Mrs Rosalie Marazas
- FRENCH TEAM	Ms Gillian von Bertouch
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	Ms Natasha Novikova
	Mrs Galina Pritchard
	Mr Vasily Smirnov
- SPANISH TEAM	Mr Fernando Cariaga
	Mrs Imma Hilly
	Mrs Ana María Castro
	Mrs Marcia Fernandez
SUPPORT STAFF	Mrs Leanne Bleathman
	Mrs Deb Frankcombe

ANNEX 2

LIST OF DOCUMENTS

LIST OF MEETING DOCUMENTS

SC-CAMLR-IX/1	PROVISIONAL AGENDA FOR THE NINTH MEETING OF THE SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES
SC-CAMLR-IX/2	ANNOTATED PROVISIONAL AGENDA FOR THE NINTH MEETING OF THE SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES
SC-CAMLR-IX/2 Corrigendum	ANNOTATED PROVISIONAL AGENDA FOR THE NINTH MEETING OF THE SCIENTIFIC COMMITTEE FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES
SC-CAMLR-IX/3	VACANT
SC-CAMLR-IX/4	REPORT OF THE SECOND MEETING OF THE WORKING GROUP ON KRILL (Leningrad, USSR, 27 August to 3 September 1990)
SC-CAMLR-IX/5	CONVENER'S SUMMARY OF RECOMMENDATIONS FROM THE SECOND MEETING OF THE CCAMLR WORKING GROUP ON KRILL Convener (D.G.M. Miller)
SC-CAMLR-IX/6	REPORT OF THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM (Stockholm, Sweden, 6 to 13 September 1990)
SC-CAMLR-IX/7	REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT (Hobart, Australia, 9 to 18 October, 1990)
SC-CAMLR-IX/8	INFORMATION REPORTED TO CCAMLR Secretariat
SC-CAMLR-IX/9	ANTARCTIC AND SOUTHERN OCEAN COALITION (ASOC) – REQUEST FOR OBSERVER STATUS TO THE SCIENTIFIC COMMITTEE Secretariat

SC-CAMLR-IX/10	THE CCAMLR ECOSYSTEM MONITORING PROGRAM (CEMP) Secretariat
SC-CAMLR-IX/11	CONVENER'S SUMMARY OF THE REPORT FOR THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM
SC-CAMLR-IX/12	SCIENTIFIC COMMITTEE – OFFICIAL CONTACT Executive Secretary

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SC-CAMLR-IX/BG/1	SUMMARY OF FISHERY STATISTICS FOR 1990 Secretariat
SC-CAMLR-IX/BG/1 Rev. 1	SUMMARY OF FISHERY STATISTICS FOR 1990 Secretariat
SC-CAMLR-IX/BG/2	STATISTICAL BULLETIN (PARTS 1 AND 2) Secretariat
SC-CAMLR-IX/BG/2 Rev. 1	STATISTICAL BULLETIN (PARTS 1 AND 2) Secretariat
SC-CAMLR-IX/BG/3	SUMMARY OF MEMBERS' RESEARCH PROGRAMS FOR 1990/91 Secretariat
SC-CAMLR-IX/BG/4	A PRELIMINARY FORMAT FOR THE REPORTING OF FINE-SCALE CATCH AND EFFORT DATA FROM SQUID JIGGING FISHERIES Secretariat
SC-CAMLR-IX/BG/5	CCAMLR DATABASES AND DATA AVAILABILITY Secretariat
SC-CAMLR-IX/BG/6	ENTANGLEMENT OF ANTARCTIC FUR SEALS IN MAN-MADE DEBRIS AT BIRD ISLAND, SOUTH GEORGIA, DURING THE 1989/90 PUP-REARING SEASON Delegation of United Kingdom
SC-CAMLR-IX/BG/7	ESTABLISHMENT OF A LONG-TERM ECOLOGICAL RESEARCH SITE IN ANTARCTICA Delegation of USA

SC-CAMLR-IX/BG/8	FINAL REPORT OF SQUID AND BY-CATCH OBSERVATIONS IN THE JAPANESE DRIFTNET FISHERY FOR NEON FLYING SQUID *OMMASTREPHES BARTRAMI* JUNE – DECEMBER, 1989 OBSERVER PROGRAM Delegation of USA
SC-CAMLR-IX/BG/9	PRELIMINARY RESULTS FROM A KRILL NET SAMPLING SURVEY IN CCAMLR AREA 48.1 IN 1989/90 SEASON Delegation of EEC
SC-CAMLR-IX/BG/9 Rev. 1	PRELIMINARY RESULTS FROM A KRILL NET SAMPLING SURVEY IN CCAMLR AREA 48.1 IN 1989/90 SEASON Delegation of Germany
SC-CAMLR-IX/BG/10	CPUES AND BODY LENGTH OF ANTARCTIC KRILL DURING 1988/89 SEASON IN THE FISHING GROUND NORTH OF LIVINGSTON ISLAND Delegation of Japan
SC-CAMLR-IX/BG/11	COMMENTS OF THE SCAR GROUP OF SPECIALISTS ON SEALS AND THE SCAR BIRD BIOLOGY SUBCOMMITTEE ON CCAMLR ISSUES Secretariat
SC-CAMLR-IX/BG/12	JOINT IWC/CCAMLR WORKSHOP ON THE FEEDING ECOLOGY OF SOUTHERN BALEEN WHALES Secretariat
SC-CAMLR-IX/BG/13	TOWARDS AN ASSESSMENT OF THE STOCK OF THE OMMASTREPHID SQUID *MARTIALIA HYADESI* IN THE SCOTIA SEA: DATA FROM PREDATORS Delegation of United Kingdom
SC-CAMLR-IX/BG/14	REFINEMENTS TO THE STRATEGY FOR MANAGING DEPLETED FISH STOCKS BASED ON CCAMLR OBJECTIVES Delegation of Australia
SC-CAMLR-IX/BG/15	THE EFFECT OF BOTTOM TRAWLING ON BENTHIC ASSEMBLAGES Delegation of Germany

SC-CAMLR-IX/BG/16	FOOD CONSUMPTION BY PREDATORS IN CCAMLR INTEGRATED STUDY REGIONS Delegation of United Kingdom
SC-CAMLR-IX/BG/17	OBSERVERS REPORT FROM THE 1990 MEETING OF THE SCIENTIFIC COMMITTEE OF THE INTERNATIONAL WHALING COMMISSION Observer (W.K. de la Mare, Australia)
SC-CAMLR-IX/BG/18	REPORT OF CCAMLR OBSERVER TO SCAR 1990 Observer (J.P. Croxall, United Kingdom)
SC-CAMLR-IX/BG/19	ELEPHANT SEAL AND CCAMLR, AN HISTORICAL REVIEW Delegation of Argentina
SC-CAMLR-IX/BG/20	TWO RECORDS OF SEABIRD ENTANGLEMENT AT CASEY, ANTARCTICA Delegation of Australia
SC-CAMLR-IX/BG/21	COLLARES PLASTICOS EN LOBOS FINOS ANTARTICOS (OTRA EVIDENCIA DE CONTAMINACION) Delegación de Chile available in Spanish only
SC-CAMLR-IX/BG/21 Rev. 1	COLLARES PLASTICOS EN LOBOS FINOS ANTARTICOS (OTRA EVIDENCIA DE CONTAMINACION) Delegación de Chile available in Spanish only
SC-CAMLR-IX/BG/22	REQUEST FROM SCAR FOR CCAMLR FUNDS TO SUPPORT THE SYMPOSIUM ON ELEPHANT SEAL BIOLOGY Secretariat

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CCAMLR-IX/1	PROVISIONAL AGENDA FOR THE NINTH MEETING OF THE COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES
CCAMLR-IX/1 Rev. 1	PROVISIONAL AGENDA FOR THE NINTH MEETING OF THE COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES

CCAMLR-IX/2	ANNOTATED PROVISIONAL AGENDA FOR THE NINTH MEETING OF THE COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES
CCAMLR-IX/2 Corrigendum	ANNOTATED PROVISIONAL AGENDA FOR THE NINTH MEETING OF THE COMMISSION FOR THE CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES
CCAMLR-IX/3	REVIEW OF FORMULA FOR CALCULATING MEMBERS' CONTRIBUTIONS Executive Secretary
CCAMLR-IX/4	EXAMINATION OF THE AUDITED FINANCIAL STATEMENTS AND APPOINTMENT OF AN EXTERNAL AUDITOR Executive Secretary
CCAMLR-IX/5	REVIEW OF THE 1990 BUDGET, DRAFT 1991 BUDGET AND FORECAST 1992 BUDGET Executive Secretary
CCAMLR-IX/6	ORGANIZATIONAL AND FINANCIAL IMPLICATIONS OF MEETING IN CHILE IN 1991 Executive Secretary
CCAMLR-IX/7	OBSERVATIONS AND RESERVATIONS OF ARGENTINA WITH RESPECT TO COMMENTS MADE BY U.K. ON DESIGNATION AND PROTECTION OF CEMP SITES Delegation of Argentina
CCAMLR-IX/8	DESIGNATION AND PROTECTION OF CEMP MONITORING SITES Executive Secretary
CCAMLR-IX/9	VACANT
CCAMLR-IX/10	PROPOSED AMENDMENT TO STAFF REGULATION 5.3 – EDUCATION GRANT Executive Secretary
CCAMLR-IX/11	PROPOSAL FOR THE PUBLICATION OF A STATISTICAL BULLETIN Secretariat

CCAMLR-IX/12	GREENPEACE INTERNATIONAL – REQUEST FOR OBSERVER STATUS TO THE COMMISSION AND SCIENTIFIC COMMITTEE Executive Secretary
CCAMLR-IX/12 Rev. 1	GREENPEACE INTERNATIONAL – REQUEST FOR OBSERVER STATUS TO THE COMMISSION AND SCIENTIFIC COMMITTEE Executive Secretary
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CCAMLR-IX/14	AVOIDANCE OF INCIDENTAL MORTALITY OF LARGE SEA BIRDS DURING LONGLINE FISHING OPERATIONS Delegation of Australia
CCAMLR-IX/14 Rev. 1	AVOIDANCE OF INCIDENTAL MORTALITY OF LARGE SEA BIRDS DURING LONGLINE FISHING OPERATIONS Delegation of Australia
CCAMLR-IX/15	THE REPORT OF THE MEETING OF THE STANDING COMMITTEE ON OBSERVATION AND INSPECTION
CCAMLR-IX/16	EXECUTIVE SECRETARY’S REPORT OF THE MEETING OF THE STANDING COMMITTEE ON ADMINISTRATION AND FINANCE
CCAMLR-IX/17	DRAFT CONSERVATION MEASURE REGARDING A PROCEDURE FOR ACCORDING PROTECTION TO CEMP SITES Chairman of the CCAMLR Subgroup on the Protection of CEMP Sites
CCAMLR-IX/18	REPORT OF THE MEETING OF THE WORKING GROUP FOR THE DEVELOPMENT OF APPROACHES TO CONSERVATION OF ANTARCTIC MARINE LIVING RESOURCES (WG-DAC)
CCAMLR-IX/19	EXECUTIVE SECRETARY – ATTENDANCE AT IX SPECIAL CONSULTATIVE MEETING OF THE ANTARCTIC TREATY – VIÑA DEL MAR, CHILE, 19 NOVEMBER TO 6 DECEMBER 1990 Executive Secretary

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CCAMLR-IX/BG/3	VACANT
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CCAMLR-IX/BG/6	UNITED KINGDOM REPORT OF FISHING GEAR LOST AND FOUND WITHIN THE CONVENTION AREA IN THE 1989/90 SEASON Delegation of United Kingdom
CCAMLR-IX/BG/7	APPLICATION FOR CCAMLR OBSERVER STATUS BY STICHTING GREENPEACE COUNCIL Executive Secretary
CCAMLR-IX/BG/8	THE IOC SOUTHERN OCEAN PROGRAMME A BRIEF OVERVIEW Observer, Intergovernmental Oceanographic Commission
CCAMLR-IX/BG/9	REPORT ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY IN THE CONVENTION AREA 1989/90 United States of America
CCAMLR-IX/BG/10	PROPOSAL TO DESIGNATE THE AREA AROUND PALMER STATION, ANTARCTICA, AS A MULTIPLE-USE PLANNING AREA Delegation of USA

CCAMLR-IX/BG/11	OIL SPILLAGE IN ANTARCTICA Delegation of USA
CCAMLR-IX/BG/12	UN GENERAL ASSEMBLY RESOLUTION 44/225 ON LARGE-SCALE PELAGIC DRIFTNET FISHING AND ITS IMPACTS ON THE LIVING MARINE RESOURCES OF THE WORLD'S OCEANS AND SEAS Secretariat
CCAMLR-IX/BG/13	MEMBERS' REPORTS OF INSPECTION CARRIED OUT IN 1989/90 Secretariat
CCAMLR-IX/BG/14	IMPLEMENTATION OF CONSERVATION MEASURES IN 1989/90 Secretariat
CCAMLR-IX/BG/15	OBSERVATIONS OF DEBRIS IN ANTARCTIC WATERS DURING THE IWC/IDCR SOUTHERN HEMISPHERE MINKE WHALE ASSESSMENT CRUISES Secretariat (Based on information received from IWC)
CCAMLR-IX/BG/16	ENTANGLEMENTS AND INCIDENTAL MORTALITY OF BIRDS AND SEALS REPORTED TO CCAMLR Secretariat
CCAMLR-IX/BG/17	ALBATROSS MORTALITY AND ASSOCIATED BAIT LOSS IN THE JAPANESE LONGLINE FISHERY IN THE SOUTHERN OCEAN Delegation of Australia
CCAMLR-IX/BG/18	REPORT ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY IN THE CONVENTION AREA 1989/90 USSR available in Russian only
CCAMLR-IX/BG/19	REPORT ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY IN THE CONVENTION AREA 1989/90 Japan
CCAMLR-IX/BG/20	REPORT OF THE IWC OBSERVER Observer (K. Chu, USA)

CCAMLR-IX/BG/21	REPORT ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY IN THE CONVENTION AREA 1989/90 Australia
CCAMLR-IX/BG/22	REPORT ON ASSESSMENT AND AVOIDANCE OF INCIDENTAL MORTALITY IN THE CONVENTION AREA 1989/90 Republic of Korea
CCAMLR-IX/BG/23	GUIDELINES FOR CCAMLR INSPECTORS Delegation of Japan
CCAMLR-IX/BG/24	MEETING DATES FOR THE TENTH MEETING OF THE COMMISSION AND SCIENTIFIC COMMITTEE Secretariat

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CCAMLR-IX/MA/1	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 USSR
CCAMLR-IX/MA/2	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 South Africa
CCAMLR-IX/MA/3	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 Federal Republic of Germany
CCAMLR-IX/MA/4	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 United States of America
CCAMLR-IX/MA/5	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 Australia
CCAMLR-IX/MA/6	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 Spain
CCAMLR-IX/MA/7	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 Sweden

CCAMLR-IX/MA/8	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 Poland
CCAMLR-IX/MA/9	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 United Kingdom
CCAMLR-IX/MA/10	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 Brazil
CCAMLR-IX/MA/11	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 Norway
CCAMLR-IX/MA/12	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 Japan
CCAMLR-IX/MA/12 Rev. 1	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 Japan
CCAMLR-IX/MA/13	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 Chile available in Spanish only at present
CCAMLR-IX/MA/14	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 Republic of Korea
CCAMLR-IX/MA/15	REPORT OF MEMBER'S ACTIVITIES IN THE CONVENTION AREA IN 1989/90 Argentina available in Spanish only

ANNEX 3

AGENDA FOR THE NINTH MEETING OF THE SCIENTIFIC COMMITTEE

AGENDA FOR THE NINTH MEETING
OF THE SCIENTIFIC COMMITTEE

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

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

3. Fish Resources
   (i) Fisheries Status and Trends
   (ii) Report of the Working Group on Fish Stock Assessment (WG-FSA)
   (iii) Report of the Convener of the WG-FSA on Information Required to Improve Knowledge of the Stocks
   (iv) Data Requirements
   (v) Advice to the Commission

4. Squid Resources
   (i) Review of Activities Related to Squid
   (ii) Advice to the Commission

5. Ecosystem Monitoring and Management
   (i) Report of the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP)
   (ii) CCAMLR/IWC Workshop on the Feeding Ecology of Southern Baleen Whales
   (iii) Data Requirements
   (iv) Advice to the Commission

6. Marine Mammal and Bird Populations

7. Assessment of Incidental Mortality
   (i) UN General Assembly Resolution 44/225 on Large-Scale Pelagic Driftnet Fishing and Its Impacts on the Living Marine Resources of the World's Oceans and Seas

8. Development of Approaches to Conservation of Antarctic Marine Living Resources

9. Cooperation with Other Organisations
   (i) Reports of SC-CAMLR Representatives at Meetings of Other International Organisations
   (ii) Nomination of SC-CAMLR Observers to Meetings of Other International Organisations
   (iii) Application for Observer Status by ASOC

10. Information Submitted by Members

11. Review and Planning of the Program of Work of the Scientific Committee
   (i) Activities in the Intersessional Period
   (ii) Coordination of Field Activities for 1990/91 and 1991/92

12. Draft Budget for 1991 and Forecast Budget for 1992

13. Election of Chairman of the Scientific Committee

14. Next Meeting

15. Other Business

16. Adoption of the Report of the Ninth Meeting of the Scientific Committee

17. Close of the Meeting.

ANNEX 4

REPORT OF THE SECOND MEETING OF THE WORKRING GROUP ON KRILL

(Leningrad, USSR, 27 August to 3 September 1990)

REPORT OF THE SECOND MEETING
OF THE WORKING GROUP ON KRILL
(Leningrad, USSR, 27 August to 3 September 1990)

INTRODUCTION

The Second Meeting of the Working Group on Krill (WG-Krill) was held at the Fishery Exhibition Building in Leningrad, USSR from 27 August to 3 September 1990. The Meeting was chaired by the Convener, Mr D.G.M. Miller (South Africa).

2. The Convener welcomed delegates and outlined the Working Group's Terms of Reference and the meeting objectives. The meeting objectives were set out in paragraphs 2.35 and 5.21 of SC-CAMLR-VIII covering a requirement to review information on krill abundance and distribution, to liaise with the CCAMLR Ecosystem Monitoring Program with respect to assessing and monitoring the effects of changes of krill abundance on predators, and to consider procedures to evaluate the impact on krill stocks of current and future levels of harvesting.

3. The Working Group was also asked to address three specific questions by the Commission through the Scientific Committee (see CCAMLR-VIII, paragraph 50).

(i) What is the biomass and potential yield of krill in Subarea 48.3?

(ii) What are the possible management measures, including limits, that might be necessary on krill catches in the subarea which would maintain ecological relationships with dependent and related populations, including:

(a) the protection of dependent predators; and

(b) the protection of young and larval fish?

(iii) If these questions cannot be answered, what new information is required and how soon could it be obtained?

4. A Provisional Agenda distributed prior to the Meeting was considered by the Working Group. The Working Group felt that, whilst there was a lot of detail to cover in the Agenda,

and some overlap was expected in discussion of some items, the work program as set out would provide the opportunity to cover the meeting's objectives.

5. The amended Agenda was adopted (Appendix A). A List of Participants (Appendix B) and a List of Meeting Documents (Appendix C) are attached.

6. The following rapporteurs were responsible for preparing the Report of the Meeting: Drs D. Butterworth (South Africa), M. Basson (UK), S. Nicol (Australia), K. Kerry (Australia), E. Murphy (UK), J. Watkins (UK), D. Powell (Secretariat) and D. Agnew (Secretariat).

ORGANISATION OF WORK

7. To facilitate deliberations concerning certain technical aspects, the Working Group agreed that these be referred to specialist sub-groups for detailed discussions. Ideally the reports of these sub-groups would have been rediscussed by the Working Group as a whole, but this was not possible because of pressure of time and business. Accordingly it was decided to include in this Report those conclusions of the sub-groups which were agreed by the Working Group. However, any reservations that the Working Group had concerning the views expressed in sub-groups would also be recorded.

DEVELOPMENT OF APPROACHES TO MANAGING THE KRILL FISHERY

Identification of Needs

8. In discussion of approaches to the conservation of marine living resources at its meeting in 1988, the Commission sought the Scientific Committee's advice on:

> 'operational definitions for depletion and target levels for recovery of depleted species', and
>
> 'the ability of the CCAMLR Ecosystem Monitoring Program to detect changes in ecological relationships and to recognise effects of simple dependencies between species including distinguishing between natural fluctuations and those induced by fisheries'.

9. Following its consideration of these issues and papers on the subject submitted to the 1989 Meeting of the Scientific Committee (SC-CAMLR-VIII/BG/56, SC-CAMLR-VIII/BG/17, SC-CAMLR-VIII/9) it was agreed that the specialist working groups should consider the Commission's questions and the broader issue of the development of approaches to conservation.

10. The Working Group noted the relationship between this requirement and its fourth Term of Reference.

11. The Working Group was also required to address three specific questions in relation to Subarea 48.3, as detailed in paragraph 3 above. In dealing with the question of approaches to management, it was agreed to focus discussions on this subarea, noting nevertheless that the management approaches and considerations arising in such discussions also would be pertinent to the krill fishery in other subareas.

AVAILABLE INFORMATION

12. In order to identify specific needs with respect to the development of approaches to managing the krill fishery, the Working Group reviewed the relevant and available information. This included papers distributed at the Meeting dealing with topics outlined in paragraph 2.11 of the Scientific Committee's last report (SC-CAMLR-VIII) in addition to new information. The papers and topics considered were: commercial krill fisheries catches and the distribution of fishing activities in the Convention Area (SC-CAMLR-VIII/BG/11, 21, WG-Krill-90/16, 19), the collection and analysis of data from krill fisheries vessels and in krill fishing grounds (SC-CAMLR-VIII/BG/4, 5, 7, 10, 23, WG-Krill-90/6, 11, 25, 26, 27), the operating of fishing vessels with respect to krill distribution, biology, behaviour and catchability (SC-CAMLR-VIII/BG/9, 23, WG-Krill-90/22), analyses of fine-scale krill catch data reported to the Commission (SC-CAMLR-VIII/BG/43, 44, WG-Krill-90/8, 9, 10), estimation of krill biomass in selected subareas (SC-CAMLR-VIII/BG/4, 5, 7, 10, WG-Krill-90/7, 15, 17, 18, 20, 21, 23, 24), the determination of the acoustic target strength of krill (SC-CAMLR-VIII/BG/30, WG-Krill-90/12, 13, 28, 29, papers by Foote *et al*., 1990) and a variety of aspects of krill biology in general (SC-CAMLR-VIII/BG/22, 24, WG-Krill-90/5) including particularly the potential for identifying separate krill 'stocks' (SC-CAMLR-VIII/BG/7, 10, 21, 28, WG-Krill-90/8, 9, 16, 18, 19). With respect to the actual development of a management procedure for the krill fishery, due account was taken of paragraphs 7.10, 7.17 and 7.18 of SC-CAMLR-VIII and two papers specifically addressing

this issue (SC-CAMLR-VIII/BG/17 and WG-Krill-90/14). The detail of papers considered in depth by the Working Group are set out where appropriate below.

Stock Identification

13. Paper SC-CAMLR-VIII/BG/21 addressed this matter for the region of the Antarctic Peninsula and related waters. In introducing the paper Dr V. Spiridonov (USSR) stated that a functional approach, based on water circulation patterns, pointed to the existence of two sub-populations of krill in the Weddell Sea and the Bellingshausen Sea, with a transition zone between the two in the vicinity of the Bransfield Strait. This division would not imply genetic separation.

14. It was pointed out that the position of the transition zone varies over time, and also that most of the catch in Subarea 48.1 comes from the vicinity of the transition zone so that it would be difficult to allocate the catch between the two sub-populations.

15. Dr I. Everson (UK) commented that catch distribution patterns derived from fine-scale data revealed that krill fishing concentrated in the outer parts of the slope shelf areas, and showed that fishing moved from Subarea 48.3 in winter to Subarea 48.2 in summer which might be related to the sea-ice position. Prof. T. Lubimova (USSR) questioned the validity of these data which indicated fishing in areas to the southeast of South Georgia during summer, because she doubted that fishing had been undertaken in such areas. It was clarified that fishing activity occurred on the outer parts of the shelf and slope areas. It was pointed out by Dr Agnew that fishing in this area during summer had only been reported for 1987/88, the first year of reporting of such data, and recording errors might well be present, since the 1988/89 data did not show fishing in these areas. It was noted that these data shed little light on the stock identity problem, because different catch positions were likely to be related to high krill concentration areas within a stock, and not necessarily to different stocks.

Abundance Estimation

16. A sub-group, convened by Dr R. Hewitt (USA) was given the task of discussing the problems associated with the use of acoustics to estimate biomass and specifically to discuss recent work on krill acoustic target strength.

17. Members of the sub-group were Drs Everson, K. Foote (Norway), Hewitt, S. Kasatkina (USSR), Kerry, V. Tesler (USSR) and Watkins. The following papers were

reviewed and discussed: WG-Krill-90/13; 28; 29; SC-CAMLR-VIII/BG/30; Everson *et al*., 1990; Foote *et al*., 1990; Foote, 1990. During the discussion, references were made to additional published works, Foote *et al*., 1990; BIOMASS, 1986.

18. Two types of method are currently used to assess the spatial distribution and abundance of krill: acoustics and direct sampling methods. The principal advantages of acoustics relative to direct sampling methods are that a much larger portion of potential krill habitat is sampled per-unit-survey time and problems of net selectivity and catchability are avoided. Principal disadvantages include undersampling krill in the upper 10 metres of the water column and possibly undersampling dispersed krill (as suggested by positive net catches where no krill have been detected acoustically).

19. Further development is required of standardised procedures for the conduct of acoustic surveys for krill. These would include specification of:

- the krill target strength relationship used to convert integrated echo return to krill biomass;

- statistical procedures for summarising the data, preparing distribution maps, and estimating total abundance and its variance; and

- guidelines for survey design and direct sampling requirements.

20. The sub-group focused most of its discussion on the specification of krill target strength. Substantial progress has been made in the last two years on defining the target strength of krill by researchers in Australia, Japan, Norway, South Africa, UK, USA and USSR. Some of this work is published, some is in the form of reports and working papers, and some of it is in progress. Most have shown either an increasing dependence of krill target strength on acoustic frequency or lower krill target strength than that previously used to scale echo returns of krill to biomass (BIOMASS, 1986), or both.

21. It was acknowledged that some uncertainty in the measurement of target strength may be introduced by:

(i) differences in the orientation of animals in the experiments with the orientation of animals in the wild (although data were presented that show that average tilt angle and its variance for animals used in the experiments of Foote *et al*. (1990) was consistent with published observations of animals in the wild);

(ii) animal density effects (although this was shown to account for only 6% of the variation in target strength in the experiments of Foote *et al*. (1990); and

(iii) possible day-night differences in target strength.

These uncertainties do not appear to change the qualitative conclusions.

22. It was recognised that krill target strength may vary not only as a function of animal size but also condition. This is due to changes in specific density of the animal and speed of sound through the animal corresponding to changes in physiological condition.

23. It was agreed that:

(i) acoustic surveys are an efficient means of determining krill distribution and abundance provided that systems are correctly and frequently calibrated;

(ii) the values of krill target strength reported to date vary over a range of approximately 10 dB. This implies a 10-fold range of estimated krill biomass. In the absence of a more thorough review of technical issues, discrepancies between reported values of krill target strength may be best resolved in technical literature. Accordingly, it is recommended that Members encourage the publication of on-going work with sufficient detail so as to judge its technical merit. It is further recommended that a workshop on krill target strength be convened as soon as possible with the following terms of reference:

(a) technically review published and unpublished work on the specification of krill target strength; and

(b) recommend a krill target strength relationship to be used in acoustic surveys of krill;

(iii) additional experiments designed to measure krill target strength under controlled conditions should be conducted and, in particular, such experiments should include observations on the orientation of the observed krill. In this regard, Prof. Lubimova informed the Working Group that the Soviet Union was interested in cooperating in krill surveys and target strength measurements;

(iv) additional measurements of the density and speed of sound through individual krill should be made over a wide range of krill sizes, and stages of reproductive maturity, gut fullness, and moult cycle; and

(v) suggestions for appropriate survey designs, methods for summarising survey data, and procedures for estimating biomass and its variance should be developed and submitted to the CCAMLR WG-Krill. In this regard, the current ICES initiative to develop a standard method for estimating biomass and its variance from line-transect measurements of animal density was noted.

24. A sub-group, convened by Dr V. Siegel (EEC), was tasked with expanding and updating the table of net characteristics presented in the Report of the First Meeting of WG-Krill (SC-CAMLR-VIII, Annex 5). The updated version is presented here as Table 1.

25. Paper WG-Krill-90/23 was introduced containing results of investigations from surveys conducted during the austral summer over the period 1984 to 88 in the area from the South Shetland Islands to the South Georgia area. The paper considers krill distribution and its relationship to primary production and environmental factors. Inferences from these surveys suggest that krill do not consume more than 4 to 5% of primary production per day during the austral summer.

26. Paper WG-Krill-90/25 was introduced by Dr V. Latogursky (USSR). The paper comments on the work done by observers on-board krill fishing vessels during November 1989 to February 1990, northwest of Coronation Island (see paragraph 121).

27. Paper WG-Krill-90/17 presents biomass estimates from acoustic surveys, as well as descriptions of the characteristics of krill distribution patterns in the Indian Ocean sector (Statistical Area 58).

28. It was pointed out that since Japanese fishing vessels have operated in the Indian Ocean sector in the past, additional information may be available from this source. Dr M. Naganobu (Japan) confirmed that these data exist. Data from survey vessels have been collected and are being analysed.

29. Paper WG-Krill-90/18 presents results of investigations on krill distribution and abundance in the Enderby-Wilkes Subarea (58.4) over the period 1985/86 to 1988/89. Data are from commercial surveys. Biomass estimates of commercial aggregations and maps of

krill distribution are given. It was felt that it would be useful to have the bottom topography indicated on maps or charts that illustrate the distributional characteristics of krill.

30. Paper WG-Krill-90/22 presents results of studies into the catchability of midwater trawls and possible approaches for assessing the amount of krill that escape the trawl. It is shown that catchability depends both on the characteristics of krill local scale distribution and trawl parameters (e.g., speed of trawling and angle of attack of set net). The agreement between estimates of catchabilities from hydroacoustic data and estimates calculated according to probability/statistical theory of fishing trawls was emphasised.

31. Paper WG-Krill-90/20 shows that the estimation of krill biomass depends on characteristics of krill distribution which varies considerably over time because of its dependence on the biological state of the animals. The author, Dr Kasatkina, referring to SC-CAMLR-VIII/BG/10, pointed out that, from the results of WG-Krill-90/20 and data on actual fishing effort, it is possible to estimate fishing intensity and initial biomass of krill at the beginning of the fishing period.

32. Guidelines on the accumulation and processing of the information, used in their estimates, have been developed by AtlantNIRO. A booklet containing guidelines was presented to the Working Group and it was agreed that it would be advisable to consider them at its next meeting. The Soviet Delegation was asked to submit this material in English.

33. These results suggest that it will be necessary to consider local distributional characteristics of krill when estimating density from trawl survey data.

34. Biomass estimates presented in tabled papers, as well as estimates from previous studies are presented in Tables 2.1 to 2.3. It was pointed out that these were estimates of the biomass in the region concerned at a point of time, averaged over the usually short period of the survey. These are termed ‘instantaneous’ estimates. Because of immigration and emigration of krill from this region over a year, ‘instantaneous’ biomass differs from the ‘effective total’ biomass, which is the biomass of all krill, which are in the region at some time during the year. It is the ‘effective total’ biomass which is pertinent to the assessment of the harvest which can be taken from the region.

35. It was recognised that not all estimates in the tables are comparable. With respect to estimates of biomass for the South Georgia region (Subarea 48.3) surveys took place at different times of the year and the areas covered differed. There is a need for standardisation of survey design and methods.

36. The importance of not only presenting biomass estimates, but also including estimates of variance and detailed descriptions of the survey and analytical methods used was emphasised. In some cases estimates of biomass from survey data were obtained by means of contouring. It was considered important to include an explicit description of the method used, since different contouring procedures can lead to very different results, and the drawing of contours can often be subjective. A further problem is the difficulty of obtaining estimates of the coefficients of variance for the biomass estimates.

37. It was pointed out by Dr Foote that statistical techniques for estimating biomass and associated variance from survey data are available. These techniques make explicit use of observed information on spatial structure, hence their generic name ‘spatial statistical techniques’ (see also paragraphs 12 to 13). Work of the kind described in SC-CAMLR-VIII/BG/10 may be especially useful in this regard.

38. The Meeting felt that, in the light of problems associated with surveys of krill, greater precision would be achieved by coordinated surveys using standardised techniques and methodologies.

39. It was noted that the peak of the krill fishery at South Georgia is during the winter months (March to June) and that there is very little fishing during the summer months when krill are spawning. Dr P. Fedulov (USSR) explained that this redistribution of fishing effort is aimed at allowing the local krill population to reaccumulate and at avoiding interference with the feeding of breeding seabirds.

40. It was felt that a better understanding of the rates of movement (immigration and emigration) of krill into and out of Subarea 48.3 was necessary in order to derive appropriate estimates of effective total biomass in that region. It was, however, pointed out that it may be very difficult to estimate these rates of movement in practice.

41. The comments made with respect to biomass estimates for the South Georgia region apply equally to estimates for other regions. It was emphasised that the estimates should be interpreted with caution.

42. In some cases coefficients of variation (or likely ranges) for biomass estimates were included in Table 2.1 and it was noted that estimates of biomass appeared to have large variances in these cases. The need to identify the component of the total variance attributable to sampling was emphasised.

Estimation of Potential Yield

43. No specific estimates of potential yield for any subarea (or combination of subareas) had been made in any of the papers presented to the Meeting. This matter is discussed further in paragraphs 63 to 80.

Identification of Demographic Parameters

44. The following demographic parameters and variables were identified as of importance for modelling exercises related to krill management:

(i) natural mortality, **M** (related to production/biomass ratio);

(ii) age at maturity;

(iii) stock-recruit relationship parameters;

(iv) the extent of variability about the stock-recruit relationship;

(v) length-weight relationship parameters;

(vi) weight-at-age (in turn requiring estimates of critical parameters of the krill growth curve);

(vii) immigration and emigration rates; and

(viii) distributional parameters for krill aggregations (e.g., concentration size, swarm radii and swarm spacing).

45. **M** is inversely related to the longevity of the individuals in a population. There is an increasing body of opinion that the life-span of krill extends to at least four to five years. While this information alone does not provide a unique estimate of **M**, it is helpful in indicating a likely order of magnitude. It was noted that **M** is likely to vary in space and time and is also likely to depend on the age of the krill. However, larval mortality is not of concern for management, as it is an estimate of **M** which is typical of that for the ages susceptible for the fishery which is required.

46. Miller and Hampton (1989) summarised available estimates of **M** for krill to be found in the literature. These covered a wide range from 0.6 to 5.5. Due to pressure of time, it was not possible to critically review the bases for these various estimates during the Meeting. It was recommended that a review be carried out prior to the next meeting of the Working Group.

47. It was suggested that efforts be made to estimate **M** from the length distribution of catches, on the assumption that these were being taken from near-unexploited populations. To reduce a major source of bias in estimating the length distribution for the population, it was suggested that hauls to obtain such information be carried out at night to minimise net avoidance problems. It was further suggested that the forthcoming BIOMASS Krill Biology Workshop be requested to investigate whether the data collected during various BIOMASS surveys could be used to provide estimates of **M**.

48. A body of literature on the age (or length) at sexual maturity exists (e.g., see review by Miller and Hampton, 1989). The relationship between these two parameters is complicated by possible maturity regression after spawning.

49. In a table contained in Morris *et al*. (1988) details of existing evaluations of length-weight relationship parameters are provided. These are of particular importance in converting acoustic target strength length relationships to weight in the estimation of biomass. It was emphasised that full details must be provided for any additions to this table, as results can be very sensitive to the conditions under which measurements are made.

50. Data from future surveys should also be used to provide further estimates of the demographic parameters listed above (paragraph 44).

51. The previous meeting of the Working Group had identified the need for more information on krill swarm distribution parameters. Paper SC-CAMLR-VIII-BG/10, Tables 2.2 and 2.3 and WG-Krill-90/20 provided a valuable summary of further information in this regard, and would be most helpful in refining concepts of krill distributional patterns.

52. Mr I. Wojcik (Poland) recalled that at the Sixth Meeting of CCAMLR (SC-CAMLR-VI, paragraph 16.5), the Polish representative advised that the Plankton Sorting and Identification Centre in Szczecin, Poland offers low-cost services in sorting and identification of zooplankton samples. He suggested that this offer might be of interest to the Working Group in the context of standardisation of the analysis of data from the krill fishery.

This would, however, first necessitate that the Working Group specify the parameters to be measured very clearly.

REVIEW OF POSSIBLE APPROACHES

53. Paper WG-Krill-90/14 discussed factors to consider in developing procedures for the management of krill. The paper stressed the importance of identifying ‘subsidiary’ management objectives which would supplement the broad, general objectives of the Convention in ways which would allow an objective assessment of the state of the stocks with respect to these general objectives. Therefore ‘subsidiary’ objectives need to be set out in terms of quantities that can be reliably estimated. Their form may change with improved assessment methods and knowledge about krill and the fisheries. This means that there would usually be a strong link between the formulation of ‘subsidiary’ objectives and the types of assessment methods used. The paper also discussed the advantages and disadvantages of a number of possible approaches to krill management. A workplan for analysing the likely performance of potential management procedures was outlined.

54. Prof. Lubimova commented that the paper was of a general nature and she had difficulty in relating its contents to the problems at hand. A number of Members considered that it provided a valuable starting point in the development of a management approach, and that it illustrated the importance of integrating research and management considerations if the evolution of this management approach to krill is to proceed effectively.

55. Paper SC-CAMLR-VIII/BG/17 discussed the process of developing a feedback operational management procedure for krill. The paper suggested that the structure of a management procedure and its development involved four components, not necessarily in order of priority:

(i) a basis for assessing the status of the krill resource in the region concerned;

(ii) an algorithm for specifying appropriate levels of regulatory mechanisms (such as a catch control law) as a function of the results of such assessment;

(iii) a basis for the simulation testing of the performance of the management procedure ((i) and (ii) above); and

(iv) an operational definition of CCAMLR Article II to provide criteria against which performance could be assessed.

The word ‘operational’ implies ‘in terms of quantities which can be measured or estimated from field observations’. An ‘operational definition’ is synonymous with the ‘subsidiary objectives’ discussed in WG-Krill-90/14 (see paragraph 53 above).

56. An illustrative example was given for krill in Subareas 48.1, 48.2 and 48.3. Assessment was based on the CPUE ‘Composite Index’. The rate of increase of TACs was limited after an initial catch ceiling was reached. An operating model of krill dynamics for simulation testing purposes was set out. Finally an operational definition of Article II taking implicit account of the effect of harvesting on dependent and related species was suggested. A video illustrating how a similar management procedure was being developed for the International Whaling Commission was shown.

57. In response to questions, the author of SC-CAMLR-VIII/BG/17 (Dr Butterworth) stated that, in the absence of ground truth data for krill dynamics, the simulation testing was based on the best available estimates for the parameters describing these dynamics, but that it was also essential to test that performance did not degrade markedly if such estimates were varied across plausible ranges corresponding to current levels of uncertainty. Further, he stated that it was quite possible to extend the krill dynamics model used for testing purposes to incorporate spatial effects and related predator populations.

58. Dr Naganobu stated that he considered the implementation of limitations on the krill fishery to be premature. He argued that current catch levels were much less than biomass estimates, so could not seriously affect the resource. He also expressed reservations about the use of CPUE-related indices as a basis for assessing resource status and setting catch limits, and suggested that thorough survey procedures were needed to extend knowledge.

59. Prof. Lubimova also expressed strong reservations about the use of CPUE-related indices as a basis for assessing resource status. She drew attention to paragraph 86(a) of the Report of the Workshop on the Krill CPUE Simulation Study (SC-CAMLR-VIII, Annex 4) which stated that the ability to detect decreases in krill abundance from CPUE data is relatively limited. She questioned whether the approach suggested was the best way to proceed and stressed the need for methods to have a biological basis, in particular to take krill distribution features into account. She emphasised the need for more biological data, but agreed that modelling studies could assist in identifying the most critical gaps in present knowledge.

60. The view was expressed by Dr Butterworth and Dr W. de la Mare (Australia) that it was essential to begin the development of a management procedure immediately, so that an

agreed and reliable approach was in place at whatever time limitations to an expanding fishery might become required. It was also pointed out that assessment and catch limits did not have to be based on CPUE data; the example in SC-CAMLR-VIII/BG/17 using such data was intended only as an illustration of the overall approach, and survey data (for example) could equally well be used as the basis for assessment. It was noted that the absence of restrictions as suggested by Dr Naganobu also constituted a form of management procedure.

61. It was agreed that it would be helpful to structure discussion under the headings set out in paragraph 55 above. In regard to heading (iv) of that paragraph, it was agreed that it would not be possible to suggest detailed operational definitions of Article II in the time available to the Meeting. However, four general concepts on which such definitions might be based were developed:

(i) aim to keep the krill biomass at a level higher than might be the case if only single-species harvesting considerations were of concern;

(ii) given that krill dynamics have a stochastic component, focus on the lowest biomass that might occur over a future period, rather than the mean biomass at the end of that period as might be the case in a single-species context;

(iii) ensure that any reduction of food to predators which may arise because of krill harvesting is not such that land-breeding predators with restricted foraging ranges are disproportionately affected in comparison with predators present in pelagic habitats; and

(iv) examine what level of krill escapement would be sufficient to meet the reasonable requirements of krill predators. It was agreed that the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) be asked to consider this aspect.

62. Representatives were asked to provide suggested operational definitions of Article II on the basis of these concepts (and further such concepts which they might wish to suggest) in writing in time for consideration at the next appropriate meeting.

DEVELOPMENT OF APPROACHES AND FUTURE DATA REQUIREMENTS

Potential Yield from Subarea 48.3

63. Some Members suggested that a possible initial approach to the determination of appropriate yields from krill populations might be to use the formula:

$$Y = \lambda M B_{\circ}$$

where **Y** is the annual yield,
M is the natural mortality,
$\mathbf{B_{\circ}}$ is an estimate of the effective total biomass of the population prior to exploitation, and
λ is a numerical factor which depends on the age-at-first capture, growth curve parameters, and the extent of recruitment variability, and is typically less than 0.5.

Beddington and Cooke (1983) provide tables for the value of λ for combinations of these last mentioned parameters.

64. Prof. Lubimova expressed the following serious reservations in relation to the use of this formula for calculation of an annual yield of krill:

- $\mathbf{B_{\circ}}$, population biomass, is taken to be an initial population biomass. The calculations at this meeting were performed using instantaneous estimates of biomass. These data are not compatible because they are obtained by different methods for different areas and years (see paragraphs 34 and 35);

- the formula does not take into account the process of krill emigration and immigration, in particular in Subarea 48.3, which is considered to be an area which demonstrates 'sterile outflux of krill'; and

- the available scientific data do not provide reliable and representative values of natural mortality of krill for the different areas under consideration.

65. The reservations mentioned above preclude the calculation of an annual yield of krill using the suggested formula. However, this formula, if modified to account for processes of

krill emigration and immigration, may be used as one of the possible approaches for krill fishery management and for the collection of information such as that requested by the Scientific Committee (SC-CAMLR-VIII, paragraph 50(c)).

66. Dr Naganobu expressed his support for the view expressed by Prof. Lubimova. He believed that the data used to calculate the biomass of krill in Subarea 48.3 were unreliable for this purpose and that more precise surveys in Subarea 48.3 were required. The krill fishery is an important industrial activity for the countries concerned and its regulation must be based on reliable data.

67. The Members who suggested that the formula in paragraph 63 could be used, considered that the reservations in paragraphs 64 to 66 had already been addressed in detail of their views, which are recorded in paragraphs 68 to 79.

68. The tables for λ referenced above in paragraph 63 were not available at the meeting. In any case, it was pointed out that they were based on a von Bertalanffy growth curve, and the values might change for the seasonably fluctuating growth shown by krill. Drs Butterworth and Basson volunteered to repeat the calculations of Beddington and Cooke for the next meeting, taking account of this last factor. It was agreed that they should do this for a range of plausible values for pertinent parameters. Results should be provided for a set of values for **M** of 0.3 and larger.

69. It was recognised that such calculations were appropriate for single-species fishery considerations so that the resultant value for λ would need to be reduced by some amount to take account of the requirements of Article II relating to dependent and related species (see also paragraph 56).

70. It was also recognised that a catch limit alone might not be an adequate future management measure if most of the catch taken in a restricted area which was also an important foraging area for land-based predators.

71. The Meeting had been asked by the Scientific Committee to advise on the potential yield of krill in Subarea 48.3. It was suggested that the crude formula:

$$Y = 0.5\, M\, B_{\circ}$$

might provide a basis to guide the discussion. It was agreed to focus on the smallest recorded estimate of **M** of 0.6 (Brinton and Townsend, 1984) for this purpose.

72. Table 2.2 provides a set of estimates of the biomass of krill within Subarea 48.3. The average of these estimates which pertain to the March to June period (for which estimates are the most comparable) is some 600 thousand tonnes. It should be noted that these estimates refer to different areas as discussed in paragraphs 34 and 35. Use of this figure for $\mathbf{B}_{\circ}$ in the formula in the preceding paragraph assumes that the krill fishery has not already depleted the effective total biomass substantially below its average level prior to exploitation.

73. It was pointed out that this is an instantaneous estimate, and does not take into account that the total biomass of the population does not only include that occurring instantaneously in the South Georgia vicinity (the region to which the estimates of the preceding paragraph apply), but must also incorporate immigration and emigration of krill from this vicinity during the course of a year (see also paragraph 34).

74. There was considerable debate on the likely extent of adult krill transport throughout the South Georgia vicinity. Hydrographic information is available but this is not sufficient to allow transport rates to be estimated; such information as there was, indicated that these rates vary greatly over time.

75. Observations of a krill patch north of South Georgia (Dr Everson, personal communication) had shown that this dispersed after five days. The extent of the observed reduction of krill density could not have been occasioned by the fishery or predators. This suggested a lower bound of some five days on the residence time of krill in the area, while the associated upper bound would be one year. The corresponding limits for effective total biomass are 44 and 0.6 million tonnes respectively.

76. Annual consumption of krill by predators located at South Georgia (to be updated) is estimated to be 9 million tonnes (SC-CAMLR-VIII/BG/15). This consumption estimate corresponds approximately to the product $\mathbf{M}\ \mathbf{B}_{\circ}$, and suggests that one or both of the lower bounds $\mathbf{M}$=0.6 and $\mathbf{B}_{\circ}$=0.6 million tonnes must be too low.

77. Taken together, these figures and the crude formula in paragraph 71 above suggest a potential annual yield for krill in Subarea 48.3 in the range 0.2 to 13 million tonnes.

78. The low end of this range is similar to recent annual catches of some 0.2 million tonnes from Subarea 48.3. However, many qualifications must be stressed in regard to these yield estimates. On the negative side:

(i) **M** may well be smaller than the 0.6 used in the calculations above;

(ii) the work of Beddington and Cooke (1983) suggests that the value λ=0.5 used in the formula in paragraph 63 is too high;

(iii) the formula is derived from single-species considerations, and the result it provides should be reduced to some extent to allow for the requirements of dependent and related species; and

(iv) the modification of the biomass estimate to allow for krill transport through the area takes no account of the fact that such krill has probably immigrated from adjoining subareas which are also subject to exploitation.

79. On the positive side:

(i) **M** may well be larger than the 0.6 used for the calculations above;

(ii) the available instantaneous biomass estimates for Subarea 48.3 are negatively biased because of transport factors;

(iii) the estimate of krill consumption by predators in the subarea supports these indications of negative bias in the lower bound for the krill potential yield; and

(iv) the estimates for yield are negatively biased by the extent to which the krill fishery may already have depleted the effective total biomass below its average level prior to exploitation.

80. The very wide range for the crude yield estimate in paragraph 77 above is indicative of considerable uncertainty and lack of key information. However, the approach used does serve to focus attention on areas where further work is urgently needed:

(i) estimation of **M** from available and new data on length composition and age information (see paragraphs 45 and 46);

(ii) continued surveys of the South Georgia vicinity to provide absolute biomass estimates (with associated estimates of survey sampling variance) in a standardised manner;

(iii) empirical and theoretical (hydrodynamic) studies to estimate the typical retention time for krill in this vicinity, to be able to relate instantaneous biomass estimates to effective annual levels; and

(iv) refinement of the crude formula $Y = 0.5\ M\ B_{\circ}$ (see paragraph 65).

Effects of Krill Catches on Young and Larval Fish

81. The Commission had also sought advice on management measures for the krill fishery in Subarea 48.3 which would contribute to the protection of young and larval fish. Dr Foote drew attention to initiatives in net design in his country, which addressed such problems. In one study, on shrimp separator trawls, fish were deflected out of the codend, and shrimp alone, without admixture of larger animals, were caught. The quality of these shrimp was superior to that of shrimp caught in conventional shrimp trawls without separator grids. In a second study, large fish were retained in the trawl, and smaller animals allowed to escape by passing through a similar separator grid. (Contact persons for these studies are B. Isaksen, Institute of Marine Research, Bergen, and R.B. Larsen, Norwegian College of Fisheries Science, Tromsö.) It was agreed that the Commission's attention should be drawn to these developments, and it was suggested that experiments with such nets should be carried out for the krill fishery to test their effectiveness in reducing the proportion of young and larval fish captured.

Other Considerations

82. Earlier in the Meeting, reservations had been expressed by Prof. Lubimova and Dr Naganobu about the reliability of attempts at the previous workshop to develop a composite CPUE-related measure to provide a time series indexing krill biomass. A time series of a relative index of abundance (at least) is an essential requirement for the management of a marine resource. Accordingly the question was posed whether regular research surveys (independent of the fishery) were feasible for krill. If not, this would imply that high priority should be given to resolving outstanding problems in using CPUE data.

83. It was noted that local surveys in limited areas would in any case be required to provide information on prey availability to krill-dependent predators (see paragraphs 91).

84. It was appreciated that the krill fishery management problem involved difficulties of stock definition and immigration/emigration that were more severe than encountered in many other fisheries, but that these complications did not obviate the need for monitoring biomass, preferably by means of absolute measures, but otherwise using relative measures.

85. It was suggested that if full-scale regular research surveys were impractical, it might be possible to adapt fishing procedures to provide a reliable index of relative abundance. For example, fishing vessels might carry out limited fishing at pre-determined grid positions before commencing their regular pattern of activities.

86. The desirability of making use of on-board observers to obtain more reliable data from fishing operations was stressed (see paragraph 121). Dr V. Marín (Chile) emphasised that data collection procedures should be designed to facilitate the testing of pre-specified hypotheses, in contrast to attempting to collect every possible item of information; this was to ensure cost-effectiveness.

KRILL MONITORING AND WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM (WG-CEMP)

87. The Scientific Committee at its Eighth Meeting (SC-CAMLR-VIII, paragraph 5.21) requested that WG-Krill, in consultation with WG-CEMP as necessary:

(i) develop appropriate designs for prey monitoring surveys for the Integrated Study Regions and their vicinities;

(ii) prepare standard methods for the technical aspects of such prey surveys;

(iii) review the relevant environmental data required in the context (i.e. in terms of the spatial and temporal scales involved) of CEMP's requirements for prey monitoring; and

(iv) develop operational plans for collaborative and cooperative integrated surveys, with particular emphasis on the Integrated Study Regions.

88. Various papers (SC-CAMLR-VI-BG/8, SC-CAMLR-VII-BG/7, SC-CAMLR-VIII/9, SC-CAMLR-VII-BG/5, 10, 12, 13, 15, 31, 32, WG-CEMP-90/11,12, 14, WG-Krill-90/8, 9, 10 and 20) were identified as being pertinent to discussions on the above.

89. The Convener of WG-CEMP, Dr J. Bengtson (USA), was invited to describe the CEMP and in particular, the need for surveys of krill distribution and biomass in relation to specific predators. Dr Bengtson noted that CEMP monitoring, in keeping with its objectives (SC-CAMLR-VI, Annex 4, paragraph 8), comprises three elements: namely, the monitoring of selected predator parameters, the monitoring of prey (principally krill) and the monitoring of important environmental variables. The monitoring of prey and the environment was necessary to facilitate interpretation of the possible cause(s) of any change in selected predator parameters. Standard Methods for the monitoring of predators had been produced and good progress had been made in the implementation of the predator monitoring program. It is now essential that monitoring of prey commence as soon as possible.

90. At its First Meeting WG-Krill had noted WG-CEMP's requirements with respect to prey monitoring but requested (SC-CAMLR-VIII, Annex 5, paragraph 93) additional information on important characteristics of predators that need to be taken into account in krill surveys. This information was subsequently provided by CEMP (SC-CAMLR-VIII, Annex 7, Tables 4 and 5). Details of approximate spatial and temporal scales relevant to monitoring approved predator parameters at land-based sites were provided in WG-CEMP-90/12 and are summarised in Table 3 of this Report.

91. It was noted that, in relation to certain parameters (e.g., adult arrival weight, breeding population size and age-specific survival) predator foraging ranges may cover entire CCAMLR subareas and that long integration periods in terms of prey acquisition were involved. Other parameters entail integration periods that are shorter and foraging areas that are relatively localised. Considering the current level of understanding of krill distribution in space and time, correlating changes in predator parameters having long integration periods with prey abundance would require the latter to be monitored over both the predator's entire foraging area and integration period. It was considered that it would be impractical to expect this amount of prey survey effort to be available. Accordingly the Working Group agreed that, as an initial approach, it would be most practical to develop a krill survey strategy to be implemented during a period of two to two-and-a-half months (particularly during mid-December to late February) within a radius of approximately 100 km of land-based monitoring sites and to a water depth of 150 m.

92. The Working Group agreed that acoustic surveys offer the most practical approach to assessing krill availability at the temporal and spatial scales detailed above. Associated net sampling is also necessary to identify acoustic targets and to sample them accordingly.

93. Although it was recognised that absolute biomass estimates are preferred for prey monitoring as part of CEMP, relative biomass information for the December to February integration period and from year to year would be still very valuable. However, further consideration must be given to the following:

(i) the degree of precision required in the estimates of krill biomass related to the predator parameters having the appropriate integration period identified in paragraphs 90 and 91;

(ii) the compilation of data on areal distribution of krill; and

(iii) the methods of calculating relationships between survey design, associated survey effort and the expected precision of estimates.

A specific recommendation for developing (ii) and (iii) above is given in paragraphs 97 to 100.

94. The precision and accuracy of krill biomass estimates which can be undertaken at present have not yet been determined and it is not possible to specify a survey design in terms of the number of transects for a given area and the number of times that surveys should be repeated within the specified integration period.

95. The Working Group also noted additional constraints on surveys including the need to survey close inshore, and to take diurnal vertical migration of krill into account possibly by limiting acoustic surveys to daylight hours (see paragraph 100).

96. Dr Everson convened a small *ad hoc* group to consider matters related to the general problems of survey design as well as the statistical combination of line transect measurements of animal density to estimate biomass over a region and provide an associated variance estimate. Drs Agnew, Butterworth, Everson, Foote, Fedulov, Spiridonov and Murphy participated in the group.

97. Noting similar work being carried out within ICES, and on the basis of the *ad hoc* group's discussions, it is recommended that a small sub-group be charged to do the following:

(i) examine the problem of estimating krill biomass from acoustic measurements of density along line transects;

(ii) describe specific statistical techniques that can be used to derive estimates of biomass and associated variance;

(iii) describe how such estimates can be applied to various krill distributions, both assumed and observed;

(iv) meet for three days immediately prior to the next WG-Krill meeting in order to discuss and evaluate items (i) to (iii); and

(v) prepare a report to WG-Krill for consideration along with recommendation of specific standard techniques to be used by Members to describe krill distribution and estimate biomass from acoustic surveys.

98. Dr Everson agreed to convene the sub-group during the intersessional period and to coordinate its activities through correspondence and keep all other Members of the Working Group informed.

99. As predator monitoring is presently being undertaken in a number of areas it was suggested that, until detailed survey specifications are developed, Members wishing to determine krill distribution and biomass should adopt the approach set out in paragraph 100 below.

100. The Working Group considered SC-CAMLR-VI/BG/8 and used this as a basis for the development of interim guidelines for survey design. Surveys should be conducted by spacing as many transects as possible evenly over the study area. If possible, transects should be repeated several times during the two to two-and-a-half-month integration period. Given that krill may undertake diurnal migration, animals may be found close to the surface at night and consequently out of range of hull-mounted transducers. It is therefore suggested that surveys be conducted during a period of six to eight hours either side of solar noon. The remainder of the diurnal cycle could then be used to obtain relevant environmental data or to carry out more detailed investigations of areas of high krill abundance in the surface layer using nets. Acoustic surveys should be conducted using a frequency of at least 120 kHz and net hauls should be taken at approximately three-hourly intervals to identify acoustic targets etc.

101. Dr Fedulov indicated that it would be important to improve understanding of environmental processes associated with krill distribution and biomass parameters. In particular, he considered that attention should be focused on transport of Weddell Sea waters

to South Georgia, mixing of water from different origins in the Bransfield Strait, current flow along the Antarctic Peninsula, seasonal and interannual variability in ice edge position, atmospheric phenomena and perhaps some other major processes. Since these processes may greatly affect krill transport and distribution patterns, they should be primarily subjected to environmental monitoring.

102. Acoustic survey data may be presented in a number of ways. These include:

(i) density along line transects integrated over the water column and averaged over set distance intervals;

(ii) density along line transects integrated within selected water depth intervals and averaged over set transect intervals;

(iii) mean depth of swarm layers;

(iv) depth of the upper surface of swarms;

(v) length and thickness of swarms;

(vi) distance between swarms; and

(vii) within-swarm parameters from ping-by-ping analyses.

It is suggested the WG-CEMP consider which of these or other parameters would be most suitable for its purposes. Some details for the application of such parameters are provided in SC-CAMLR-VIII-BG/10.

103. It was noted that parameters such as those identified in paragraph 102 may vary during the course of a season. For instance, recent replicate surveys near Elephant Island conducted by the USA showed a five-fold increase in krill biomass (WG-Krill-90/11). It is clear therefore that replicate surveys should be carried out, and that the frequency of replication will depend on the precision required as well as any underlying structure in the dynamics of the krill concentration being considered. In addition, any identified changes in foraging range and behaviour of the predators including those changes related to specific stages in the breeding cycle should also be taken into account.

104. Since the spatial and temporal integration requirements influence the design of acoustic surveys, it is recommended that WG-CEMP provide advice on the changes in predator foraging range, behaviour and diet likely to occur during predator breeding cycles.

105. Attention was drawn to the environmental data required in terms of the spatial and temporal scales of krill monitoring desired by CEMP. In this context various papers were tabled (WG-CEMP-90/4, 11, 19 and WG-Krill-90/30).

106. At the 1989 Meeting of WG-Krill and at the 1989 Meeting of the Scientific Committee (SC-CAMLR-VIII, paragraph 5.21) information was requested on the possible application of satellite data for monitoring those environmental parameters most likely to influence krill biomass and distribution especially at the scales identified as practical in paragraph 91 above. WG-Krill-90/30 addressed this need. Table 4 lists the types and characteristics of satellites which the Working Group considered would be useful sources of data for monitoring krill. Dr Marín also reported that a cooperative program for a satellite network over the Antarctic was being developed by the FRG and Chile.

107. It was noted that satellite data would be useful for detecting hydrographic features, particularly with respect to large-scale processes such as fronts and gyres. Satellite information might also be of use in characterising surface water features associated with the movement of krill in and out of a particular area.

108. The Working Group agreed that information available from satellites concerning sea surface colour, sea surface temperature, sea surface altimetry and ice cover would contribute greatly in the delineation of gross hydrographic features such as fronts and gyres and also primary production.

109. A number of international programs are currently concentrating on large-scale hydrographic processes (see paragraph 28). For this reason finer resolution hydrographic information is unlikely to become available unless specific programs are developed. Despite the hydrographic complexity of important areas where krill concentrations may be found, such as the South Orkneys and the Antarctic Peninsula, information on large-scale processes influencing water dynamics in such areas was nevertheless considered to be useful.

110. It was agreed that direct measurements of currents (e.g., by Doppler current profiling) are preferred to geostrophic measurements in coastal areas. Physical and chemical water properties, to be used for identification of water masses, may be best obtained through direct

sampling. Sea ice position, cover and movement can be best determined by analysis of satellite imagery. Environmental data requirements for interpretation of krill surveys undertaken for CEMP are summarised in Table 5.

111. Progress was noted in the development of operational plans for collaborative and cooperative monitoring surveys in the Integrated Study Region as suggested by the Scientific Committee (SC-CAMLR-VIII, paragraph 5.21(d)). The Secretariat was requested to compile a list of all proposed joint surveys from the Reports of Members' Activities.

112. The potential utility of consolidating data derived from prey monitoring surveys was noted, and in this context attention was drawn to facilities such as Geographic Information Systems (GIS) (WG-CEMP-90/4) which would facilitate archiving and analysis of large amounts of data collected from specific areas. Dr R. Holt (USA) agreed to report back to the Working Group on possible applications of GIS with regard to the problem of predator/prey and environmental monitoring.

113. Along with the requirement that fine-scale krill catch data be reported for the Integrated Study Regions (specifically Subareas 48.1, 48.2 and 48.3), it was suggested that even finer scale data (e.g., haul-by-haul) also be reported from areas within 100 km of the shore where land-based predators colonies are found in these subareas. The impracticality of requesting two types of data from the fishery was pointed out and Dr V. Sushin expressed his concern that possible errors existed in the fine-scale data already submitted (see paragraph 15). The Data Manager agreed to investigate any possible errors in the fine-scale data in collaboration with scientists from the USSR.

114. Despite the request from the Scientific Committee (SC-CAMLR-VIII, paragraph 2.39) Dr Sushin indicated that the Soviet krill fishery was not in a position to collect haul-by-haul data and suggested that SC-CAMLR-VIII/BG/10 presents an alternative way of acquiring information of this kind. In this context, the Working Group noted that the presence of observers on Soviet commercial fishing vessels will allow some evaluation of the difficulties of obtaining haul-by-haul data in the future.

115. Although there was support for the experimental analysis of haul-by-haul data from small areas of ecologically interesting areas, it was pointed out that a good reason must be put forward for requesting such data and the desired time and space constraints should be specified. SC-CAMLR-VIII, paragraph 2.46 suggests that reporting of such data should only be specified once appropriate analyses have been identified. WG-Krill felt, however, that

some preliminary analyses of available haul-by-haul data are needed in order to facilitate identification of suitable analyses to be carried out on such data in general.

KRILL RESEARCH OF POTENTIAL USE IN PROVIDING FUTURE ADVICE FOR MANAGEMENT

Identification of Needs

116. The Working Group agreed that many of the aspects associated with the identification of needs for future krill research had already been discussed under Agenda Item 3. Reference should therefore be made to paragraphs 13 to 51 dealing with the need to improve krill stock identification, the assessment of krill abundance in various areas, the estimation of potential yield and the identification of demographic parameters considered to be important in the improvement of knowledge of both krill biology and associated aspects of the operational characteristics of the fishery (e.g., catchability of and selectivity for specific length classes).

Available Information

117. The Working Group discussed recommendations of the First Working Group Meeting and SC-CAMLR-VIII.

118. With regard to paragraphs 2.37 and 2.38 of SC-CAMLR-VIII (review of analyses of both past and currently available acoustic data and the examination of available echo-charts to gather data on krill concentration parameters and aggregation types), WG-Krill noted that consideration of Item 3 of its Agenda addressed these problems. However, it was felt that these analyses were still needed especially with respect to the investigation of the possible underlying causes of the formation and maintenance of fishable concentrations. It was agreed that the results of these analyses along with submissions on data access procedures should be reported to the Working Group's next meeting.

119. Concerning analysis of fine-scale data (SC-CAMLR-VIII, paragraph 2.41), a number of tabled papers specifically addressed this problem: SC-CAMLR-VIII/BG/43; WG-Krill-90/8; 9; 10 and 19. It was recognised that these analyses should be continued in view of a requirement to monitor the fishery activities specifically as these may be confined to relatively restricted areas.

120. The Working Group re-emphasised the importance of the continued evaluation of the potential utility and feasibility of collecting bridge log data, haul-by-haul catch and effort data (including relevant operational details) from commercial fishery and acoustic data from both survey and fishery vessels (SC-CAMLR-VIII, paragraphs 2.39, 2.40 and 2.46). In this connection it was noted that no new information has been provided. The Working Group encouraged the reporting of results of analyses of these data.

121. With regard to the collection of appropriate data aimed at quantifying demographic parameters (SC-CAMLR-VIII, paragraphs 2.40, 2.43 and 2.44), the Working Group noted that the Soviet Union is deploying scientific observers on commercial vessels and providing analysis facilities ashore. In relation to this the Working Group's attention was drawn to a form used by Soviet observers aboard commercial vessels (see WG-Krill-90/25). After some discussion it was agreed that the form be modified to include space for reporting the catch of post-larval and juvenile fish in commercial krill trawls and comments on the behaviour of associated krill predators. A modified version of this form will be prepared by the Secretariat and distributed to Members of the Working Group to provide guidelines for observers on commercial vessels in general. Prof. Lubimova also provided the Secretariat with 'Guidelines for Collecting and Reporting Data on the Occurrence of Juvenile Fish in Krill Trawls' (in Russian) used by observers on Soviet fishing vessels. The Working Group requested that these guidelines be translated.

122. In relation to the problem of incidental catch of post-larval and juvenile fish in krill commercial trawls the WG-Krill recognised that available information is limited and contradictory. In addition the Commission has requested specific advice on the problem in Subarea 48.3 (CCAMLR-VIII, paragraph 50). There was considerable discussion as to whether the by-catch was significant. Therefore the Working Group recommended that information on the amount of fish by-catch by species in the krill fishery (expressed as number and weight of fish) should be collected and reported to CCAMLR for consideration by the Working Group on Fish Stock Assessment.

123. The Working Group had an extensive discussion on the requirement to collect krill length data from commercial hauls (SC-CAMLR-VIII, paragraph 2.43 and 2.44) and papers WG-Krill-90/6, 11 Rev. 1, 26 and 27 were discussed. The Working Group accepted that it was unrealistic to expect the same intensity of sampling from commercial vessels as from scientific vessels. The Working Group concluded that the interim measure which requires the collection of at least 50 krill from one haul per day per vessel should stand until analyses

investigating the level of precision achievable had been carried out. The Working Group accepted that it was necessary to define how such data would be used before it could modify its recommendations concerning changes to the number of krill that should be collected.

124. The Working Group therefore recommended that commercial length frequency data already collected should be analysed either nationally or by the Secretariat, to estimate the level of precision achievable with the present sampling regime.

125. With regard to stock identification, Dr Spiridonov drew attention to work on the occurrence of two species of krill parasites which may have some utility in differentiating between krill populations (Dolzhenkov *et al*., 1987). Dr Nicol drew attention to several new methods for stock identification including mitochondrial DNA and suggested that the investigation of these methods would be a fruitful area for international cooperation. The Working Group recognised that this merited further investigation.

Spatial and Temporal Scales of Assessment

126. The Working Group recognised that an improved understanding of the dynamics of the advection of adult and sub-adult krill in and out of specific areas is crucial to many of the problems fundamental in the assessment of krill distribution and biomass.

Available Techniques and Future Data Requirements

127. It was recognised that given WG-Krill was producing recommendations on data requirements, it would be necessary to address the problems of data management in the near future to ensure optimal and efficient use of such data.

128. The Working Group emphasised that analyses submitted in future should contain sufficient details of methods and techniques (e.g., methods of biomass calculation and estimates of sampling variance) to allow comprehensive assessment by WG-Krill.

129. In view of the need to obtain information on large-scale water mass movement to interpret transport of krill through subareas, the Working Group noted that data pertinent to this were being collected and analysed as part of other international programs (e.g., WOCE, JGOFS). It was agreed that the Convener of WG-Krill should establish formal contact with SCOR to ensure an exchange of information.

130. The problems of estimating the potential yield of krill stocks in subareas of interest and of adequate survey design were addressed earlier in the Meeting. Various activities and tasks have been specified in the paragraphs 80, 100 and 102.

Future Work

131. The discussions at this meeting had identified many areas of importance to the Working Group in assessing the impact of fishing on krill stocks and krill availability to predators. It was felt that although it had been necessary to address this broad range of subjects at the first two meetings, priorities should be decided for the Working Group's work at future meetings.

132. It was agreed that in addition to the continuing requirement to review stock assessment work, attention be focused on the following specific areas:

(i) survey design;
(ii) development of management methods;
(iii) acoustic target strength of krill;
(iv) stock identification; and
(v) krill movement;

and that the highest priority be given to survey design and the development of management methods.

133. The Working Group also felt that at this stage it was essential to be able to plan ahead for the conduct of its work and be able to review progress annually. Various tasks had been referred to the Secretariat, others suggested to Members and some assigned to *ad hoc* groups (e.g., paragraphs 62, 68, 97 and 113) to be undertaken over the next 12 months whose reports should be reviewed at a meeting of the Working Group in 1991.

134. The Scientific Committee had deliberately scheduled and located the meetings of WG-Krill and WG-CEMP in 1990 to facilitate close communication between the two Working Groups. It was agreed that this arrangement had been beneficial and if possible similar arrangements should be made for the 1991 Meetings of the two Working Groups.

135. After considering the list of related meetings planned for 1991, it was agreed that the favoured timing for the meeting of the WG-Krill is in July/August 1991.

136. It was noted that the Scientific Committee at its 1990 Meeting will almost certainly raise matters for inclusion on the agenda of a meeting of WG-Krill in 1991. Nevertheless it was felt that the preparation of a draft agenda at this time, based on the items mentioned in paragraph 2 and the specific tasks referred to various groups throughout the Report, would be a concise means of recording the plans of the Working Group for the ensuing year and would facilitate an early beginning to preparations for the Meeting. The Draft Agenda is attached to this Report (Appendix D).

OTHER BUSINESS

137. Dr Naganobu suggested that available computer network systems should be investigated with a view to improving information flow among CCAMLR Member nations.

ADOPTION OF THE REPORT

138. The Working Group adopted the Report of the Meeting including the following:

ANSWERS TO THE SPECIFIC QUESTIONS RAISED BY THE COMMISSION

139. In answer to the questions posed by the Commission through the Scientific Committee (see paragraph 3 above), the Working Group refers the Scientific Committee and the Commission to the following sections of its Report:

(i) paragraphs 63 to 80 reflect the various opinions expressed. Some Members considered that a range of biomass estimates and potential yield could be provided on a crude basis; paragraphs 75 and 77 respectively reflect their views. Others expressed serious reservations about the biomass estimates and the formula used to calculate annual yield;

(ii) (a) this topic was addressed in general terms under Agenda Item 3(iii). Specific attention is drawn to the concepts developed in paragraph 61;

(b) paragraph 81 reflects suggestions on gear development to alleviate this problem. It is recommended that experiments be carried out on gear modification with a view to reducing the possible mortality of young fish in krill trawls. Paragraph 122 makes recommendations on data collection; and

(iii) requirements for new information are outlined in paragraph 80 and paragraphs 118, 119, 120, 122, 123, 124, 128 and 129. Determination of the time required to obtain sufficient data to provide satisfactory answers to the questions posed would be a substantial exercise which the Working Group was unable to carry out in the time available to it.

CLOSE OF THE MEETING

140. The Convener closed the Meeting and thanked the USSR Ministry of Fisheries for its hospitality in hosting the Meeting. He also thanked the rapporteurs, Secretariat and the Working Group Members for their participation and input.

Table 1: Scientific nets used in the Southern Ocean for krill research.

Gear	Advantage	Limitations
Polish German ″ Krill trawls	- large sample size - little to zero net avoidance - deployed on a large number of trawlers = large data set	- net deployment restricted to larger research vessels - net selection for krill > 40 – 45 mm depending on trawl mesh size
RMT 1 ------------------------- RMT 8	(a) relatively simple to handle on most research vessels (b) electronic device enables to have real time net data on e.g. depth of net, filtered water volume (c) opening and closing device for vertical profiles, multiple version of the net available (d) effective on krill larvae sampling -- (e) see (a) to (c) of RMT 1 (f) effective on relative abundance of krill (> 20 mm) for length and development stage compositions (g) working with conducting cable	- strong net avoidance of krill - especially uneffective for krill > 35 mm --- - net selection for krill > 20 mm - net avoidance in daylight, factor unknown - difficult to handle when no A-frame available on the ship
Bongo	- see (a) and (d) under RMT 1 - two samples at a time	- see RMT 1 - no real time information on depth of net - no opening/closing device
Neuston	- easy to handle on most ships - effective for late krill larvae during certain periods of the season	- impossible to handle during bad weather - restricted to surface sampling
MOCNESS[a] 1 10	- see RMT 1 (b) to (d) - see RMT 8 - working with conducting cables	- see RMT 1 - see RMT 8 - fixed net frame, difficult to handle on smaller vessels, requires large A-frame for deployment
IKMT 6’ 12’	- simple to handle on most research vessels - used as a gear for estimation since 1980 (USSR)	(a) unknown net avoidance and size selectivity (b) requires large A-frame for deployment - see IKMT 6’ under (a) (c) not very suitable for estimation of concentration density
Discovery net[b]	-	- see Bongo ?
Kaiyo Maru Midwater Trawl KYMT	- see RMT 8 (f)	- see RMT 8 - no opening/closing device
Fixed frame $5m^2$ IKMT (method modified)	- capable of high speed tows (≅ 4 Kt)	- unknown net avoidance and selectivity - requires large A-frame for deployment
BIONESS ($1m^2$)[a]	- see MOCNESS 1	- see MOCNESS 1
ORI net ($1.6\ m^2$)	- opening/closing device - easy to handle on research vessels	- no real time information on depth of net - see RMT 1
Commercial 77.4/202 ($78m^2$)	- used mainly for estimation of density of aggregations and concentrations	- underfishing of juveniles. Hardly suitable for data compilation on size composition of krill.
Samyshev-Yevdokimov trawl, developed jointly by YugNIRO and Scientific Research Association of Commercial Fisheries in Kaliningrad (NPO Promrybolovstva) ($30m^2$)	- used since 1989. Provides for acquisition of data reflecting precisely size composition of catches and krill concentration density. Reduces traumatism of animals entrapped in trawl (as compared with Isaacs-Kidd trawl). Proposed as standard fishing gear for scientific purposes in the USSR.	- is not equipped with opening/locking design. However after 1991 this shortcoming will be eliminated. Sectional system for trawl closing is under development.

[a] not used frequently but may have potential or is under development
[b] out of use except for comparative studies

Table 2.1: Krill biomass estimates derived from papers considered at the 1990 Meeting of WG-Krill: Subarea 48.1.

Area/Subarea	Source	Data Source and Method of Analysis	Area of Survey	Year and Month	Biomass Estimates ('000 t)	Density Estimates (g.m^{-2})
48.1	Nast 1986[a]	Trawl survey SIBEX I and II		Oct/Nov 1983 Nov/Dec 1984 Mar/Apr 1985	723 252 164	10.32 3.60 2.34
48.1 Antarctic Peninsula	SC-CAMLR-VIII/BG/21	Trawl surveys: *Eurica* March 1984 *Argus* December 1984 Analysis by strata	 92 300 km^2 84 600 km^2	 March 1984 December 1984	 1 233±41% 1 708±30%	 13.36 20.19
48.1	To be presented to SC-CAMLR-IX	Trawl survey (contoured, strata) (Saville 77) RV *Meteor* survey	14 310 n miles^2 97 200 n miles^2 78 940 n miles^2 88 230 n miles^2 93 800 n miles^2	February 1982 March 1985 May/June 1986 Nov/Dec 1987 Dec/Jan 1989/90	240 904 52 933 950	4.9±79% 2.7±102% 0.55±165% 3.2±82% 2.7±83%
48.1 Drake Passage	Kalinowski 1982[a]	FIBEX (Poland, Acoustic)		Feb/Mar 1981	1 195.6	8.40
48.1 Drake Passage	Lillo & Guzman 1982[a]	FIBEX (Poland, Acoustic)		Feb/Mar 1981	70.8	9.93
48.1 Bransfield Strait	Kalinowski 1982[a]	FIBEX (Poland, Acoustic)		Feb/Mar 1981	2 271	100.00
48.1 Bransfield Strait	Lillo & Guzman 1982[a]	FIBEX (Poland, Acoustic)		Feb/Mar 1981	448.8	22.26
48.1	Klindt 1986[a]	SIBEX I (FRG, Acoustic)		Oct/Nov 1983	51.7	0.72
		SIBEX II (FRG, Acoustic)		Nov/Dec 1984	379.8	5.48
		SIBEX II (FRG, Acoustic)		Mar/Apr 1985	16.5	0.26
48.1 Drake Passage	Kalinowski *et al.* 1985[a]	SIBEX I, (Poland, Acoustic)		Dec/Jan 1983/84	122.5	1.17
48.1 Bransfield Strait	Kalinowski *et al.* 1985[a]	SIBEX I, (Poland, Acoustic)		Dec/Jan 1983/84	70.6	0.88
48.1 Elephant Island	SC-CAMLR-VIII/BG/10	Acoustic surveys 1984-85	753 n miles^2 1 048 n miles^2	Dec/Jan 1984/85	541[b] 610[b]	209 170
48.1 (48.2, 48.5?) Drake Passage - Scotia Sea	SC-CAMLR-VIII/BG/52	Acoustic (south of 57°S)		1987/88	23 850	-
48.1 Elephant Island	SC-CAMLR-VII/BG/21	Acoustic 120/200 kHz	7 453 n miles^2	1988	260/715[c]	10.19/28.01
48.1 Bransfield Strait (part)	SC-CAMLR-VII/BG/21	Acoustic 120/200 kHz	2 894 n miles^2	1988	39/83[c]	3.94/8.38
48.1 Bransfield Strait	SC-CAMLR-VII/BG/21	Acoustic 120 kHz	7 787 n miles^2	1988	385	14.44
48.1 N. King George Island	SC-CAMLR-VII/BG/21	Acoustic 120 kHz	8 836 n miles^2	1988	309	10.21
48.1	WG-CEMP-90/11	Acoustic Survey 1 Survey 2 Survey 3 Survey 4		Jan/Feb 1990	range 465 (92-838) 1 132 (405-1 858) 2 133 (256-4 009) 2 475 (870-4 080)	

[a] Data from Table 4 of SC-CAMLR-VIII/BG/11
[b] Biomass of commercial aggregations
[c] Results of analyses at 120/200 kHz presented

Table 2.2: Krill biomass estimates derived from papers considered at the 1990 Meeting of WG-Krill: Subareas 48.2, 48.3 and 48.4.

Area/Subarea	Source	Data Source and Method of Analysis	Area of Survey	Year and Month	Biomass Estimates ('000 t)	Density Estimates ($g.m^{-2}$)
48.1 South Orkneys	SC-CAMLR-VIII/BG/10	Acoustic surveys 1984-85	2 002 n $miles^2$	January 1985	500*	0.251
48.3	WG-Krill-90/19	Commercial(C)/ Research(R) trawl surveys	51 690 km^2 33 370 km^2 12 700 km^2 14 700 km^2 11 700 km^2 48 113 km^2 12 600 km^2 79 120 km^2 2 820 km^2	March 1974 (C) February 1975 (C) June 1981 (C) July 1981 (C) June 1983 (C) October 1984 (C) November 86 (C) February 1988(R) May 1988 (C)	560 906 476 79 54 3.8 607 878 1 402	108.4 28.6 37.9 5.4 4.6 0.1 48.2 10.9 310.0
48.4 South Sandwich Is	WG-Krill-90/21	Trawl survey (biomass rich area treated separately)	90 391 km^2	Mar-Apr 1990 (0-100m layer)	3 385	-

* Biomass of commercial aggregations

Table 2.3: Krill biomass estimates derived from papers considered at the 1990 Meeting of WG-Krill: Subarea 58.4.

Area/Subarea/ Division	Source	Data Source and Method of Analysis	Area of Survey	Year and Month	Biomass Estimates ('000 t)	Density Estimates ($g.m^{-2}$)
58.4.1 Wilkes Land	WG-Krill-90/18	Commercial trawl survey of concentrations		1986-89	[a]	
58.4.2	Miller 1986[b]	SIBEX I net haul data		Mar/Apr 1984	550	3.48
58.4.2 Prydz Bay 48.6 Bouvet Is.	BIOMASS 1986[b]	FIBEX[c], Acoustic	4 512 000 km^2	Feb/Mar 1981	4 512	1.97
58.4.2 Prydz Bay	Miller 1987[b]	SIBEX II[c], Acoustic	1 090 000 km^2	Feb/Mar 1985	124	0.48
58.4.2 Prydz Bay	Higginbottom *et al*. 1988[b]	FIBEX[c], Acoustic	70 000 km^2	Jan/Mar 1981	1 300	1.2
58.4.2 Prydz Bay	Higginbottom *et al*. 1988[b]	ADBEX[c], Acoustic	1 280 000 km^2	Jan/Feb 1984	180	2.7
58.4.1 Prydz Bay 58.4.2	Higginbottom *et al*. 1988[b]	SIBEX II[c], Acoustic		Jan 1985	3 700	2.9
58.4.2	WG-Krill-90/17	Hydroacoustic surveys 1988-90	80 500 km^2	Jan/Feb 1988	3 500±600	43
			540 000 km^2	Feb 1989	12 000±4 000	75
			760 000 km^2	Jan 1990	30 000±10 000	84

[a] Specific concentrations were surveyed in three 'subareas' between 130° to 150°E, 64° to 66°S. Estimates of biomass for the subarea have not been calculated from this.

[b] Data obtained from SC-CAMLR-VIII/BG/11

[c] Australia, France, Japan, South Africa

Table 3: Aspects of temporal and spatial scales for developing prey surveys in support of CEMP.

Method Number	Dates	Integration Period	Foraging Range/Area (km)	Foraging Depth (m)
Prydz Bay Integrated Study Region				
A1	Oct	6-7 months	100s	?
A2	Nov-Dec	7-8 months	?	?
A3	Dec	>1 year		
A4				
A5	Dec-Feb	1-4 days		70-175
A6	Dec-Feb	4 months		
A7	Feb	2 months		
A8	Nov-Feb	14 days		
A9				
Antarctic Peninsula Integrated Study Region				
A1	Oct-Nov	6-7 months	100s	40-120
A2	Oct-Dec	7-8 months	25-50	40-120
A3	Oct-Nov	> 1 year	100s	40-120
A4	Oct-Feb	1 year	100s	40-120
A5	Nov-Feb	2.5 months	25-50	40-120
A6(A)	Jan	1 year	100s	40-120
A6(B/C)	Nov-Jan	2.5 months	25-50	40-120
A7	Jan-Feb	2 months	25-50	40-120
A8	Dec-Feb	5 months	25-50	40-120
A9	Oct-Feb	5 months	25-50	40-120
C1	Dec-Jan	60-70 days	100	25-120
C2	Dec-Mar	80-120 days	100	25-120
South Georgia Integrated Study Region				
A1	Oct-Nov	6-7 months	100s	20-150
A2	Nov-Dec	7-8 months	50-100?	20-150
A3	Nov	1 year	100s	20-150
A4	Oct-Feb	1 year	100s	20-150
A5	Jan-Feb	over 2 months	10-50	20-150
A6	Feb	3 months	10-100	20-150
A7	Feb	2 months	10-50	20-150
A8	Jan-Feb	7 days	10-50	20-150
A9				
C1	Nov-Mar	80-100 days	20-100	30-150
C2(A)	Dec-Mar	110 days	20-100	30-150
C2(B)	Jan-Mar	60 days	20-100	30-150

Table 4: Sources of satellite data that may be useful for monitoring environmental features in Antarctica.

Name of Sensor	Type of Data	Spatial Resolution (m)	Temporal Resolution (days)
NOAA Polar Orbiter	•visible radiance •near infrared •thermal infrared	1 100	< 0.25
Landsat Multispectral Scanner	•visible radiance •near infrared	80	15
Landsat Thematic Mapper	•thermal infrared	30	15
SPOT Multispectral Imager	•visible radiance •near infrared	10-20	10
European Research Satellite-1	•synthetic aperture radar	30	10
Soyuzkarta Panchromatic Imager		6	12*
Soyuzkarta Multispectral Imager	•visible radiance •near infrared	20	12*

* As plotted by the US Geological Survey

Table 5: Environmental data requirements for interpretation of krill surveys undertaken for CEMP.

Feature	Scale		Proposed Methods	Status*
	Spatial	Temporal		
1. WATER				
1.1 Water movements	Macro/Meso	Inter-annual Within season	Direct measurement of currents	M/R
1.2 Physical/chemical properties	Macro/Meso Micro	Inter-annual Within season Weekly	1. Nutrients/tracers 2. Temp., salinity 3. Satellite imagery	M/R M/R M/R
2. ICE				
Sea ice movement, ice edge position, % cover, polynyas	Macro/Meso	Inter-annual Within season	Satellite imagery	M

* Status: M = suitable to monitor now, R = topic currently the subject of research

APPENDIX A

AGENDA FOR THE SECOND MEETING

Working Group on Krill
(Leningrad, USSR, 27 August to 3 September 1990)

1. Welcome

2. Introduction
   (i) Review of the Working Group's Terms of Reference
   (ii) Review of the Meeting Objectives
   (iii) Adoption of the Agenda

3. Development of Approaches to Managing the Krill Fishery
   (i) Identification of Needs
      (a) Working Group's Fourth Term of Reference
      (b) Scientific Committee/Commission Questions (CCAMLR-VIII, paragraph 50)
   (ii) Available Information
      (a) Stock Identification
      (b) Assessment of Abundance
      (c) Estimation of Potential Yield
      (d) Identification of Demographic Parameters
   (iii) Review of Possible Approaches
   (iv) Development of Approaches and Future Data Requirements
   (v) Advice to the Scientific Committee

4. Krill Monitoring and Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP)
   (i) Identification of Needs (SC-CAMLR-VIII, paragraph 5.21)
      (a) Identification of Monitoring Areas
      (b) Development of Suitable Survey Design
      (c) Development of Survey Methods
      (d) Environmental and Krill Monitoring
   (ii) Available Information
   (iii) Spatial and Temporal Scales of Monitoring
   (iv) Techniques of Monitoring

(v) Future Data Requirements
(vi) Advice to the Scientific Committee

5. Krill Research of Potential Use in Providing Future Advice for Management
   (i) Identification of Needs
      (a) Stock Identification
      (b) Assessment of Abundance
      (c) Estimation of Potential Yield
      (d) Identification of Demographic Parameters
   (ii) Available Information (SC-CAMLR-VIII, paragraphs 2.37 to 2.44)
   (iii) Spatial and Temporal Scales of Assessment
   (iv) Available Techniques and Use of Forthcoming Data
   (v) Future Data Requirements
   (vi) Advice to the Scientific Committee

6. Future Work of the Working Group

7. Other Business

8. Adoption of the Report

9. Close of the Meeting.

APPENDIX B

LIST OF PARTICIPANTS

Working Group on Krill
(Leningrad, USSR, 27 August to 3 September 1990)

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APPENDIX C

LIST OF DOCUMENTS

Working Group on Krill
(Leningrad, USSR, 27 August to 3 September 1990)

Meeting Documents:

WG-KRILL-90/1	REVISED PROVISIONAL AGENDA
WG-KRILL-90/1 Rev. 1	AGENDA
WG-KRILL-90/2	LIST OF PARTICIPANTS
WG-KRILL-90/3	LIST OF DOCUMENTS
WG-KRILL-90/4	ON INVESTIGATION OF ANNUAL FLUCTUATION OF *EUPHAUSIA SUPERBA* LARVAE A.S. Fedotov and L.L. Menshenina (USSR)
WG-KRILL-90/5	SIZE COMPOSITION IN *EUPHAUSIA SUPERBA*'S MALES AND FEMALES IN THE COURSE OF LIFE CYCLE R.R. Makarov (USSR)
WG-KRILL-90/6	A STANDARDISED SAMPLING PROCEDURE FOR COMMERCIAL KRILL CATCHES S. Nicol (Australia)
WG-KRILL-90/7	UNITED STATES AMLR PROGRAM 1989/90 FIELD SEASON REPORT
WG-KRILL-90/8	FINE-SCALE CATCHES OF KRILL IN SUBAREA 48.1 Secretariat
WG-KRILL-90/9	FINE-SCALE CATCHES OF KRILL IN SUBAREA 48.2 Secretariat
WG-KRILL-90/10	FINE-SCALE CATCHES OF KRILL IN SUBAREA 48.3 Secretariat
WG-KRILL-90/11	HOMOGENEITY OF BODY LENGTH COMPOSITION OF ANTARCTIC KRILL WITHIN THE COMMERCIAL HAUL T. Ichii (Japan)
WG-KRILL-90/11 Rev1	HOMOGENEITY OF BODY LENGTH COMPOSITION OF ANTARCTIC KRILL WITHIN THE COMMERCIAL HAUL T. Ichii (Japan)

WG-KRILL-90/12	Withdrawn
WG-KRILL-90/13	AN EVALUATION OF REDUCED TARGET STRENGTH ESTIMATES REPORTED FOR KRILL *(EUPHAUSIA SUPERBA*) Michael C. Macaulay (USA)
WG-KRILL-90/14	FACTORS TO CONSIDER IN DEVELOPING MANAGEMENT MEASURES FOR KRILL William K. de la Mare (Australia)
WG-KRILL-90/15	COMMENTS ON THE CALCULATION OF THE COMPOSITE INDEX OF KRILL ABUNDANCE V.A. Spiridonov (USSR)
WG-KRILL-90/16	THE DISTRIBUTION PATTERN AND FISHERY FOR THE ANTARCTIC KRILL (*EUPHAUSIA SUPERBA)* OFF THE WILKES LAND AND BALLENY ISLANDS (WITH NOTES ON THE APPLICATION OF CPUE DATA AS INDICES OF KRILL ABUNDANCE) V.N. Dolzhenkov, E.A. Kovalev, V.A. Spiridonov, V.P. Timonin, I.A. Zhigalov (USSR)
WG-KRILL-90/17	CONDITION OF KRILL RESOURCES IN THE STATISTIC REGIONS 58.4.2 AND 58.4.3 IN 1988-1990 FROM THE ACOUSTIC SURVEY DATA V.A. Bibik and V.N. Yakovlev (USSR)
WG-KRILL-90/18	THE CHARACTER OF DISTRIBUTION AND STATE OF THE RESOURCES OF *EUPHAUSIA SUPERBA DANA* IN THE AREA OF THE WILKES LAND (Data for seasons 1985/86-1988/89) V.N. Dolzhenkov and V.P. Timonin (USSR)
WG-KRILL-90/19	THE DISTRIBUTION, BIOMASS AND CHARACTERISTICS OF THE FISHERY FOR *EUPHAUSIA SUPERBA* OFF THE SOUTH GEORGIA ISLAND (SUBAREA 48.3) V.I. Latogursky, R.R. Makarov and L.G. Maklygin (USSR)
WG-KRILL-90/20	CHARACTERISTICS OF DISTRIBUTION OF KRILL AGGREGATIONS IN FISHING GROUNDS OFF CORONATION ISLAND IN 1989-1990 SEASON S.M. Kasatkina and V.I. Latogursky (USSR)
WG-KRILL-90/21	KRILL BIOMASS ASSESSMENT IN STATISTICAL AREA 48 IN AUTUMN 1989-90 FROM THE TSM *ATLANTNIRO* DATA A.C. Fedotov (USSR)

WG-KRILL-90/22 MIDWATER TRAWL CATCHABILITY ON KRILL EXPLOITATION AND POSSIBLE APPROACHES TO KRILL TOTAL EXEMPTION ASSESSMENT
Yu.V. Zimarev, S.M. Kasatkina and Yu.P. Frolov (USSR)

WG-KRILL-90/23 SUMMARY RESULTS OF KRILL INTEGRATED STUDIES IN STATISTICAL AREA 48 CARRIED OUT IN RESEARCH CRUISES OF RV *ARGUS* AND RV *EVRIKA* IN 1984-1988
V.A. Sushin, L.G. Maklygin and S.M. Kasatkina (USSR)
(available in Russian only)

WG-KRILL-90/24 PRELIMINARY RESULTS OF RESEARCH CRUISE OF RV *ATLANTNIRO* TO THE WEST OF THE ATLANTIC OCEAN SECTOR OF THE ANTARCTIC IN MARCH-APRIL 1990
P.P. Fedulov, V.N. Shnar, A.C. Fedotov and I.V. Krasovsky (USSR)
(available in Russian only)

WG-KRILL-90/25 REPORT OF THE SCIENTIFIC OBSERVER ABOARD FISHING VESSEL BMRT *SAPFIR*
V.I. Latogursky (USSR)
(available in Russian only)

WG-KRILL-90/26 HOW MANY KRILL SHOULD WE MEASURE?
Yoshinari Endo (Japan)

WG-KRILL-90/27 ON THE INTENSITY OF SAMPLING KRILL TRAWL CATCHES
D.G.M. Miller (South Africa)

WG-KRILL-90/28 MEASUREMENTS OF DIFFERENCES IN THE TARGET STRENGTH OF ANTARCTIC KRILL (*EUPHAUSIA SUPERBA)* SWARMS AT 38 AND 120 KHZ
I. Hampton (South Africa)

WG-KRILL-90/29 ACOUSTICALLY ESTIMATING KRILL ABUNDANCE IN THE SOUTHERN OCEAN
Charles H. Greene, Sam McClatchie, Peter H. Wiebe and Timothy K. Stanton (USA)

WG-KRILL-90/30 DISCUSSION OF SATELLITE IMAGERY APPLIED TO CAMLR REGIONS
Robert E. Dennis (USA)

Other Documents:

WG-CEMP-90/4 AN APPROACH TO INTEGRATED ANALYSES OF PREDATOR/PREY/ ENVIRONMENTAL DATA
Stephanie N. Sexton and Jane E. Rosenberg (USA)

WG-CEMP-90/11 SURFACE WATER MASSES, PRIMARY PRODUCTION, KRILL DISTRIBUTION AND PREDATOR FORAGING IN THE VICINITY OF ELEPHANT ISLAND DURING THE 1989-90 AUSTRAL SUMMER
Anthony F. Amos *et al*. (USA)

WG-CEMP-90/12 TEMPORAL AND SPATIAL SCALES FOR MONITORING CEMP PREDATOR PARAMETERS (WG-CEMP)

SC-CAMLR-VIII/BG/4 PROPOSALS OF STANDARDIZATION OF COMPLEX INVESTIGATIONS AIMED AT CREATION OF A SYSTEM OF BIOLOGO-OCEANOGRAPHIC MONITORING IN THE ANTARCTIC WATER
Delegation of USSR

SC-CAMLR-VIII/BG/5 METHODICAL INSTRUCTIONS IN CONSTRUCTION OF A MODEL OF THE QUANTITATIVE DISTRIBUTION OF KRILL BY DATA OBTAINED IN OCEANOGRAPHICAL, BIOLOGICAL AND HYDROACOUSTIC SURVEYS
Delegation of USSR

SC-CAMLR-VIII/BG/7 SUMMARISED RESULTS OF AN INTEGRATED FISHERIES SURVEY IN THE 1987/88 SEASON
USSR
(Available in Russian only)

SC-CAMLR-VIII/BG/9 THE INFLUENCE OF THE SHAPE OF MESHES ON THE SELECTIVE PROPERTIES OF TRAWLS WITH SPECIAL REFERENCE TO ANTARCTIC KRILL
Delegation of USSR

SC-CAMLR-VIII/BG/10 ASSESSMENT OF KRILL BIOMASS IN FISHING GROUNDS USING THE DATA ON FISHING INTENSITY AND HYDROACOUSTIC METHOD
Delegation of USSR

SC-CAMLR-VIII/BG/11 COMMERCIAL KRILL FISHERIES IN THE ANTARCTIC 1973 – 1988
Delegation of South Africa

SC-CAMLR-VIII/BG/17 TOWARDS AN INITIAL OPERATIONAL MANAGEMENT PROCEDURE FOR THE KRILL FISHERY IN SUBAREAS 48.1, 48.2 AND 48.3
D. Butterworth (South Africa)

SC-CAMLR-VIII/BG/19 THE RELATIONSHIP BETWEEN KRILL (*EUPHAUSIA SUPERBA*) FISHING AREAS IN THE WEST ATLANTIC AND THE SPECIES' CIRCUMPOLAR DISTRIBUTION
D. Miller (South Africa)

SC-CAMLR-VIII/BG/21 POPULATION SUBDIVISION AND DISTRIBUTION OF *EUPHAUSIA SUPERBA* IN THE REGION OF THE ANTARCTIC PENINSULA AND ADJACENT WATERS IN RELATION TO FISHERY DEVELOPMENT
Delegation of USSR

SC-CAMLR-VIII/BG/22 GROWTH AND MATURATION OF *EUPHAUSIA SUPERBA* DANA IN NORTHERN AREAS OF ITS DISTRIBUTION RANGE (WITH REFERENCE TO SOUTH GEORGIA AND BOUVET ISLAND AREAS)
Delegation of USSR

SC-CAMLR-VIII/BG/23 ANALYSIS OF OPERATING CONDITIONS OF THE FISHING VESSEL IN RELATION TO THE DISTRIBUTION, BIOLOGICAL STATE AND BEHAVIOUR OF ANTARCTIC KRILL (A CONTRIBUTION TO THE DEVELOPMENT OF SIMULATION MODEL)
Delegation of USSR

SC-CAMLR-VIII/BG/24 DATES OF SPAWNING OF ANTARCTIC EUPHAUSIIDS
Delegation of USSR

SC-CAMLR-VIII/BG/28 CPUES AND BODY LENGTH OF ANTARCTIC KRILL DURING 1986/87 SEASON IN THE FISHING GROUND NORTHWEST OF ELEPHANT ISLAND
Delegation of Japan

SC-CAMLR-VIII/BG/29 COMPARISON OF BODY LENGTH OF ANTARCTIC KRILL COLLECTED BY A TRAWL NET AND *KAIYO MARU* MIDWATER TRAWL
Delegation of Japan

SC-CAMLR-VIII/BG/30 TARGET STRENGTH ESTIMATION OF ANTARCTIC KRILL, *EUPHAUSIA SUPERBA* BY COOPERATIVE EXPERIMENTS WITH COMMERCIAL TRAWLERS
Delegation of Japan

SC-CAMLR-VIII/BG/31 DISTRIBUTION OF ANTARCTIC KRILL CONCENTRATIONS EXPLOITED BY JAPANESE KRILL TRAWLERS AND MINKE WHALES
Delegation of Japan

SC-CAMLR-VIII/BG/43 KRILL FISHING, ANALYSIS OF FINE-SCALE DATA REPORTED TO CCAMLR
Delegation of United Kingdom

SC-CAMLR-VIII/BG/44 THE FINE-SCALE DISTRIBUTION OF KRILL IN AREA 48 DURING 1987 AND 1988
Secretariat

SC-CAMLR-VIII/BG/52 THE FIFTH ANTARCTIC OCEAN SURVEY CRUISE OF JFA RV *KAIYO MARU* SUMMARY OF RESULTS
Delegation of Japan

SC-CAMLR-VI/BG/8 PREY MONITORING SURVEYS
Delegation of United Kingdom

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EVERSON I., J.L. WATKINS, and D.G. BONE, and K.G. FOOTE. 1990. Implications of a new acoustic target strength for abundance estimates of Antarctic krill. *Nature* 345(6273): 338-340.

FOOTE K.G., I. EVERSON, J.L. WATKINS, and D.G. BONE. 1990. Target strengths of Antarctic krill (*Euphausia superba*) at 38 and 120 kHz. *J. Acoust. Soc. Am*. 87(1): 16-24.

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APPENDIX D

DRAFT AGENDA FOR THE THIRD MEETING

Working Group on Krill

1. Opening of the Meeting
2. Matters Referred by the Scientific Committee
3. Development of Approaches to Managing the Krill Fishery
4. Krill Survey Methods
5. Stock Identification
6. Acoustic Target Strength of Krill
7. Krill Movement
8. Krill Biomass and Distribution
9. Coordination with CEMP
10. Other Business
11. Adoption of the Report
12. Close of the Meeting.

ANNEX 5

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 9 to 18 October, 1990)

TABLE OF CONTENTS

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 9 to 18 October, 1990)

INTRODUCTION

The meeting of the Working Group on Fish Stock Assessment (WG-FSA) was held at the CCAMLR Headquarters, Hobart, Australia from 9 to 18 October 1990. The Convener (Dr K.-H. Kock, Germany) chaired the Meeting.

2. The Convener welcomed participants to the Meeting and noted with regret that several long-standing Members of the Working Group were unable to be present. Dr Guy Duhamel (France), at short notice, was unable to attend and Dr W. Slosarczyk (Poland) was recovering from a long illness.

3. The Working Group was saddened to learn of the death of Dr John Gulland FRS. John had had an interest in the Antarctic extending over many years and had until recently participated in CCAMLR meetings initially as an Observer for FAO and then on the EEC Delegation. He had been a key figure in establishing the Working Group both as a contributor to discussion and rapporteur from 1984 to 1988.

GENERAL MATTERS AND APPOINTMENT OF RAPPORTEURS

4. A List of Participants is given in Appendix A.

5. The following were appointed rapporteurs:

- Dr I. Everson (UK), Agenda Items 1 to 5;
- Dr M. Basson (UK), Agenda Item 6;
- Conveners of Assessment Groups, Agenda Item 7;
- Dr A. Constable (Australia), Agenda Item 8; and
- Dr D. Agnew (Secretariat), Agenda Items 9 and 10.

ADOPTION OF THE AGENDA

6. Several minor amendments were made to the Provisional Agenda and it was adopted in its revised form. The Agenda is attached as Appendix B, and a List of Documents presented to the Meeting is attached as Appendix C.

POSSIBLE IMPROVEMENTS IN THE SCIENTIFIC COMMITTEE'S ABILITY TO PROVIDE MANAGEMENT ADVICE

7. In paragraph 3.49 of SC-CAMLR-VIII, the Scientific Committee had asked the Convener of the WG-FSA to advise on what would be needed to improve the Scientific Committee's ability to provide advice for the management of fish stocks. The Convener had prepared a draft document which was edited and amended during the Meeting and is attached as Appendix D.

REVIEW OF MATERIAL FOR THE MEETING

Catch and Effort Statistics

8. Data submissions were incomplete at the start of the Meeting and although some data were provided during the Meeting, the data were still incomplete when the analyses were undertaken. Indications of the data submitted and gaps in the dataset are shown in SC-CAMLR-IX/BG/5.

Size and Age Composition Data

9. Submissions of size and age composition data for 1989/90 were incomplete and did not always correspond with locations and times of catch and effort data. The status of the different datasets is shown in SC-CAMLR-IX/BG/5.

By-Catch of Fish Larvae and Juvenile Fish in the Krill Fishery

10. The Working Group noted that this topic has been raised several times over the past few years, initially at the BIOMASS Working Group on Fish Ecology and more recently within CCAMLR. No action has been taken by CCAMLR to quantify the by-catch of fish in the krill fishery in spite of considerable concern expressed by many Members.

11. Several papers have been published which either report catches of fish in krill trawls, or else indicate situations when krill trawls might catch significant quantities of fish. Relevant summary information abstracted from these papers is given in the following paragraphs.

12. Rembiszewski *et al.* (1978) undertook a study from January to March 1976 in the Atlantic sector of the South Ocean. 27 species of fish were caught in association with krill swarms. Juvenile Channichthyidae were the dominant group in the catches. Hauls made on the shelf at South Georgia during the night contained about 5% of Channichthyidae by weight. This amount was considered by the authors to be insignificant in terms of contamination of the krill catch but could be significant in affecting recruitment of these fish species. There are indications that the fish tend to be present on the edges of krill swarms. Hauls made in the centre of large krill swarms generally contain few fish.

13. Slosarczyk and Rembiszewski (1982) studied fish by-catch in krill trawls in the Bransfield Strait and Elephant Island region from February to March 1981. Juvenile and post-larval Channichthyidae and Nototheniidae were present in nearly all the hauls made on the shelf in the Bransfield Strait, Elephant Island and north of South Shetland Islands. The authors concluded that, although these fish represent only a small proportion of the total catch, if these catch rates are representative of the commercial fishery there could be significant adverse effects on fish recruitment.

14. Slosarczyk (1983a) found significant numbers of *Trematomus bernacchii* and *Pagothenia brachysoma* in trial hauls on the shelf in the vicinity of the Balleny Islands from January to February 1978. This is an area where the author noted that a significant amount of krill fishing has taken place in the past.

15. Slosarczyk (1983b) found large numbers of Nototheniidae and Channichthyidae in experimental krill catches in the vicinity of Clerke Rocks at the eastern end of South Georgia.

16. On 11 April 1977, off Clerke Rocks, Kompowski (1980a) noted juvenile (18 to 23 cm total length) *Champsocephalus gunnari* in krill concentrations. In several hauls these fish constituted about 20% of the catch by weight. During this study krill were being processed into meal by a large fishing fleet and large numbers of juvenile fish were observed in the krill catches.

17. In the same study, Kompowski (1980b) found significant numbers of juvenile *Chaenocephalus aceratus* (7.8 to 11.2 cm total length) in the catches of krill trawls. These fish were found to have been feeding exclusively on krill, dawn and dusk being the times of the most intensive feeding activity.

18. During the BIOMASS/SIBEX experiment in the Antarctic Peninsula region the largest concentrations of juvenile fish were found in hauls made in the Bransfield Strait (Slosarczyk and Cielniaszek, 1985). The authors concluded that juvenile fish of commercial species do not occur in great numbers associated with krill swarms during the period December to March in this area.

19. Williams (1985) analysed results from a series of RMT hauls in the Prydz Bay area. The largest by-catches of fish were taken in hauls on the shelf or near to the shelf break. He found up to 13% by weight of juvenile fish in all RMT hauls directed at krill swarms, rising to 19% in aimed hauls on the shelf. 95% of the fish were young *Pleuragramma antarcticum*, with the balance comprising juvenile channichthyids.

20. Skora (1988), during a study in the 1986/87 season found 24 fish species belonging to six families in a series of hauls using a krill trawl in the South Shetlands area. He noted an increased frequency of *Chaenodraco wilsoni* and fewer *Chaenocephalus aceratus* in the catches compared with previous seasons.

21. These results from research vessel surveys demonstrate that, under certain circumstances and in some regions, large numbers of fish are likely to be taken in the course of the directed fishery for krill. The results also indicate that the by-catch of juvenile and larval Nototheniidae and Channichthyidae is greatest on the shelf and near to the shelf break. It is not clear whether this effect is present during the winter months at South Georgia when the krill fishery there is at its peak (Everson and Mitchell, 1989). No information was available to the Meeting on the distribution of young fish in winter at South Georgia.

22. It was noted that the only information available to the Working Group on the by-catch of fish in commercial krill trawls was anecdotal and remained unsubstantiated.

23. It was agreed that the problem of by-catch of fish in the krill fishery should be investigated further. Two approaches were considered necessary. Firstly, rigorous monitoring of the commercial krill fishery in order to determine the magnitude of the problem. Secondly, determinations of the locations and times of year when the demersal fish are at greatest risk. For example, at South Georgia, results from young fish surveys in winter would be of particular importance.

24. Mr D. Miller (South Africa), Convener of the Working Group on Krill (WG-Krill), reported on discussions at the recent meeting in Leningrad. During WG-Krill, Prof. T. Lubimova (USSR) had stated that the USSR had initiated a monitoring program to determine the quantity of fish taken as by-catch in the USSR krill fishery. Dr K. Shust (USSR) indicated that the results would be available at the Ninth Meeting of the Scientific Committee. The USSR monitoring protocol was not available to this WG-FSA Meeting.

25. The WG-Krill had provided a modified version of the USSR krill catch monitoring record sheet to include a section on by-catch of fish in the catch. This was seen by WG-FSA as a useful start but, because there was no provision for quantitative information or species composition, this form was considered inadequate for assessing by-catch of fish in krill catches.

26. The WG-FSA agreed that, in view of the observations recorded in the work described in paragraphs 12 to 20, it may be prudent for the Scientific Committee to recommend the prohibition of krill fishing in areas considered to be fish nursery areas until further data are collected and analysed.

27. The Working Group recommended that in order to obtain the necessary data, a program monitoring the by-catch of fish in the krill fishery should be initiated as soon as possible. The following is an outline of the program that the Working Group considered would provide information that would allow it to assess the magnitude of the problem.

(i) Data Collection: The Secretariat was asked to prepare a Daily Logsheet for recording the information. A draft will be circulated to Members for comment (see paragraph 300).

(ii) Field Personnel: Observers would need to be designated to monitor the krill catches whilst onboard commercial krill fishing vessels.

(iii) Species identification: The observers would be trained to identify juvenile specimens of the main species likely to appear in the krill catches. All post-larval fish would be counted and preserved for examination in a laboratory. It was noted that there had been offers in the past for the use of plankton sorting facilities. It was felt that making use of such facilities would provide a useful means of standardisation of sample analysis.

(iv) Duration: It was recommended that the program be conducted initially for a period of five years.

28. The Working Group draws the attention of the Scientific Committee to the fact that establishing and running such a program will have financial implications.

29. The WG-Krill had also discussed use of separator panels in the codend of trawls to minimise the by-catch of fish in the commercial fishery. WG-FSA was unaware of any such developments in pelagic fisheries but felt that such devices might be effective. It was agreed that, even if such devices were developed now, they would be unlikely to be used widely for several years.

Other Available Biological Information

30. New information was provided on Myctophidae in WG-FSA-90/18, 19, 20, 21, 23, 35, and 36.

31. In 1989/90 the fishery was conducted in two areas, deep water around the South Polar Frontal Zone to the north of South Georgia; and, on the shelf around Shag Rocks. A midwater trawl is used with a vertical opening and width of 30 metres. Tows normally last from one to five hours. Fishing vessels search for temperature discontinuities and then survey the area acoustically to determine optimum locations for fishing. Most of the catch is converted to meal and oil although some is frozen for experimental food production.

32. Catches larger than one tonne tend to be of pure *Electrona carlsbergi*. Smaller catches tend to contain other species such as *Gymnoscopelus nicholsi*.

33. Avian predators do not appear to congregate in the vicinity of myctophid aggregations. It is not clear which are the major predators on *E. carlsbergi*.

34. Two papers (WG-FSA-90/7 and 34) were tabled on the toothfish *Dissostichus eleginoides*.

35. There is no evidence to support the view that the fish taken in the commercial longline fishery are senescent as stated at CCAMLR-VIII (CCAMLR-VIII, paragraph 106). All available evidence indicates that these fish are either sexually mature or immature.

36. Analysis of data from longlining before the start of the fishery had been used to determine constants of the von Bertalanffy growth equation. Some Members suggested that, since only fish up to age 18 years were represented in the samples and this species is known to live longer, this could lead to an overestimate in the parameter 'k' which would have consequences for the subsequent length cohort analyses.

37. New information on age and growth in *Notothenia rossii* from the South Shetland Islands was provided in WG-FSA-90/9. There was good agreement between results from ageing using otoliths and scales for juvenile fish. Differences between results presented at the Meeting and some other published results were attributed to:

(i) population/geographical variations of the fish sampled;

(ii) size-specific as opposed to age-specific offshore migration (the larger sized fish of an age class are thought to migrate offshore first); and

(iii) different criteria used in the interpretation of annual growth rings.

38. Analysis of data from trammel net hauls at Potter Cove, South Shetland Islands over a period of eight years indicated that there had been a decline in the abundance of *N. rossii* and *Notothenia gibberifrons* (WG-FSA-90/14). It was thought that the cause was unlikely to be due to an increase in numbers of predators because *Notothenia neglecta*, a species that does not migrate out of the bays, showed no decline. The most likely cause appears to be that the decline is a consequence of the level of fishing in the early 1980s in the area.

39. A pilot study on stock separation in *C. gunnari* at South Georgia using protein electrophoresis (WG-FSA-90/10) indicated that there is evidence for there being separate stocks at South Georgia and Shag Rocks. It is planned to continue this study on a larger scale in the forthcoming season. Additional studies, using different techniques such as mitochondrial DNA, were reported using samples from Kerguelen and Heard Island. Dr Kock, Mr R. Williams (Australia), Mr E. Balguerias (Spain) and Dr Everson agreed to try to

collect samples from their own study areas to supply to other analysts, as there are advantages in including samples from widely spaced as well as close locations for the analyses.

40. Information on growth in *C. gunnari* using vertebrae was provided in WG-FSA-90/33. The length at age was similar to that determined from several studies using otoliths. There is a larger difference between all these results and those derived from daily growth increments in otoliths.

Mesh Selectivity and Related Experiments

41. Further information on mesh selectivity in *C. gunnari* around South Georgia was provided in WG-FSA-90/32 which gave essentially similar results to studies previously presented to the Working Group.

42. It was noted that this is a topic on which the Working Group had been asked to provide advice in the past (CCAMLR-VI, paragraph 84 and CCAMLR-VII, paragraph 87) and had done so through the Scientific Committee (SC-CAMLR-VIII, paragraph 3.18). Some Members noted with regret that this advice with respect to modification of mesh size regulations contained in Conservation Measure 2/III had been rejected (CCAMLR-VIII, paragraphs 80 to 83).

Assessments Prepared by Member Countries

43. Assessments were considered by species within statistical subareas.

Subarea 48.3

44. New assessments on *C. gunnari* were presented in papers WG-FSA-90/26, 27 and 34.

45. Concern was expressed that age composition data from research vessels rather than commercial vessels had been used for the analyses. The research vessel catches had been made using bottom trawls whereas the commercial fleet was restricted to the use of midwater trawls by Conservation Measure 13/VIII. It was pointed out that there are difficulties in obtaining such information from the commercial fleet.

46. In response to criticisms expressed at last year's meeting (SC-CAMLR-VIII, Annex 6, paragraph 66), a multiplicative model had been used to standardise fishing effort indices. This incorporates components for vessel power, gear type and time of year.

47. It was noted that in the process of adjusting the model, an unestimable source of variation is associated with the number of hauls within a month. It was also noted that previous experience in the use of multiplicative models for CPUE standardisation indicates that this effect is reasonable so long as the factors are reasonably balanced. A logarithmic transform will stabilize the variances so long as the effort is not too small (de la Mare, 1987).

48. Assessments on *Patagonotothen brevicauda guntheri* were provided in WG-FSA-90/12 and 28.

49. Catches had been low during the 1989/90 season due to the imposition of a 12 mile limit which closed most of the fishing grounds around Shag Rocks.

50. Analysis of fine-scale data submitted to CCAMLR indicated that catches of *P.b. guntheri* had been reported from areas where they have never been found during surveys. It was suggested that the location of these catches may have been incorrectly reported. An alternative explanation is that a significant by-catch of other species may have been taken and reported as *P.b. guntheri*. This species is also reported as a by-catch in fishing targeted at larger species (e.g., *C. gunnari*) for which a mesh size regulation applies, and this suggests that illegal nets may have been used.

51. An assessment of *C. aceratus* and *Pseudochaenichthys georgianus* was provided in WG-FSA-90/6.

Subarea 48.2

52. A re-assessment of the stock of *N. gibberifrons* was provided in WG-FSA-90/16.

Subarea 58.5

53. A re-analysis of data from *C. gunnari* from the Kerguelen Shelf and Skif Bank was provided in WG-FSA-90/17.

54. An analysis of *N. rossii* at Kerguelen was provided in WG-FSA-90/41. Some discrepancies were noted between catches submitted to CCAMLR and those provided in the paper. This is probably due to the use of calendar year in WG-FSA-90/41 instead of split-year as commonly used in CCAMLR.

Subarea 58.4

55. An assessment of the stocks of *Notothenia squamifrons* on the Ob and Lena Banks was provided in WG-FSA-90/37. Some differences were noted between the catch figures included in the paper and those reported to CCAMLR (see Figure 1). Although the data had been reported by calendar year, this did not fully explain the large discrepancy in total catch of *N. squamifrons* in Division 58.4.4. The Data Manager was asked to investigate further.

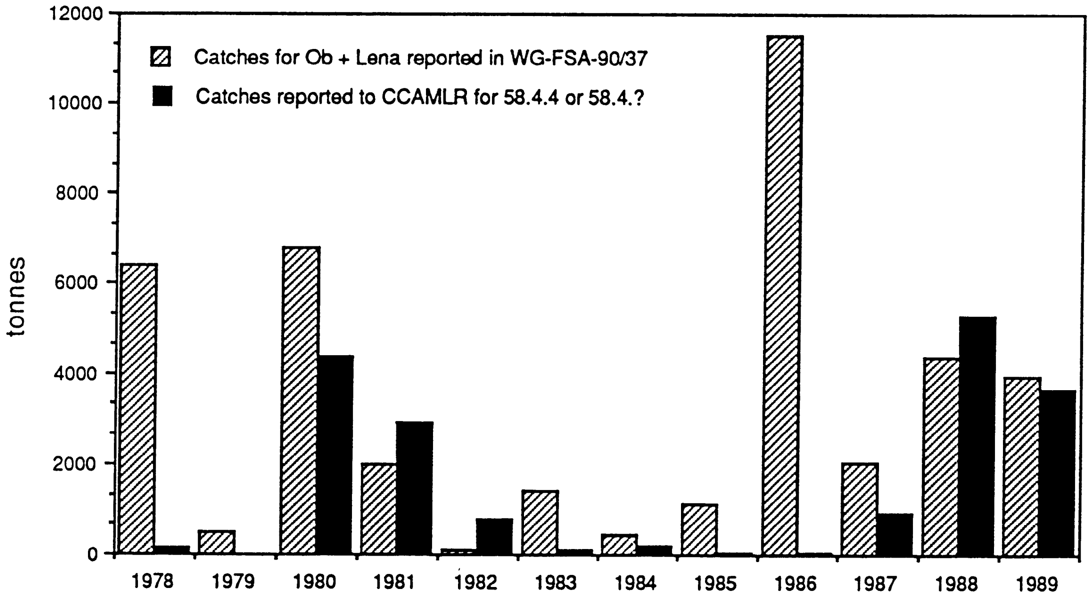

Figure 1: Comparison of reporting of catches from Division 58.4.4 (Ob and Lena Banks).

Other Relevant Documents

56. Results of demersal fish surveys around South Georgia were reported in documents WG-FSA-90/11, 13, 29 and 30 and from Kerguelen in WG-FSA-90/38 and from Heard Island in WG-FSA-90/42.

57. Results of integrated Soviet research expeditions in the Indian Ocean sector were provided in WG-FSA-90/39 and 40. First results of Italian research activities on the coastal ichthyofauna in Terra Nova Bay (Ross Sea) were provided in WG-FSA-90/43.

58. Revised estimates of areas of seabed for specified depth strata within Subarea 48.3 were provided in WG-FSA-90/8.

59. Descriptions of assessment software available in the Secretariat were provided in WG-FSA-90/22 and the analyses undertaken during the 1989 Meeting of the Working Group were described fully in WG-FSA-90/5.

METHODOLOGIES USED FOR SURVEYS AND ASSESSMENTS

60. The Working Group asked the Secretariat to compile a list of publications relevant to the main assessment methodologies currently available for use by the Working Group.

61. Biomass estimates for fish stocks taken in Subarea 48.3 have been calculated using areas (km^2) of seabed calculated within selected depth ranges. The areas of such depth strata in each region were compiled in 1987 (Everson, 1987). The area calculations for Subarea 48.3 were revised in WG-FSA-90/8. These were then used to standardise biomass estimates of *C. gunnari* and *N. gibberifrons* determined from research vessel surveys conducted between 1984 and 1990 (Appendix E).

62. At its 1989 Meeting, the Working Group highlighted the importance of biomass surveys to the Working Group's assessment work and emphasised that the availability of full details of such surveys is crucial in interpreting survey results (SC-CAMLR-VII, Annex 6, paragraph 206). Consequently, the Working Group had recommended that full details of survey design and haul-by-haul data should be included with submissions containing or reporting survey results.

63. To a large degree, the above recommendation has not been complied with and the Working Group felt that the problem may be resolved if Members were provided with guidelines on the minimum level of information to be included in papers submitted to the Working Group reporting results of stock assessments both survey and analytically based.

64. A small task group under the Convenership of Dr Basson was therefore tasked with listing the minimum information to be contained in working papers on, or data from, surveys, stock assessments and other analyses. The terms of reference of this group were:

(i) to develop guidelines on the minimum information requirements of papers to be submitted to the Working Group;

(ii) to identify the information required from assessment surveys with respect to:

(a) vessels undertaking assessment surveys (including gear specifications);

(b) survey design;

(c) data collected; and

(d) methods of analysing survey data;

(iii) to identify the information required in the presentation of results of stock assessment analyses (principally Virtual Population Analyses) and related stock assessment projections (e.g., yield-per-recruit analyses or TAC calculations) prior to meetings of WG-FSA with respect to:

(a) input data;

(b) output data; and

(c) analysis methods used;

(iv) to identify the basic requirements for the presentation of other assessment related analyses (e.g., estimation of natural mortality or growth parameters) in general terms.

65. The results of the Task Group's deliberations are to be found in Appendix F.

66. The Working Group was informed that UK and Soviet scientists had participated in a workshop to review the results of two surveys conducted in Subarea 48.3 during January 1990 (reports of the two surveys are presented in WG-FSA-90/11, Rev. 1 and

WG-FSA-90/29). A report of the Joint UK/USSR Workshop, 23 to 27 July 1990 was submitted (WG-FSA-90/13).

67. One of the recommendations in the report of the Joint Workshop was that the analyses of survey data should be undertaken separately for major areas such as Shag Rocks and South Georgia. In the light of this and reported evidence of the possibility of more than one stock of *C. gunnari* in Subarea 48.3 (WG-FSA-90/10), it was felt that, in the future, it may become necessary to do separate assessments for South Georgia and Shag Rocks.

68. Currently, catch data from the commercial fishery are not available for South Georgia and Shag Rocks separately. If reliable fine-scale data were submitted as agreed by the Commission in 1987, it would be possible to group the data to deal with multiple stocks, if they are found to exist.

69. Dr Shust felt that clear evidence of more than one stock in Subarea 48.3 was required before more effort could be directed to the collection and analyses of biological data, particularly with respect to ageing and the construction of age/length keys.

70. Others felt that where possible, biological data should be collected and analysed on a fine-scale basis.

71. It was agreed that when analysing trawl survey data for biomass estimation, Shag Rocks and South Georgia should be treated as separate strata.

72. If fine-scale data are not submitted it will be prudent to take some action so that, in the future, catches can be split up to reflect the presence of separate stocks, if this is found to be the case. This can be achieved by, for example, creating a subarea around Shag Rocks.

73. To date, fine-scale data for only one season (1987/88) have been submitted. The USSR scientists informed the Working Group that the collection and reporting of fine-scale data was proving extremely difficult to carry out and that this situation was unlikely to change unless action, such as having scientific observers onboard fishing vessels to oversee or undertake the task, was implemented.

74. The Joint UK/USSR Workshop noted that in conducting the surveys significant damage to fishing gear had been sustained in trying to sample areas where the sea bottom is extremely rough. It recommended that such areas should be identified to assist the planning of future surveys and further study undertaken to determine how necessary it is to obtain

samples within them (WG-FSA-90/13, paragraph 77). The Working Group agreed that it was not essential to survey these areas (e.g., grid square 20 for the South Georgia area as specified in WG-FSA-90/13) and that density-estimates from adjacent grids could be used in the estimation of ‘absolute’ biomass. If only relative estimates of biomass are required, no such adjustment would be necessary and those grid squares could be excluded from the analyses altogether.

75. Analyses of the 1989/90 data from around South Georgia, from the RV *Hill Cove* and the RV *Akademik Knipovich* surveys (see WG-FSA-90/13), using the standard swept area method produced estimates of biomass with very high coefficients of variation, mainly because of the presence of very large hauls at some stations. The sensitivity of results to the large hauls and the large coefficients of variation make interpretation of the results difficult.

76. Various alternative methods were considered and further analyses are planned using those methods.

77. It was suggested that better results may be obtained by applying the swept area method to transformed data. It was, however, pointed out that although the coefficient of variation of the estimate from the transformed data may be very low, the coefficient of variation is often very high once the estimate has been transformed back to the original ‘scale’.

78. Attention was drawn to the BMRT *Anchar* survey (WG-FSA-90/30) which produced a large estimate of biomass for *C. gunnari*, with a relatively low coefficient of variation. One possible explanation was that the lower coefficient of variation may be due to the diurnal vertical migration of this species and the fact that all hauls on this survey were made during the day. On the *Hill Cove* and *Akademik Knipovich* surveys, not all hauls were made during the day.

79. Dr P. Gasiukov (USSR) informed the Meeting of work done by USSR scientists on diurnal migration of *C. gunnari* from fishing data showing evidence of very strong patterns of vertical migration. A paper describing these results was tabled too late for consideration by the Working Group. The Working Group encouraged the submission of the paper in an updated version for the next meeting.

80. The possible influence of diurnal migration on the results was recognised at the Joint UK/USSR Workshop and the report (WG-FSA-90/13) suggests that bottom trawl surveys be conducted only in daylight (WG-FSA-90/13, paragraph 70).

81. An alternative explanation for the lower coefficient of variation of the biomass estimate from the *Anchar* survey was that it was a seasonal effect. The *Anchar* survey was conducted during April and during that period fish may be more randomly distributed. The *Hill Cove* and *Akademik Knipovich* surveys were conducted during January and February when large aggregations may form.

82. It was suggested that serial correlation between hauls in the surveys may significantly effect the coefficient of variation. The Working Group recommended that this possibility be investigated.

83. It was suggested that comparative studies of gear type used in the different surveys be conducted.

84. The Working Group agreed that investigations on the catchability coefficients of surveys were necessary. This is of particular importance when biomass estimates from surveys are used as estimates of absolute biomass. Two approaches to this problem were identified: an experimental approach which uses direct field observations; and, an analytical approach which uses mathematical or statistical models to estimate catchability. The Working Group encouraged further work on this subject using both approaches.

85. The first approach would be to focus on developing appropriate methods to deal with the kind of data obtained from surveys of patchily distributed species (e.g., the data from the *Hill Cove* and *Akademik Knipovich*). The second approach would be to focus on improving or changing the survey design and timing to try to avoid or minimise the problem of unusually large hauls.

86. With respect to the second approach, the urgency to obtain fisheries data in order to determine spatial and temporal scales of variation in the distribution of *C. gunnari*, as well as other species, was emphasised. It was agreed that additional information on the density and extent of aggregations encountered during research surveys would be very useful (see Appendix F).

87. It was suggested that a relatively simple method of improving the survey design would be to allow for time, after the survey had been completed, to return to areas of high abundance (which are usually associated with areas of high variance in density) and sample at additional, randomly chosen stations.

88. The Working Group recommended that the random survey design stratified by depth and area used by the *Hill Cove* and *Akademik Knipovich* (WG-FSA-90/13) should be used in future surveys around South Georgia, until further investigations lead to suggestions on improvements or changes to this survey design.

89. The Working Group recommended that biomass calculations from survey data are done according to the standard swept area method by three depth strata (see WG-FSA-90/13) until further investigations lead to suggestions on changes to this approach. The Working Group recommended that the problems associated with using the swept area method to survey data on species that are patchily distributed should be further investigated.

90. It was suggested that data from previous surveys around South Georgia be re-analysed according to the three depth strata outlined in WG-FSA-90/13 and new seabed areas (WG-FSA-90/8) for comparative purposes.

91. It was agreed that the problem should first be addressed by Members through correspondence. Results will be analysed at a meeting to be held between the next meeting of WG-FSA and SC-CAMLR-X. A list of main points to be discussed was prepared:

- definition of acceptable levels for CVs;
- strategies for identifying and sampling different types of fish distributions;
- utility of two-phase surveys;
- properties of the estimators of biomass;
- sources of error in comparisons between surveys;
- cost effective allocation of sampling resources; and
- need for external consultancy.

92. A paper presenting results on acoustic surveys used to estimate the biomass of myctophids, was submitted to the Meeting (WG-FSA-90/19). The problems identified and recommendations made by WG-Krill with respect to the estimation of biomass from acoustic surveys was thought to be of relevance in this regard (Annex 4, paragraphs 16 to 23).

93. The details that should be included in papers presenting results from acoustic surveys are outlined in Appendix F.

ASSESSMENT WORK

94. Summaries of the assessments presented in the following section are given in Appendix L. The Working Group felt that it would appreciate comments from the Scientific Committee and Commission on the usefulness and clarity of these summaries.

South Georgia (Subarea 48.3)

95. The history of catches taken around South Georgia is given in Table 1 and Figure 2. The figure demonstrates how fishing has shifted from one species to another which, in conjunction with a high variability in recruitment of *C. gunnari* and the establishment of total allowable catches by CCAMLR, has led to a high variability in annual catches. The total catch of all species in 1989/90 catch of 40 148 tonnes was only approximately 60% of that in 1988/89. The commercial catch of *C. gunnari* * did not exceed the TAC of 8 000 tonnes set by the Commission in 1989 (Conservation Measure 13/VIII). The catch of *P.b. guntheri* dropped to only 145 tonnes despite a TAC of 12 000 tonnes set by the Commission (Conservation Measure 16/VIII) in 1989. The reason for the decline in the catch of *P.b. guntheri* was that fishing grounds inside 12 miles around Shag Rocks have not been fished by the Soviet fleet. Catches of *D. eleginoides* in the longline fishery increased by a factor of 2 to 8 311 tonnes, whereas catches of the lanternfish *E. carlsbergi* of 23 623 tonnes in the South Polar Frontal Zone north of South Georgia were slightly less than in 1988/89. The very low reported catches of *N. rossii*, *C. aceratus*, *P. georgianus* and *N. gibberifrons* are due to the exclusive use of midwater trawls and a by-catch provision of 500 tonnes in the *C. gunnari* fishery in accordance with Conservation Measure 13/VIII, and to the prohibition of directed fishing on these species in accordance with Conservation Measure 14/VIII.

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* No STATLANT data have been submitted by Poland for the 1989/90 season and as a consequence, the preliminary catch figures from the CCAMLR catch reporting system have been used to calculate the total catch of *C. gunnari* in Table 1.

Table 1: Catches of various finfish species from Subarea 48.3 (South Georgia Subarea) by year. Species are designated by abbreviations as follows: SSI (*Chaenocephalus aceratus*), ANI (*Champsocephalus gunnari*), SGI (*Pseudochaenichthys georgianus*) and LXX (*Myctophidae spp.*), TOP (*Dissostichus eleginoides*), NOG (*Notothenia gibberifrons*), NOR (*Notothenia rossii*), NOS (*Notothenia squamifrons*), NOT (*Patagonotothen brevicauda guntheri*). 'Others' includes Rajiformes, unidentified Channichthyidae, unidentified Nototheniidae and other Osteichthyes.

Split year	SSI	ANI	SGI	LXX	TOP	NOG	NOR	NOS	NOT	OTHERS	TOTAL
1970	0	0	0	0	0	0	399704	0	0	0	399704
1971	0	10701	0	0	0	0	101558	0	0	1424	113713
1972	0	551	0	0	0	0	2738	35	0	27	3351
1973	0	1830	0	0	0	0	0	765	0	0	2595
1974	0	254	0	0	0	0	0	0	0	493	747
1975	0	746	0	0	0	0	0	1900	0	1407	4053
1976	0	12290	0	0	0	4999	10753	500	0	190	28732
1977	293	93400	1608	0	441	3357	7945	2937	0	14630[a]	124611
1978	2066	7557	13015	0	635	11758	2192	0	0	403	37626
1979	464	641	1104	0	70	2540	2137	0	15011	2738[b]	24705
1980	1084	7592	665	505	255	8143	24897	272	7381	5870	56664
1981	1272	29384	1661	0	239	7971	1651	544	36758	12197[c]	9167
1982	676	46311	956	0	324	2605	1100	812	31351	4901	89036
1983	0	128194	0	524	116	0	866	0	5029	11753[d]	146482
1984	161	79997	888	2401	109	3304	3022	0	10586	4274	104742
1985	1042	14148	1097	523	285	2081	1891	1289	11923	4238	38517
1986	504	11107	156	1187	564	1678	70	41	16002	1414	32723
1987	339	71151	120	1102	1199	2844	216	190	8810	1911	87882
1988	313	34620	401	14868	1809	5222	197	1553	13424	1387	73794
1989	1	21359	1	29673	4138	838	152	927	13016	55	70160
1990	2	8027	1	23623	8311	11	2	24	145	2	40148

[a] Includes 13 724 tonnes of unspecified fish caught by the Soviet Union
[b] Includes 2 387 tonnes of unspecified Nototheniidae caught by Bulgaria
[c] Includes 4 554 tonnes of unspecified Channichthyidae caught by the GDR
[d] Includes 11 753 tonnes of unspecified fish caught by the Soviet Union

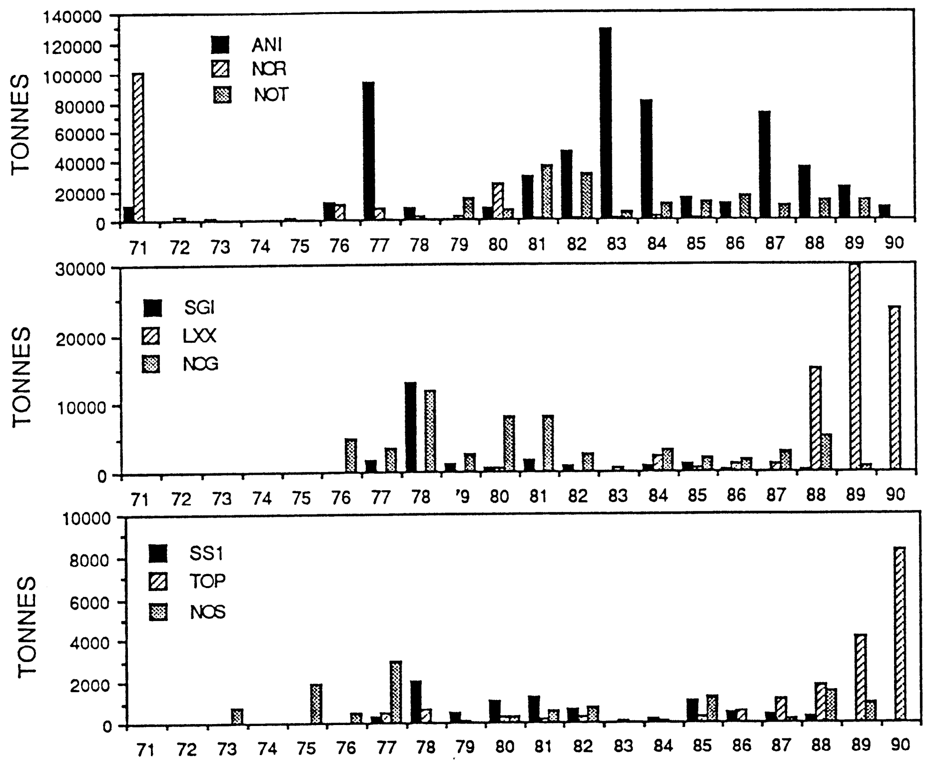

Figure 2: Catches of major species in Subarea 48.3.

Notothenia rossii (Subarea 48.3)

96. The Commission's Conservation Measures in force since 1985 have aimed to keep the catches of the species to a level as low as possible. Reported catches in 1989/90 were only 2 tonnes.

97. There were no new data available from the commercial fishery. Length compositions from research vessel catches (*Hill Cove*, *Akademik Knipovich*) consisted mostly of 45 to 60 cm long fish with mean lengths of 52 to 53 cm which were comparable to observations from previous seasons. Biomass estimates from the UK/Polish survey (*Hill Cove*) and two USSR surveys (*Akademik Knipovich*, *Anchar*) were 1 481 to 3 900 tonnes. This indicates that the stock remained at a very low level.

Management Advice

98. In view of the current low level of the stock of *N. rossii,* all Conservation Measures for this species should be kept in force.

Champsocephalus gunnari (Subarea 48.3)

99. The total catch in 1989/90 was 8 027 tonnes. This included 387 tonnes taken by research vessels.

100. No length frequency or age data from the commercial fishery were reported. The lack of length frequency data from the commercial fishery poses serious problems for the assessment of the stock and the interpretation of VPA results based on length frequency data from research surveys.

101. Results from three bottom trawl surveys were presented in (WG-FSA-90/13 and WG-FSA-90/30). Estimates for South Georgia and Shag Rocks were available from the *Hill Cove* and *Akademik Knipovich* surveys, whereas the *Anchar* survey only covered the area around South Georgia. Estimates for South Georgia only (i.e., excluding Shag Rocks) range between 95 405 tonnes (*Hill Cove* survey) and 971 000 tonnes (*Akademik Knipovich* survey). This compares to a stock biomass estimate of 21 069 tonnes for the UK/Poland trawl survey in 1988/89 (WG-FSA-89/6). A summary table of estimates is given below:

		Shag Rocks		South Georgia		Total
		Biomass	(%CV)	Biomass	(%CV)	Biomass
Hill Cove survey (WG-FSA-90/13)						
1. Standard swept area method (SAM)	[47][1]	279	(83)	95	(63)	374
2. SAM with mean 'large haul'	[60]	54	(38)	95	(63)	149
3. SAM with large haul adjustment	[62]	232	(-)	95	(63)	327
Akademik Knipovich survey (WG-FSA-90/13)						
4. Standard swept area method (SAM)	[47]	109	(31)	878	(69)	987
5. SAM, 2 areas (a)[2]	[53]	109	(31)	936	(43)	1045
6. SAM, 2 areas (b)[3]	[53]	109	(31)	971	(69)	1080
7. SAM with mean large haul	[60]	109	(31)	333	(42)	442
8. SAM with large haul adjustment[2]	[62]	109	(31)	437	-	546
9. SAM with large haul adjustment[3]	[62]	109	(31)	537	-	646
Anchar survey (WG-FSA-90/30)						
10. Standard swept area method (SAM)				887	(31)	NA

(1) Reference to paragraph number in WG-FSA-90/13
(2) 2 areas = grids 12 to 18, and remainder of South Georgia, see WG-FSA-90/13
(3) 2 areas = east and west South Georgia, see WG-FSA-90/13

102. The Working Group agreed to use the biomass estimates from the *Hill Cove* and the *Akademik Knipovich* based on the swept area method with an adjustment for the very large hauls, as outlined in WG-FSA-90/13.

103. These estimates for South Georgia and Shag Rocks combined are around 150 000 tonnes and 442 000 tonnes with coefficients of variation of 42% and 33% respectively.

104. Some Members felt that these coefficients might be underestimations of CV values mainly because:

(i) under model 3 (WG-FSA-90/13) the total variance is the sum of variances at catch level plus twice their covariances which are unknown, and assumed 0; and

(ii) model 3 arose as a modification of a design (model 1, WG-FSA-90/13) based on a two fixed factors model.

The mean estimation under model 3 depends on whether or not the proportion of stations allocated to each rectangle at a given depth matches the corresponding fraction of seabed.

105. An assessment of *C. gunnari* in Subarea 48.3, using virtual population analysis (VPA) was presented in WG-FSA-90/26. The analysis was tuned to standardised catch-per-unit effort using the Laurec-Shepherd method of tuning. The method of standardisation was based on a multiplicative model and details of the method and results are given in WG-FSA-90/27. The analysis assumed that the length frequency distribution of the commercial catches would be similar to length frequency distributions from the *Hill Cov*e survey, from samples taken to the north of the island and Shag Rocks (see WG-FSA-90/13 and 26). The authors felt that this assumption would be reasonable since most of the catches were taken in that area and the mesh size of the trawl used by the *Hill Cove* was thought to be similar to those of commercial vessels.

106. It was pointed out that the *Hill Cove* used a net with a 45 mm mesh codend and a 20 mm mesh liner (WG-FSA-90/11 Rev. 1), although the intention was to use a net with a 80 mm mesh codend and a 40 mm mesh liner (WG-FSA-90/13, Annex 4).

107. The VPA results indicate that a strong year class entered the fishery in 1987/88 as 1 year old fish.

108. Some Members felt that the effort data used for the regression analysis in WG-FSA-90/27 violates the assumption of a constant variance common to all observations. In the present situation it means that:

(i) reported correlation coefficients are not correct; and

(ii) parameter estimates are not least squares estimates.

109. This situation arises from the fact that fine-scale commercial catches are reported as the sum of varying quantities of hauls, therefore the fitting of a multiplicative model for standardisation of CPUE data may require the use of data reported on a haul-by-haul basis.

110. One of the two assessment modifications in WG-FSA-90/26 used the frequencies for age classes 1 and 2, based on the frequencies in these age classes from trawl survey results.

111. The analyses presented in WG-FSA-90/26 estimated the 1989/90 biomass level of *C. gunnari* at between 163 000 tonnes and 191 000 tonnes. Results from the VPAs and recent estimates of relative biomass from surveys are presented in Figure 3.

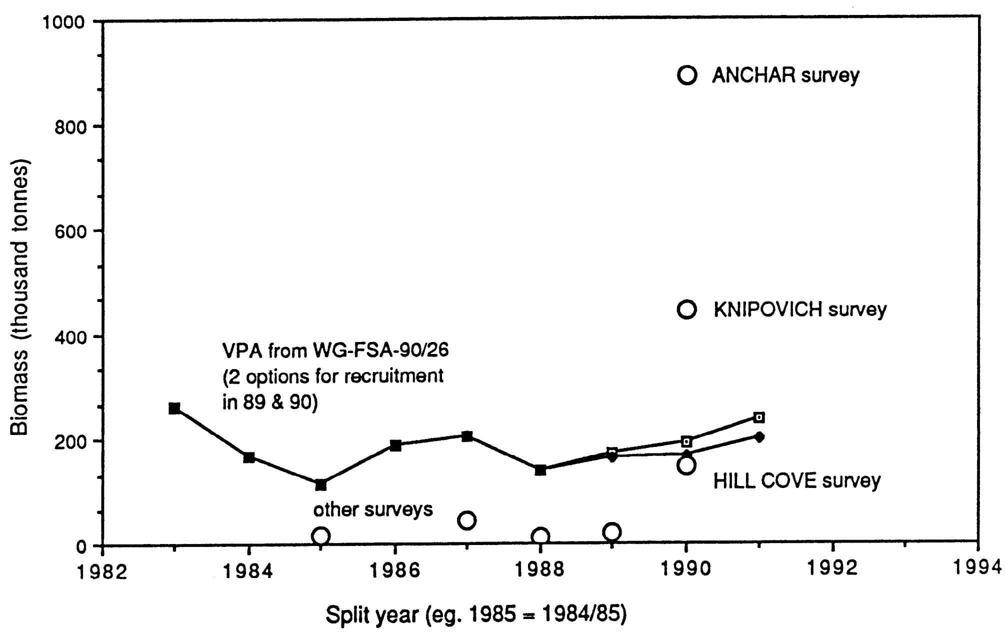

Figure 3: Biomass estimates for *C. gunnari* in Subarea 48.3.

112. Figure 4 illustrates the different ranges of values obtained from the VPA estimates of uncorrected biomass from the surveys. Ranges of survey results are calculated as the point estimate plus and minus 1 standard deviation under the assumption of a log-normal distribution.

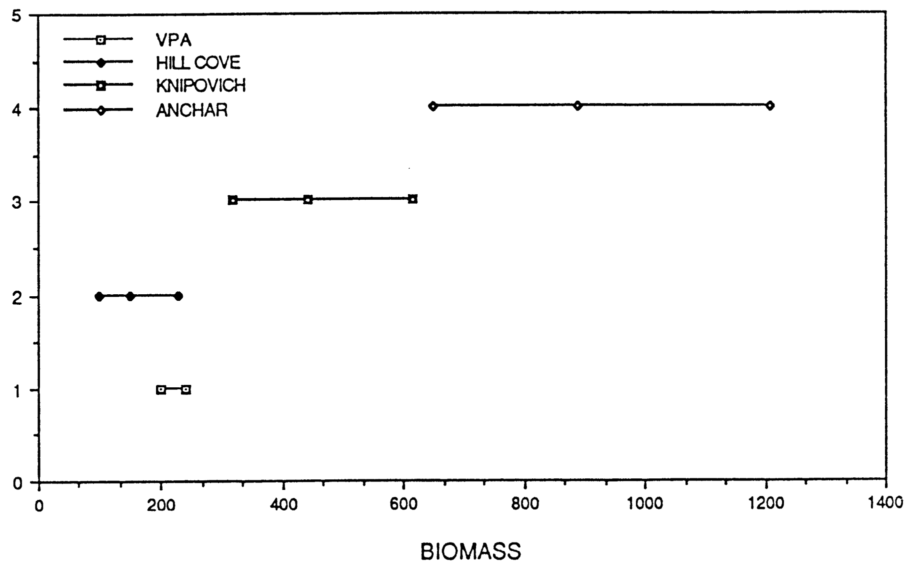

Figure 4: VPA estimates of uncorrected biomass for *C. gunnari* in Subarea 48.3 (survey results).

113. The USSR Delegation pointed out that biomass estimates from trawl surveys, given in the tables and Figure 3, were obtained under the assumption that the catchability coefficient of trawls used to take *C. gunnari*, equals 1, and this assumption is unrealistic.

114. A number of simultaneous biomass estimates were made for *C. gunnari*, based on results of trawl surveys and VPA analysis from 1984/85 and 1988/89 (WG-FSA-89/6):

	1984/85	1986/87	1987/88	1988/89
Biomass estimate from trawl survey: (B_{RV})	15.821	50.414	15.086	21.069[(1)]
Biomass estimate from VPA analysis (B_{VPA})	117.4	204.4	141.8	163.8
Proportionality coefficient ($_q$) $B_{RV} = qB_{VPA}$	0.14	0.25	0.11	0.13

[(1)] Survey covered South Georgia only

115. The mean value of this coefficient equals 0.16, maximum value - 0.25. Therefore, based on the VPA assessment in WG-FSA-90/26, the hypothesis that the catchability coefficient for *C. gunnari* from the trawl surveys conducted during 1984/85 to 1988/89 equals 1, underestimates the biomass by about 4 to 6 times.

116. It was pointed out that this analysis is unlikely to be reliable because the VPA biomass estimates are from late in the VPA projections where the biomass calculations are uncertain. In addition, the VPA is tuned to effort data on the assumption that fishing mortality at different stock biomass is proportionally related to effort. Finally, the most recent surveys

which give biomass estimates greater than the VPA biomasses have not been included in this analysis, but provide estimates of the catchability coefficient greater than 1.0. Based on the 1989/90 estimates of biomass from the tuned VPA (with two modifications) and the uncorrected swept area method estimates for each of the surveys carried out in 1990, the following values of the coefficient of proportionality were found.

	Uncorrected Swept Area Method Survey Biomass	VPA Biomass (Modification 2) Estimate = 167 000 Proportionality Coefficient	VPA Biomass (Modification 1) Estimate = 191 000 Proportionality Coefficient
Hill Cove	374 000	2.24	1.96
Akademik Knipovich	987 000	5.91	5.17
Anchar[1]	887 000	5.31	4.64

[1] South Georgia only, catchability coefficient underestimations

117. Some Members felt that although the assumption of a catchability coefficient of 1 may imply the underestimation of true biomass, there may be other factors (such as herding or the patchy distribution of fish) which may lead to overestimation of true biomass.

118. The Working Group attempted to do further VPAs using biomass estimates from bottom trawl surveys as relative indices of abundance and using the Laurec-Shepherd method of tuning. Two major problems were encountered in the process.

119. The first problem was due to the fact that no length frequency data from the commercial fishery were submitted. The catch-at-age data from WG-FSA-90/26 were used and, as an alternative assumption, the length frequency distribution from one of the stations (No. 23) on the *Hill Cove* was used to obtain catch-at-age data. Commercial fishing vessels were operating in that area during the survey. These two assumptions produced quite different values of catch-at-age and results from the VPA were sensitive to these assumptions.

120. The second problem was associated with estimates of biomass-at-age from the *Hill Cove* survey. Two sets of estimates were presented, one in WG-FSA-90/26 and one set in WG-FSA-90/11, which had to be corrected for the seabed area in each depth stratum. Even after correction, these two sets of estimates were very different and the problem could not be resolved at the Meeting, since the length frequencies by haul were not available to the Working Group.

121. An alternative approach to assessing the current status of the stock and estimating TACs was therefore considered. Estimates of biomass from the surveys (*Hill Cove* and *Akademik Knipovich*, WG-FSA-90/13) were used in projection calculations with values of

$\mathbf{F_{0.1}}$ to calculate TACs. The values that were chosen are from the bottom end of the range of both surveys. The estimates from the standard swept area method were not used because of the problems associated with applying this method to these particular data sets (see WG-FSA-90/13). The biomass estimates that were used, with coefficients of variation (CV) are:

Survey	Biomass	CV
Hill Cove	149 598	0.42
Akademik Knipovich	442 168	0.33

122. The USSR Delegation believed that these estimates should be corrected for the assumed catchability coefficient of surveys of 0.25 from the table in paragraph 114. The adjusted biomass values from the trawl surveys are:

Survey	Biomass	CV
Hill Cove	598 392	0.42
Akademik Knipovich	1 776 672	0.33

123. Other Members of the Working Group suggested that estimates of catchability derived from VPA and survey results for 1984/85 to 1988/89 (paragraph 114) should not be applied to biomass estimates for surveys conducted during 1989/90 since, as described in paragraph 116, the catchability coefficients for surveys conducted during 1989/90 are different from those for earlier surveys. It was also pointed out that the coefficients of variation for the adjusted estimates in paragraph 122 are too small because statistical uncertainty in the estimate of catchability was not included in the calculations.

124. The estimates of biomass were split into biomass-at-age using both sets of percentages-at-age referred to in paragraph 120 above. Two values of natural mortality (**M**=0.48 and **M**=0.56) were used to project the population forward to 1 July 1990. Biomass levels in 1990/91 and 1991/92, as well as, catches based on $\mathbf{F_{0.1}}$ were calculated. The $\mathbf{F_{0.1}}$ calculations for **M**=0.48 and **M**=0.56 were based on the analysis in WG-FSA-90/5. Results are given in Table 2a and 2b and explained fully in WG-FSA-90/5.

Table 2a: Using biomass-at-age data from WG-FSA-90/26 (in thousand tonnes).

Survey Estimate	1990/91		1991/92	
	Stock	Catch	Stock	Catch
M=0.48, $\mathbf{F}_{0.1}$=0.33				
150	222	44	189	36
442	627	129	477	101
M=0.56, $\mathbf{F}_{0.1}$=0.38				
150	214	46	164	34
442	603	137	407	94

Table 2b: Using biomass-at-age data from WG-FSA-90/11 Rev. 1 (in thousand tonnes).

Survey Estimate	1990/91		1991/92	
	Stock	Catch	Stock	Catch
M=0.48, $\mathbf{F}_{0.1}$=0.33				
150	236	50	201	39
442	670	146	512	109
M=0.56, $\mathbf{F}_{0.1}$=0.38				
150	228	52	173	36
442	644	154	435	101

125. Taking into account the annual catchability coefficient of surveys of 0.25, the adjusted calculations of projected biomass and catch are given in Tables 3a and 3b.

Table 3a: Adjusted calculations of projected biomass and catch from WG-FSA-90/26 (in thousand tonnes).

Survey Estimate	1990/91		1991/92	
	Stock	Catch	Stock	Catch
M=0.48, $\mathbf{F}_{0.1}$=0.33				
598	888	176	756	144
1 777	2 508	516	1 908	404
M=0.56, $\mathbf{F}_{0.1}$=0.38				
598	856	184	656	136
1 777	2 412	548	1 623	376

Table 3b: Adjusted calculations of projected biomass and catch from WG-FSA-90/11 Rev. 1 (in thousand tonnes).

Survey Estimate	1990/91		1991/92	
	Stock	Catch	Stock	Catch
M=0.48, $\mathbf{F}_{0.1}$=0.33				
598	944	200	804	156
1 777	2 680	584	2 048	936
M=0.56, $\mathbf{F}_{0.1}$=0.38				
598	912	208	692	144
1 777	2 576	616	1 740	404

126. Some Members suggested that adjusted calculations of projected biomass described in paragraph 125 are invalid because the correction factor, as described in paragraph 124, should not be applied to survey biomass estimates for 1989/90.

127. The USSR Delegation expressed doubt as to the validity of the estimates $\mathbf{F_{0.1}}$ when $\mathbf{M}$=0.48 and $\mathbf{M}$=0.56, which were used in these calculations. The values $\mathbf{F_{0.1}}$=0.33 and $\mathbf{F_{0.1}}$=0.38 were obtained under the assumption that *C. gunnari* is being fully exploited from 2 years of age. This is reflected in the following coefficients of partial recruitment (PR):

Age	1	2	3	4	5	6
PR	0	1	1	1	1	1

128. VPA analysis, however, shows that the coefficient of partial recruitment for age group 2 equals 0.44. This leads to $\mathbf{F_{0.1}}$=0.497 when $\mathbf{M}$=0.48 and $\mathbf{F_{0.1}}$=0.570 when $\mathbf{M}$=0.56.

129. Results of TAC calculations from the VPA assessment presented in WG-FSA-90/26 are summarised below.

Table 4: Projections for 1990/91 (all units in thousand tonnes).

	Modification 1		Modification 2	
	Stock	Catch	Stock	Catch
$\mathbf{M}$=0.48, $\mathbf{F_{0.1}}$=0.497	198	53	215	57
$\mathbf{M}$=0.56, $\mathbf{F_{0.1}}$=0.570	238	64	200	54

130. Results from the VPA (paragraph 129) and the projections based on survey estimates, unadjusted for catchability (paragraph 124) suggest a range of biomass values of between 198 000 tonnes and 670 000 tonnes with associated TAC values of between 44 000 tonnes and 64 000 tonnes. When results from projections based on survey estimates adjusted for catchability (paragraph 125) are considered, the range for total biomass is extended to 2 680 000 tonnes and the range of TAC values is extended to 616 000 tonnes. If the actual stock biomass is reasonably well estimated by the *Hill Cove* survey results, setting a TAC based on the *Akademik Knipovich* survey will lead to a substantial depletion of the stock.

131. In each case the projected population level would be less in 1991/92 than in 1990/91 if recruitment is average.

132. In addition to the large differences between the survey estimates of biomass on which the projections are based, all estimates have associated levels of uncertainty. In the case of the projections based on biomass surveys, the coefficients of variation can be used to investigate the effect of this uncertainty on the calculation of TACs.

133. The fact that the biomass is measured with some degree of error implies that there is a probability that the true biomass may be lower or higher than the estimated biomass. If the distribution that describes the probabilities was normal, there would be a 50% probability that the true biomass was higher than the point estimates. However, if we assume that the distribution which describes these probabilities is derived from a log-normal distribution of the biomass estimate, the implication is that there is a 31% probability that the true biomass is higher than the estimated biomass and there is a 69% probability that the true value is lower.

134. The implication of this is that, if a TAC is based on the point estimate, there is a 69% probability (or 69% risk) that it would be too high. If the TAC is based on a biomass value that is HIGHER than the point estimate, the probability that the TAC is too high increases. Conversely, if the TAC is based on a biomass value that is LOWER than the point estimate, the probability that the TAC is too high decreases. A schematic illustration of this is given in Figure 5. The figure is based on the assumption that there is a log-normal probability distribution around the point estimate.

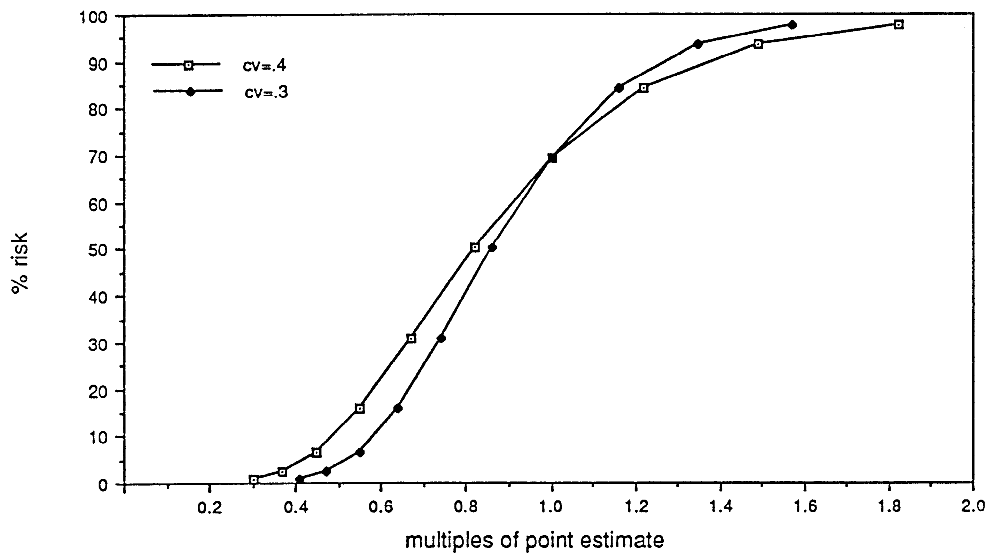

Figure 5: Estimation of probability of TAC for *C. gunnari* in Subarea 48.3 being too high.

135. There are many assumptions involved in the above example. Firstly, the probability distribution may not be log-normal, but is almost certainly skewed. Secondly, although there is a level of uncertainty associated with each individual survey estimate, there is a much

larger, overall level of uncertainty as reflected by the large difference between the estimates. The basic principle remains the same, however, as catch levels increase, the associated risk (that catches are too high) increases.

136. As an illustration of how the TAC is affected, Table 5 summarises TAC levels associated with the lowest biomass estimate (i.e., 150 000 tonnes) minus 1 standard deviation and plus 1 standard deviation of the natural log of the point estimate. Taking into account catchability coefficient similar calculations give the following results:

Table 5: Biomass estimate from *Hill Cove* Survey, CV=42%. Using biomass-at-age as in Section A, Table 2 and **M**=0.48, $\mathbf{F_{0.1}}$=0.33. Biomass in thousand tonnes (SD=standard deviation).

Biomass Used in Projection	1990/91 Stock	1990/91 Catch
150 *(e^{-CV})= 98	151	29
150	222	44
150 *(e^{+CV})= 228	331	67

Management Advice

137. As was the case last year, the wide range of results from the assessments pose serious problems in presenting management advice to the Commission.

138. If the actual stock biomass is reasonably well estimated by the *Hill Cove* survey results, setting a TAC based on the *Akademik Knipovich* survey will lead to a substantial depletion of the stock. If the stock biomass is more correctly estimated by the *Akademik Knipovich* survey, setting a TAC based on the *Hill Cove* survey results will result in a substantial increase in the stock.

139. The Working Group therefore, taking account of the fact that survey results in earlier years had all been somewhat lower than the recent estimates as well as VPA results given in WG-FSA-90/26, believed that a TAC from the lower end of the range of results would be appropriate. The low end of the appropriate range is given by the *Hill Cove* survey using **M**=0.48 and gives a TAC of 44 000 tonnes. The high end of the range is given by the VPA results in WG-FSA-90/26 and give a TAC of 64 000 tonnes.

140. No length and age data of *C. gunnari* from the commercial fleet was reported to CCAMLR. The Working Group felt this was a serious problem especially given the wide

range of TACs calculated using research vessel data. Because of these uncertainties, the Working Group recommends a conservative TAC be adopted to reduce the probability of overexploiting the species.

141. Concern was expressed about the earlier patterns of exploitation in the fishery in which fishing appeared to concentrate selectively on a single year class. This undermines the basis on which $\mathbf{F_{0.1}}$ calculations are made, rendering them too high. Some Members also pointed out that keeping the TAC low would lead to improvements in the age structure of the stock by allowing more fish to survive to older ages. This would help ensure stable recruitment from a larger spawning stock biomass. Other Members believed that a good spread of age classes now existed in the stock and that this issue was not of current concern. They also considered, taking into account that the trawl surveys need to be corrected for catchability, that the TAC range above is likely to be conservative.

Patagonotothen brevicauda guntheri (Subarea 48.3)

142. Conservation Measure 16/VIII limited the catch of this species to 12 000 tonnes in the 1989/90 season. However, the actual catch was 145 tonnes because fishing occurred only outside 12 miles from Shag Rocks.

143. The only catches of this species that have been reported to CCAMLR as fine-scale data are from the South Georgia area in 1987 and 1988, where they have not been found by research surveys (paragraph 50). This was viewed with great concern by some Members as it introduces doubt as to the accuracy of fine-scale data reported to CCAMLR.

144. Catch and effort data from Soviet BMRT vessels from 1978/79 to 1988/89 were available, as was a biomass estimate of 81 000 tonnes from the Spanish survey in 1986/87.

145. At the 1989 Meeting, the Working Group concluded that in the absence of reliable estimates of natural mortality and information on current stock size, catch levels should not be based on VPA results using $\mathbf{F_{0.1}}$ and assumptions about recruitment.

146. WG-FSA-90/28 presented an assessment of the stock based on VPA analysis, after attempting to reduce the uncertainty in the estimates of **M**. Last year the Working Group concluded that **M** is unlikely to be higher than 0.7 and **M** values used were 0.48 and 0.63. The analysis in WG-FSA-90/28 suggested that higher values of **M** were more likely and presented results using **M**=0.9.

147. The method used in WG-FSA-90/28 for testing the applicability of **M** values was a new variation on the method of Paloheimo (Ricker, 1975). The new feature of the method was that fishing mortality coefficients from VPA analysis using a trial series of values of **M** were regressed against standardised fishing effort. In principle, if **M** is correct the regression line will pass through the origin.

148. Some Members of the Working Group were concerned that this procedure would not produce reliable results. The amount of information on **M** from a time series of catch-at-age and effort data is low (de la Mare, 1989; Shepherd and Nicholson, 1986). There were unresolved statistical problems with the regressions used in the method because estimates of **F** from the VPA are not independent from the standardised efforts. Moreover, a functional rather than simple linear regression would be more appropriate because the standardised efforts are themselves random variables. Without full confidence intervals associated with the estimates or further analysis of the properties of the method based on analytic or simulation studies, the Working Group was unable to assess the reliability of the results presented.

149. Other Members of the Working Group felt that the proposed method complemented assessments made in 1989, making it possible to refine them and obtain a well-founded value for **M**. In choosing a value for **M** this method does not require calculating the confidence interval, but is based on verification of a statistical hypothesis that the intercept equals 0 in the regression equation. Taking into account sample size, this hypothesis is not rejected for **M**=0.9, but when **M**=0.48 and **M**=0.63 this hypothesis is not supported by data. Since these methods of assessing the natural mortality coefficient are based on various principles and data, it was suggested that **M**=0.9 is more realistic.

150. The assessment presented to the Meeting (WG-FSA-90/28) was based on the same data as last year (WG-FSA-89/21). No additional catch-at-age or effort data was available. The series of catch and effort data from 1978/79 to 1988/89 (Figure 6) was used to calibrate the VPA for a range of **M** values from 0.48 to 1.06. The change in biomass over that period for two values of **M** is shown in Figure 7. The large catches in 1980/81 (36 791 tonnes) and 1981/82 (31 403 tonnes) reduced the biomass at that time.

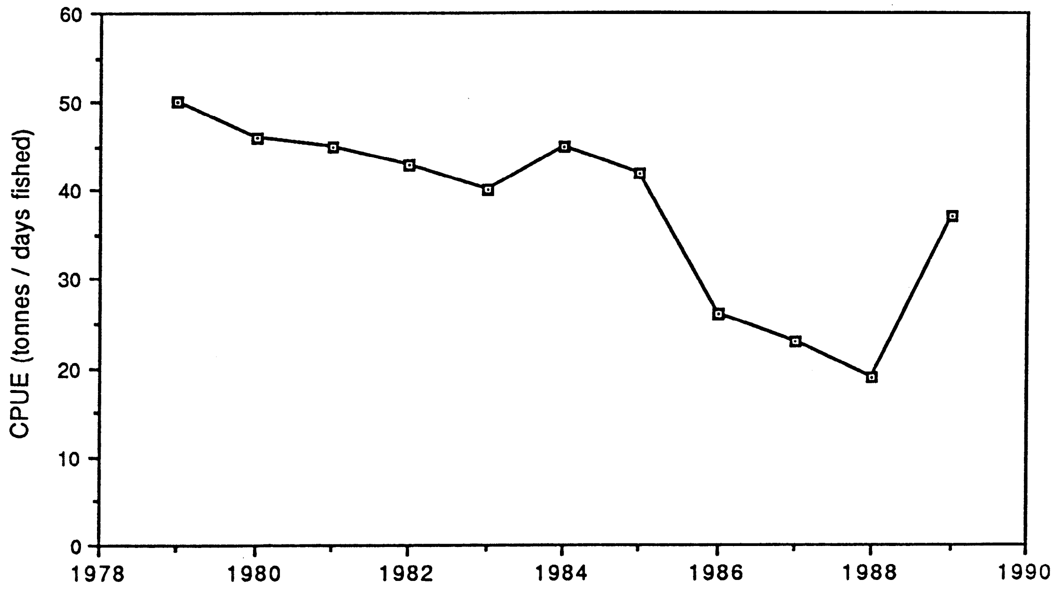

Figure 6: Catch-per-unit effort (tonnes/days fished) for *P.b. guntheri* in Subarea 48.3 (from WG-FSA-90/28, Table 3).

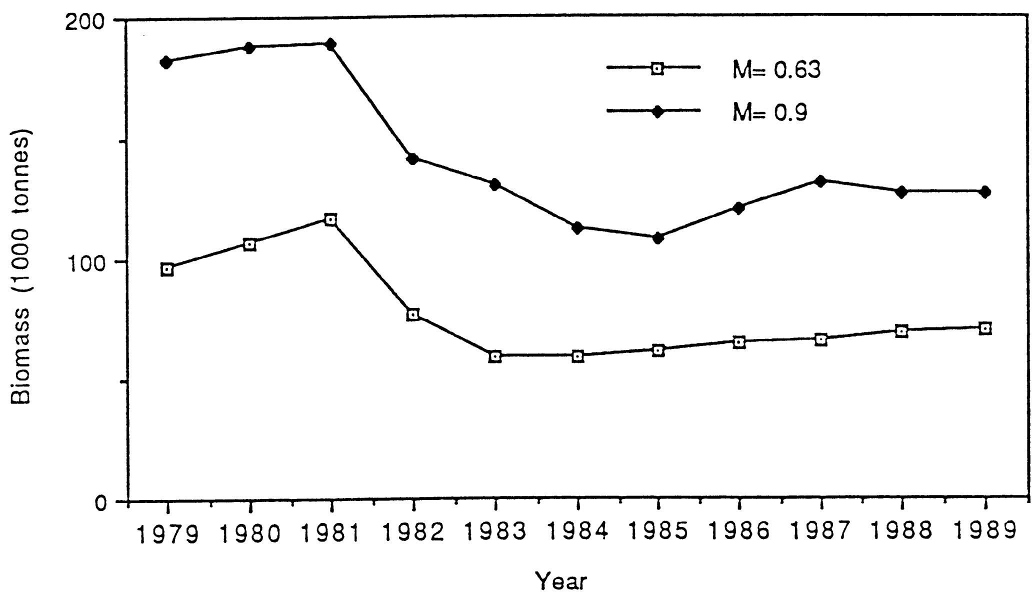

Figure 7: Results of VPA analyses for *P.b. guntheri* in Subarea 48.3.

151. The biomass estimate for 1988/89 from the VPA was projected forward one further year to predict the stock size in 1990/91 and to calculate yield estimates. In these projections, the average value of recruitment from the historical sequence of age classes in the VPA was used. The values of $\mathbf{F_{0.1}}$ were taken from the yield-per-recruit analyses in WG-FSA-90/28 and WG-FSA-90/5.

Natural Mortality	$F_{0.1}$	Projected Biomass 1990/91 (tonnes)	$F_{0.1}$ Yield Estimate (tonnes)	Proportion of Catch from Ages 1 to 3	Proportion of Catch from Ages 1 to 2
0.48	0.56	83 663	20 315	37.9%	4.5%
0.63	0.78	96 375	25 167	43.6%	5.9%
0.9	1.32	143 896	36 356	62.4%	14.9%

The yield projection from this year is higher than that given last year. With the reduction in the fishery in 1989/90, fishing mortality is assumed to have been reduced. However, the yield projections are based on the assumption of constant recruitment at the average value.

152. The different rates of **M** give widely different stock sizes and yield estimates from the exploited part of the population. However, with higher values of **M** the importance of recruitment in the last few years also increases. The VPA gives no information on the strength of these recent age classes, which are nevertheless of critical importance to the estimates of projected yield in 1990/91 (particularly the 3 year old age class).

Management Advice

153. To estimate yields for *P.b. guntheri*, an estimate of biomass and the current age structure are needed. Data on the age distribution of the catches are required for the most recent year.

154. Recruitment levels to the *P.b. guntheri* stock in recent years are unknown. Unfortunately, the current status of the stock depends critically on the strength of incoming age classes to the fishery. This effect is more apparent when higher values of natural mortality are used. In the absence of any index of pre-recruit abundance (mainly 1 and 2 year old fish), yield estimates given here should be used with caution. It may be inappropriate to base recommended catch levels on the assumption of constant recruitment. The absence of fishing in the 1989/90 season should have resulted in an increase in *P.b. guntheri* abundance and biomass. However, the importance of recruitment in the projections decreases with lower rates of natural mortality. To reduce the risk from uncertainty in the true value of **M** and the greater uncertainty concerning current recruitment levels, the TAC should be at the lower end of the range (20 000 to 36 000 tonnes).

Dissostichus eleginoides (Subarea 48.3)

155. Catches of *D. eleginoides* have been reported since 1976/77. Until 1985/86 catches were several hundred tonnes per year, except in 1977/78 when 1 920 tonnes were taken. Most catches were probably taken in the Shag Rocks/Black Rocks area where the species is a common by-catch in the *P.b. guntheri* fishery. Since 1985/86 catches have increased from 564 tonnes to 4 138 tonnes in 1988/89 and again to 8 311 tonnes in 1989/90. Prior to 1988/89, catches of this species would have been mainly juveniles taken by trawls. Since 1988/89 almost all catches have been taken by longlining.

156. The Working Group considered new information from the fishery presented in WG-FSA-90/34. The paper gave estimates of growth parameters based on a relatively small aged sample (124 fish). The paper also gave estimates of natural mortality given below.

Method	Estimate
Alverson-Carnee	0.18
Rikhter-Efanov	0.16

157. It was noted that these values seemed high compared with the von Bertalanffy growth parameter **K** value of 0.072. These values of **K** and **M** imply that very few fish would survive to reach full size. It was suggested that the catch composition would reflect size and selection factors related to hook size and that this would lead to over-estimation of **M**. The Working Group had used the value **M**=0.06 in its calculations of potential yield at its last meeting taken from Kock, Duhamel and Hureau (1985). The Working Group agreed to use the values 0.06 and 0.18 in the calculations in this Meeting.

158. However, Soviet representatives expressed the view that the value of **M**=0.06 is too low. The simple checking of both values using the Sparre method (SC-CAMLR-VIII, Annex 6, Appendix 5) shows that **M**=0.06 gives the life expectancy for *D. eleginoides* of 75 years, whereas **M**=0.18 gives a life expectancy of 25 years which is more consistent with the observed age data. Furthermore, the calculation of **M** in WG-FSA-90/34 is performed using the information from the Shag Rocks study area, whereas Kock's data are based on Zakharov and Frolkina (1976) where the study was conducted on *D. eleginoides* from the Patagonian shelf (i.e., from a completely different region) and **M** was calculated by the method of Pauly (1980) using a temperature of 4°C.

159. It was pointed out that the calculation of 'life expectancy' as defined by Sparre depends on the assumption that **M** is independent of age. However, a wide range of animals

have natural mortality increasing with age, with the effect that lower values of **M** can be compatible with shorter life expectancy than would be obtained using Sparre's definition. It was also pointed out that the catch of much longer individuals implies that the fish live to much greater ages, and that such fish will be under-represented in trawl samples, and from the longline fishery because of hook selection factors.

160. No direct estimates of total biomass of this stock are available. Reliable future direct estimates are unlikely to be obtainable because the range of mature fish extends to considerable depths and they are also semipelagic. Accordingly, indirect methods of assessment will need to be used. It was recommended that a mark-recapture experiment be undertaken.

161. WG-FSA-90/7 investigated the reproductive status of a small sample of fish from the USSR longline fishery. The fish were found to be developing towards spawning condition. The authors concluded that the assertion that the longline fishery takes senescent fish (CCAMLR-VIII, paragraph 106) is almost certainly in error.

162. The data on size and age composition presented in WG-FSA-90/34 showed that fish aged 8 to 18 years and lengths 60 to 120 cm predominate in the catch. Since the species reaches maturity at 8 to 10 years, the data from the catch indicate that it is unlikely that any substantial proportion of the catch would be senescent.

163. WG-FSA-90/34 also presented an attempt at an assessment using a length based cohort model (Jones, 1981). The results gave an exploitable stock of 68 318 tonnes with a TAC of approximately 8 000 tonnes.

164. With respect to the growth parameters used, it was also pointed out that these should be derived from samples of the entire range of size classes in the population. In the case of longline fishing, any effects of size selection attributable to the fishing method would introduce bias in the estimation of growth parameters based on length data from the fishery alone. Consequently, the use of biased growth parameters will also affect results of length based cohort analyses.

165. Some Members of the Working Group stressed that the results could not be considered to be reliable because the length composition of the stock would not yet have responded to the effects of fishing. The method used is not reliable when fishing has been conducted for only a

few years. Additional calculations given in Appendix G show that the results obtained from length cohort analysis are very sensitive to the growth parameters used. The available parameters had been estimated from relatively small samples.

166. Other Members of the Working Group feel that Jones' cohort analysis is sufficiently well-founded to be applicable in assessing *D. eleginoides* stocks. Reasons for this are:

- long life expectancy; this allows one to expect a lack of wide fluctuations in recruitment; and

- low fishing intensity which has no effect on population equilibrium.

This last aspect is supported by the fact that over the period 1986 to 1990 there was no apparent decrease in catch per-unit-effort. The applicability of Jones' cohort analysis here is consistent with the use of summarised information obtained over a number of years on catch size structure.

167. Biomass estimates for this species have been obtained by trawl surveys, but these are known to be underestimates because they cover only the upper end of the bathymetric range for the species (WG-FSA-90/13). A crude estimate of biomass was attempted by assuming that the *Hill Cove* and *Akademik Knipovich* surveys correctly estimate the biomass of the cohorts two to five. The biomass for the whole stock can then be extrapolated using a growth curve, length-weight relationship and natural mortality to produce a factor by which the survey biomass at each age must be multiplied to yield the stock biomass. The calculation depends on a number of assumptions:

- the surveys correctly estimate the biomass of the young year classes;
- the young year classes represent average levels of recruitment;
- mortality rates in young fish are the same as in adult fish; and
- natural mortality and growth curve parameters are accurately estimated.

It is not possible to ensure that these assumptions are fulfilled and failures of any or all of them could produce substantial inaccuracy in the calculated biomass. Accordingly, considerable and unquantifiable uncertainty is attached to the results of the calculations.

168. The results of these calculations are shown in Table 6. Table 7 gives corresponding estimates of MSY based on rates derived from Beddington and Cooke (1983). The details of these calculations given are recorded in the summary of assessments carried out at this Meeting which will be submitted to the next meeting.

Table 6: Estimated exploitable biomass of *D. eleginoides* at Shag Rocks. HC=*Hill Cove* survey, AK=*Akademik Knipovich* survey. The values based on each age have been calculated separately.

	Mortality Coefficient **M**=0.06			Mortality Coefficient **M**=0.18		
		Biomass by			Biomass by	
Age	Factor	HC	AK	Factor	HC	AK
2	614.3	1426702	250795	157.09	366832	64484
3	204.9	130271	22900	59.4	37766	6639
4	98.5	28720	5049	32.2	9387	1650
5	57.9	157575	27700	21.3	58072	10208

Table 7: MSY from method of Beddington and Cooke. All estimates are based on a single age class.

	M=0.06		**M**=0.18	
Age	HC	AK	HC	AK
2	27392	4815	21129	3714
3	2501	440	2175	382
4	551	97	541	95
5	3025	532	3345	588
Average 2 to 5	8367	1471	6798	1195

169. The USSR Delegation expressed doubt as to the usefulness of projecting young cohorts as a method of assessing *D. eleginoides* biomass based on the following:

(i) in accordance with conclusions reached by scientists from the UK and the USSR (WG-FSA-90/13) it was acknowledged that trawl surveys do not reflect adequately the *D. eleginoides* stock status and, consequently, cannot be used in calculations;

(ii) calculation of *D. eleginoides* stock size-structure using trawl survey data was based on an algorithm which does not correspond to the swept area method (WG-FSA-90/14);

(iii) a sample of 124 specimens was used to determine age-structure of *D. eleginoides* (WG-FSA-90/11). This illustrates that a range of lengths of *D. eleginoides* (from

20 to 200 cm) precludes one from correctly constructing an age/length key. Moreover, as pointed out in WG-FSA-90/11, this method of *D. eleginoides* age determination is yet to be properly studied; and

(iv) a lack of data on the catchability coefficient, which makes it impossible to use absolute estimates rather than relative biomass indexes from trawl surveys. This makes all subsequent results unreliable.

Management Advice

170. The Working Group noted that the assessment of *D. eleginoides* will continue to be very difficult as direct estimates of stock size are unlikely to be obtainable. Indirect assessment methods require that the effects of exploitation are monitored over a long period so that sufficient data are accumulated to produce statistically reliable results. However, the rate of exploitation does have to be a reasonable fraction of the MSY to produce a great enough effect on the stock to be detected, but if the exploitation rate is too high, an excessive stock decline will be likely before any unambiguous signs of over-fishing appear.

171. Bearing these points in mind, the Working Group concluded that a TAC in the range 1 200 to 8 000 tonnes would be appropriate pending improved assessments.

Electrona carlsbergi (Subarea 48.3)

172. Last year, the USSR reported that they had begun an experimental fishery for *E. carlsbergi* (SC-CAMLR-VIII, Annex 6, paragraph 7). Catches up to 1986/87 were low, varying from 500 to 2 500 tonnes. In 1987/88 and 1988/89, catches had increased to 14 868 and 29 673 tonnes respectively. The catch in the 1989/90 season remained around this level, with 23 623 tonnes taken. Fine-scale reports from 1988 showed that most catches occurred in the vicinity of Shag Rocks and South Georgia Island (Subarea 48.3) in that year (CCAMLR Statistical Bulletin, Volume 2, 1990, Figure 24). Since 1988, the catches have been taken south of the Antarctic Polar Front north of South Georgia. Length composition of catches was submitted in 1990 for Subareas 48.3, 48.4, and 48.6. Length composition and an age/length key for catches from Subarea 48.4 in 1989 are also available (SC-CAMLR-IX/BG/5).

173. A review of recent USSR research publications on mesopelagic fish prepared by the Secretariat (WG-FSA-90/23) summarised general distribution and biological characteristics of the major myctophid species found in the Antarctic. Additional papers that were presented detailed the results of surveys in the region of the Antarctic Polar Front by the USSR between 1987 and 1989. These surveys included the northern part of Subarea 48.3. The information presented was concerned with the feeding ecology of *E. carlsbergi* (WG-FSA-90/18), its pattern of reproduction (WG-FSA-90/20) and demography (WG-FSA-90/21), and seasonal and annual variability in its spatial distribution (WG-FSA-90/35).

174. The results suggest that the longevity of *E. carlsbergi* is four to five years with a maximum length ranging between 95 and 105 mm. A large proportion of the fish sampled north of the Antarctic Polar Front were 3 to 4 years old while to the south the majority were 2 to 3 years old. *E. carlsbergi* is not a truly Antarctic species, concentrating to the north of and around the Antarctic Polar Front where its prey is densely concentrated. Its distribution is known to extend to 70°S, although few specimens have been found south of the Weddell-Scotia Confluence in the Atlantic Ocean sector.

175. Reproductive development was found mostly in fish sampled to the north of the Antarctic Polar Front. In samples from the south of the Polar Front, *E. carlsbergi* was found to be mostly immature. Maturity seems to occur around 3 years old. A high proportion of 2 year old fish were found to be immature. Spawning occurs from April over the winter period.

176. The results of the surveys led the authors to propose subdivisions of the region around the Antarctic Polar Front including the northern part of Subarea 48.3 (WG-FSA-90/21 and WG-FSA-90/36). They suggested in these papers that *E. carlsbergi* found south of the Polar Front (in Subarea 48.3) were unable to reproduce and that oceanographic conditions prevented their return to the region north of the Polar Front where reproduction was possible. As a result, the authors considered that exploitation of this species in this area would not jeopardise the reproductive capacity of the population and the only concern would be to prevent depletion of this part of the South Atlantic stock to a level that would interfere with species dependent on the myctophids.

177. However, aspects of the data indicate that more research on the population dynamics of myctophids is required before such a conclusion can be reached. The length-frequency and age data in WG-FSA-90/21 indicate that mostly immature 2 year olds were found in the survey samples from the area south of the Antarctic Polar Front. No data were available to assess whether these juvenile myctophids are unable to migrate to the north of the

Convergence after entering the Antarctic Ocean. As the Polar Front is a surface phenomenon and *E. carlsbergi* is distributed to at least 250 m in depth, the Working Group considered that the Antarctic Polar Front should not prevent these fish from returning to sub-Antarctic waters.

178. An estimate of biomass of myctophid species from acoustic survey data collected between 1987 and 1989 was presented in WG-FSA-90/19. An estimate of 1.7 million tonnes was calculated to be present in the region 48 to 56°S and 8 to 48°W. Although the variance associated with this estimate was not given, the authors indicated that this estimate may vary depending on the oceanographic conditions. Most of the survey area had a low density of myctophids. In the dense concentrations, *E. carlsbergi* was the predominant species. The bulk of the biomass came from near the Antarctic Polar Front.

179. The Working Group recognised the similarities between estimating biomass of myctophids and the problems being addressed by the WG-Krill in estimating the abundance of krill using acoustic data. Specific questions that need to be given priority are concerned with survey design and data analysis and interpretation. The Working Group felt that, although the target strengths used to calculate the above estimate appear reasonable, the presentation of the data used to calculate the target strength of *E. carlsbergi* would be useful for developing a standard methodology for assessing myctophid abundance.

180. The Working Group identified a further problem with the management of this fishery in that the catch taken in Subarea 48.3 comes from part of a larger stock that has a distribution extending to the north of the CCAMLR Convention Area and in the terms of the Convention, this is an associated species. The Working Group recommends that the Scientific Committee address the problem of how to provide management advice on such a fishery. All catches on this stock have been reported to occur in Subarea 48.3. The Working Group recommends that, if they occur, catches of myctophids in the vicinity of the Antarctic Polar Front to the north of Subarea 48.3 should also be reported to CCAMLR with a breakdown of catches into fine-scale areas.

181. The Working Group acknowledged the paucity of data concerned with the role of myctophids in the Antarctic ecosystem. The relative importance of these species as prey in the South Georgia region should be considered by the Scientific Committee.

Management Advice

182. In order for the Commission to be able to take full account of the factors affecting the myctophid fishery in Statistical Area 48, the Working Group recommends that the reporting of catches of myctophids found in the CCAMLR Convention Area should include all catches of these species taken to the north of Statistical Area 48. All catch data should be reported in the fine-scale format.

183. Recognising the many problems associated with biomass estimates from acoustic data, the Working Group recommends that a priority be given to developing a methodology for the design of myctophid biomass surveys and the subsequent analysis of data.

Notothenia gibberifrons (Subarea 48.3)

184. The total catch of *N. gibberifrons* decreased from 838 tonnes in 1988/89 to 11 tonnes in 1989/90.

185. The catch rates for this species as a by-catch in midwater trawls were analysed in WG-FSA-90/15. These results showed that substantial catch rates of *N. gibberifrons* could occur even with midwater trawls. In 1987/88 the catch rate was estimated to be about 0.68 tonnes per haul. In 1988/89 the catch rate had declined to 0.1 tonnes per haul.

186. The Working Group noted that these results show that even though no by-catch was reported from the 1989/90 season, it cannot be presumed that future fishing with midwater trawls will always result in negligible by-catch.

187. Three new estimates of biomass from trawl surveys were available.

Survey	Biomass (CV)	Reference
Hill Cove	12 417 (28%)	WG-FSA-90/13
Akademik Knipovich	21 891 (23%)	WG-FSA-90/13
Anchar	53 600 (21%)	WG-FSA-90/30

188. Concern was expressed at the disparity between the results from the three surveys. It was noted that the *Anchar* survey did not cover areas within 12 miles and that catch rates (density) outside 12 miles were generally higher. Hence, extrapolating the results from outside 12 miles for the area within 12 miles would bias the estimates upwards. In order to

determine whether this effect alone would account for the discrepancy, the *Hill Cove* results were re-analysed excluding the hauls made within 12 miles. The results of these calculations (Appendix H) show that the lack of samples taken within 12 miles does not explain the difference in results.

189. The Working Group agreed that the biomass estimate of *N. gibberifrons* from the *Anchar* survey should not be used because it gave a result much larger than any of the six other surveys conducted in recent years.

190. Assessment efforts for *N. gibberifrons* in Subarea 48.3 were hampered by the lack of fine-scale catch and effort data and biological data (i.e., age/length keys for 1988/89 and 1989/90).

191. The results of trawl surveys conducted during 1984/85 and 1985/86 to 1989/90 were used to tune two VPA analyses for the period 1975/76 to 1989/90. The first analysis used an estimate of biomass during 1989/90 (21 891 tonnes) obtained by Soviet scientists aboard the *Akademik Knipovich* while the second analysis used a lower estimate (12 417 tonnes) obtained by UK scientists aboard the *Hill Cove*.

192. The VPA analyses were tuned by minimising the sum of squared differences between the VPA estimates of total biomass and the survey estimates in each year. This approach, which assumes that bottom trawl surveys provide absolute rather than relative measures of abundance, was criticised on grounds that bottom trawl surveys tend to underestimate biomass in absolute terms.

193. In response to the criticism, it was pointed out that:

(i) an attempt to treat the survey estimates as relative measures had produced impossible results; and

(ii) the inprecision in survey results suggested that the underestimation was small in comparison to the variance inherent in biomass estimates, and for some years (1986/87 to 1988/89) the VPA estimates of biomass were actually equal to or lower than survey estimates.

194. The VPA results show that the abundance of *N. gibberifrons* has declined over the period of fishing. VPA and bottom trawl surveys indicate that abundance declined from

about 40 000 tonnes in 1975/76 to about 13 000 tonnes in 1981/82 and has remained low since that time (see Figure 8).

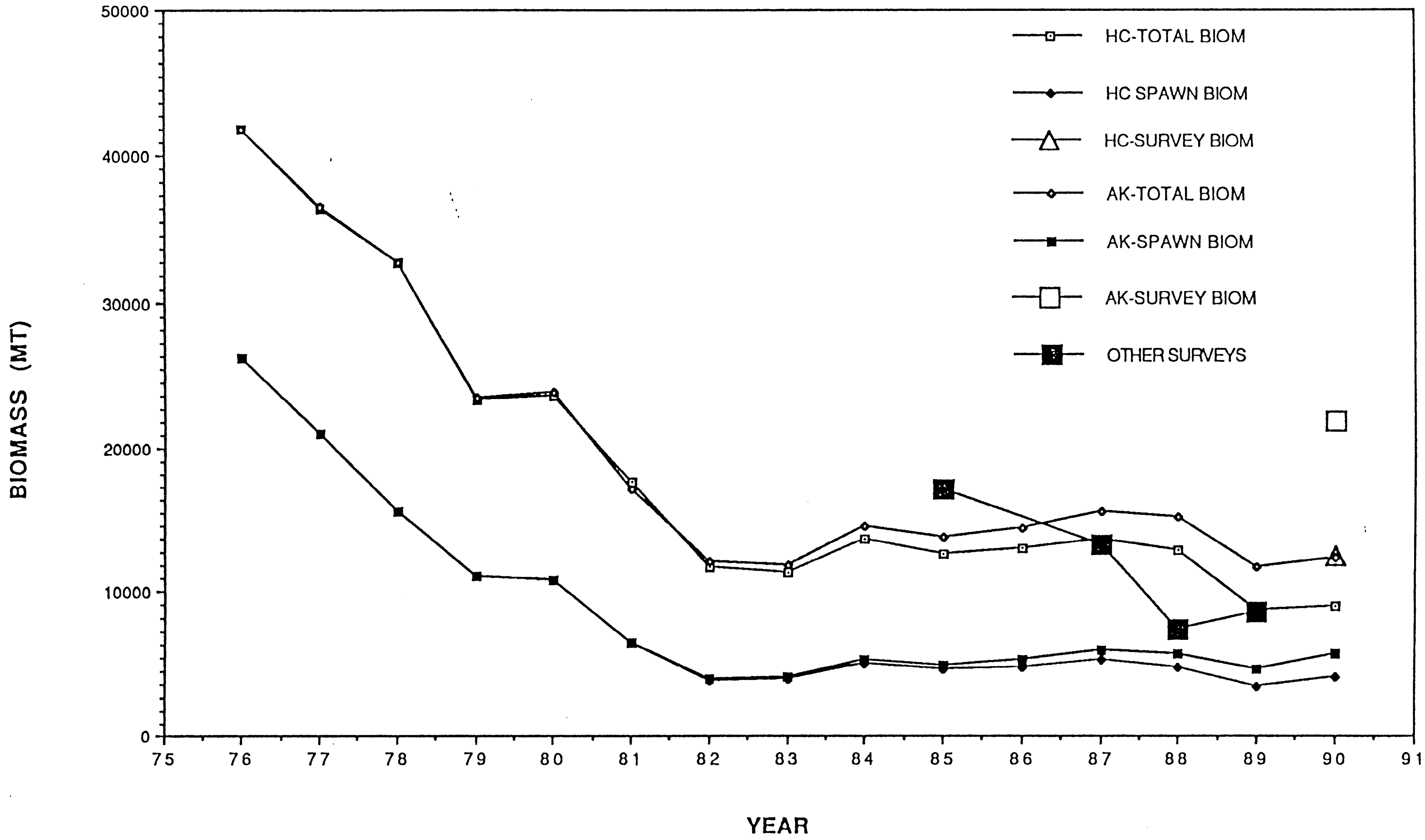

Figure 8: VPA results for *N. gibberifrons* in Subarea 48.3.

195. VPA estimates of current biomass, biomass projections for 1990/91 to 1991/92 and TAC calculations are summarised in the table below. In calculating TAC values, fishing mortality rates of $\mathbf{F_{0.1}}$=0.09 yr^{-1} were assumed.

TAC projection and VPA tuned to *Akademik Knipovich* survey in 1990:

	Current 1989/90	Projected 1990/91	Projected 1991/92
Biomass	12 784	14 129	14 420
TAC		1 134	1 161

TAC projection and VPA tuned to *Hill Cove* survey in 1990:

	Current 1989/90	Projected 1990/91	Projected 1991/92
Biomass	8 523	9 606	10 101
TAC		667	723

Management Advice

196. Current stock size is about 20 to 30% of the level existing at the start of fishing. The most recent assessments indicate that the stock may not be as depleted as had been found in previous assessments. The Working Group recommends, however, that there should be no directed fishery for *N. gibberifrons* because this may lead to excessive by-catch of other species.

197. The likely slow rate of increase of the stock suggests that catches below the $\mathbf{F_{0.1}}$ level are appropriate and that the by-catch of *N. gibberifrons* should be restricted to not more than 500 tonnes.

Chaenocephalus aceratus and *Pseudochaenichthys georgianus* (Subarea 48.3)

198. Reported catches of both species have been relatively small in recent years, exceeding 2 000 tonnes of *C. aceratus* only in 1987/88 and only 2 tonnes were taken in 1989/90. However, catches of these species have only been reported by Poland, the German Democratic Republic and Bulgaria, but never by the Soviet Union, which takes the majority of the catches in Subarea 48.3, although the species were a regular by-catch in the bottom

trawl fishery, such as in 1977/78. The Soviet Union reported large catches in the category 'Pisces nei' during this period. WG-FSA-90/6 hypothesised that these catches were made up largely of *C. aceratus* and *P. georgianus* and has attempted to reconstruct the fishery by re-allocating 75% of the catch of 'Pisces nei' reported by the Soviet Union to the two species in the same proportion as these species were reported in the Polish catches (Table 8).

Table 8: Reported and adjusted catch of *C. aceratus* and *P. georgianus*.

	C. aceratus		*P. georgianus*	
Year	Reported Catch	Adjusted Catch	Reported Catch	Adjusted Catch
1977	293	1 972	1 608	10 815
1978	2 066	3 986	13 015	21 220
1979	464	1 726	1 104	3 660
1980	1 084	3 258	665	1 990
1981	1 272	3 576	1 661	4 670
1982	676	2 145	956	3 032
1983	0	2 753	0	6 062
1984	161	647	888	3 572
1985	1 042	2 395	1 097	2 522
1986	504	626	156	194
1987	339	1 389	120	456
1988	313	709	401	1 045
1989	1	15	1	5

199. Input parameters to the assessments have been extensively described in WG-FSA-90/6. In *P. georgianus* major discrepancies were detected between ageings and resultant growth coefficients reported for the species in the late 1970s and the most recent years (Figure 9). This was most likely due to the different methods used for ageing. VPA calculations were performed with different values of **M**. The VPA with the best fit to the survey data in *C. aceratus* was that with input **M**=0.30 and in *P. georgianus* with input **M**=0.4.

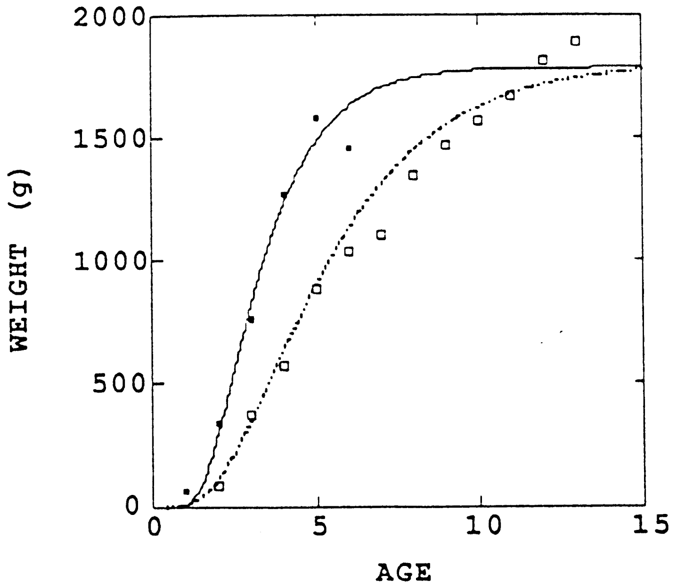

Figure 9: Mean weight-at-age for *P. georgianus* from Polish 1988 and 1989 data (■) with fitted von Bertalanffy growth curve (——), and Mucha's data for 1977 to 1979 (□) with the growth curve given by Kock *et al.* (1985).

200. Results of the VPA for *C. aceratus* indicate that the pristine stock size may have been around 18 000 to 19 000 tonnes and has been reduced to approximately 40% in 1987. Stock size has increased slowly since then to approximately 9 000 in 1988/89 which, however, is not apparent from biomass estimates obtained during research vessel surveys from 1987 to 1989 (Figure 10). Biomass estimates from research vessel surveys in the 1989/90 season, however, were higher than from previous seasons. They were 14 226 tonnes (*Hill Cove*), 14 424 tonnes (*Akademik Knipovich*) and 17 800 tonnes (*Anchar*). A stock-recruit relationship was evident from the VPA (Figure 11).

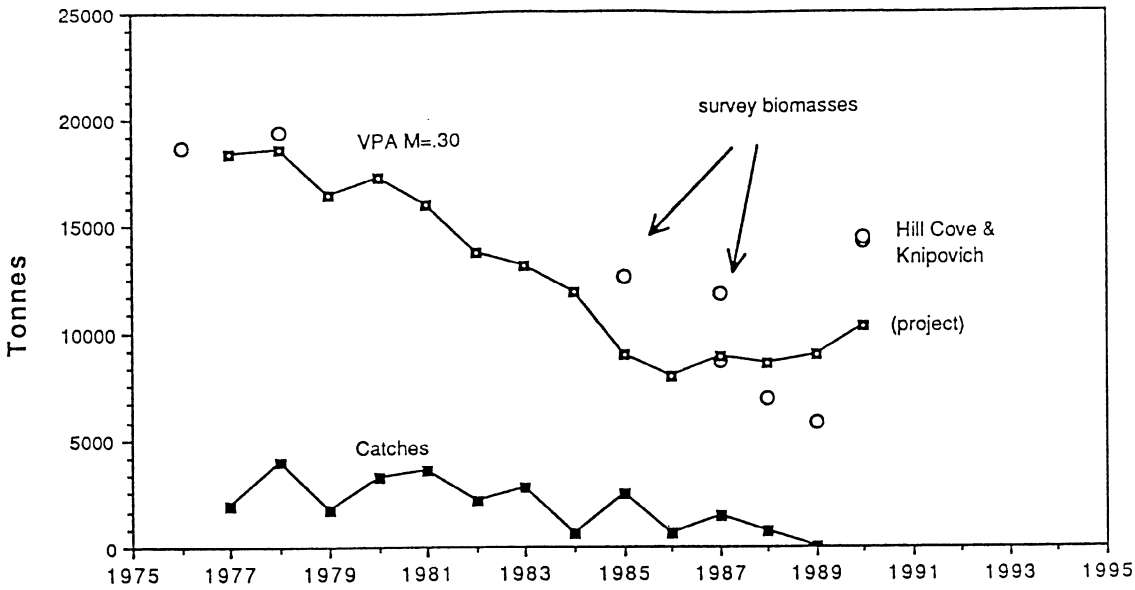

Figure 10: VPA and survey biomasses for *C. aceratus*.

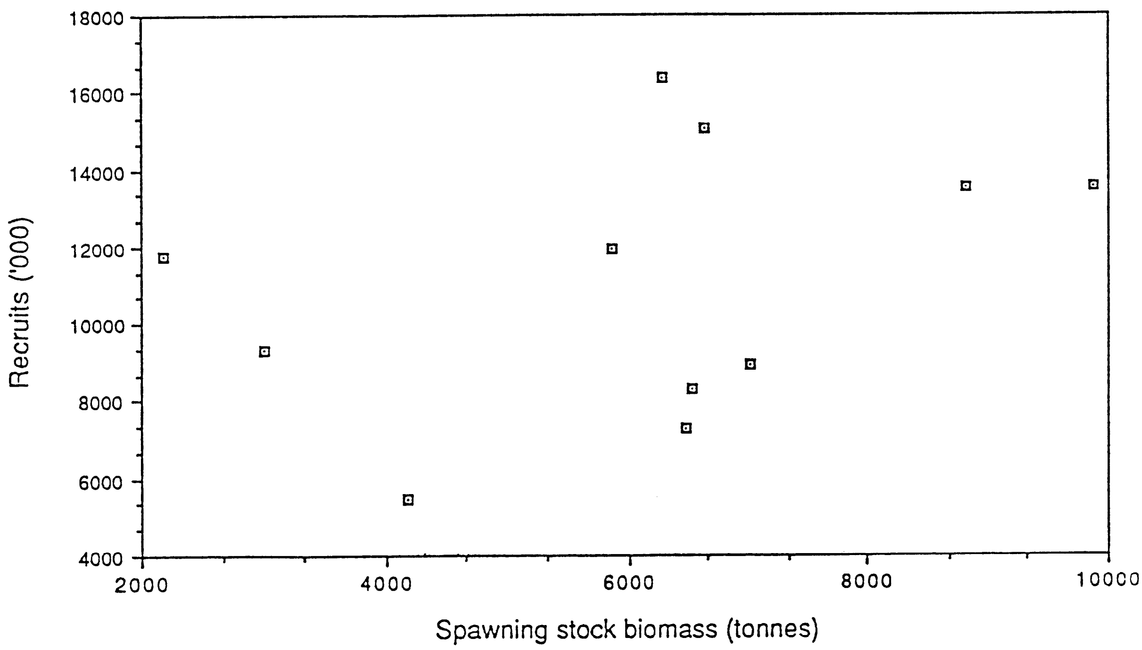

Figure 11: Stock recruit relationship for *C. aceratus*.

201. Results of the VPA for *P. georgianus* indicate that the current biomass is around 10 000 tonnes and that the pristine biomass was about 39 000 to 44 000 tonnes dependent on

the level of **M** (Figure 12). Biomass estimates obtained during the 1989/90 season were in the same order of magnitude: 5 761 tonnes, *Hill Cove*; 12 200 tonnes, *Akademik Knipovich*; and, 10 500 tonnes, *Anchar*.

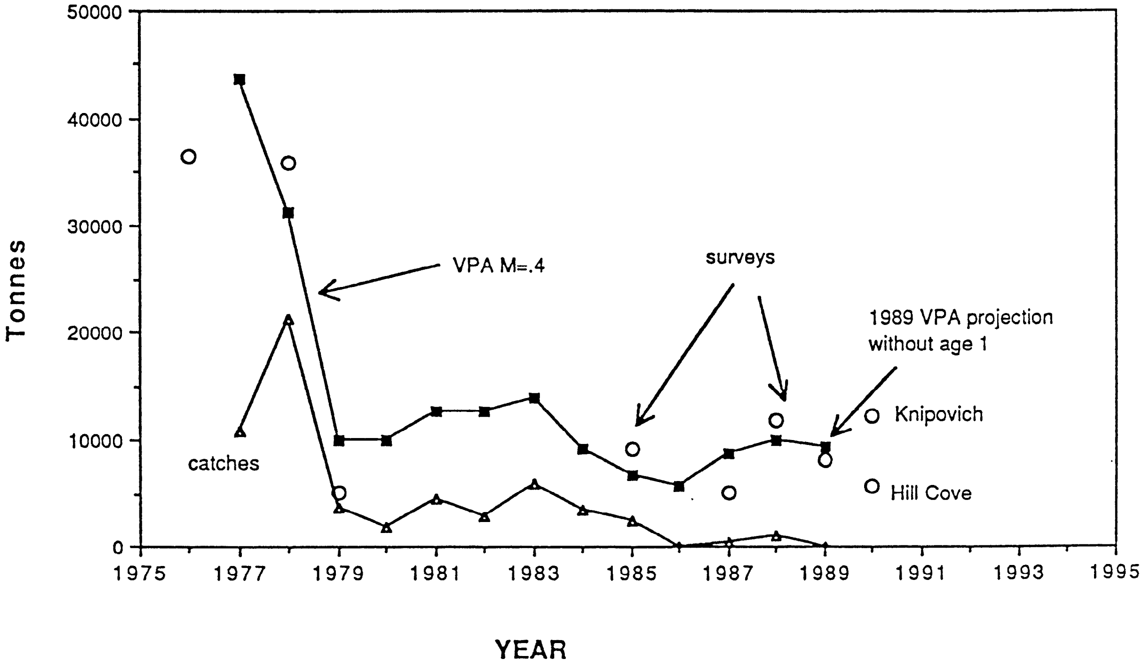

Figure 12: Results of VPA and adjusted survey biomasses for *P. georgianus* in Subarea 48.3.

Note: VPA biomass from VPA in 1989 is projection only; it does not include an estimate for recruitment and is therefore an underestimate.

202. Yield-per-recruit analysis in *C. aceratus* with **M**=0.3 resulted in $\mathbf{F_{max}}$=0.327 and $\mathbf{F_{0.1}}$=0.195. These results were comparable with those of Kock *et al.* (1985), who obtained $\mathbf{F_{0.1}}$ values of 0.15 to 0.18 using the Beverton and Holt (1957) model with **M**=0.2. Yield-per-recruit analysis in *P. georgianus* produces $\mathbf{F_{max}}$=1.44 and $\mathbf{F_{0.1}}$=0.626 with **M**=0.4. Y/R calculations by Kock *et al.* (1985) using growth parameters obtained in the late 1970s and **M**=0.3 showed $\mathbf{F_{0.1}}$=0.3 to 0.4.

203. Short-term projections were performed using the 1990 stock sizes of both species from the VPA with **M**=0.3 (*C. aceratus*) and **M**=0.4 (*P. georgianus*). The results are set out in Tables 9 and 10.

Table 9: Results of short-term projections in *C. aceratus*.

	Catch (tonnes)		Stock Biomass 1 July (tonnes)	
	1990	1995	1990	1995
tac=300 tonnes	300	300	10 268	13 472
$\mathbf{F_{0.1}}$=0.214	1 597	1 172	10 268	7 844

Table 10: Results of short-term projection in *P. georgianus*.

	Catch (tonnes)		Stock Biomass 1 July (tonnes)	
	1990	1995	1990	1995
tac=300 tonnes	300	300	9 969	16 559
$\mathbf{F_{0.1}}$=0.626	3 576	2 516	9 969	8 897
50% of $\mathbf{F_{0.1}}$=0.313	2 043	2 002	9 969	11 456

204. Short-term projections in *C. aceratus* showed that at $\mathbf{F_{0.1}}$=0.214 the stock will increase slowly from 7 200 tonnes to 8 700 tonnes in 1995, with a TAC of 300 tonnes a year set as a by-catch provision by the Commission (Conservation Measure 13/VIII). The low expectation of sustainable yield for this stock is largely a result of the low levels of recruitment observed from the VPA.

205. The fishing regimes used for the projections in *P. georgianus* were those of 300 tonnes as established by the Commission in 1989, $\mathbf{F_{0.1}}$ and 50% $\mathbf{F_{0.1}}$. The analysis showed that fishing at $\mathbf{F_{0.1}}$ at the present stock size would cause a slow decline stock size.

206. The outcome of the analysis of *P. georgianus* is largely affected by the reliability of ageing in this species. From the analysis presented in WG-FSA-90/6 which involved only age classes 1 to 6 and a resultant fast growth rate, it appears that the stock may have highly variable recruitment. However, if the true growth rate of this species was much lower, as some investigations suggest which describe up to 13+ age classes being present in the stock, the details of the analysis presented in WG-FSA-90/6 could change considerably. This would particularly affect $\mathbf{M}$, $\mathbf{F_{0.1}}$ and the recruitment estimates.

Management Advice

207. The analysis presented in WG-FSA-90/6 indicates that the stock of *C. aceratus* seems to be very vulnerable to overfishing at relatively low levels of fishing effort. The

spawner-recruit relationship and low initial stock size indicates that the stock may not sustain a high yield when it recovers. Management at $\mathbf{F_{0.1}}$ at the present stock size appear to be inappropriate for both *C. aceratus* and *P. georgianus*. A TAC of 300 tonnes, as presently established as a by-catch provision, which is much lower than $\mathbf{F_{0.1}}$ would appear to allow a more rapid recovery in stock biomass of both species.

Notothenia squamifrons (Subarea 48.3)

208. A TAC of 300 tonnes as a by-catch provision (Conservation Measure 13/VIII) was established by the Commission in 1989. The catch in the 1989/90 season was only 24 tonnes.

209. Despite the long catch history since 1971/72, very little information on length and no information on age composition has been submitted to CCAMLR. Biomass estimates obtained in 1989/90 differed widely: 1 359 tonnes (*Hill Cove*), 6 391 tonnes (*Akademik Knipovich*) and 133 800 tonnes (*Anchar*).

210. Biological characteristics of the closely related Kerguelen population indicate that the species is long living with a large number of age classes present in the stock. Due to the absence of information on catch-at-age, recruitment or mortality estimates the Working Group was unable to assess the state of the stock.

Management Advice

211. In the absence of information for an assessment of the stock the Conservation Measure presently in force should be retained.

South Orkney Islands (Subarea 48.2)

212. Catches in Subarea 48.2 were only substantial in the late 1970s. Since then, catches of all species have been usually in the order of a few thousand tonnes only except in 1982/83 and 1983/84 when 18 412 and 15 056 tonnes were taken.

Table 11: Catch by species in Subarea 48.2.

	Champsocephalus gunnari	*Notothenia gibberifrons*	*Notothenia rossii*	Pisces nei	Total
1978	138 895	75	85	2 603	141 659
1979	21 439	2 598	237	3 250(1)	27 524
1980	5 231	1 398	1 722	6 217(2)	14 548
1981	1 861	196	72	3 274	5 403
1982	557	589		2 211	3 357
1983	5 948	1		12 463(3)	18 412
1984	4 499	9 160	714	1 583	15 956
1985	2 361	5 722	58	531	8 672
1986	2 682	341		100	3 123
1987	29	3		3	35
1988	1 336	4 469			5 805
1989	532	601		1	1 134
1990	2 528	340			

(1) Mainly *Chaenocephalus aceratus*
(2) *P. georgianus* and unidentified nototheniids and channichthyids
(3) Unknown species

213. Catch figures for the 1989/90 season have been submitted for *C. gunnari* and *N. gibberifrons* only, although length compositions have been submitted to CCAMLR also for *N. rossii* and *Chionodraco rastrospinosus*. Catches of *C. gunnari* increased by a factor of 5 from 532 tonnes in 1988/89 to 2 528 tonnes in 1989/90, while catches of *N. gibberifrons* were 340 tonnes.

214. Although some new information on *C. gunnari*, *N. gibberifrons*, *N. rossii* and *Chionodraco rastrospinosus* from the 1988/89 and the 1989/90 fishing seasons had been submitted to CCAMLR, the lack of biomass estimates since 1986/87 and gaps in the time series of up to several years made it impossible to assess the present state of the stocks.

215. An assessment provided on *N. gibberifrons* carried out by the Working Group in 1988 encountered difficulties in matching biomass estimates from two research vessel surveys in 1977/78 and 1984/85 with the trend in biomass from VPA analysis. By allocating 75% of the catches of ‘Pisces nei’ reported in 1979/80 to 1982/83 to *N. gibberifrons* (see below), WG-FSA-90/16 was able to match both trends in biomass. The results indicated that the stock was reduced to 60% of its initial level in 1977/78 by 1985/86 and that a substantial part of the catches had consisted of juveniles. The current state of the stock is unknown.

	Before Reallocation		After Reallocation	
	N. gibberifrons	Pisces nei	*N. gibberifrons*	Pisces nei
1979	2 598	133	2 598	133
1980	1 398	501	1 772	452
1981	196	2 770	2 274	114
1982	589	2 181	2 275	359
1983	1	12 349	9 266	3 819
1984	9 160	1 389	9 160	1 389
1985	5 722	522	5 722	522
1986	341	100	341	100
1987	3	1	3	1
1988	4 469	0	4469	0
1989	601	0	601	0

216. To provide new assessments of the stocks around the South Orkney Islands, length and age data from the catches since the mid 1980s, in particular *C. gunnari* and *N. gibberifrons*, are needed. An estimate of current stock biomass from a research vessel survey is highly desirable.

Management Advice

217. Due to the lack of new information the Working Group had asked for in its 1989 report, the Working Group was unable to provide management advice for either species.

Antarctic Peninsula (Subarea 48.1)

218. No commercial fishing took place in Subarea 48.1 in 1989/90.

219. No new information was available to the Working Group on any of the stocks in the Antarctic Peninsula region.

Management Advice

220. Due to the absence of data, the Working Group was unable to give management advice for any species.

Statistical Area 58

221. In 1989/90, fishing took place in Subarea 58.4 and Division 58.5.1.

222. In addition, research programs, including biomass surveys, took place in Divisions 58.5.2 and 58.4.2 in the 1990 season.

223. A summary of catches reported from Statistical Area 58 is given in Table 12. As in previous years, harvesting has been confined to Divisions 58.4.4 (Ob and Lena Banks) and 58.5.1 (Kerguelen). The major harvested species remain *Notothenia squamifrons* (Subareas 58.4 and 58.5) and *C. gunnari* and *D. eleginoides* (Division 58.5.1).

Subarea 58.5

Division 58.5.1 (Kerguelen)

224. Assessment of the Kerguelen fishery was extremely difficult in the absence of any French delegate or anyone else with direct knowledge of the fishery. It is hoped that Dr Duhamel will be able to attend future Working Group meetings to provide data and assessment.

Notothenia rossii (Division 58.5.1)

225. No new data derived from catches have become available since 1988 when directed fishing on the stock was prohibited. By-catch levels in the last few years have been of the order of a few hundred tonnes with some 155 tonnes being taken in 1989/90.

226. A recent Soviet analysis of catch data prior to 1984 (1970 to 1984) (WG-FSA-90/41) confirms earlier analyses undertaken by WG-FSA despite the fact that data for the period under consideration has not been complete.

Table 12: Total catches by species and subarea in Statistical Area 58. Species are designated by abbreviations as follows: ANI (*Champsocephalus gunnari*), LIC (*Channichthys rhinoceratus*), TOP (*Dissostichus eleginoides*), NOR (*Notothenia rossii*), NOS (*Notothenia squamifrons*), ANS (*Pleuragramma antarcticum*), MZZ (Unknown), SRX (*Rajiformes spp.*), WIC (*Chaenodraco wilsoni*).

Split	ANI		LIC	WIC	TOP				NOR			NOS			ANS		MZZ			SRX
YEAR	58	58.5	58.5	58.4	58	58.4	58.5	58.6	58	58.4	58.5	58	58.4	58.5	58	58.4	58	58.4	58.5	58.5.1
1971	10231				XX				63636			24545					679			
1972	53857				XX				104588			52912					8195			
1973	6512				XX				20361			2368					3444			
1974	7392				XX				20906			19977					1759			
1975	47784				XX				10248			10198					575			
1976	10424				XX				6061			12200					548			
1977	10450				XX				97			308					11			
1978	72643	250	82		196	-	2	-	46155			31582		98	234		261			
1979				101	3	-	-	-				1307					1218			
1980		1631	8	14		56	138	-			1742		4370	11308				239		
1981		1122	2			16	40	-		217	7924		2926	6239				375	21	
1982		16083				83	121	-		237	9812		785	4038		50		364	7	
1983		25852				4	128	17			1829		95	1832		229		4	17	1
1984		7127				1	145	-		50	744		203	3794					*611	17
1985		8253		279		8	6677	-		34	1707		27	7394		966		11	7	4
1986		17137		757		8	459	-		-	801		61	2464		692				3
1987		2625		1099		34	3144	-		2	482		930	1641		28		22		
1988		159		1816		4	554	488		-	21		5302	41		66				
1989		23628		306		35	1630	21			245		3660	1825		47		23	24	
1990		226		339			1062				155		1450	1262					2	

* Mainly *Rajiformes* spp.

NB: Before 1979/80 catches reported in Statistical Area 58 mainly concern Division 58.5.1 (Kerguelen Subarea)

227. Similarly, results of Soviet trawling surveys in 1987 and 1988 (WG-FSA-90/18) indicate that the species biomass was lower than reported to the Working Group in 1988 and 1989 (WG-FSA-88/22 and WG-FSA-89/10). Although the authors of the Soviet report conclude that their estimate may be an underestimate of stock biomass, they support the need for integrated surveys of pre-spawner and spawner biomass as recommended by WG-FSA at its last meeting (SC-CAMLR-VIII, Annex 6, paragraph 170).

228. French research (SC-CAMLR-VIII, Annex 6, paragraph 169) concluded that there has been some increase in the abundance of juveniles of this species and that an increase in recruitment to the mature stock should be apparent for a few years.

Management Advice

229. Conservation measures (no directed fishery) should continue to protect the adult stock. Trends in the abundance of the juvenile part of the stock need to continue to be monitored. Biomass surveys will be required to establish whether the stock has made a substantial recovery prior to any resumption of exploitation.

Notothenia squamifrons (Division 58.5.1)

230. In the 1990 season, 1 262 tonnes were caught which is similar to catches in the last few years, but well below the catch levels before 1984.

231. The only new data available are biomass estimates in WG-FSA-90/38.

232. In spite of detailed requests for data made at the last meeting of the Working Group, no new data have been received. Consequently, no further assessment can be made on this stock despite evidence from last year's meeting that this stock has been significantly depleted and that only about 15% of the current stock biomass is comprised of adults.

Management Advice

233. Present catch levels are of the same order of magnitude as the biomass estimates given in WG-FSA-90/38. Continuation of catches at those levels will prevent recovery of the stock size to optimal levels.

Champsocephalus gunnari (Division 58.5.1)

234. Only 226 tonnes were caught in the 1990 season and no new data were available to extend the cohort analysis to 1990.

235. New figures for the biomass of the 1985 cohort of *C. gunnari* in 1988 were available from two sources: a re-calculation of the cohort analysis performed at last year's Working Group meeting (WG-FSA-90/17), and a re-evaluation of the Soviet-French biomass survey in 1988 (WG-FSA-90/38).

236. The re-calculation of the biomass in WG-FSA-90/17 was based on the assumption that a negligible number of the cohort survive to age 4 (i.e., are fished out at age 3). This resulted in an estimated stock size of 22 711 tonnes in 1989. The Soviet re-calculation of the results of the biomass survey conducted in 1988 (WG-FSA-90/38) suggests a stock size of an order of magnitude greater (200 000 to 230 000 tonnes).

237. The re-calculated cohort derived biomass (WG-FSA-90/17) appears to be the more realistic estimate as it is more consistent with previous biomass calculations for the 1979 and 1982 cohorts at age 2 and the assumption of effective extinction of the cohort at the end of the fourth year is supported by the fact that the catch in the 1990 season was only 226 tonnes, despite a considerable effort applied.

238. There appears to be a trend of declining stock size with successive cohorts, although at the moment this is only based on three data sets (Figure 13).

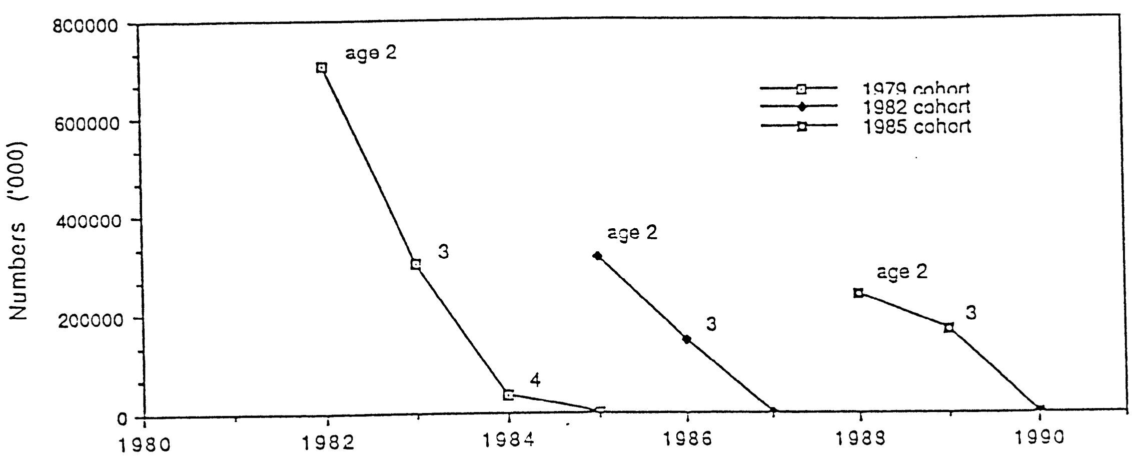

Figure 13: *C. gunnari* stock numbers from Kerguelen shelf.

Management Advice

239. The 1985 cohort now appears extinct and no management advice can be given until the condition of the 1988 cohort is known. The results of WG-FSA-90/17 and the low catch in the 1990 season indicate that the high mortality occurs in 3 year old fish. As pointed out in last years' report, it is not known whether the extinction of 3-group fish is due to fishing or natural mortality. The 1988 cohort is expected to be recruited to the fishery in the 1990/91 season. The cause of mortality could be resolved this season by restricting the catch to a relatively low level and conducting a biomass survey prior to the 1990/91 and 1991/92 fishing seasons.

Dissostichus eleginoides (Division 58.5.1)

240. 557 tonnes were caught in the 1990 season, which is lower than the average of the past few seasons. In some recent seasons the catch of *D. eleginoides* has been low because of re-direction of effort to the *C. gunnari* fishery. In the 1990 season the catches of both species were low.

241. At last year's meeting, WG-FSA noted that the evaluation of the total stock biomass is likely to be difficult due to inaccessability of part of the adult stock and due to incomplete knowledge of the species' biology.

242. Available biomass survey results tend to confirm the conclusion with recently reported estimates of abundance providing a range of values of 114 000 (WG-FSA-88/22 Rev. 1), 43 000 (SC-CAMLR-VIII, Annex 6, paragraph 161) and 12 700 tonnes (WG-FSA-90/78).

Management Advice

243. In the absence of more refined estimates of abundance, WG-FSA was unable to develop additional advice to that given last year. Further assessment of the stock is urgently required to estimate the level of catch necessary to stabilize the stock. Such assessment should also entail the collection of length frequency and age/length data in order to facilitate elucidation of stock dynamics.

Division 58.5.2 (Heard Island)

244. There is no fishery in this area at present. During the 1990 season, a biomass survey was conducted by Australia (WG-FSA-90/42). Based on a random stratified design, the results of this survey indicate that the most abundant species was *D. eleginoides* with a biomass of just over 18 000 tonnes. Other species of commercial interest, *C. gunnari* and *N. squamifrons*, had a total biomass of 14 200 and 7 900 tonnes respectively. This survey is the first to cover the entire shelf area of Heard Island since the Australian EEZ was declared in 1979. Although comparison with other survey results is difficult, the survey tends to confirm the presence of a small concentration zone of *C. gunnari* to the northeast of Heard Island. Despite being a first attempt at a comprehensive survey of the shelf area, it has indicated an otherwise low biomass of fish.

Division 58.4.4 (Ob and Lena Banks)

245. For the first time, catch data for *N. squamifrons* have been reported individually for Ob and Lena Banks for the years 1978 to 1989 (WG-FSA-90/37). This has permitted more detailed assessment of these stocks. The catch data given in WG-FSA-90/37, however, differ significantly from those submitted to CCAMLR (see Figure 1). These two versions need to be reconciled. The history of catches from this area is shown in Figure 14. Although the catches have been reported by calendar year (WG-FSA-90/37), the total catch is much greater than previously reported, particularly in 1986. For the purposes of stock assessment, the catch data by calendar year from 1978 to 1989 have been used.

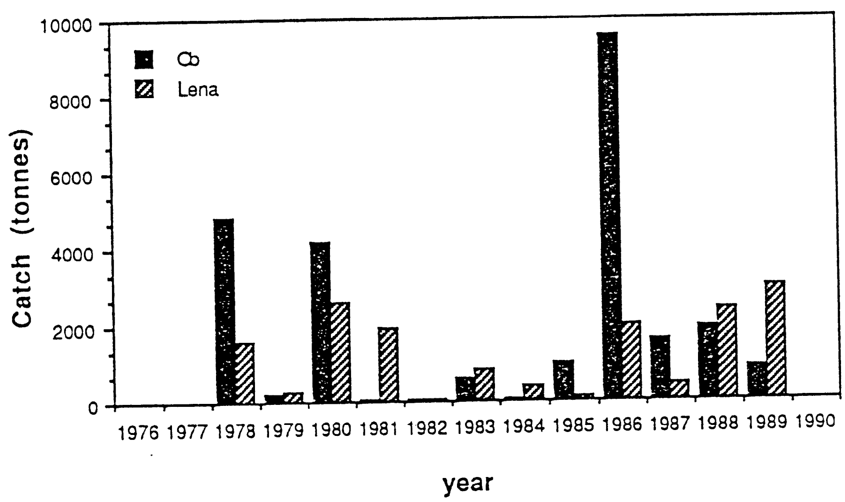

Figure 14: *N. squamifrons* - catches at Ob and Lena Banks.

Notothenia squamifrons (Division 58.4.4)

Lena Bank

246. In 1989/90, the catch for Ob and Lena Bank was reported as 1 450 tonnes, but no area separation was given. To approximate the catch from Lena Bank in 1989/90, the same ratio of catches from the two seamounts was used as reported in 1988/89 (WG-FSA-90/37). The estimated catch in 1989/90 was 1 112 tonnes from Lena Bank and 338 tonnes from Ob Bank.

247. The results of trawl surveys on Lena Bank from 1980 to 1989 were also reported in WG-FSA-90/37. A number of different vessels and nets were used throughout this time in different months of the year. However, the details of the results were not provided and there is a possibility that the non-random design of the surveys may have over-estimated abundance. The 1980 and 1986 surveys were considered to be the most reliable by the author of WG-FSA-90/37. Stock size is reported based on the swept area method using wingspread estimates with a catchability coefficient of 0.5.

248. A series of catch and effort indices from 1978 to 1989 was presented in WG-FSA-90/37 and was used to carry out a VPA for each area in Division 58.4.4. However, no catch-at-age data or fishing mortality estimates were provided. The biomass estimates resulting from this assessment are unusual, showing an upward trend at Lena Bank (Figure 15) at a time when catches were increasing (1986 to 1989). This upward trend in biomass estimates from the VPA suggests that the effects of fishing are not adequately represented by the fit of the model. Therefore, the stock assessment for Lena Bank was re-calculated by VPA, using the survey estimates to calibrate changes in biomass.

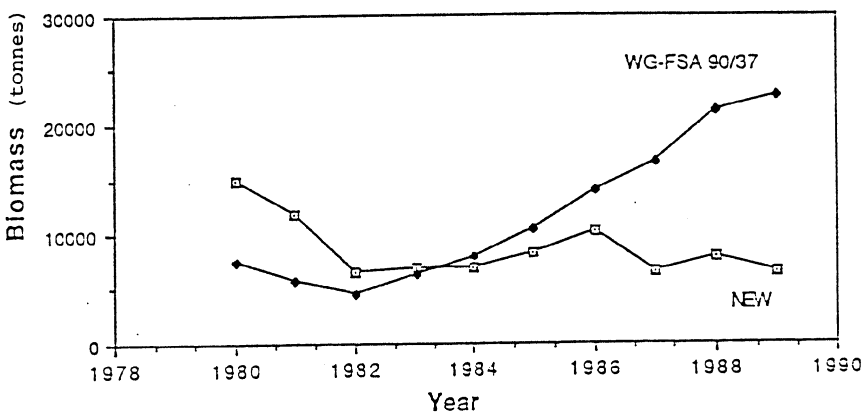

Figure 15: Trends in biomass of *N. squamifrons* on Lena Bank from VPAs provided in WG-FSA-90/37 and after re-calculation by the Working Group.

249. The catch-at-age data for Lena Bank was based on the proportions at each age previously used in the assessment (WG-FSA-89/5). The catches-at-age were scaled up to the total catch reported for the Lena Bank using weights-at-age given in WG-FSA-90/37. The distributions of catches-at-age for 1988 and 1989 were both based on the 1987 sample distributions.

250. In the revised assessment, the trawl survey estimates of biomass in 1980 (19 800 tonnes) and 1986 (11 800 tonnes) were used as relative measures of abundance. The VPA was tuned so that the biomass at the end of 1986 was 60% of the biomass at the end of the 1980 fishing season. Estimates of the catchability coefficients for the surveys, based on the VPA model were 0.9 in 1986 and 1.2 in 1980. Based on this assessment, the Lena Bank stock shows a decrease in biomass from 1980 to 1989 (Figure 15). This is more consistent with the catch history of the fishery, when the rate of natural mortality and age distribution is considered.

251. Fishing mortality in 1988/89 was estimated to be 0.8 for fully recruited age classes. The projection to 1989/90, based on a catch of 1 112 tonnes, results in fishing mortality of 0.47. The stock was further projected to 1990/91 using average values of recruitment from the VPA.

252. The yield estimate based on $\mathbf{F_{0.1}}$ of 0.13 was 305 tonnes using the projected biomass in 1990/91 of 3 454 tonnes.

Management Advice

253. Although the catch data from 1978 to 1989 (by calendar year) were presented in WG-FSA-90/37, catches were not reported separately from the two seamounts in 1990. Length frequency and age composition data are also required for the years since 1987. Details of the design and results from trawl surveys from 1980 to 1989 for Ob and Lena Bank should be provided to the Working Group.

254. Recent values of fishing mortality for Lena Bank are much higher than the $\mathbf{F_{0.1}}$ level, and the stock has decreased in size in recent years. As this species is slow growing and long lived (15+ years), catches at historical levels will not be sustainable. Catches should be limited to the level of $\mathbf{F_{0.1}}$ yield.

Ob Bank

255. Catches of *N. squamifrons* from 1978 to 1989 on Ob Bank are shown in Figure 14. The maximum catch occurred in 1986 when 9 531 tonnes were reported. Catches in most years were low, reflecting little fishing effort on this species. However, there are two main periods of fishing from 1978 to 1980 and from 1985 to 1989. Based on the distribution of catches in Division 58.4.4 in 1988/89, the 1989/90 catch was estimated at 338 tonnes.

256. Two trawl surveys were reported for the Ob Bank (WG-FSA-90/37) carried out in 1980 and 1986, and analysed using a catchability coefficient of 0.5. For the Lena Bank assessment described earlier, catchability coefficients of 0.9 and 1.2 were calculated for surveys in 1980 and 1986, using the same vessel and gear as used in the Ob Bank surveys. Assuming a catchability coefficient of 1.0 for these surveys gives biomass estimates of 5 100 tonnes (1980) and 5 500 tonnes (1986).

257. Catch-effort indices from 1978 to 1989 were used to carry out the VPA reported in WG-FSA-90/37. The trend in biomass from 1978 to 1989 is shown in Figure 16. After a drop in biomass following the large catch in 1986, the biomass shows an upward trend. As catch-at-age and fishing mortality estimates were not provided, it is not possible to evaluate the fit of the model to the Ob Bank fishery.

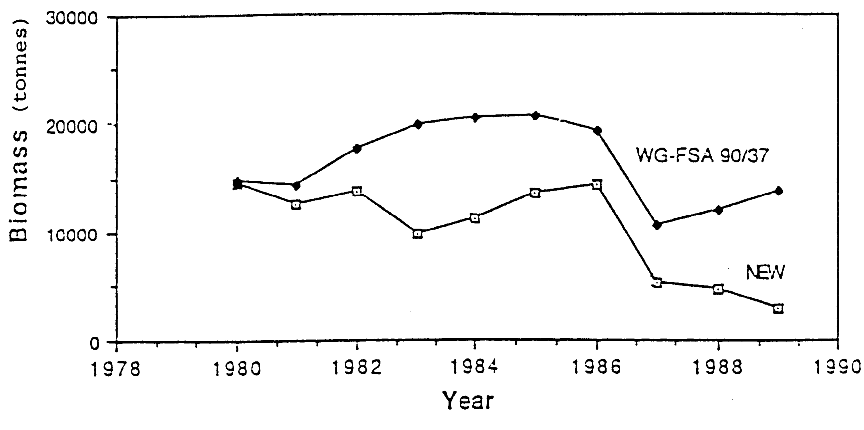

Figure 16: Trends in biomass of *N. squamifrons* on Ob Bank from VPAs provided in WG-FSA-90/37 and after re-calculation by the Working Group.

258. The Ob Bank stock was also re-assessed by VPA using the biomass estimate from the 1986 survey to calibrate the model. Catch-at-age data have not been available since 1987. In addition, the catch-at-age for 1980 to 1987 from the Ob Bank has not been estimated, although the data on length and age composition from the commercial fishery have been

submitted. The relative proportions at each age from Lena Bank data for the years 1980 to 1989 were used as input to the assessment.

259. The results of the VPA using the trawl survey estimate are shown in Figure 16. The trend in biomass differs from that in WG-FSA-90/37, particularly in the most recent years. The fishing mortality in 1988/89 was estimated to be 0.4 for fully recruited age classes. A projection to 1989/90 results in a fishing mortality estimate of 0.17. Using a further projection to 1990/91 resulted in a biomass of 2 949 tonnes and an $\mathbf{F_{0.1}}$ yield estimate of 267 tonnes.

Management Advice

260. As for the Lena Bank stock, the provision of catch data separated by area and the details of surveys carried out in the Ob Bank is recommended. The assessment of this stock should be re-analysed as soon as catch-at-age and separate catch data for each bank are available.

261. The level of fishing mortality on the Ob Bank stock has been higher than $\mathbf{F_{0.1}}$ for a number of years. As a result of the large catch in 1986, the stock is currently depleted. Catches should be reduced below $\mathbf{F_{0.1}}$ levels for a few years to allow the stock to rebuild to optimum levels.

Subarea 58.4

262. Although it was agreed at the last meeting of WG-FSA that care should be taken to report catch by species correctly, *C. wilsoni* catches in Division 58.4.2 are still being reported as *C. gunnari*. Also, no fine-scale catch reports or analysis have been submitted for *P. antarcticum* in Subarea 58.4 although the desirability of these data was stressed at the last meeting and by Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) (Annex 6).

Division 58.4.2

263. A Soviet survey in Prydz Bay and the shelf areas to the west revealed the presence of some dense concentrations of *C. wilsoni* and *Trematomus eulepidotus*. Catches reported by

the Soviet Union for these species were 339 and 148 tonnes respectively. Biomass estimates of the two species from both trawl and acoustic surveys were provided together with preliminary biological data, but the lack of age composition data, fine-scale catch and effort data and more detailed information on the conduct of the survey makes further assessment impossible at this stage.

264. Fine-scale catch and effort data for all previous catches of *C. wilsoni* in this division, have not been submitted despite the request at last year's meeting. In addition, fine-scale catch and effort data and biological data are required for all species taken in future seasons.

Management Advice

265. Due to the lack of data no management advice could be provided.

GENERAL ADVICE TO THE COMMISSION

266. In addition to the recommendations concerning stock assessments, the Working Group reviewed:

- Conservation Measures established in 1989;
- the progress of data submission; and
- questions posed by the Commission to the Scientific Committee.

Review Of Conservation Measures

267. Conservation measures established in 1989 were reviewed on the basis of available data and assessments conducted by the Working Group. Conservation measures of an administrative nature were not included in these discussions.

Conservation Measure 13/VIII: Limitation of the Total Catch of *Champsocephalus gunnari* in Statistical Subarea 48.3 in the 1989/90 Season

268. The TAC for *C. gunnari* needs to be revised in the light of the assessments and advice presented in paragraphs 137 to 141 and Appendix L.

269. From the reported catches this year, the by-catch in the mid-water trawl fishery for *C. gunnari* appeared to be very low. The Working Group agreed that Provision 5 of this Conservation Measure, which prohibits bottom-trawling in Subarea 48.3, should be retained. The Working Group also felt that the retention of by-catch provisions would not hinder the midwater trawl fishery for *C. gunnari* but would maintain a safeguard for the species listed in Provision 2 of the Conservation Measure (see paragraph 95).

270. The Working Group agreed that the by-catch limit of 300 tonnes should be retained for all species in Provision 2, except *N. gibberifrons*. For the latter species, 500 tonnes was noted as the possible limit to by-catch (see assessment summary, Appendix L). However, some Members expressed caution that an allowable by-catch of 500 tonnes may have detrimental effects on other depleted species because of the inability to control by-catch and the possibility of mis-identifying or not recognising the smaller catches of these other species.

271. The Working Group agreed that the fishery in Subarea 48.3 should close if any of these by-catch levels are reached as detailed in Provision 3.

272. It was also agreed that Provision 4, where the fishing vessel must move to another fishing ground within the subarea if any of the by-catch species exceed 5% in any haul, should be retained and that the catches be reported as described in Provision 6.

Conservation Measure 14/VIII: Prohibition of Directed Fishery on *Notothenia gibberifrons, Chaenocephalus aceratus, Pseudochaenichthys georgianus* and *Notothenia squamifrons* in Statistical Subarea 48.3 in the 1989/90 Season

273. The Working Group agreed that this Conservation Measure should be retained.

Conservation Measure 15/VIII: Closed Seasons in the 1989/90 Season in Statistical Subarea 48.3

274. The Working Group felt that it was unable to comment on the closed season between 20 November 1989/90 and 15 January 1990 as it was an administrative matter. The closed season between 1 April and 4 November 1990 was set in place to protect the stock during its spawning period, and the Working Group agreed that because the spawning season may vary from year to year in an unpredictable manner and that *C. gunnari* has been reported to spawn

in April (Kock, 1990, CCAMLR Selected Scientific Papers 1989, SC-CAMLR-VIII/BG/16) this closed season should be retained to protect spawning.

Conservation Measure 16/VIII: Catch Limit on *Patagonotothen brevicauda guntheri* in Statistical Subarea 48.3 for the 1989/90 Season

275. The Working Group agreed that the TAC for *P.b. guntheri* should be revised. Two views were expressed on the nature of the revision. WG-FSA-90/12 made it clear that the reported catches of this species did not correspond to the fine-scale data, which suggested that catches came from both South Georgia and Shag Rocks. As *P.b. guntheri* is a small fish that requires a small net for capture, trawling for this species around South Georgia may take a by-catch of depleted species that the Commission is trying to protect (see paragraph 50). Some Members felt that until reliable data are submitted the fishery should be closed.

276. The discrepancies in the data will be investigated by the Members from the USSR. In their view, the problem was one of reporting rather than of exploitation and, as such, the TACs for this species should be set in line with the assessments (see paragraphs 151 and 154, and Appendix L).

Conservation Measure 17/VIII: Catch Reporting System in Statistical Subarea 48.3 in the 1989/90 Season

277. The Working Group considered that it should only comment on paragraph 2, regarding the data to be reported, as the remainder of this measure is administrative. However, it was felt that access to this data for analyses prior to the Working Group meeting was useful and that effort data would also be useful in this regard. Accordingly, the Working Group agreed that in addition to the data requested in this paragraph, effort data should be submitted in accordance with the indices specified in the STATLANT B forms (total catch, days and hours fished).

Resolution 5/VIII: Protection of Seabirds from Incidental Mortality Arising from Longline Fishing

278. The Working Group felt it was unable to comment on this resolution.

Resolution 6/VIII: Protection of *Notothenia gibberifrons* in the Peninsula Area (Statistical Subarea 48.1) and around South Orkneys (Statistical Subarea 48.2)

279. The Working Group noted that in light of the Commission's request to refrain from directed fishing for *N. gibberifrons* and to ensure that by-catch of this species be avoided, there had been no fishing in Subarea 48.1 but, in Subarea 48.2, a directed fishery on *C. gunnari* took 340 tonnes of *N. gibberifrons* as by-catch. Due to the lack of information from a number of seasons the Working Group was unable to assess the present state of *N. gibberifrons* in Subarea 48.2.

Submission of Data

280. The list of data requested for submission by the Working Group at its 1989 Meeting is contained in Appendix 9 of its report (SC-CAMLR-VIII, Annex 6). The submission of these data and other requests by the Scientific Committee was endorsed by the Commission at its last meeting (CCAMLR-VIII, paragraph 63). These are summarised in Appendix I, which also summarises the data received by the Working Group and the data from this list that are still required by the Working Group.

281. Overall, very little of the data from this list has been submitted to CCAMLR. The Working Group agreed that the failure to submit data, endorsed as necessary by the Commission, was a serious problem. While the Working Group provides the best assessments it can using all the scientific data available, the Working Group agreed that its understanding of the fisheries would be enhanced with the submission of all the data requested. The Working Group also agreed that when formulating advice for the Scientific Committee it needs to take the uncertainty associated with stock assessments into account. The level of uncertainty can be reduced with the submission of more data. While the uncertainty remains high, the Working Group has no option but to recommend conservation measures that tend towards higher probabilities of preventing depletion of the stocks as well as providing for more stable fisheries.

Questions from the Commission

282. Last year the Commission requested that the Scientific Committee provide advice on the following questions concerned with new and developing fisheries (CCAMLR-VIII, paragraph 123):

(a) the types of information needed to characterise and estimate the potential yield of unexploited and under-exploited fishery resources;

(b) the types of information needed to determine an initial threshold level above which catches should not be allowed to increase without programs in place to assess the effects of the catches, including by-catch, on target, dependent and associated species;

(c) how the needed baseline information can best be obtained;

(d) how the developing fishery might best be regulated in order to identify and efficiently achieve, but not exceed, the maximum catch levels consistent with Article II of the Convention;

(e) how the identified information needs might best be met; and

(f) how long it might take to acquire the required knowledge.

283. The Working Group considered that the answers to these questions were interrelated and that detailed answers will vary depending on the fishery to be developed. The Working Group, therefore, decided to provide a more general discussion on the issues that arose from these questions.

284. The potential yield of a stock is that catch level that is consistent with the objectives of CCAMLR set out in Article II. This can be assessed using estimates of biomass, natural mortality, growth parameters, and age and size at sexual maturity. The precision and accuracy of the initial estimate of the potential yield will depend on the quantity and quality of data presented for the initial analysis and the resulting level of uncertainty in each of the parameters used in the calculations.

285. The magnitude of the error (uncertainty) in the estimate of potential yield provides the lower and upper bounds for defining the risks to the stock (0-100% respectively) when establishing catch levels. The risks to the stock are those of failing to meet the objectives of Article II by catching more than the potential yield. For each point within the range between these bounds the fishery will pose a corresponding risk of exceeding the potential yield that depends on the relationship between the stock, the fishery and the ability to estimate the necessary biological parameters.

286. The consideration of risk also needs to incorporate those risks to the ecosystem as a whole. In cases where the species to be targeted has an important role in the ecosystem, the maximum allowable catch may need to be less than the potential yield.

287. In the very early stages of the fishery, the availability of data will be low. Therefore, the danger of exceeding the potential yield consistent with Article II will be relatively high compared to an established fishery. Consequently, it was agreed that the development of the fishery should be directly linked with the process of elaborating scientific advice and management.

288. A first step in the development of a fishery could be to determine the level of catch at which there would be no possibility of exceeding the potential yield, i.e. the lower boundary of the estimate of potential yield (modified for the ecosystem interactions if necessary). Catches below this level could be essentially unregulated. For example, myctophids are known to have a high abundance, although the exact biomass is not known. It is conceivable that a commercially viable level of catch could be taken from these stocks without jeopardising the stocks. The important point is to determine the level at which regulation may need to be applied to the fishery to prevent the risks detailed above.

289. The Working Group identified the following information that would be important for assessing this initial catch level, below which there would be no regulation:

(i) biological information from comprehensive research/survey cruises, such as distribution, abundance, demographic data and information on stock identity;

(ii) details of dependent and associated species and the likelihood of them being affected in some way by the proposed fishery;

(iii) the nature of the proposed fishery, including target species, methods of fishing, proposed region and any minimum level of catches that would be required to develop a viable fishery; and

(iv) information from other fisheries in the region or similar fisheries elsewhere in the world that may assist in the evaluation of potential yield.

290. The Working Group felt that such information should be submitted before the fishery begins to develop so that the development of the fishery fulfils the objectives of CCAMLR. The information detailing the proposed fishery was considered to be important because it

would allow the Scientific Committee to specify the data requirements necessary for the formulation of advice for the particular fishery to be developed. Each species, fishing method and area to be fished have unique characteristics that will need to be considered when formulating advice. In this context, the Scientific Committee will need to address the problem of stock designation and identify discrete management areas based on biological characteristics of the stock.

291. During this initial phase of the fishery, biological and catch data could be obtained that will be useful to:

(i) refine the precision and accuracy of the estimated potential yield, thereby reducing the uncertainty in the estimate; and

(ii) provide assessments on how the fishery could be developed to achieve catches at the potential yield.

292. As a result of these continuing revisions of the potential yield and its associated errors the uncertainty associated with allowable catch levels will be reduced and the fishery will become more predictable.

293. One possible method for incorporating the uncertainty associated with estimates of biomass and potential yield in calculations of the level of total allowable catch, which would ensure the objectives in Article II are achieved, is outlined in SC-CAMLR-IX/BG/14. In this method, estimates of stock parameters and their associated errors are used to calculate the probability of the stock declining below its existing level as well as for it maintaining a level above an estimated ‘Greatest Net Annual Increment’ (GNAI), given a nominated catch rate over a 20 to 30 year period. This method would help estimate the risk of depleting the stock when fishing at selected levels.

294. The Working Group recognised the desirability of proactive management that fully accounts for the uncertainty in the estimates of population parameters and the degree of unpredictability in the stocks themselves in the development of a fishery. This would ensure that the development of the fishery does not outpace the ability of the Commission to achieve the objectives in Article II.

FUTURE WORK

Data Requirements

295. A table of data requirements identified by the Working Group throughout the rport is given in Appendix I. Appendix I also gives details of data requirements identified in Appendix 9 of the 1989 Working Group report.

296. It was emphasised that much of the data from the commercial fishery in 1990, specifically fine-scale catch data and biological data, was unavailable to the Working Group. It was noted that the acquisition of this data was vital for the correct functioning of the Working Group and it was also mandatory under Articles IX and XX of the Convention.

297. In particular, the fine-scale data are of great value to the work of the Working Group, and steps should be taken to ensure their quality and timely submission.

298. The Working Group specifically sought information on the potential predators of *E. carlsbergi* in order to determine the impacts that this fishery is likely to have on dependent species. It was also requested that in order to determine the full impact of this fishery, fine-scale catch data should be reported for *E. carlsbergi* from areas outside the Convention Area, in addition to the existing requirement for reporting these data within the Convention Area.

299. Data on the size selectivity of the longline fishery for *D. eleginoides* are required for future assessments of this species. Dr C. Moreno (Chile) reported that similar investigations had been carried out by Chilean scientists for the *D. eleginoides* fishery conducted off Chile, and a report of these activities will be available to the Working Group at its next meeting. In addition, a description of the Soviet fishery operation was requested by the Working Group.

300. The Working Group re-emphasised the urgent need to obtain data on the by-catch of fish in the krill fishery (paragraph 27). It <u>recommended</u> that the reporting format described in Appendix J should be developed for the reporting of by-catch data from commercial krill trawls. The Secretariat was asked to distribute a draft for comment as soon as possible.

301. The Working Group requires data from research vessel surveys to be reported haul-by-haul so that additional analyses can be undertaken when required. Accordingly, it was <u>recommended</u> that survey data be reported haul-by-haul to the CCAMLR Data Centre. The Data Manager was asked to develop and distribute details of reporting formats for survey

data which should include *inter alia* details of haul number, vessel call sign, date and position in degrees and minutes.

302. The Working Group also recommended that where possible haul-by-haul data of this nature should be reported to CCAMLR from experimental fisheries.

303. In addition to taking note of the guidelines for reporting assessment results to the Working Group identified by the Task Group in Appendix F, the Working Group endorsed the form described in Appendix K for use when reporting details of intended and completed research surveys to the Scientific Committee and Working Group.

304. Incidental information obtained during research surveys concerning the distribution of young fish would be of use to the Working Group, especially when considering the impacts of incidental mortality in the krill fishery.

Data Analyses and Software to be Prepared Prior to the Next Meeting

305. The Working Group thanked the Secretariat for providing excellent support to the Working Group during the Meeting. In particular, it was noted that hardware facilities had been upgraded this year to include an MS-DOS machine and that a wider range of stock assessment programs were available to the Working Group. All the requests of the Working Group in 1989 had been addressed.

306. A request was made that a simpler interface be made between DOS machines and the Secretariat’s printers.

307. The Draft Statistical Bulletin (SC-CAMLR-IX/BG/2) was available to the Working Group for the first time during this Meeting. The Working Group considered the Bulletin to be a welcome addition to the Secretariat’s publications and a number of comments were made concerning the format of the Bulletin.

308. It was noted that SC-CAMLR-IX/BG/5 provided details of currently available biological data. The document also contained details of data access protocols. Several Members had accessed this data during the year for use in analyses presented at the Meeting, and Members were encouraged to use this facility for similar analyses in the future.

309. Following the assessment of *C. gunnari* presented in WG-FSA-90/27 it was suggested that the Data Manager investigate the relationship between standardised CPUE data from STATLANT reports and stock biomass as estimated, for example, by VPA analysis. The fisheries for *C. gunnari* and *N. gibberifrons* in Subarea 48.3 could be used as starting points for this investigation.

310. It was agreed that the Secretariat should compile a summary of all the data on each species in each area and an introduction to the assessments performed on those species in the past, and provide it to next year's Working Group meeting.

311. It was suggested that the Secretariat produce a paper at the next meeting summarising the performance of successive working groups. This would include a description of changes in the assessments undertaken and the advice provided by the Working Group at successive meetings, and how this advice has been treated by the Scientific Committee and the Commission.

Organization of the Next Meeting

312. The Working Group agreed that the late submission of papers to the Meeting this year meant that delegates were unable to give full consideration to some papers. The Working Group <u>agreed</u> that in future

- papers that arrive at the Secretariat later than the day before the meeting will not be considered at that meeting; and

- the deadline for submission of papers for consideration at the meeting will be re-named the 'recommended date' for submission. Papers submitted by this date will be distributed prior to the meeting.

313. The Convener informed the Working Group that he would be stepping down from the position following the 1991 Meeting of the Working Group.

314. Last year an intersessional meeting was arranged between the Convener of the Working Group, the Chairman of the Scientific Committee and the Data Manager. This Meeting was considered valuable for the pre-meeting organization of work by the Secretariat, and whilst it was thought unnecessary to arrange travel specifically for this purpose in 1991

the Working Group felt that another meeting should take place during the next intersession if circumstance allows.

ADOPTION OF THE REPORT

315. The Report of the Meeting was adopted.

CLOSE OF THE MEETING

316. The Convener closed the Meeting and thanked the participants for their willing collaboration and patience. He also thanked the rapporteurs and the Secretariat for their excellent support in conducting the Meeting.

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APPENDIX A

LIST OF PARTICIPANTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 9 to 18 October 1990)

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APPENDIX B

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 9 to 18 October 1990)

1. Opening of the Meeting

2. Organization of the Meeting and Appointment of Rapporteurs

3. Adoption of the Agenda

4. Possible Improvements in the Scientific Committee's Ability to Provide Management Advice

5. Review of Material for the Meeting
   - 5.1 Questions Raised and Information Needed by the Commission
   - 5.2 Catch and Effort Statistics
   - 5.3 Size and Age Composition Data
   - 5.4 By-Catch of Fish Larvae and Juvenile Fish in the Krill Fishery
   - 5.5 Other Available Biological Information
   - 5.6 Mesh Selectivity and Related Experiments
   - 5.7 Assessments Prepared by Member Countries
   - 5.8 Other Relevant Documents

6. Methodologies Used for Surveys and Assessments

7. Assessment Work
   - 7.1 Organisation of Assessment Work
   - 7.2 Discussion of Assessments Carried Out by Member Countries and During the Meeting
     - 7.2.1 South Georgia (Subarea 48.3)
       - 7.2.1.1 *Notothenia rossii*
       - 7.2.1.2 *Champsocephalus gunnari*
       - 7.2.1.3 *Patagonotothen brevicauda guntheri*
       - 7.2.1.4 *Dissostichus eleginoides*

8.2 South Orkney Islands (Subarea 48.2)
  - 8.2.1 *Champsocephalus gunnari*
  - 8.2.2 *Notothenia gibberifrons*
  - 8.2.3 Other species

8.3 Antarctic Peninsula (Subarea 48.1)
  - 8.3.1 *Champsocephalus gunnari*
  - 8.3.2 *Notothenia gibberifrons*
  - 8.3.3 Other Species

8.4 Kerguelen Islands (Division 58.5.1)
  - 8.4.1 *Notothenia rossii*
  - 8.4.2 *Notothenia squamifrons*
  - 8.4.3 *Champsocephalus gunnari*
  - 8.4.4 *Dissostichus eleginoides*

8.5 Ob and Lena Banks (Division 58.4.4)
  - 8.5.1 *Notothenia squamifrons*
  - 8.5.2 Other Species

8.6 Coasts of the Antarctic Continent (Division 58.4.1 and 2)
  - 8.6.1 *Pleuragramma antarcticum*
  - 8.6.2 *Chaenodraco wilsoni*
  - 8.6.3 Other Species

8.7 Pacific Ocean Sector (Statistical Area 88)

8.8 Responses to Questions Raised by the Commission

9. Future Work
   - 9.1 Data Requirements
   - 9.2 Data Analyses Required and Software to be Prepared or Developed Prior to the Next Meeting
   - 9.3 Organisation of Next Meeting

10. Other Business

11. Adoption of the Report

12. Close of the Meeting.

APPENDIX C

LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 9 to 18 October 1990)

WG-FSA-90/1	PROVISIONAL AGENDA FOR THE 1990 MEETING OF THE CCAMLR WORKING GROUP ON FISH STOCK ASSESSMENT (WG-FSA)
WG-FSA-90/1 Rev. 1	PROVISIONAL AGENDA FOR THE 1990 MEETING OF THE CCAMLR WORKING GROUP ON FISH STOCK ASSESSMENT (WG-FSA)
WG-FSA-90/2	ANNOTATION TO PROVISIONAL AGENDA FOR THE 1990 MEETING OF THE CCAMLR WORKING GROUP ON FISH STOCK ASSESSMENT (WG-FSA)
WG-FSA-90/3	LIST OF DOCUMENTS
WG-FSA-90/4	LIST OF PARTICIPANTS
WG-FSA-90/5	ANALYSES CARRIED OUT DURING THE 1989 MEETING OF THE WORKING GROUP ON FISH STOCK ASSESSMENT Secretariat
WG-FSA-90/6	AN ASSESSMENT OF *CHAENOCEPHALUS ACERATUS* AND *PSEUDOCHAENICHTHYS GEORGIANUS* IN SUBAREA 48.3 D.J. Agnew and K.-H. Kock
WG-FSA-90/7	TOOTHFISH *DISSOSTICHUS ELEGINOIDES*, AT SOUTH GEORGIA Inigo Everson and Stuart Campbell
WG-FSA-90/8	AREAS OF SEABED WITHIN SELECTED DEPTH RANGES IN CCAMLR SUBAREA 48.3, SOUTH GEORGIA Inigo Everson and Stuart Campbell
WG-FSA-90/9	PRELIMINARY RESULTS OF AN AGE/LENGTH STUDY OF JUVENILE *NOTOTHENIA ROSSII* MARMORATA FROM POTTER COVE, SOUTH SHETLAND ISLANDS E. Barrera-Oro and R. Casaux (Argentina)

WG-FSA-90/10	PILOT STUDY ON ELECTROPHORETIC VARIATION AND STOCK STRUCTURE IN THE MACKEREL ICEFISH, *CHAMPSOCEPHALUS GUNNARI*, SOUTH GEORGIA WATERS G.R. Carvalho and D.P. Lloyd-Evans
WG-FSA-90/11	REPORT OF THE UK/POLISH FISH STOCK ASSESSMENT SURVEY AROUND SOUTH GEORGIA AND SHAG ROCKS IN JANUARY 1990 G.B. Parkes *et al*.
WG-FSA-90/11 Rev. 1	REPORT OF THE UK/POLISH FISH STOCK ASSESSMENT SURVEY AROUND SOUTH GEORGIA AND SHAG ROCKS IN JANUARY 1990 G.B. Parkes *et al*.
WG-FSA-90/12	THE FISHERY FOR *PATAGONOTOTHEN BREVICAUDA GUNTHERI* IN CCAMLR SUBAREA 48.3 Inigo Everson and Catherine Mitchell
WG-FSA-90/13	REPORT OF A JOINT UK/USSR WORKSHOP 23 TO 27 JULY 1990 Analysis of Results from Demersal Fish Surveys at South Georgia, Undertaken by United Kingdom and USSR, January and February 1990
WG-FSA-90/14	DECLINING TREND IN THE ABUNDANCE OF FJORD FISH OF THE SPECIES *NOTOTHENIA ROSSII* MARMORATA AND *NOTOTHENIA GIBBERIFRONS* OBSERVED AT TWO LOCALITIES OF SOUTH SHETLAND ISLANDS Esteban Barrera-Oro and Enrique Marschoff (Argentina)
WG-FSA-90/15	AN ESTIMATION OF CONFIDENCE LIMITS FOR THE MEAN CATCH PER HAUL OF *NOTOTHENIA GIBBERIFRONS* IN COMMERCIAL SEMIPELAGIC TRAWLS IN THE YEARS 1987 AND 1988 Enrique R. Marschoff (Argentina)
WG-FSA-90/16	A RE-ASSESSMENT OF THE STOCK OF *NOTOTHENIA GIBBERIFRONS* IN THE SOUTH ORKNEY ISLANDS (STATISTICAL SUBAREA 48.2) K.-H. Kock and D.J. Agnew
WG-FSA-90/17	A RE-ANALYSIS OF THE KERGUELEN SHELF AND SKIFF BANK STOCKS OF *CHAMPSOCEPHALUS GUNNARI* G. Duhamel and D.J. Agnew

WG-FSA-90/18	FEEDING AND FOOD INTAKE OF *ELECTRONA CARLSBERGI* (TÅNING) (MYCTOPHIDAE) O.V. Gerasimova (USSR)
WG-FSA-90/19	BIOMASS OF MYCTOPHIDS IN THE ATLANTIC SECTOR OF THE SOUTHERN OCEAN AS ESTIMATED BY ACOUSTIC SURVEYS A.A. Filin *et al.* (USSR)
WG-FSA-90/20	ON REPRODUCTION OF *ELECTRONA CARLSBERGI* TÅNING G.P. Mazhirina (USSR)
WG-FSA-90/21	COMPARATIVE BIOLOGICAL CHARACTERISTICS OF *ELECTRONA CARLSBERGI* (TÅNING) (MYCTOPHIDAE) FROM THE NOTAL AND ANTARCTIC AREAS IN THE SOUTHERN OCEAN ATLANTIC SECTOR K.V. Gorchinsky *et al.* (USSR)
WG-FSA-90/22	SECRETARIAT STOCK ASSESSMENT SOFTWARE Secretariat
WG-FSA-90/23	MESOPELAGIC FISH OF THE SOUTHERN OCEAN - REVIEW OF THE RECENT USSR RESEARCH PUBLICATIONS Secretariat
WG-FSA-90/24	THE EFFECT OF BOTTOM TRAWLING ON BENTHIC ASSEMBLAGES K.-H. Kock (Germany)
WG-FSA-90/25	CAN WE IMPROVE THE SCIENTIFIC COMMITTEE'S ABILITY TO PROVIDE UNEQUIVOCAL MANAGEMENT ADVICE ON FISH STOCKS IN THE CONVENTION AREA? Convener, Working Group on Fish Stock Assessment
WG-FSA-90/26	STATE OF STOCK AND TAC ASSESSMENT FOR *CHAMPSOCEPHALUS GUNNARI* FROM THE AREA OF SOUTH GEORGIA (48.3) FOR 1990/91 SEASON P.S. Gasiukov (AtlantNIRO, USSR)
WG-FSA-90/27	STANDARDIZATION OF FISHING EFFORT FOR *CHAMPSOCEPHALUS GUNNARI* IN THE AREA OF SOUTH GEORGIA ISLAND (48.3) P.S. Gasiukov (AtlantNIRO, USSR)

WG-FSA-90/28 STATE OF STOCK AND TAC ASSESSMENT OF *PATAGONOTOTHEN GUNTHERI* FOR 1990/91 SEASON IN THE AREA OF SOUTH GEORGIA (48.3)
P.S. Gasiukov and R.S. Dorovskikh (AtlantNIRO, USSR)

WG-FSA-90/29 USSR FISH STOCK ASSESSMENT SURVEY MADE IN AREA 48.3 IN FEBRUARY 1990
A.N. Kozlov and K.V. Shust (VNIRO, USSR)

WG-FSA-90/30 PRELIMINARY RESULTS OF THE RESEARCH CRUISE OF BMRT *ANCHAR*, SCOTIA SEA, APRIL TO JUNE 1990
V.A. Khvatchia and V.I. Shlibanov (AtlantNIRO, USSR)

WG-FSA-90/31 ON THE INSTANTANEOUS MORTALITY RATE OF *CHAMPSOCEPHALUS GUNNARI*, SOUTH GEORGIA (SUBAREA 48.3)
G.A. Frolkina and R.S. Dorovskikh (AtlantNIRO, USSR)

WG-FSA-90/32 CODEND SELECTIVITY IN *CHAMPSOCEPHALUS GUNNARI* FISHERY
V.G. Bidenko (AtlantNIRO, USSR)

WG-FSA-90/33 AGE DETERMINATION OF *CHAMPSOCEPHALUS GUNNARI* TAKEN FROM THE SOUTH GEORGIA AREA IN 1990
P.N. Kochkin (VNIRO, USSR)

WG-FSA-90/34 THE STATE OF *DISSOSTICHUS ELEGINOIDES* STOCK AND TAC FOR 1990/91 IN SUBAREA 48.3 (SOUTH GEORGIA)
K.V. Shust, P.S. Gasiukov, R.S. Dorovskikh and B.A. Kenzhin (VNIRO and AtlantNIRO, USSR)

WG-FSA-90/35 SEASONAL AND ANNUAL VARIABILITY IN DISTRIBUTION OF *ELECTRONA CARLSBERGI* IN THE SOUTHERN POLAR FRONT AREA WITH THE SOUTH GEORGIA AREA TAKEN AS AN EXAMPLE
A.N. Kozlov, K.V. Shust and A.V. Zemsky (VNIRO, USSR)

WG-FSA-90/36 FUNCTIONAL SUBDIVISION OF THE HABITAT AREA OF *ELECTRONA CARLSBERGI* (TÅNING, 1932) FAMILY MYCTOPHIDAE, TAKING INTO ACCOUNT LONGITUDINAL ZONES OF THE SOUTHERN OCEAN
A.V. Zemsky and S.A. Zozutia (VNIRO, USSR)

WG-FSA-90/37 ASSESSMENT OF STOCKS AT OB AND LENA BANKS (DIVISION 58.4.4)
A.K. Zaitsev (YugNIRO, USSR)

WG-FSA-90/38	MORE PRECISE EVALUATION OF THE FISH BIOMASS ON THE SHELF OF THE KERGUELEN ISLANDS BASED ON THE MATERIALS OF THE REGISTERED TRAWLING SURVEYS MADE IN 1987–1988 P.B. Tankevich, V.V. Gerasimchuk, E.A. Roshchin, L.M. Kokoz and S.M. Pronenko (YugNIRO, USSR)
WG-FSA-90/39	THE INTEGRATED ANTARCTIC EXPEDITION OF THE YUGNIRO IN THE SEASON OF 1989–1990: MAIN RESULTS OF THE ICHTHYOLOGICAL STUDIES A.K. Zaitsev, V.G. Prutko and V.N. Yakovlev (YugNIRO, USSR)
WG-FSA-90/40	THE YUGNIRO EXPEDITION IN THE INDIAN OCEAN SECTOR OF THE ANTARCTIC AND IN LAZAREV SEA IN THE SUMMER SEASON OF 19899–0: PRELIMINARY FINDINGS OF THE OCEANOGRAPHIC RESEARCH V.A. Bibik, A.V. Dulnev, A.V. Klausov, A.S. Pelevin, E.G. Ryabchikov and V.N. Yakovlev (YugNIRO, USSR)
WG-FSA-90/41	DYNAMICS OF ABUNDANCE AND STATE OF *NOTOTHENIA ROSSII ROSSII* STOCKS ON THE KERGUELEN ISLAND SHELF P.B. Tankevich and V.A. Shlyakhov (YugNIRO, USSR)
WG-FSA-90/42	PRELIMINARY RESULTS OF THE BIOMASS SURVEY OF BOTTOM FISH AROUND HEARD ISLAND (AREA 58.5.2) R. Williams (Australia)
WG-FSA-90/43	NECTON AND ANTARCTIC FISHING RESOURCES – FIRST RESULTS OF THE 1987/88 EXPEDITION Marino Vacchi (ICRAP)

APPENDIX D

CAN WE IMPROVE MANAGEMENT ADVICE FOR CCAMLR FISH STOCKS - LIVING WITH UNCERTAINTY

INTRODUCTION

Since 1984, proposals have been put forward in the Scientific Committee and the Commission with increasing support each year for more stringent measures regulating finfishing, including its prohibition in Statistical Area 48 or Statistical Subarea 48.3. These have not been adopted because fishing countries have argued that the scientific advice was uncertain due to:

(i) the unavailability or lack of information required for the assessment of some stocks;

(ii) the late and inadequate submission of data from some fisheries which have been operating for a number of years; and

(iii) the lack of information from recently developed fisheries, such as the longline fishery on *Dissostichus eleginoides* or the midwater trawl fishery on the myctophid *Electrona carlsbergi* in the South Polar Frontal Zone.

2. As a result the Working Group on Fish Stock Assessment (WG-FSA) was only able to assess the state of 14 out of 32 stocks for which catches have been reported.

3. The continuous lack of sufficient information which should have been available from the fisheries in accordance with Article XX of the Convention resulted in the adoption of Conservation Measures which are not sufficient to ensure the recovery of most of the stocks. This has led to a lowering of the credibility of CCAMLR in the eyes of the public and a strong polarisation of opinions inside CCAMLR.

4. Following a request by the Scientific Committee (SC-CAMLR-VIII, paragraph 3.49), an attempt is made in the following to outline data and analyses required to improve the knowledge on the stocks and, hence the outcome of the work of the WG-FSA.

STOCK IDENTITY

5. The knowledge of stock identity is a prerequisite in any (fish) stock assessment. Vast oceanic areas in between shelf areas in the Southern Ocean have led to the general conclusion that these isolated shelf areas host separate populations (stocks). The problem of stock separation has been investigated using morphometric and meristic characteristics in a number of species, such as *D. eleginoides*, *Notothenia rossii* or *Champsocephalus gunnari* but the statistical methods involved in the analysis were often inadequate to resolve the problem. Recently, investigations on stock separation have been started in *C. gunnari* using protein electrophoresis and mitochondrial DNA which have indicated, for example, the possible presence of more than one stock of *C. gunnari* around South Georgia and Shag Rocks. Similar studies should be carried out for other species, in particular those species with an extended bathymetric range such as *D. eleginoides* and *Notothenia squamifrons* for which deeper water may not form the anticipated stock boundary and in pelagic species such as *Pleuragramma antarcticum* and *E. carlsbergi*.

DATA COLLECTION

Field Sampling

Research Vessel Surveys

6. Research vessel surveys could ideally provide the following information:

- standing stock biomass for all species (exploited and unexploited);
- length and age structure from the exploited populations;
- length-to-weight relationships;
- maturity ogives;
- geographical and bathymetric range of stocks; and
- year class strength of pre-recruits.

7. The objective of research vessel surveys is to estimate the density of fish in the survey area. These density estimates are used in a stratified survey design to estimate the biomass of the exploited population and of the pre-recruits of the target species. A number of alternative techniques exist including:

- bottom trawl survey;
- mid-water trawl survey;
- acoustic survey;
- egg production method; and
- mark-recapture experiments.

8. All these techniques have problems inherent to the methodology used (e.g., catchability coefficients, target strength, etc.). As the most commonly used method is the bottom trawl survey the following discussion mainly refers to our experience with this technique in the Convention Area.

9. The only fishing area covered by fishery-independent surveys conducted over a number of years is South Georgia, where at least one bottom trawl survey has been carried out per season since 1984/85. The coordination of surveys and collaboration in the analysis of the results such as undertaken by UK and USSR in 1989/90 (see WG-FSA-90/11 and 13) have the potential to provide a substantial advance in the work of the WG-FSA.

10. In Subarea 48.3 fisheries have recently developed on *E. carlsbergi* and *D. eleginoides*. *E. carlsbergi* is a pelagic species which can be surveyed acoustically with net hauls to provide essential biological information. The methods are still undergoing development. *D. eleginoides* is found over a wide depth range and is currently taken in a longline fishery. New techniques need to be developed for its assessment.

11. The other fishing grounds are much less covered by research vessel surveys, in particular the South Orkney Islands. The Federal Republic of Germany carried out a number of surveys around Elephant Island between 1983 and 1987 but will probably be unable to continue this on an annual or biennial basis. Fishery-independent surveys in fishing areas other than South Georgia are particularly crucial for the assessment of these stocks because the irregular nature of the fishery on these grounds often prevents the utilisation of common assessment methods, such as the Virtual Population Analysis. One approach to increase the frequency of surveys might be multinational surveys with logistic and financial support provided by a number of Members and coordinated through CCAMLR.

12. A protocol for the submission of survey data to CCAMLR has been recently developed containing all relevant information (survey design, wing spread of the trawl, etc.) for stock assessment purposes.

13. Abundance estimates from bottom trawl surveys with a stratified random survey design have their limitations in species which are highly gregarious, such as *C. gunnari* and *N. rossii*, when these surveys are not stratified according to fish density. This is usually impossible prior to a survey, as fish concentrations are not stable seasonally and annually (see WG-FSA-90/11). Other types of surveys, such as pre-recruit surveys may be more feasible to estimate year class strength in these species.

14. There is uncertainty as to the relationship between estimates of biomass from trawl surveys and actual stock biomass. This uncertainty has become important in recent years as the number of survey biomass estimates available for assessment work has increased. The relationship between survey estimates of abundance and actual abundance should be investigated for important stocks. Methods used to study these relationships will require careful evaluation by the Working Group since the statistical problems involved are significant.

15. Abundance indices from pre-recruit surveys are commonly utilized in the assessment work of fisheries organisations in other parts of the World Ocean, such as in ICES (e.g., International Young Fish Survey). They have been mentioned repeatedly in CCAMLR in the last few years as one means to better assess the recovery of some stocks, such as *N. rossii* and *C. gunnari*.

16. Pre-recruit surveys based on trammel net catches of *N. rossii* in the Kerguelen Islands since 1984 indicate a slow but continuous recovery of the stock (Duhamel, 1990). A similar program carried out in Potter Cove (King George Island) demonstrated a decline in the abundance of juvenile *N. rossii* (see WG-FSA-90/14). A similar shore-based trammel net survey at South Georgia would help to assess the state of the stock of *N. rossii* in that area.

17. Results from pre-recruit surveys on *C. gunnari* were available to CCAMLR only once, when a report on a Soviet pre-recruit survey carried out in June to July 1985 was submitted (Boronin *et al.*, 1987). However, its results were difficult to incorporate in the work of the WG-FSA as it was only a point estimate and the survey design was inadequately described. Intensifying pre-recruit surveys, designed either to estimate the abundance of 0 group or 1 group fish, would certainly improve the assessment of the stocks of *C. gunnari* considerably and may be an alternative or complement to the bottom trawl surveys currently carried out. They require, however, a sound knowledge of the horizontal and vertical distribution of the 1 group fish, which may not be available at present. Abundance of 0 group fish may be monitored according to the scheme proposed by North (1987).

18. The results from all survey methods are subject to uncertainty arising from a number of sources. The results are subject to statistical uncertainty arising from sampling error, which, because fish usually have patchy distributions, remains high even with large amounts of survey effort. Additionally the distribution and abundance of fish can change considerably from year to year. Other technical factors have to be estimated to convert survey results into estimates of absolute abundance, and these are also estimated with uncertainty. Consequently the results of a series of surveys can show large fluctuations over time, which may or may not be due to variations in the abundance of fish. While increased scientific effort can reduce the uncertainty to some extent, particularly over a long time-scale, all the uncertainty cannot be eliminated, and in most practical situations it is likely to remain considerable.

Commercial Fishery

Catch Statistics

19. Accurate catch statistics are a prerequisite for any fish stock assessment and Members are obliged to submit catch data annually (Article XX). The WG-FSA has discussed this matter repeatedly and has listed a number of areas and stocks over the last years where the Working Group felt that catch statistics were inadequate. Problems ranged from non-reporting of species, such as *Pseudochaenichthys georgianus* and *Chaenocephalus aceratus*, misidentification of species, such as *Chaenodraco wilsoni*, reporting of catches where the species does not occur, such as *Patagonotothen brevicauda guntheri* (see WG-FSA-90/12), lumping of catch statistics from separate fishing grounds, such as Ob and Lena Banks, to the lack or unavailability of historical catch statistics. Detailed lists of catch data needs are contained in the reports of the Scientific Committee since 1984.

20. The collection of catch statistics is carried out under national responsibility. The adoption of conservative Conservation Measures by the Commission might be one of the means to encourage Members to improve their data submission in compliance with Article XX.

Fine-Scale Catch and Effort Statistics

21. Fine-scale catch and effort statistics are the primary source for the WG-FSA for information on patterns of commercial fishing and catch-per-unit effort. The timely submission of this information is a prerequisite for the work of the WG-FSA and will become

even more crucial in the near future when a time series of these data is available. Although the Commission in 1987 agreed that fine-scale catch and effort data for finfish should be submitted from the 1987/88 season onwards, this kind of information has been submitted to CCAMLR only for the 1987/88 season but not for the 1988/89 and 1989/90 seasons. Furthermore, it was evident from WG-FSA-90/12 that some of the information contained in the fine-scale data was not adequate for assessment work. According to the fine-scale data the catches of *P.b. guntheri* were mainly taken around the mainland of South Georgia where this species has never been found before.

Discards

22. Uncertainties about the amount of discards (i.e., fish caught, but not landed) form a substantial problem in fish stock assessment in other parts of the World Ocean, such as in the Northwest and in the Northeast Atlantic. This problem has found little attention in the work of the WG-FSA, although it is likely to be less substantial as most fish are either processed or reduced to fish meal and oil. However, some deep water fish occurring in the diet of wandering albatross at South Georgia were likely to be discards rather than taken alive close to the surface. Reports from the fishing nations on discards and the presence of observers onboard fishing vessels to estimate the amount of discards would help the WG-FSA to better assess the magnitude of that problem for their assessment work.

Conversion Rates

23. Conversion rates are commonly used to extrapolate commercial and even research vessel catches from the weight of various types of fish products. Information on the various products and their conversion factors is sparse and originates from investigations in the 1970s which were sometimes carried out only on a trial basis. Given the improvements in the processing technology since then, these values are likely to be out of date, and could lead to considerable bias in catch statistics if still in use. Conversion rates and their differences between fishing fleets as a potential source of bias in catch statistics has never been considered by the WG-FSA. An account of the conversion rates used in the various fishing fleets is needed for comparative purposes.

Biological Sampling

24. The basic requirement for a number of assessment models, such as the VPA, is the length/weight and age composition of the catches. This is crucial as the exploited stock may have a length and age composition which is very different from the population as a whole. This is particularly obvious in *C. gunnari* (see WG-FSA-90/11). Non-representative sampling may then lead to a considerable bias in the age composition and hence in the assessments.

25. In the past, Members were often unable to cover their fishing fleet adequately by biological sampling. As a result, age compositions of the 'by-catch' species, such as *Notothenia gibberifrons*, but also the target species were often lacking, in particular from the more southern fishing grounds in the Atlantic sector of the Southern Ocean.

26. One way to improve biological sampling from the commercial fishery would be that non-fishing members could assist fishing countries by sending additional observers on fishing vessels via coordination by CCAMLR.

New or Developing Fisheries

27. Members who intend to start a fishery should provide CCAMLR with the following information:

- the proposed fishing operation, including target species, methods of fishing, proposed region and any minimum level of catches that would be required to develop a viable fishery; and

- details of the stock size, abundance, demography (e.g., growth parameters, size and age at sexual maturity).

28. The Scientific Committee and its Working Groups should then compile:

- a description of the components of the ecosystem, highlighting those species at the primary level and their likelihood of being affected in some way by the proposed fishery, including summaries of current applicable scientific knowledge; and

- a review of other fisheries that may have similar effects on the same or related components of the Antarctic marine ecosystems as the proposed fishery (CCAMLR-VIII, Annex E, Appendix 1).

This would then allow the Commission to decide on the rational use of this resource.

Ageing

29. Reliable ageing and the compatibility of ageing results between investigations are crucial to assessment work. But these two requirements are fulfilled only in a few species. This was evident from the comparative ageings of the CCAMLR otolith/scales/bones exchange (Kock, 1990) and earlier compilations of age and growth data (Kock *et al.*, 1985). Problems of ageing require detailed discussion involving not only technical aspects but also various aspects of the life history of a species. They are thus too time-consuming to be dealt with during meetings of the WG-FSA and require additional workshops comparable but more specific to the one held in Moscow in 1986. If ageing is to become more reliable and age readings between laboratories would become more compatible, a number of assessments could be considerably improved.

ASSESSMENTS

Assessment Techniques

30. The assessment models commonly in use in the WG-FSA (virtual population analysis, cohort analysis, separable virtual population analysis, yield-per-recruit and catch prediction) are those utilized in many working groups on fish stock assessment of other fisheries conventions. There are a number of new techniques, such as the multi-species VPA, being developed for fish population studies but the data base on Antarctic fish species is limited compared to other fish stocks, such as in the North Sea. Therefore, many of the more sophisticated approaches will not be appropriate and may even be misleading. The main problem is determining or knowing the robustness of these techniques. The introduction of new assessment techniques may bear the potential of improving our assessments, but need careful consideration before being introduced. This matter could definitely not be dealt with during one of the regular meetings of the WG-FSA when participants are fully occupied with the assessment work itself, thus leaving little room for additional discussions. The investigation of new assessment techniques and their potential utilisation for our work could

best be done by a small task group comprised of participants of the WG-FSA experienced in this field and possibly one or two consultants at a meeting during the intersessional period.

Natural Mortality

31. Estimates of the coefficient of natural mortality **M** are still based on very limited information and have been often determined by inadequate techniques (see SC-CAMLR-VIII, Appendix 5, for discussion). More information from the first years of fishing, preferably from the exploratory phase of the fishery, such as from 1965 to 1969 around South Georgia, is needed to increase the precision of estimates of **M**. This information has been requested and provided for *C. gunnari* in Subarea 48.3 during the 1990 Meeting of the WG-FSA.

Single or Multi-Stock (Species) Approach?

32. The Commission has been setting Conservation Measures for individual stocks over the last few years. This approach, common also in fisheries conventions, has been questioned as it bears the risk that catches from depleted stocks which had suffered from recruitment failure may not be sufficiently small to ensure their recovery. This may particularly be the case in 'by-catch' species, such as *Chaenocephalus aceratus* or *Notothenia gibberifrons.* Hence, the goal to secure a sustainable yield at $\mathbf{F_{0.1}}$ or even $\mathbf{F_{max}}$ for each stock separately becomes illusory.

33. Two approaches seem possible:

(i) the bottom-up approach, where we look at each stock separately and add an appropriate risk or uncertainty term; and

(ii) the top-down approach where we look at the system or exploited fish assemblages as a whole in terms of energy flow, catch, production etc.

34. The first approach which has been followed to some extent already in previous years seems to be more promising on the short-term if we include a sufficiently large safety margin. This may involve a closure of the fishery for a short period but may also include the prohibition of certain types of fishing gear, such as bottom trawls, as has been done for the 1990 season.

35. It is unlikely that current multi-species approaches are easily transferrable to the Southern Ocean. Fish species interactions at least in the Atlantic Ocean sector are likely to be low compared to areas such as the North Sea, and most species are directly dependent on *Euphausia superba* and other euphausiids and hyperiids. If predation is a major cause for natural mortality in fish species, marine mammals and birds are the most likely cause. Multi-species models which still need to be developed or transferred will have their merits to help to understand the dynamics of the Antarctic or the shelf water ecosystems, but even simple multi-species models are difficult if not impossible to turn into effective management tools at the present stage of knowledge. Hence, multi-species considerations should be used to improve single-species management rather than applying multi-species models at the present stage.

DISCUSSION

36. The foregoing sections have highlighted a number of activities which can be carried out under the auspices of CCAMLR that are likely to improve the quality of assessments done by the WG-FSA. These are:

- cooperation in the conduct of surveys and the analysis of results;
- an increase in the number of surveys to estimate current standing stock biomass;
- the introduction of regular pre-recruit surveys;
- the improvement of catch and effort statistics;
- information on the amount of discards and conversion rates of various fish products;
- length/weight and catch-at-age and biological data of <u>all</u> commercially exploited stocks, also of those species in which the fishery is still in an exploratory phase or a fishery is intended to be developed; and
- an increase in the reliability and compatibility of ageing results.

37. However, even if all this information was available there is still great uncertainty inherent to fisheries stock assessment in general. In addition to the low precision of research

vessel surveys, there are potential biases in the biomass estimates. These are due to differences in catchability between vessels and between years. Any bias is likely to be increased by the patchy distribution of some of the target species. There are also biological uncertainties associated with the:

- separation of stocks;
- rates of growth and natural mortality; and
- relationship between spawning stock size and recruitment.

38. These difficulties are compounded where the commercial fishery fails to provide accurate and complete information.

39. In addition to the many problems outlined above which are common to fisheries stock assessments worldwide, there is additional uncertainty associated with the unique circumstances prevailing in the Southern Ocean. This uncertainty is directly attributable to a general lack of information on Southern Ocean fisheries which has been compounded by the region's geographic remoteness, its large area and international jurisdiction. Furthermore, all natural systems are subject to considerable environmental unpredictability making it difficult to forecast biotic variability using currently available statistical techniques. Both these sources of uncertainty are likely to severely limit the employment of robust feedback policies in stock assessment and management.

40. Therefore, given the wide range of uncertainty highlighted, it must be concluded that advice provided by the WG-FSA can rarely be considered unequivocal and should be accepted as 'the best scientific evidence currently available'.

CONCLUSIONS

41. The quality of stock assessment and management advice by the WG-FSA will be improved by an increase in the number of research surveys and an improvement in the quality of catch and effort statistics.

42. Uncertainty arising in the assessment of stocks will continue to be a major problem in the provision of management advice on fisheries resources in the Convention Area and this uncertainty must be taken into account in reaching management decisions.

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APPENDIX E

CALCULATION OF STANDARDISED BIOMASS ESTIMATES

The area of seabed within three depth strata in the Shag Rocks and South Georgia regions of Subarea 48.3 was calculated in 1987 (Everson, 1987) and revised in 1990 (Everson and Campbell, 1990). The three depth strata were 50 to 150 m, 151 to 250 m and 251 to 500 m. Balguerías (1989) summarised the 1987 measurements by depth strata in each region.

2. The ratio of 1990 data to 1987 data in each depth strata in each region (Table 1) was used to standardise *Notothenia gibberifrons* (Table 2) and *Champsocephalus gunnari* (Table 3) biomass estimates calculated from data collected aboard research vessels during 1985 through 1990 as:

$$B_{ijk} = \sum_{l=1}^{3} R_{jl} \; B_{ijkl}$$

where **B** = biomass estimates,
R = ratio of 1990 seabed areas to 1987 seabed areas (km^2),
i = species (*N. gibberifrons* or *C. gunnari*),
j = regions (Shag Rocks or South Georgia),
k = year of survey (1985 through 1990), and
l = depth strata (50 to 150 m, 151 to 250 m, or 251 to 500 m).

3. Biomass estimates for 1984/85 (FRG), 1986/87 (US/Polish), 1986/87 (Spanish), 1987/88 (US/Polish), 1988/89 (UK/Polish) and 1989/90 (*Hill Cove* and *Akademik Knipovich*) were presented by Kock (pers. comm.), Gabriel (1987), Balguerías (1989), MacKenna and Saila (1988), Parkes *et al.* (1989) and WG-FSA-90/13 respectively.

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Table 1: Ratios of areas of seabed within depths ranges around Shag Rocks and South Georgia, calculated in 1987 and 1990.

Area/Depth (m)	1987 Area[(a)]	1990 Area[(b)]	Ratio $\frac{1990}{1987}$
Shag Rocks			
50 to 150	3 100.7	1 473.5	0.475
151 to 250	5 855.0	1 870.6	0.319
251 to 500	2 411.3	1 610.0	0.668
South Georgia			
50 to 150	8 588.7	8 860.4	1.032
151 to 250	18 096.7	19 204.3	1.061
251 to 500	10 609.0	8 201.9	0.773

(a) BALGUERIAS, E. 1989. Informe de resultados ‘Antártida 8611’. Biología Pesquera. *Publicaciones Especiales del Instituto Español de Oceanografía, número 2*: 267-483.
(b) WG-FSA-90/8.

Table 2: Standard biomass estimates for Subarea 48.3 - *N. gibberifrons* (area ratios calculated in Table 1).
P = biomass estimates calculated using unrevised area data
S = biomass estimates standardised by revised area calculations

Area/ Depth (m)	Area Ratio	1984/85		1986/87		1986/87		1987/88		1988/89		*Hill Cove*	*Akademik Knipovich*	*Anchar*
		P	S[a]	P[b]	S	P[c]	S	P[d]	S	P[e]	S	S[f]	S[f]	S
Shag Rocks														
50-150	0.475	-	-	349	166	8986	4268	538	256	-	-	-	-	
151-250	0.319	-	-	51*	16	72599	23159	60	19	-	-	-	-	
251-500	0.668	-	-	0	0	105	70	10	7	-	-	-	-	
Total		-	-	400	182	81690	27497	608	282	-	-	267	0	
South Georgia														
50-150	1.032	-	3126	1920	1981	250	258	1834	1893	2422	2500	-	-	
151-250	1.061	-	11422	7567	8029	2163	2295	4404	4673	4635	4918	-	-	
251-500	0.773	-	2559	4057	3136	866	669	950	734	1453	1123	-	-	
Total		-	17107	13544	13146	3279	3222	7188	7300	8510	8542	12417	21891	

(a) K.-H. Kock, pers. comm.
(b) SC-CAMLR-VI/BG/12 Rev.1
(c) BALGUERIAS, E. 1989. Informe de resultados 'Antártida 8611'. Biología pesquera. *Publicaciones Especiales del Instituto Español de Oceanografía, número 2*: 267-483.
(d) SC-CAMLR-VII/BG/23
(e) WG-FSA-89/6
(f) WG-FSA-90/13

Table 3: Standard biomass estimates for Subarea 48.3 - *C. gunnari* (area ratios calculated in Table 1).
P = biomass estimates calculated using unrevised area data
S = biomass estimates standardised by revised area calculations

Area	Area Ratio	1984/85		1986/87		1986/87		1987/88		1988/89		*Hill Cove*	*Akademik Knipovich*	*Anchar*
		P	S[a]	P[b]	S	P[c]	S	P[d]	S	P[e]	S	S[f]	S[f]	S
Shag Rocks														
50-150	0.475	-	-	5551	2637	235	112	225	107	-	-	-	-	
151-250	0.319	-	-	4992	1592	62425	19914	1188	379	-	-	-	-	
251-500	0.668	-	-	0	0	7	5	34	23	-	-	-	-	
Total		-	-	10 543	4229	62667	20034	1447	509	-	-	232289	108652	
South Georgia														
50-150	1.032	-	1188	10224	10551	3405	3514	3557	3671	2093	2160	-	-	
151-250	1.061	-	15285	32634	34625	143929	152709	10878	11542	18752	19896	-	-	
251-500	0.773	-	759	7556	5841	3959	3060	651	503	223	172	-	-	
Total		-	17232	50414	51017	151293	159283	15086	15716	21068	22328	95405	437261	

(a) K.-H. Kock, pers. comm.
(b) SC-CAMLR-VI/BG/12 Rev.1
(c) BALGUERIAS, E. 1989. Informe de resultados ‘Antártida 8611’. Biología pesquera. *Publicaciones Especiales del Instituto Español de Oceanografía, número 2*: 267-483.
(d) SC-CAMLR-VII/BG/23
(e) WG-FSA-89/6
(f) WG-FSA-90/13

APPENDIX F

TASK GROUP FOR INFORMATION REPORTED TO THE WORKING GROUP

The following appendix contains the results of the deliberation of the Task Group on the information requirements for working papers submitted to the WG-FSA, convened by Dr M. Basson (UK) and consisting of Drs D. Agnew (Secretariat), P. Gasiukov (USSR), K. Sullivan (New Zealand) and Mr E. Balguerías (Spain) and D. Miller (South Africa).

2. For each of the categories of information identified in paragraph 64 in the body of this report, the appropriate types of information required are listed in this Appendix.

3. It was suggested by the Task Group that this information should be regarded as a minimum requirement when papers were submitted for consideration of the Working Group, but that the precise manner of presenting such information be left up to the discretion of authors.

I. STOCK ASSESSMENT SURVEYS - VESSELS, DESIGN AND DATA COLLECTION

SURVEY AREA

Survey area
Geographical boundaries: Latitude and Longitude
Map of area surveyed (preferably including bathymetry)

DESCRIPTION OF VESSEL

Name of vessel
Vessel size: Length (m), GRT (t)
Vessel type
Whether vessel included in CCAMLR register
Commercial vessels or research vessels

DESCRIPTION OF FISHING AND OTHER GEAR

Description of gear used, e.g. bottom, semipelagic, midwater, other, acoustics
Auxiliary gear (groundrope, dan leno assembly etc.)

Mesh size in codend (mm)
Type of mesh (diamond, square, other)

DESCRIPTION OF ACOUSTIC EQUIPMENT
Frequency used
Calibration method (hydrophone or standard sphere)
Calibration details
Source level
Pulse length
Directivity index
Receiving sensitivity
Calibration constant (source level plus receiving sensitivity)
TVG correction details
Target strength (TS)
Other information: TS/length relationship, length/weight relationship

SURVEY DESIGN
Survey design: Semi-random random, other
Target species
Stratification (if any) e.g. according to depth zones, fish density, other
Details of sources for stratification (e.g. seabed areas – Everson 1984)
Standard haul duration (preferably 30 min) (min)
Number of stations (planned and carried out)
Map of station positions should be included

METHODS OF SURVEY DATA ANALYSES
Swept area method
Acoustic survey
Stratification of survey results

DATA COLLECTED BY SURVEYS (haul-by-haul data)
Date and time
Start and end position of trawl
Duration at trawl depth
Trawling depth
Trawling speed
Net mouth opening (headline and wingspread)
Catch by species in weight and numbers

Length frequency information
Length composition
Age/length information
Species composition
Maturity stage information
Feeding information
Other (detail)

4. As far as possible summaries of this type of information should be provided in tabular form.

5. Most of this data should be submitted to CCAMLR on a haul-by-haul basis (Forms C1, B2, B3 and B4), and in the reporting format identified in paragraph 301 in the body of this report. The location of this information should be specified in the paper submitted to the Working Group.

II. RESULTS OF ANALYSES OF SURVEY DATA

6. As far as possible, the following details on the analyses of survey data, in particular the estimation of biomass, should be included. Details on:

- input data used, e.g. haul-by-haul data, see Section I above;
- input parameters, e.g. net mouth opening;
- method(s) of estimation (e.g. swept area method) including references to relevant papers if applicable;
- any modifications to the standard method with references and equations if applicable;
- method of stratification used;
- estimates of biomass within each stratum and the coefficients of variation; and
- estimate of total biomass and its coefficient of variation.

7. In the case of acoustic surveys, details on the following should also be included:

- value of target strength used to estimate biomass;
- how this value was estimated or reference; and
- area over which biomass was estimated.

8. With respect to biological data, see Section I above. If aggregated or overall data are presented, the method of aggregation should be described in detail. In particular, with respect to: overall length compositions; and age compositions.

III. STOCK ASSESSMENT ANALYSES

VIRTUAL POPULATION ANALYSIS (VPA) AND POPULATION PROJECTIONS

9. The presentation of VPA results in papers presented to the Working Group should contain the following information in detail.

(i) Input data:

(a) the fish stock (area and species) covered by the assessment;

(b) for each year the total catch by the commercial fishery;

(c) a description of the fishing methods and vessel types for each year, with catch weights by each method;

(d) fishing effort by method and area, standardised CPUE and source of data;

(e) length composition data and age/length key used to determine catch-at-age matrix. State source of data used;

(f) weight-at-age for each year and source of data;

(g) population parameters of **M** (natural mortality), $\mathbf{A_r}$ (age of recruitment) and $\mathbf{A_{mat}}$(age of maturity), including ogives of recruitment and maturity and references to sources.

(h) growth parameters, length-weight relationship and source;

(i) tuning method used and reference;

(j) other available data for this stock. This should include any trawl or acoustic survey results available and the source of this information;

(k) previous assessment results and sources;

(l) outline of any problems with the data, the fitting of the VPA model and comments on the assessment;

(ii) Output data:

(a) catch-at-age and weight-at-age data used as input data;

(b) stock numbers and biomass for each age in each year;

(c) a matrix of fishing mortality values for each age in each year;

(d) terminal fishing mortality rate and how determined;

(e) the exploitation pattern (selectivity) at age in the terminal year;

(f) biomass and spawning biomass for each year;

(g) average recruitment of first age class and the period of years used for calculation. Any stock recruitment relationship should be shown;

(h) catchability coefficient of trawl surveys based on VPA biomass estimates;

(iii) Population projection:

(a) population number-at-age in terminal year and source;

(b) weights-at-age used for year of projection and source;

(c) selection pattern of **F** and how determined, values of $\mathbf{F_{0.1}}$ and $\mathbf{F_{opt}}$ and source;

(d) number of recruits in first age class and how it was determined (e.g. mean recruitment from VPA and period of years used);

(e) estimates of biomass, spawning biomass and yield for **F** values for following year;

(f) status of stock relative to virgin biomass and optimum level;

(g) estimate of optimum long-term yield;

(h) any information on the strength of recruit and pre-recruit age classes in the current year (e.g. from surveys);

(i) comments.

YIELD-PER-RECRUIT AND ASSOCIATED ANALYSES

10. When presenting analyses of these types, the full set of input data should be supplied, together with the source of this data. In particular, the data and source of the following should be supplied:

- natural mortality used;
- selection/recruitment patterns;
- weight-at-age in the catch and stock; and
- maturity ogive.

IV. GENERAL ANALYSES

11. With respect to any analyses (e.g. estimation of natural mortality and rates or growth parameters), the following information should be included:

- the data used, the source of the data;
- all input parameters used;
- methods used to estimate parameters;
- assumptions of the methods; and
- estimates with coefficients of variation.

APPENDIX G

EFFECT OF UNCERTAINTY IN GROWTH PARAMETERS ON LENGTH COHORT ANALYSES

E. Balguerías - 14 October 1990

Document WG-FSA-90/34 presents an assessment of *Dissostichus eleginoides* in Subarea 48.3 using the Length Cohort Analyses (LCA) (Jones, 1981). The paper suggests values for $\mathbf{L}_\infty$ and **K** calculated from a reduced number of age classes ranging from 1 to 16 years. Assuming *D. eleginoides* as a longlife species living probably more than 30 years, the estimates of $\mathbf{L}_\infty$ and **K** contained in that paper may be underestimated and overestimated respectively.

2. The LCA is very sensitive to any change in the input values of the growth parameters. To show this effect, two sets of LCA simulations have been carried out using the original data set provided in document WG-FSA-90/34 and introducing small modifications in $\mathbf{L}_\infty$ and **K**.

3. The first set of simulations assumes constant values for **K** (0.0717) and **M** (0.18) and three different values of $\mathbf{L}_\infty$ (190, 200, 210). The results (Table 1, Figure 1) show that increases of 10 cm and 20 cm in $\mathbf{L}_\infty$ produce reductions in the stock size (number of individuals) of 32% and 45% respectively.

4. In the second set of simulations $\mathbf{L}_\infty$ (190) and **M** (0.18) remain constant. The values of **K** used in the simulations were 0.0717, 0.06 and 0.05. Table 2 and Figure 2 show that very small decreases in **K** lead to increases of 103% and 522% in the stock size.

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Table 1: Effect of changes in **L∞** (maximum theoretical length) in stock size calculated using the Jones length cohort model.

Length (cm)	N.ind (x1000) **L∞** = 190 **K**=0.0717 **M**=0.18	N.ind (x1000) **L∞** = 200 **K**=0.0717 **M**=0.18	N.ind (x1000) **L∞** = 210 **K**=0.0717 **M**=0.18
36	1 085	753	613
42	1 020	711	581
48	957	670	549
54	894	629	517
60	829	584	482
66	754	531	439
72	679	476	394
78	610	428	354
84	543	380	315
90	471	327	271
96	389	264	218
102	298	194	157
108	215	129	102
114	153	83	62
120	112	54	39
126	84	36	25
132	65	26	17
138	51	19	12
144	39	14	8
150	30	10	6
156	21	7	4
162	14	5	3
168	9	3	2
174	4	2	1
Total	9 325	6 336	5 171
	100.00	67.95	55.45
% Reduction		32.05	44.55

Table 2: Effect of changes in **K** (growth coefficient) in stock size calculated using the Jones length cohort model.

Length (cm)	N.ind (x1000) **L∞** = 190 **K**=0.0717 **M**=0.18	N.ind (x1000) **L∞** = 190 **K**=0.06 **M**=0.18	N.ind (x1000) **L∞** = 190 **K**=0.05 **M**=0.18
36	1 085	2 364	8 013
42	1 020	2 180	7 211
48	957	2 003	6 460
54	894	1 832	5 759
60	829	1 665	5 100
66	754	1 492	4 475
72	679	1 324	3 893
78	610	1 171	3 365
84	543	1 026	2 881
90	471	880	2 430
96	389	729	2 004
102	298	574	1 606
108	215	435	1 256
114	153	328	972
120	112	250	747
126	84	192	568
132	65	148	425
138	51	113	310
144	39	84	217
150	30	60	145
156	21	41	90
162	14	25	50
168	9	14	24
174	4	6	8
Total	9 325	18 935	58 010
	100.00	203.05	622.07
% Increasing		103.05	522.07

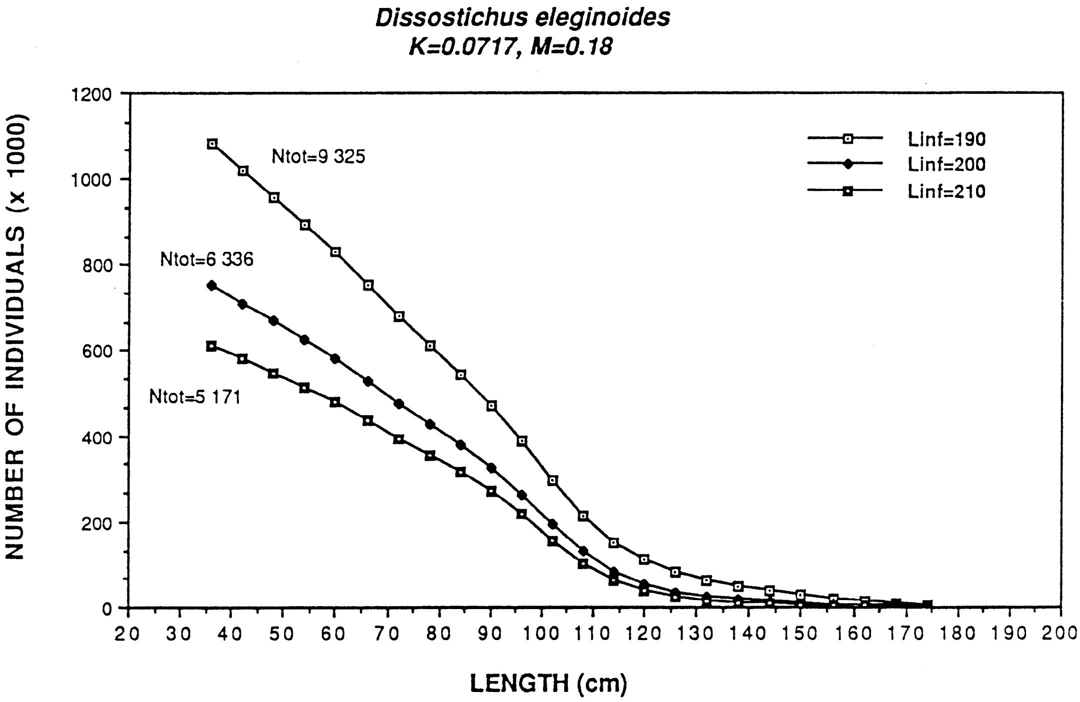

Figure1: Effect of changes in **L□** (maximum theoretical length) in stock size calculated using the Jones length cohort model.

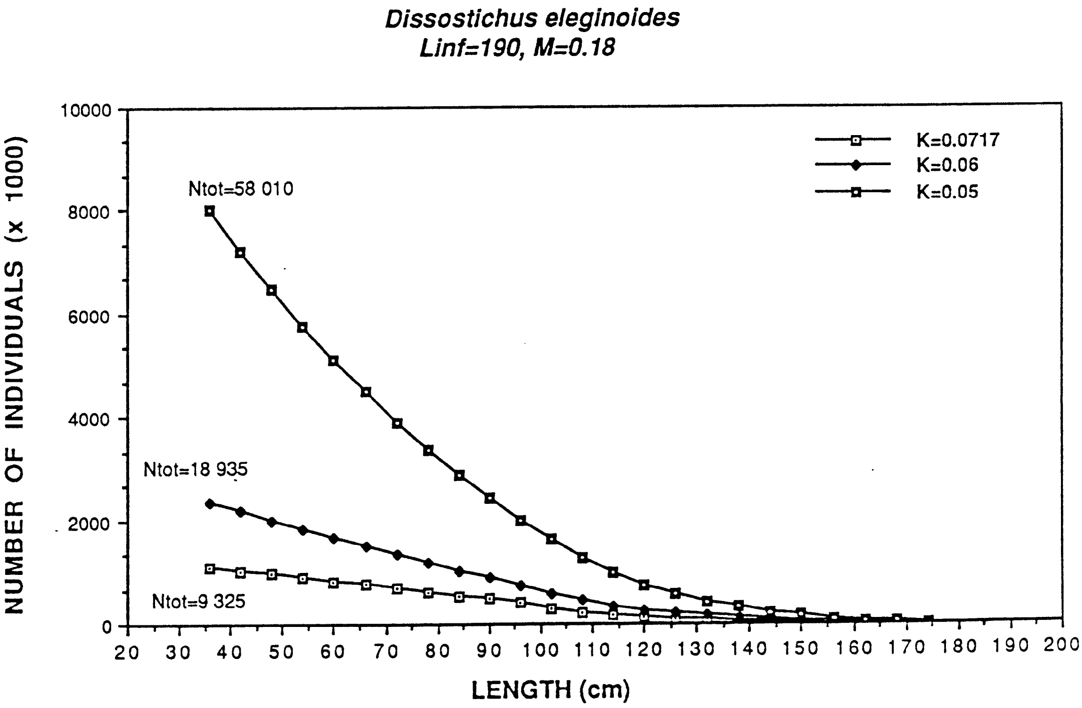

Figure 2: Effect of changes in **K** (growth coefficient) in stock size calculated using the Jones length cohort model.

APPENDIX H

ESTIMATED ABUNDANCE OF *NOTOTHENIA GIBBERIFRONS* FROM COMPARISON OF *ANCHAR* SURVEY WITH *HILL COVE* SURVEY EXCLUDING HAULS WITHIN 12 MILES OF SOUTH GEORGIA

E. Marschoff

Three different estimations for the biomass of *Notothenia gibberifrons* around South Georgia and its coefficient of variation have been tabled:

Bhc=12 417 tonnes, CVhc=28% (*Hill Cove*, WG-FSA-90/13)
Bak=21 891 tonnes, CVak=23% (*Akademik Knipovich*, WG-FSA-90/13)
Ban=53 650 tonnes, CVan=21% (*Anchar*, WG-FSA-90/30).

2. Sampling units have been defined in accordance with the fine-scale reporting system. In each sampling unit, three depth strata (50 to 150, 150 to 250 and 250 to 500 m) have been used as appropriate, and trawls performed in positions selected independently of the distribution of fish.

3. WG-FSA-90/8, Table 3, gives the total area of seabed in each stratum:

		Proportion
50 to 150 m:	8 860.4	(0.2443)
150 to 250 m:	19 204.3	(0.5295)
250 to 500 m:	8 201.9	(0.2262)
50 to 500 m:	36 266.6	

4. In order to obtain an easily comparable measure of each survey, calculations were performed in order to obtain a ‘weighted mean haul (WMH)’ for the cruise as the weighted mean of the mean hauls at each stratum; the weighting coefficients used are the corresponding proportions of seabed (WG-FSA-90/8). All hauls have been corrected to a net opening of 20 m and a duration of 30-minutes. It is assumed that the speed remained constant since no data were available on the speed of each haul.

5. It was suggested that the high value of the biomass from the *Anchar* cruise might originate from the fact that *Anchar* did not fish closer than 12 miles from the shore. This hypothesis was examined by recalculating WMH for *Hill Cove*, but not using the hauls taken in the 12 mile zone (*Hill Cove** in the table below omits the hauls within 12 miles of South Georgia). It is clear that this might not be the cause.

	50 to 150 m		150 to 250 m		250 to 500 m			
	Mean	N	Mean	N	Mean	N	WMH	N
Akademik Knipovich	29.80	15	28.97	35	75.85	20	39.78	70
Anchar	56.98	15	104.45	35	52.39	31	81.09	81
Hill Cove	8.51	8	35.92	39	13.17	12	24.08	59
*Hill Cove**	13.38	5	31.57	29	11.97	11	22.69	45

APPENDIX I

DATA REQUIREMENTS FOR THE WORKING GROUP

I		II	III
	Data Required by Appendix 9 of WG-FSA-89	Data Received by WG-FSA	Data Required by WG-FSA-90
1.	Catch and effort data for *D. eleginoides*[(1)] (Also recommended by SC-CAMLR-VIII, paragraph 3.12)	No fine-scale longline data reported Data on STATLANT submitted	Commercial data required (length and biological) Fine-scale data required
2.	Growth and mortality of *C. gunnari* in Subarea 48.3, year by year[(3)]	Data are contained in WG-FSA-90/31 and WG-FSA-90/33 Data from 1960s submitted	–
3.	Biological information on incidental catch of *N. rossii* in Subarea 48.3[(4)]	Length composition from 1990 research data only	Biological information on incidental catch of *N. rossii* in Subarea 48.3[(4)]
4.	Length and age, *N. squamifrons*, Subarea 48.3 - commercial data[(5)]	Research data on lengths Biomass estimates from recent surveys	Length and age, *N. squamifrons*, Subarea 48.3 - commercial data[(5)]
5.	*C. gunnari* and *N. gibberifrons* length and age data, Subarea 48.2 Research survey data[(6)]	No survey data of biomass Research data only for 1989 and 1990 length frequencies	*C. gunnari* and *N. gibberifrons* length and age data, Subarea 48.2 Research survey data[(6)]
6.	Commercial age and length data for *N. gibberifrons*[(7)]	Research data only	Commercial age and length data for *N. gibberifrons*[(7)]
7.	Fine-scale catches of *P. antarcticum*, Subarea 58.4[(8)]	No fine-scale data	Fine-scale catches of *P. antarcticum*, Subarea 58.4
8.	Catches reported as *C. gunnari* from Division 58.4.2 should be *C. wilsoni* [(9)]	Corrected by Secretariat but new catches also mis-reported	Catches reported as *C. gunnari* from Division 58.4.2 should be *C. wilsoni*
9.	Data from recent trawl surveys in Division 58.4.4 should be re-submitted[(10)]	Data not reported	–
10.	Catch data for *N. squamifrons*, Division 58.4.4 should be submitted[(11)]	Catches presented in WG-FSA-90/37	STATLANT catches of *N. squamifrons* reported from Division 58.4.4 should be corrected to agree with those in WG-FSA-90/37 Catches should be reported for Ob and Lena Banks
11.	Age/length data from catches of *C. gunnari* in Division 58.5.1 prior to 1980[(12)]	No data	Age/length data from catches of *C. gunnari* in Division 58.5.1 prior to 1980[(12)]

I	II	III
12. Various data from *N. squamifrons* in Division 58.5.1: • length and ALK data • catch data separated for Division 58.5.1 • data consistency[13]	No new biological data No further separation performed	Various data from *N. squamifrons* in Division 58.5.1: • length and ALK data • catch data separated for Division 58.5.1 • data consistency[13]
13. Reports requested from *Slavgorod, Borispol, Passat 2* fishing in October 1989 (SC-CAMLR-VIII, paragraph 3.7)	No reports received by WG-FSA	Reports requested from *Slavgorod, Borispol, Passat 2* fishing in October 1989 (SC-CAMLR-VIII, paragraph 3.7)
14. Data from *E. carlsbergi* requested (SC-CAMLR-VIII, paragraph 3.23)	Target species was not identified in reported catches No fine-scale data	Report on ELC rather than MZZ Fine-scale data from Convention Area and areas north of convergence requested (this report, paragraph 180)
15. Biomass and biological data of *E. carlsbergi* requested (SC-CAMLR-VIII, paragraph 3.23)	Biological and biomass survey data presented in WG-FSA-90/18, 20, 21, 23, 25 Some length and ALK data from Subareas 48.3, 48.4, 48.6 No fine-scale data	– Biological data from historical catches requested Fine-scale data requested
16. –	–	Data on size selectivity of longline fishery
17. –	–	Want haul-by-haul information from research vessel surveys and experimental fisheries
18. –	–	An increase in availability of biological data from commercial catches (general)
19. –	–	Information on levels of discarding and conversion rates from fish products to nominal weight are required (Item 4)
20. –	–	Representative length-frequency from the commercial catch of *C. gunnari* in Subarea 48.3 should be reported for recent years (this report, paragraph 100)

( ) Numbers in superscripted parenthesis refer to item numbers in Appendix 9 of the 1989 WG-FSA report (SC-CAMLR-VIII, Annex 6).

FIELD SAMPLING LOGSHEET - BY-CATCH OF FISH IN COMMERCIAL KRILL CATCHES

SHIP: ....   NATIONALITY: ....   DATE: ....

NET TYPE: ....   MESH: ....   SUBAREA: ....

Haul No.	Position		Water Depth		Fishing Depth		Speed of Vessel		Net Dimensions		Time (GMT)		Krill Catch (kg)	Subsample Weight (kg)	Fish		
	Start	End	Start (m)	End (m)	Start	End	Start	End	Start	End	Start	End			Species	Number	Weight
	° ‘ “ S ° ‘ “ W/E	° ‘ “ S ° ‘ “ W/E									h m	h m					
	° ‘ “ S ° ‘ “ W/E	° ‘ “ S ° ‘ “ W/E									h m	h m					
	° ‘ “ S ° ‘ “ W/E	° ‘ “ S ° ‘ “ W/E									h m	h m					

Page ____ of ____

APPENDIX K

DETAILS OF INTENDED AND COMPLETED RESEARCH SURVEYS

SURVEY DETAILS

Survey Area: _________

Geographical boundaries: Latitude ________ to ________

Longitude _______ to ________

Map of area surveyed (preferably including bathymetry)

Dates of survey: _____ / _____ / _____ (Y/M/D)

DESCRIPTION OF VESSEL

Name of vessel: _________________________________

Vessel size:

Length: __________ (m) GRT __________ (t)

Vessel type: ___________________________

Vessel included in CCAMLR register: _____ YES _____ NO

Commercial vessel: _____ YES _____ NO

Research vessel: _____ YES _____ NO

DESCRIPTION OF FISHING AND OTHER GEAR

Description of gear used:

Bottom trawl ______________

Semipelagic trawl ______________

Midwater trawl ______________

Other (specify) ______________

Acoustics ______________

Auxiliary gear (groundrope, dan leno assemble etc.):

____

____

Mesh size in codend: ___________ mm

Diamond mesh: ___________

Square mesh: ___________

Other (specify): ___________

DESCRIPTION OF ACOUSTIC GEAR

Frequency ____________

Calibration details:

Calibration method ______ Hydrophone ______ Standard sphere

Source level ______ (dB re 1uPa @1m)

Pulse length ______ (ms)

Directivity index ______ (dB)

Volt. rec. sens. ______ (dB re 1V uPa-1 @ max TVG)

Calibration control (source level & voltage response)

TVG correction ______ YES ______ NO

Details ____

Target strength (TS) ________ (dB)

Other information:

TS/length relationship _______________

Length/weight relationship _______________

SURVEY DESIGN

Survey design: Semi-random ___________ Random ____________

Target species: ____

Stratification (if any) according to:

Depth zones (list): _______________

Fish density (list): _______________

Other (specify): _______________

Details of sources for stratification (e.g., seabed areas (Everson, 1984)):

____

Standard haul duration (preferably 30 min) ______ (min)

No. of stations:

Planned _____ Carried out _____

Map of stations to be included

METHODS OF SURVEY DATA ANALYSES

Swept area method _____ YES _____ NO

Acoustic survey _____ YES _____ NO

Other (detail) __________________________

Stratification of survey results ____________

____

____

*HAUL-BY-HAUL DATA

**Haul number

**Date and time (GMT)

**Start and end position of trawl ___________ S ___________ W/E

**Duration at trawl depth ___________ hrs/min

**Trawling depth

**Trawling speed

**Net mouth opening

***Catch by species in weight and numbers

***Length frequency information

* As far as possible summaries of this type information should be provided in tabular form.

** & *** Most of this data should be submitted to CCAMLR on a haul-by-haul basis (Forms C1, B2, B3 and B4).

*BIOLOGICAL DATA

Length composition _____ YES _____ NO

Age-length information _____ YES _____ NO

Species composition _____ YES _____ NO

Maturity stage information _____ YES _____ NO

Feeding information _____ YES _____ NO

Other (detail) _____ YES _____ NO

* Most of this information should be included in haul-by-haul information reported to CCAMLR and therefore it should be clearly indicated where it can be found.

APPENDIX L

1990 ASSESSMENT SUMMARIES

1990 ASSESSMENT SUMMARIES

Assessment Summary: *Notothenia rossii*, Subarea 48.3

Source of Information: This Report

Year	1985	1986	1987	1988	1989	1990	Max[2]	Min[2]
Recommended TAC						0		
Agreed TAC						300		
Landings	1891	70	216	197	152	2	24897	2
Survey Biomass	12781		11471[a] 1634[b]	1699	2439	1481[a] 3915[b] 3900[b]		
Surveyed by	FRG		Spain[a] USA/POL[b]	USA/POL	UK/POL	UK/POL[a] USSR[b]		
Sp. Stock Biomass[3]				No information				
Recruitment (age...)				available				
Mean F (.....)[1]				since 1985/86				

Weights in tonnes, recruits in ....
[1] ... weighted mean over ages (...)
[2] Over period 1980 to 1990
[3] From VPA using (..........)

Conservation Measures in Force: 3/IV, 13/VIII.

Catches: Since the prohibition of a directed fishery on the species in 1985, annual reported catches were always less than 250 tonnes.

Data and Assessment: No analytical assessment carried out in 1989 and 1990 due to the lack of relevant data. Biomass estimates available for the recent five years.

Fishing Mortality: No recent information but probably low.

Recruitment: No recent information but may be influenced by increased predation by fur seals (see SC-CAMLR-VIII, Annex 4, Appendix 10).

State of Stock: Recent biomass estimates gave no evidence for a recovery of the stock. Stock size probably less than 5% of pristine level.

Forecast for 1990/91:

Option Basis	1990			1991			Implications/ Consequences
	F	SSB	Catch	F	SSB	Catch	

Weights in tonnes

Assessment Summary: *Champsocephalus gunnari*, Subarea 48.3

Source of Information: This Report

Year	1985	1986	1987	1988	1989	1990	Max[2]	Min[2]
Recommended TAC				31500	10200	12000		
Agreed TAC				35000	- [4]	8000		
Landings	14148	11107	71151	34619	21359	8027	128194[6]	7592
Survey Biomass	17232		159283	15716	22328[5]			
Surveyed by			Spain	USA/POL	USA/POL			
Sp. Stock Biomass[3]								
Recruitment (age...)								
Mean F (.....)[1]								

Weights in tonnes
[1] ... weighted mean over ages (...)
[2] Over period 1980 to 1990
[3] From VPA using (..........)
[4] Prohibition from 4 November 1988
[5] Standard estimate from Appendix D
[6] Maximum catch in 1983

Conservation Measures in Force: 13/VIII, 15/VIII

Catches: The total catch in 1989/90 was 8 027 tonnes. This included 387 tonnes taken by research vessels

Data and Assessment: No commercial length or age data were submitted. A VPA assessment tuned to standardised effort was presented in WG-FSA-90/26. Population projections based on biomass estimates from trawl surveys were carried out.

Fishing Mortality: Fishing mortality from VPA is low for 1989/90.

Recruitment: The last known strong year class entered the fishery in 1987/88.

State of Stock: Assessments and surveys indicate that the 1989/90 stock is at a much higher level than that projected for 1989/90 at the previous meeting. Assessments are subject to significant uncertainty.

Forecast for 1990/91:

Option Basis	1990 F	1990 Stock	1990 Catch	1991 F	1991 Stock	1991 Catch	Implications/ Consequences
[1] $\mathbf{F_{0.1}}$($\mathbf{M}$=0.48)				0.33	222	44	If stock is much higher than assumed here, the stock will increase under these TAC levels
[2] $\mathbf{F_{0.1}}$($\mathbf{M}$=0.56)				0.57	238	64	

Weights in '000 tonnes [1] WG-FSA-91/5 [2] WG-FSA-90/26

Assessment Summary: *Patagonotothen brevicauda guntheri*, Subarea 48.3

Source of Information: This Report

Year	1985	1986	1987	1988	1989	1990	Max[2]	Min[2]
Recommended TAC					-	-		
Agreed TAC					13000	12000		
Landings	11923	16002	8810	13424	13016	145	36788[4]	5029
Survey Biomass			81000					
Surveyed by			Spain					
Sp. Stock Biomass[3]						na		
Recruitment (age 1)						na		
Mean F (3 - 5)[1]						na		

Weights in tonnes
1 ... weighted mean over ages (...)
2 Over period 1980 to 1990
3 From VPA using (..........)
4 Maximum catch in 1989

Conservation Measures in Force: 16/VIII

Catches: 145 tonnes in 1989/90.

Data and Assessment: WG-FSA-90/28. Catch-at-age 1978/79 to 1988/89.

Fishing Mortality: Close to zero 1989/90. Age classes 3 and 4 fully recruited.

Recruitment: Insufficient information available.

State of Stock: Uncertain.

Forecast for 1990/91:

Option Basis	1990 F	1990 SSB	1990 Catch	1991 F	1991 SSB	1991 Catch	Implications/ Consequences
M=0.48				0.56		20315	
M=0.63				0.78		25167	
M=0.90				1.32		36356	

Weights in tonnes

Assessment Summary: *Dissostichus eleginoides*, Subarea 48.3

Source of Information: This Report

Year	1985	1986	1987	1988	1989	1990		Max[2]	Min[2]
Recommended TAC						-			
Agreed TAC						-			
Landings	285	564	1199	1809	4138	8311		4138	109
Survey Biomass	8159		1208	674	326	9631*	335+		
						1693*	3020+		
Surveyed by	FRG		USA/POL[4]	USA/POL[4]	UK/POL[4]				
Stock Biomass[3]						20745 - 435817			
Recruitment (age...)						na			
Mean F (.....)[1]						na			

Weights in tonnes

[1] ... weighted mean over ages (...)
[2] Over period 1980 to 1989
* Shag Rocks
[3] Estimated from cohort projections
[4] Survey excluding Shag Rocks
+ South Georgia

Conservation Measures in Force: No Conservation Measures in force. Resolution 5/VIII.

Catches: Catches have doubled in past two seasons following commencement of longline fishery at Shag Rocks.

Data and Assessment: Length based cohort analysis and extrapolation analysis of single year class. Both methods subject to criticism.

Fishing Mortality: No information available.

Recruitment: No information available.

State of Stock: Assessments indicate that catch currently at/or substantially above MSY. Both assessments subject to significant uncertainty.

Forecast for 1990/91:

Option Basis	1990 F	1990 SSB	1990 Catch	1991 F	1991 SSB	1991 Catch	Implications/ Consequences

Weights in tonnes

Assessment Summary: *Notothenia gibberifrons*, Subarea 48.3

Source of Information: This Report

Year	1985	1986	1987	1988	1989	1990	Max[2]	Min[2]
Recommended TAC								
Agreed TAC								
Landings	2081	1678	2844	5222	838	11	11758	0
Survey Biomass	17107		13146	7300	8542	12417[a] 21891[b] 53450[c]		
Surveyed by	FRG		USA/POL	USA/POL	UK/POL	UK[a] USSR[b] USSR[c]		
Sp. Stock Biomass[3]	4681	4947	5462	4962	3650	4145	26114	3650
Recruitment (age...)	15573	14897	13085	8509	4123	153		
Mean F (.....)[1]	0.38	0.18	0.25	0.35	0.21	0.0011	0.48	0.0011

Weights in tonnes, recruits in thousands

[1] ... weighted mean over ages 2 to 19+

[2] Over period 1975/76 to 1989/90

[3] From VPA using UK trawl survey biomass estimate for 1990

Conservation Measures in Force: 13/VIII, 15/VIII.

Catches: Catches during 1989/90 were 11 tonnes, the lowest on record.

Data and Assessment: Two VPA analyses tuned to trawl survey biomass estimates (one based on UK estimate for 1990, the other tuned to USSR estimate for 1990). Population projections assuming $\mathbf{F_{0.1}}$ = 0.0935 yr^{-1}.

Fishing Mortality: Fishing mortality during 1989/90 lowest on record, fishing mortality rates exceeded $\mathbf{F_{0.1}}$ in all previous years.

Recruitment: Steady during 1975/76 to 1987/88 but some evidence of declines during 1987/88 to 1989/90.

State of Stock: Biomass levels stable at low levels since 1981/82.

Forecast for 1991/92:

Option Basis	F	1991 SSB	Catch	F	1992 SSB	Catch	Implications/ Consequences
VPA - USSR Biomass estimate	$\mathbf{F_{0.1}}$ = 0.0935	7594	1134	$\mathbf{F_{0.1}}$ = 0.0935	8374	1161	
VPA - UK Biomass estimate		4947	667		5636	723	

Weights in tonnes

Assessment Summary: *Chaenocephalus aceratus*, Subarea 48.3

Source of Information: This Report

Year	1985	1986	1987	1988	1989	1990	Max[2]	Min[2]
Recommended TAC					1100	0		
Agreed TAC					0	300		
Landings	1042	504	339	313	1	2	1272	901
Survey Biomass	11542		8621	6209	5770	14226[a] 14424[b] 17800[b]		
Surveyed by	FRG		USA/POL	USA/POL	UK/POL	UK/POL[a] USSR[b]		
Sp. Stock Biomass[3]	2174	3006	4179	4156	4404	5098[4]		
Recruitment (age 2)	6154	6573	5375	8648	6717	4047[4]		
Mean F (.....)[1]	0.57	0.19	0.17	0.13	0.002			

Weights in tonnes, recruits in thousands

[1] ... weighted mean over ages 3 to 11

[2] Over period 1980 to 1990

[3] From VPA using revised VPA from WG-FSA-90/6

[4] Predicted

Conservation Measures in Force: 13/VIII, 14/VIII.

Catches: Reported catches were less than 500 tonnes annually after 1985. Note that no catch figures were provided by the USSR.

Data and Assessment: These have been extensively described in WG-FSA-90/6 and have been revised during 1990 meeting.

Fishing Mortality: Probably low.

Recruitment: No independent recruitment surveys. VPA results indicate a spawner-recruit relationship.

State of Stock: Surveys up to 1989 and VPA indicate stock size of approximately 50% of initial size in 1975/76.

Forecast for 1990/91 (from WG-FSA-90/6):

Option Basis	1990 F	1990 SSB	1990 Catch	1991 F	1991 SSB	1991 Catch	Implications/ Consequences
TAC 300 t		3886	300 t		4377	300 t	
$\mathbf{F_{0.1}}$	0.214	3886	1597	0.214	3719	2314	SSB declining when fishing at $\mathbf{F_{0.1}}$

Weights in tonnes

Assessment Summary: *Pseudochaenichthys georgianus*, Subarea 48.3

Source of Information: This Report

Year	1985	1986	1987	1988	1989	1990	Max[2]	Min[2]
Recommended TAC					1800	0		
Agreed TAC						300		
Landings	1097	156	120	401	1	1	1661	1
Survey Biomass	8134		5520	9461	8278	5761[a] 12200[b] 10500[b]		
Surveyed by	FRG		USA/POL	USA/POL	UK/POL	UK/POL[a] USSR[b]		
Sp. Stock Biomass[3]	5564	3758	5498	8090	8889[4]			
Recruitment (age 1)	5358	18197	4337	1372				
Mean F (.....)[1]	0.84	0.08	0.09	0.15				

Weights in tonnes, recruits in 1 000

[1] ... weighted mean over ages 3 to 6

[2] Over period 1980 to 1990

[3] From VPA described in WG-FSA-90/6

[4] Predicted

Conservation Measures in Force: 13/VIII, 14/VIII.

Catches: Reported catches were less than 400 tonnes annually after 1985. Note that no catch figures are provided by the USSR.

Data and Assessment: These have been extensively described in WG-FSA-90/6. Reliability of assessment is probably low due to unresolved problems with ageing.

Fishing Mortality: Probably low in recent years.

Recruitment: No independent recruitment survey. VPA results indicate a highly variable recruitment.

State of Stock: Present stock size probably at 25% of the pristine stock size in 1975/76.

Forecast for 1990/91 (from WG-FSA-90/6):

Option Basis	1990			1991			Implications/ Consequences
	F	SSB	Catch	F	SSB	Catch	
TAC=300 t		8357	300 t		8950	300 t	
$\mathbf{F_{0.1}}$	0.626	7213	1857	0.626	7679	2039	
50% $\mathbf{F_{0.1}}$	0.313	8710	1388	0.313	9273	1514	

Weights in tonnes

Assessment Summary: *Notothenia squamifrons*, Subarea 48.3

Source of Information:

Year	1985	1986	1987	1988	1989	1990	Max[2]	Min[2]	Mean[2]
Recommended TAC						0			
Agreed TAC						300			
Landings	1289	41	190	1553	927		1553	0	563
Survey Biomass			13950	409	131				
Surveyed by			USA/POL	USA/POL	UK/POL				
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....
[1] weighted mean over ages (...)
[2] Over period 1980 to 1989
[3] From VPA using (..........)
[4] Predicted

Conservation Measures in Force: 13/VIII, 14/VIII

Catches:

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1990/91:

Option Basis	1990 F	1990 SSB	1990 Catch	1991 F	1991 SSB	1991 Catch	Implications/ Consequences

Weights in tonnes

Assessment Summary: *Notothenia rossii*, Division 58.5.1

Source of Information: This Report

Year	1985	1986	1987	1988	1989	1990	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings	1707	801	482	21	245	155	9812	21	2531
Survey Biomass									
Surveyed by									
Sp. Stock Biomass[3]						[4]			
Recruitment (age...)						[4]			
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

[1] ... weighted mean over ages (...)

[2] Over period 1980 to 1990

[3] From VPA using (..........)

[4] Predicted

Conservation Measures in Force: Conservation Measure 2/III. Resolution 3/IV. Limitation of trawlers allowed on fishing grounds each year. Arrêté N°: 18, 20, 32 (for details see SC-CAMLR-VIII, Annex 6, Appendix 10, page 290).

Catches:

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1990/91:

Option Basis	1990 F	1990 SSB	1990 Catch	1991 F	1991 SSB	1991 Catch	Implications/ Consequences

Weights in tonnes

Assessment Summary: *Notothenia squamifrons*, Division 58.5.1

Source of Information: This Report

Year	1985	1986	1987	1988	1989	1990	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC			5000	2000	2000[5]+				
Landings	7394	2464	1641	41	1825	1262	11308	41	4057
Survey Biomass									
Surveyed by									
Sp. Stock Biomass[3]						[4]			
Recruitment (age...)						[4]			
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

1 ... weighted mean over ages (...)
2 Over period 1980 to 1990
3 From VPA using (..........)
4 Predicted
5 TAC set by fishing season, not split-year

Conservation Measures in Force: Catch limits set since 1987 (French/Soviet agreement). Conservation Measure 2/III; Arrêté 20 and 32.

Catches:

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1990/91:

Option Basis	1990 F	1990 SSB	1990 Catch	1991 F	1991 SSB	1991 Catch	Implications/ Consequences

Weights in tonnes

Assessment Summary: *Champsocephalus gunnari*, Division 58.5.1

Source of Information: This Report

Year	1985	1986	1987	1988	1989	1990	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings (Skif Bank)	223	0	2625	2	0		2625	0	578
Landings (Kerguelen)	8030	17137	0	157	23628		25848	0	9784
Landings (Combined)						226			
Survey Biomass									
Surveyed by									
Sp. Stock Biomass[3]						[4]			
Recruitment (age...)						[4]			
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

1 ... weighted mean over ages (...)

2 Over period 1980 to 1990

3 From VPA using (..........)

4 Predicted

Conservation Measures in Force: Conservation Measure 2/III; Arrêté 20; Conservation Measure as for *N. rossii* TACs set under French-Soviet Agreement.

Catches:

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1990/91:

Option Basis	1990			1991			Implications/ Consequences
	F	SSB	Catch	F	SSB	Catch	

Weights in tonnes

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.1

Source of Information: This Report

Year	1985	1986	1987	1988	1989	1990	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings	6677	459	3144	554	1630	1062	6677	40	1304
Survey Biomass					27200				
Surveyed by									
Sp. Stock Biomass[3]						[4]			
Recruitment (age...)						[4]			
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

[1] ... weighted mean over ages (...)

[2] Over period 1980 to 1990

[3] From VPA using (..........)

[4] Predicted

Conservation Measures in Force: None.

Catches:

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1990/91:

Option Basis	1990 F	1990 SSB	1990 Catch	1991 F	1991 SSB	1991 Catch	Implications/ Consequences

Weights in tonnes

Assessment Summary: *Notothenia squamifrons*, Division 58.4.4

Source of Information: This Report

Year	1985	1986	1987	1988	1989	1990	Max[2]	Min[2]
Recommended TAC (Lena Bank)								
Agreed TAC								
Landings (Ob Bank[a])*	1023	9531	1601	1971	913			
Landings (Lena Bank[a])*	87	1977	441	2399	3003			
Landings (Combined[b])	27	61	930	5302	3360	1450	5302	27
Survey Biomass (Ob Bank)	11000				12700			
Survey Biomass (Lena Bank)	11800							
Surveyed by	USSR				USSR			
Sp. Stock Biomass[3]						na		
Recruitment (age...)						na		
Mean F (.....)[1]								

Weights in tonnes, recruits in ....

[1] ... weighted mean over ages (...)
[2] Over period 1985 to 1990
[3] From VPA using (..........)
* Calendar Year data

[a] From WG-FSA-90/37
[b] From SC-CAMLR-IX/BG/2 Part 2 (Statistical Bulletin)

Conservation Measures in Force: 2/III, 4/V.

Catches: There are great discrepancies between the catches reported for the individual banks in WG-FSA-90/37 and those for the entire area in the Statistical Bulletin.

Data and Assessment:

Fishing Mortality: Ob Bank 0.4 (1989) and Lena Bank 0.8 (1989).

Recruitment: No data available.

State of Stock: Ob Bank - probably significantly depleted. Lena Bank - becoming fully exploited.

Forecast for 1990/91:

Option Basis	1990 F	1990 SSB	1990 Catch	1991 F	1991 Biomass	1991 Catch	Implications/ Consequences
$\mathbf{F_{0.1}}$ Ob Bank	0.17			0.13	2949	267	
$\mathbf{F_{0.1}}$ Lena Bank	0.47			0.13	3454	305	

Weights in tonnes

ANNEX 6

REPORT OF THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM

(Stockholm, Sweden, 6 to 13 September 1990)

REPORT OF THE WORKING GROUP FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM

(Stockholm, Sweden, 6 to 13 September 1990)

INTRODUCTION

The Fifth Meeting of the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) was held at the Royal Swedish Academy of Sciences and the Swedish Museum of Natural History, Stockholm, Sweden from 6 to 13 September 1990.

2. Participants were welcomed by Mrs Désiree Edmar, Assistant Under-Secretary of the Swedish Cabinet Office and Head of the Swedish Delegation to CCAMLR and Mr Olaf Tandberg, Foreign Secretary of the Swedish Royal Academy of Sciences. The Convener of the Working Group, Dr J. Bengtson (USA) thanked the Government of Sweden for inviting the Working Group to hold its meeting in Stockholm and expressed his gratitude to the Swedish Polar Research Secretariat and the Swedish Museum of Natural History for their assistance in organising the meeting.

3. The Convener opened the meeting and introduced the Provisional Agenda. The Agenda was adopted with the following changes: Item 11 was amended to read ‘Designation and Protection of Sites’ and a new agenda item ‘Future Work of WG-CEMP’ was added.

4. The Agenda is attached as Appendix A, a List of Participants is given in Appendix B and documents submitted for consideration at the meeting are listed in Appendix C.

5. The report of the meeting was prepared by Drs J. Croxall (UK), P. Boveng (USA), K. Kerry (Australia), V. Marín (Chile), D. Agnew and E. Sabourenkov (Secretariat).

REVIEW OF MEMBER’S ACTIVITIES

6. The Convener noted that many Members were now carrying out CEMP studies, and that some have information from activities dating back to before CEMP started which are of direct use in the program. Last year the Working Group summarised Members’ activities into monitoring of predatory species in accordance with Standard Methods, research on assessing the utility of potential predator parameters and directed ecological research needed to

interpret changes in monitored predator parameters. It was agreed that relevant summary tables from the report of the 1989 Meeting of the Working Group should be updated at the meeting and appended to this report (Tables 1 to 3).

7. It was pointed out that these summary tables deal only with studies of predatory species and do not cover work on prey species and environment. It was agreed that, in addition to updating summary tables, Members should inform the Working Group on other aspects of their CEMP-related studies in the last season and advise on plans for the next season.

8. Studies by Argentina in 1989/90 were concentrated as in the previous season on monitoring parameters of Adélie penguins in the colonies at Stranger Point, King George Island, South Shetland Islands, and Mossman Peninsula, Laurie Island, South Orkney Islands, in accordance with Standard Methods A1 to A3 and A6 to A8. An attempt was being made to elaborate an annual index for the parameter A1 (adult weight on arrival at breeding colonies) (WG-CEMP-90/8). Work on a procedure for determining the sex of adult Adélie penguins by discriminant analyses of several morphometric measurements was continued (WG-CEMP-90/7 Rev. 1). In relation to the parameter A8 (penguin chick diet) a sampling design was suggested for optimisation of the detection of interannual variability and selectivity of prey by size (WG-CEMP-90/9).

9. In the 1990/91 season the CEMP studies of Argentina will continue work carried out in 1989/90. The Working Group was informed that plans for construction work at Esperanza Station (Antarctic Peninsula) had been cancelled and that Argentina will commence monitoring of Adélie penguins at this site starting with the 1990/91 season. Data available from previous studies at Esperanza will be submitted.

10. Australia has continued monitoring of Adélie penguins at Magnetic Island (Davis Station). Data for most of the approved parameters for penguins are being collected. At present funds are available for this work to be continued at least for another two years. There are plans to combine this work with offshore studies on prey and the environment, including radio-tracking of penguins at sea. An automated penguin monitoring system has been developed and will be field-tested during the 1990/91 season at an Adélie penguin colony near Mawson Station (WG-CEMP-90/24). This device will provide information on bird identity, weight and direction in and out of the breeding colony. When fully operational it will automatically provide data collected in accordance with Standard Methods A1, A2, A5 and possibly A7.

11. At present Australia does not conduct, for the purposes of CEMP, any research on prey and the environment. However, the new Australian research ship *Aurora Australis* (an icebreaker with commercial scale trawling capability) will provide new possibilities.

12. Australian scientists in 1989/90 collected a series of measurements (WG-CEMP-90/25) for possible use in sexing Adélie penguins by discriminant analysis of several morphometric measurements and as a result of this study an additional set of morphometric measurements was provided (WG-CEMP-90/25).

13. Brazil submitted a written report (WG-CEMP-90/26). In 1989/90 Brazil carried out monitoring of chinstrap and macaroni penguins at Stinker Point, Elephant Island, South Shetland Islands on parameters A6 to A8. Summary data on these parameters have been submitted to the CCAMLR Secretariat. Draft standard methods for monitoring suggested parameters of cape petrel are being prepared and will be submitted later to WG-CEMP. Plans for the 1990/91 season include the continuation of monitoring the same parameters of penguins at Elephant Island together with collecting data on several weather parameters by means of an automatic weather station.

14. Chile reported results of directed research on birds, mammals and plankton and of an hydrological survey around Livingston Island which were carried out in the 1989/90 season. This survey is a part of an overall program on the evaluation of energy transfer among elements of the ecosystem in parts of the Antarctic Peninsula Integrated Study Region. In the 1990/91 season Chile will continue monitoring parameters A3, A4 and A6 at Ardley Island and parameters C1 and C2 at Cape Shirreff. Chile is also conducting directed research at Coppermine Peninsula, Robert Island, South Shetland Islands, and has identified this site as an important location for multidisciplinary studies. In addition, Chile is conducting cooperative studies with the USA around Seal Island, South Shetland Islands to identify foraging ranges of penguins and fur seals.

15. Japan is conducting monitoring of annual trends in breeding population size of Adélie penguins at Syowa Station. This program was presented to the meeting. In the 1990/91 season, a survey of krill distribution together with the collection of data on some hydrological parameters is planned for the Elephant Island area from aboard RV *Kaiyo Maru*. Joint research with US scientists is planned during 1990/91 to investigate the foraging areas of fur seals and penguins near Seal Island, Elephant Island (aboard RV *Kaiyo Maru*), and the ecology of penguins breeding ashore at Seal Island. Simultaneous land-based and sea-bound observations on the diet and energy requirements of penguins are also planned in the near future. Plans also include satellite tracking of seals in the Prydz Bay Integrated Study

Region. This program will be carried out in cooperation with Australian scientists. Japanese scientists will continue to work with US scientists on satellite tracking of elephant and crabeater seals in the Weddell Sea and Antarctic Peninsula area.

16. Research activities of Korea in 1989/90 in support of CEMP were concentrated on a plankton survey in the Bransfield Strait during which samples were obtained at 29 oceanographic stations. Future programs will include more intensive studies of phyto- and zooplankton distribution, particularly krill, in the northern part of the Bransfield Strait and Gerlache Strait.

17. In the past Norway's contribution to CEMP has mainly been studies of hydroacoustic methods of krill stock assessments. In 1989/90 Norway established a permanent land station, 'Troll', in Queen Maud Land at 72°00'S, 02°34'E, and two field camps in the same general area. Studies have been initiated in a colony of about one million Antarctic petrels near one of the camp sites, 'Svarthamaren', some 200 km inside the edge of the ice-shelf at 71°53'S, 05°10'E. Directed research is expected to continue at this colony.

18. Efforts are currently being made by Norway to establish a regular long-term program of Antarctic research in cooperation with other Nordic countries, i.e. Sweden and Finland. This program, and future national Norwegian activities, might be expanded to include regular studies of seals and birds on Bouvet Island in accordance with CEMP Standard Methods. A report of censuses of seal and bird populations on the island during 1989/90 is currently being prepared for publication. The Working Group expressed its particular interest in the suggested initiation of monitoring on Bouvet Island (see paragraph 48 below).

19. South Africa is conducting several research programs outside the CEMP Integrated Study Regions. These programs include studies of macaroni and gentoo penguins and elephant seals on Marion Island. Monitoring of populations of these species is conducted largely in accordance with CEMP Standard Methods. Prey monitoring studies are designed mainly to understand the relationship between the distribution of prey species and hydrographic processes in the vicinity of the Prince Edward Islands. In the coming two years South Africa plans to start monitoring and directed research on a colony of Antarctic petrels located some 50 miles inland in Queen Maud Land from SANAE station (Robertskollen nunatukk, 71°27'S, 03°15'W).

20. Sweden welcomed the suggestion by Norway for cooperation among Nordic countries in CEMP-related research. At present Sweden does not participate in routine monitoring as part of CEMP. However, biological studies aimed at providing background information are

continuing in cooperation with scientists from the UK and USA. The recent launch of a new Swedish icebreaker, *Oden*, has created high expectations in developing new research programs.

21. United Kingdom land-based research in support of CEMP is conducted at Signy Island, South Orkney Islands and Bird Island, South Georgia. At Signy Island, parameters A3 and A6 are monitored for Adélie and chinstrap penguins. Long-term mark-and-recapture data for Weddell seals has recently been analysed in conjunction with USA and Australian data from continental sites (Testa *et al*. (1990) *J. Anim. Ecol*., in press). At Bird Island parameters currently monitored are A1, A3, A6, A7, A8 and A9 (macaroni penguin), B1 to B3 (black-browed albatross), C1 and C2 (fur seal). In addition A3, A6 and A8 are monitored for gentoo penguin and there are comprehensive demographic programs on grey-headed and wandering albatrosses and Antarctic fur seal. Pilot studies aimed at developing constant-effort recapture methods to provide standardised demographic data for macaroni and gentoo penguins are in progress.

22. Recent and current research at Bird Island has emphasised penguin and fur seal reproductive biology. Publications of particular relevance to CEMP include those on interannual variability in breeding chronology and biology (WG-CEMP-90/18, 90/37, 90/38), penguin chick fledging weight (WG-CEMP-90/13), penguin foraging trip duration (WG-CEMP-90/17) and year-round studies of gentoo penguin diet (WG-CEMP-90/16). Publications in preparation include comparisons of fur seal pup growth as assessed by CEMP Procedures A and B, relationships between time and activity budgets at sea and foraging-attendance cycle duration in fur seals, analysis of diving pattern and performance in penguins and fur seals and black-browed albatross demographic trends over the last 15 years. The current penguin research program is to be concluded in 1991 and will be succeeded by more intensive investigations of albatross demography and ecology. Monitoring studies will be maintained at their current level.

23. United Kingdom prey studies have concentrated on krill distribution and swarming behaviour using acoustics, nets and underwater photography. Studies on krill target strength continue. A study is in progress to provide advice on survey design for monitoring krill in predator/prey studies.

24. The United States conducted a variety of studies of relevance to CEMP in the Antarctic Peninsula Integrated Study Region during the 1989/90 season (WG-CEMP-90/22, WG-Krill-90/7). Monitoring of land-based marine mammals and birds was conducted at Seal Island and Palmer Station. Chinstrap and macaroni penguins were monitored at Seal Island

(Standard Methods A4, A5, A6, A7, A8 and A9) and Adélie penguins were monitored at Palmer Station (Standard Methods A4, A6, A7 and A8). Antarctic fur seals were monitored at Seal Island using Standard Methods C1 and C2. In addition, several directed research projects on marine mammals and birds were conducted at Seal Island: fur seal and penguin foraging behaviour and activity budgets; fur seal and penguin foraging areas; effects of instrument attachment on penguins (WG-CEMP-90/21); fur seal pup and penguin growth (WG-CEMP-90/34); fur seal diet; krill requirements of predators (WG-CEMP-90/30); and determining the sex of penguins by bill measurements.

25. United States CEMP investigations at sea focused on integrated studies of prey, predators, and environmental features as well as directed research on crabeater seals. Integrated studies in 1989/90 included research on surface water masses, primary production, krill distribution, and predator foraging in the vicinity of Elephant Island, South Shetland Islands (WG-CEMP-90/11). Studies of crabeater seal demography, life history parameters, and reproductive biology were conducted in collaboration with Swedish scientists (WG-CEMP-90/35). Seasonal patterns of crabeater seal feeding behaviour, activity budgets, and habitat use are being investigated using satellite telemetry in collaboration with scientists from Japan.

26. During 1990/91, the US plans to continue monitoring and directed research at Seal Island and Palmer Station in the Antarctic Peninsula Integrated Study Region. The US will also continue its integrated studies at sea using the NOAA Ship *Surveyor* in the vicinity of Elephant Island. Cooperative studies with Japan and Chile will involve simultaneous monitoring of penguin and seal foraging behaviour, foraging areas, and the distribution of krill. Scientists from Chile and Japan will also participate in joint research on penguins and fur seals at Seal Island. Analysis of crabeater seal data will continue in collaboration with Swedish scientists.

27. As in the past, Soviet research in relation to CEMP in 1989/90 was concentrated on trawl and acoustic surveys, mainly of krill, conducted simultaneously with large-scale oceanographic surveys. In total, six multidisciplinary research cruises were carried out in the Atlantic and Indian Ocean sectors of the Southern Ocean. In particular, surveys of krill spawning and post-spawning distribution were undertaken to the east of South Sandwich Islands and in the Prydz Bay Integrated Study Region. Some of the research effort focused on *Pleuragramma antarcticum* as a potential indicator species for CEMP. For the first time Soviet scientists made observations on the distribution and abundance of flying birds during the research cruise of RV *Akademik Fedorov* along the Antarctic coast. The results are presented in WG-CEMP-90/33.

28. For the 1990/91 season, the USSR plans to continue large-scale multidisciplinary studies of krill distribution and oceanography in various areas of the Southern Ocean. A total of seven research cruises is planned although specific details of the cruise tracks are not yet known. Two cruises are planned to undertake directed fisheries research and studies of krill distribution in the Atlantic Ocean sector between 30° and 60° W, south of 40°S. In the Indian Ocean sector, four cruises are planned for areas in Prydz Bay, the Lazarev Sea, and near Enderby Land. Krill and oceanographic variability will be investigated during a research cruise in the Pacific Ocean sector between 150° and 180°E.

29. Dr Croxall mentioned that several Members, not present at the meeting, were conducting research of relevance to CEMP. In particular he drew attention to ornithological research by France at Crozet and Kerguelen Islands and the potential for the resumption of Adélie penguin research (which could include CEMP monitoring) at Adélie Land after airstrip construction is completed. New Zealand was continuing aerial surveys of Adélie penguin colonies in the Ross Sea and is conducting satellite tracking of Adélie penguins to determine foraging ranges during the incubation period. The German Democratic Republic conducts bird and seal research at King George Island, including collaborative research with Chile at Ardley Island. The Federal Republic of Germany is studying diet and distribution of crabeater seals and ecology of *P. antarcticum* in the southern Weddell Sea.

30. The Secretariat reported that a letter had been received from a Czechoslovakian scientist seeking information to assist in planning ornithological research at Nelson Island, South Shetland Islands, as part of the Czechoslovakian Antarctic Program. He specifically requested information on CEMP. A copy of the Standard Methods document was sent to him as well as other documents published by CCAMLR and his letter was drawn to the attention of the Chairman of the SCAR Bird Biology Subcommittee.

31. The Convener noted the diversity and large volume of CEMP-related research now being conducted by Members. It was clear that by providing a forum for regular and frequent communication among scientists and the opportunity for international collaboration, CEMP had been most successful in stimulating research on topics essential to the work of the Commission.

RELEVANCE OF CEMP TO THE WORK OF THE COMMISSION

32. The Convener introduced this item, noting that it was a topic raised at a number of previous meetings of WG-CEMP.

33. In 1988, at its Seventh Meeting, the Commission sought advice from the Scientific Committee (CCAMLR-VII, paragraphs 140 to 141) on:

> ‘operational definitions for depletion and target levels for recovery of depleted populations’, and
>
> ‘the ability of the CCAMLR Ecosystem Monitoring Program to detect changes in ecological relationships and to recognise effects of simple dependencies between species including distinguishing between natural fluctuations and those induced by fisheries.’

34. In 1989, at their Eighth Meetings, the Scientific Committee and the Commission asked WG-CEMP to reconsider these questions and to address the wider issue of the development of appropriate approaches to management and conservation in the light of the objectives of the Convention.

35. ‘.....<u>operational definitions for depletion and target levels for recovery of depleted populations</u>’. WG-CEMP is chiefly concerned with the detection of change in predator and prey parameters selected for monitoring. For predators, these parameters currently involve demography (including population size) and various indices of reproductive performance (including foraging). Decreases in population size could obviously be direct evidence of depletion of that particular population or stock but WG-CEMP is unable to formulate operational definitions at present. WG-CEMP has considered extensively the design of sampling in its monitoring program and is recommending that monitoring of parameters should be aimed at detecting at least a 10% change at a 90% confidence level (SC-CAMLR-VIII, Annex 7, paragraph 29). It is likely, therefore, that information on defined levels of change in monitored parameters, including population size, will be available to the Scientific Committee and Commission in the future.

36. ‘.....<u>the ability of the CCAMLR Ecosystem Monitoring Program to detect changes in ecological relationships and to recognise the effects of simple dependencies between species including distinguishing between natural fluctuations and those induced by fisheries</u>.’ In SC-CAMLR-VIII, paragraph 7.12, WG-CEMP reported that it was investigating the possibility of distinguishing between changes in food availability that result from commercial harvesting and changes due to natural fluctuations in the biological and physical environment. Because of the complexity of this topic and the possible need for modelling studies, they noted that advice could not be provided at present and that further work and discussion will be needed. At its 1990 Meeting the Working Group noted that it felt unable to add anything

to this statement, beyond restating the clear expectation of being able to detect changes in biological parameters that would undoubtedly reflect changes in ecological relationships.

37. With regard to appropriate approaches to management, a specific priority for WG-CEMP is the development of ways of incorporating the data on monitored predator parameters into the formal management deliberations of CCAMLR at both the Scientific Committee and Commission levels.

38. As a basis for initial discussion, the document SC-CAMLR-VIII/9 (SC-CAMLR-SSP/6: 353-365) was reviewed. The paper suggested that it was relatively straightforward and highly desirable to devise a system for annually assessing the overall pattern of changes in indices at the levels of parameter, species, site and area. Management recommendations would arise from considering the patterns of change in predator indices in the light of available relevant biological and physical environmental data. Such recommendations would only be likely where there is evidence of significant broad-scale general effect, or of acute effects at more local levels. This would apply, however, even when there was no evidence that harvesting is, or has been, a contributing factor. The logic for this is that if predator populations may be in trouble, any level of harvesting, if conducted at critical times and places, may have significant adverse effects. Examples of possible management action, involving restrictions on krill catch size, timing and location were compared from the perspectives of ease of implementation, consequences for the fishery and the probability of aiding predators (SC-CAMLR-VIII, paragraph 7.14).

39. At CCAMLR-VIII there was general agreement that such approaches merited further investigation and development and WG-CEMP was encouraged to discuss the whole topic at its next meeting. Prof. T. Lubimova (USSR) had expressed reservations about the content of SC-CAMLR-VIII/9 noting it contained a number of speculative ideas based on one approach to the problem. It was agreed that these reservations should also be discussed.

40. Present discussion focused on suggested assessment procedures. It was agreed that these should involve:

(i) determining the magnitude and significance of changes in individual parameters;

(ii) evaluating overall patterns of change within species, sites and areas;

(iii) reviewing factors potentially influencing or correlated with the changes; and

(iv) identifying factors unlikely to be implicated in the changes.

41. There was general agreement that it was both appropriate and desirable to determine annually the magnitude and direction of year-to-year changes and overall trends in each of the predator parameters being monitored at each site. The level of significance of change and trends should also be calculated. These results would be evaluated annually by WG-CEMP, with particular attention to comparisons within species, sites and regions and a summary of conclusions prepared. The results of these analyses would then be considered by WG-CEMP in the light of available data on relevant aspects of the biological environment (e.g. current/recent diet of monitored species, current/recent prey stock assessments and level and distribution of commercial catches at appropriate temporal and spatial scales) and physical environment (oceanographic features, weather and climate prevailing, especially during the monitoring period). Such a review would, where appropriate, enable WG-CEMP to formulate advice to the Scientific Committee.

42. There was also general support for the view that analysis and evaluation of submitted CEMP data and the development of recommendations based thereon did not require, and should not await, the determination of the precise quantitative nature of predator/prey/ environment relationships.

43. It was agreed that the Secretariat should, as soon as possible after the deadline for receipt of the annual data submission, prepare a summary of the data received, including determining the magnitude and level of significance of changes and trends in comparison with the previously submitted data. Members were also encouraged to conduct similar analyses of their own data.

44. It was noted that, in respect of many parameters, the procedure outlined in paragraph 43 would require the development of explicit instructions for analysis of submitted data. Members were asked to submit proposals to the next meeting of the Working Group.

45. Mr D. Miller (South Africa) drew attention to parallel initiatives in the Working Group on Krill (WG-Krill) aimed at the development of standardised procedures for the formulation of management advice on krill to the Scientific Committee. These included consideration of data from predators, specifically predator food (i.e. krill) requirements and levels of krill escapement from harvesting activities necessary to meet such requirements. These particular topics are discussed in more detail in paragraphs 95 and 135. There was

agreement that such development emphasised the continued need for close liaison, including interchange of results of data analysis, between WG-CEMP and WG-Krill.

PREDATOR MONITORING

Sites and Species

46. The Convener invited discussion of current and new sites, drawing attention to the report of the SCAR Bird Biology Subcommittee (WG-CEMP-90/32). This report indicated Esperanza might become a CEMP Network Site. The potential importance of Esperanza, on the boundary between the Weddell Sea and the Bransfield Strait, was noted. Dr D. Vergani (Argentina) confirmed that there were plans to begin monitoring Adélie penguins at Esperanza in the coming season.

47. The SCAR Bird Biology Subcommittee also noted the importance of the long-term penguin research activities by US scientists at Admiralty Bay, King George Island. It was noted that data from this program would provide a valuable contribution to CEMP, and that the US should be encouraged to consider appropriate arrangements, as feasible, to include the site in CEMP.

48. The Working Group welcomed the comment (paragraph 18) that Norway might consider continuing research activities and initiating monitoring activities at Bouvet Island. Bouvet Island is an important site because it is ‘downstream’ of major krill fisheries, it is in an oceanographic transition zone, as well as being a site of penguin and fur seal colonies. The Working Group agreed that developing such studies at Bouvet, the only proposed land-based site in Subarea 48.6, would be a valuable contribution to the CEMP program.

49. Chile has identified Cape Shirreff, Livingston Island as an important site and will expand its past research efforts there by beginning CEMP monitoring during 1990/91 as part of an ecosystem study that includes oceanographic surveys in the surrounding waters. Joint studies between Chile and the US are also being planned for this site.

50. It was noted that construction activity at Dumont D’Urville Station is expected to conclude in the near future. The Working Group encouraged France to re-initiate monitoring efforts at this site as soon as feasible.

51. The Working Group decided to change the eastern and southeastern boundaries of the Antarctic Peninsula Integrated Study Region to coincide with the corresponding boundaries of Subarea 48.1. This change will make it easier to incorporate the fine-scale krill catch data into CEMP studies, but will not change reporting requirements for fine-scale data.

52. A proposal by the United Kingdom to include gentoo penguins (*Pygoscelis papua*) as a designated CEMP species was accepted. The species meets all the CCAMLR criteria, it is a year-round resident at many sites, and it attains sexual maturity at a younger age than most other penguins. Dr Croxall was asked to draft the appropriate modifications for gentoo penguins to the Standard Methods and tables and to report these proposed changes to the Working Group's next meeting.

Data Collection Methods

53. The draft second edition of the CEMP Standard Methods (WG-CEMP-90/43), revised during the intersessional period by a small subgroup, contained many new sections. In particular, recent developments in the analytical techniques and new data reporting sheets were included. The Convener invited the Working Group to comment on the new edition, noting that several papers for this session were relevant to the evaluation of the methods (WG-CEMP-90/7 Rev. 1, 8, 9, 12, 13, 15 to 18, 21, 24 to 27, 32, 34, and 37 to 41).

54. The Working Group agreed that, although several comments that had been expected from experts outside CEMP had not yet been received, the evaluation and adoption of the second edition should proceed. It was noted that the process of developing the methods is dynamic, and that each method may be subject to revision periodically as new information becomes available. The Secretariat was requested to incorporate the agreed revisions into a new version of the document to be distributed at the Ninth Meeting of the Scientific Committee.

55. During discussions of individual standard methods, the following general comments were made.

(i) A concern was expressed that some items listed under MANDATORY DATA were so obvious as to not need explicit mention. The Working Group was reminded that the MANDATORY DATA section is as much for aiding the development of field data forms as for describing the procedures and that, therefore, that section should remain intact.

(ii) The Working Group was reminded that data may now be available for filling in gaps in tables of relevant dates for each species and location for each method. Members were requested to provide information that would add to or revise those tables as soon as possible.

(iii) Members were requested to provide to the Secretariat, no later than 15 October 1990, relevant references to update the lists of BACKGROUND PAPERS for each method.

56. In reviewing Members' activities, the Working Group reiterated its view that many CEMP activities require the collection of data for sustained periods of time. To fulfil the many objectives inherent in monitoring, such time periods should be uninterrupted. Both these factors have to be taken into account when developing new monitoring programs.

Standard Methods for Penguins

Standard Method A1.2: Adult Weight on Arrival at Breeding Colony

57. Dr Vergani presented WG-CEMP-90/8, which contained a description of a technique intended to provide an index of Adélie penguin weight on arrival, when no information about sex or age of the birds is available. Because several Members expressed reservations about the primary statistical method (separating ‘modes’ of a composite distribution) it was agreed not to alter the analytical portion of the standard method at this time. The Working Group, however, encouraged further developments, particularly regarding techniques for determining the sex of Adélie penguins (discussed below in paragraphs 71 to 74).

Standard Method A2.2: Duration of the First Incubation Shift

58. The method was adopted as drafted but it was noted that investigators from Argentina and Chile may have additional comments when they have had time to review the method and reporting form.

Standard Method A3.2: Breeding Population Size

59. The method was adopted as drafted.

Standard Method A4.2: Age-specific Annual Survival and Recruitment

60. No analytical methods have yet been drafted for this method because of the variety and complexity of available techniques. Members were requested to inform the Working Group of protocols now in use by their investigators.

Standard Method A5.2: Duration of Foraging Trips

61. A study by US scientists (WG-CEMP-90/21) indicated that radio-transmitters may increase durations of foraging trips by chinstrap penguins. Dr Croxall noted that a similar study on gentoo penguins did not detect an effect (WG-CEMP-90/17). The Working Group agreed that efforts to detect and minimise the potential effects of attached instruments should be continued.

62. It was agreed that the method should include specific information regarding which brands of adhesives have been found to work, and which do not work, for the attachment of instruments. Also, it was noted that some investigators have successfully attached transmitters to penguins without adhesives, using metal hose clamps or plastic cable-ties.

63. Members were reminded of the request made in item 2 of the COMMENTS section of this method, for input on the issue of whether each individual of a nesting pair should be included in studies of foraging trip durations. Issues bearing on this topic include statistical independence of the two parent birds and representation of both sexes in the study.

Standard Method A6.2: Breeding Success

64. It was noted that because the former version of Procedure B included activities that related to two different approaches to estimating breeding success, this section was split into Procedures B and C in the second version. Procedure B now pertains to chicks raised per breeding pair and Procedure C relates to chicks raised per colony.

Standard Method A7.2: Chick Weight at Fledging

65. Dr Croxall noted that the findings of WG-CEMP-90/13 suggest that chick weight at some intermediate development stage (say 30 days of age) may be more revealing than

fledging weight (at about 60 days) because an inverse relationship had been observed between chick meal size and weight at 60 days. It was agreed to insert appropriate comments in the data collection and data interpretation sections of this method.

Standard Method A8.2: Chick Diet

66. Because much of the work described in the General Procedures pertained to HIGHLY DESIRABLE DATA (not mandatory), the Working Group developed text for the two procedures: Procedure A aims to characterise the general composition of chick diet; Procedure B provides detailed information about the composition of prey in the diet. Members were requested to consider specific objectives that might be desirable based on the types of data available from Procedure B.

67. In that regard, WG-CEMP-90/9 demonstrated the use of nested ANOVA for the design of a study to detect interannual variability and prey size selectivity. Particular sampling regimes will depend on economic constraints which inevitably vary among Members' programs. Dr Marín suggested that the portion of the technique up to partitioning of the expected mean squares would be of more general use than the final sample size estimates. Because the method pertained to research that might be conducted under Procedure B (see previous paragraph), no specific proposal was warranted at this time.

68. To estimate krill size distributions from carapace lengths in samples that are not in suitable condition to reliably distinguish the sexes, additional regression equations should be added to Table 1 for this method. The new equations should be formed as composites of the regressions for the individual sexes. Separate equations should be developed for adult and subadult krill. Within each of these age groups, equations should be provided for several sex ratios. This would enable investigators to use the approximate sex ratio in a sample to choose the appropriate equation. The US Delegation agreed to provide the composite equations to the Secretariat by 15 October 1990.

69. Because of the potential for time-of-day effects on the composition of penguin chick diet, it was agreed that the mandatory data include both date and time of day, both to be recorded as GMT.

Standard Method A9.2: Breeding Chronology

70. This method involves the recording of dates of various events over the breeding season. It is most useful when the full set of dates is reported, but the chronology of individual events is also of value to monitoring. It was agreed therefore that Members be encouraged to collect data on breeding chronology even if their investigators may not have arrived at a particular site sufficiently early in the season to have collected complete data on breeding chronology. Breeding chronology data should be collected for those portions of Method A9 (e.g. hatching dates, fledging rates) which correspond to the relevant Methods A1 to A8.

Standard Method Appendix 1: Determining the Sex of Penguins

71. Substantial progress has been made in these methods, allowing nearly 100% accuracy for some species. However, further research has shown that the early version of this appendix was insufficiently detailed to treat all CEMP penguin species. Adélie penguins in particular, because of their small, tapered bills, are difficult to measure precisely, as pointed out by Dr Kerry in WG-CEMP-90/25.

72. Dr Vergani summarised WG-CEMP-90/7 Rev. 1 in which a method using several allometric parameters in addition to bill depth was used to correctly determine the sex of about 87% of a sample of Adélies. The Working Group agreed that the method was promising and encouraged efforts to increase the accuracy of the method.

73. A subgroup including Drs Kerry, Vergani and Croxall agreed to redraft Standard Methods Appendix 1, incorporating specific methods for each species, and recent improvements in the techniques. Draft diagrams and outstanding textual information for the revised version should be sent to the Secretariat not later than 8 October 1990.

74. The ability to accurately determine the sex of penguins (including juvenile birds) is important in penguin research generally and essential in respect of several CEMP methods. Members were encouraged to examine additional ways of determining the sex of penguins.

Standard Methods for Flying Birds

Standard Method B1.2: Breeding Population Size
Standard Method B2.2: Breeding Success
Standard Method B3.2: Age-specific Annual Survival and Recruitment

75. South Georgia is the only suitable site for applying these methods (which pertain to black-browed albatross). Because Dr Croxall felt the methods and reporting forms needed only minor revisions, the Working Group agreed to adopt these methods pending minor changes to be discussed with the Data Manager.

Standard Methods for Seals

Standard Method C1.2: Duration of Cow Foraging/Attendance Cycles

76. Dr Croxall described preliminary results from a study at Bird Island which indicated that visual twice-daily monitoring of fur seal foraging trips underestimated trip duration by 7% and overestimated duration ashore by 18% when compared to monitoring by radio-telemetry. Durations of trips monitored visually were more variable (CV = 45%) than trips monitored by telemetry (CV = 40%). Visually monitored durations ashore were less variable (CV = 38% vs. CV = 52%). Also, no significant effect of instruments on foraging cycles was detected. Full details will be available at the next meeting of the Working Group.

Standard Method C2.2: Pup Growth

77. Dr Kerry suggested that the Working Group consider using implanted passive transponder tags (PTTs) to mark individual fur seal pups as an aid to conducting Procedure A (growth rates of known individuals), or as a method of avoiding multiple captures of individuals when using Procedure B (growth rates of random samples of pups). The Working Group acknowledged that PTTs could be useful but also noted that background studies would be necessary to determine specific aspects of implanting, retaining, and detecting PTTs in fur seal pups.

78. WG-CEMP-90/34 suggested a statistical method for comparing growth rates among years and applied it to data from three years of monitoring fur seal pup growth at Seal Island, Antarctic Peninsula Integrated Study Region. No significant differences in growth rates were

detected among the three years. There were, however, significant differences in the estimates of pup weights on specific dates. It was agreed that it would be useful to investigate whether pup weight at a certain age or date would be a useful index to complement existing monitoring parameters for fur seals.

79. The Working Group adopted the second edition of ‘Standard Methods for Monitoring Parameters of Predator Species’, noting that agreed revisions would be communicated to the Secretariat by 15 October 1990.

Field Research Techniques

80. Dr Bengtson expressed his concern and the Working Group agreed that in conducting monitoring studies on Antarctic marine mammals and birds, WG-CEMP should take appropriate steps to ensure that field research techniques were carried out in a manner that:

(i) avoided or minimised adverse effects on wildlife;

(ii) followed recognised techniques and therefore were compatible with the results of other studies; and

(iii) did not significantly alter the behaviour or welfare of the species being studied.

81. There were two areas of particular concern:

(i) techniques of handling seals and seabirds; and
(ii) general procedural effects.

Handling techniques include such activities as capture and restraint, tagging and banding, stomach pumping, and attaching or removing electronic instruments. Examples of possible general procedural effects include disturbing colonies by investigators' presence or increasing the energetic requirements of seals and birds by attaching electronic instruments to their backs.

82. Some of these items had already received explicit attention. The Standard Methods identify specific steps that investigators should follow to minimise disturbance in penguin and fur seal colonies. In addition, evaluations of the extent to which electronic instruments affected the behaviour of gentoo penguins (WG-CEMP-90/13) and chinstrap penguins

(WG-CEMP-90/21) were tabled at the meeting. The US Delegation reported that it planned to undertake further studies on the potential effects of instrument deployment on penguins during the 1990/91 field season. Members were encouraged to continue considering the topic of potential effects of monitoring procedures and to report their findings to the Working Group.

83. Additional possibilities of investigators using improper handling techniques arise as new programs and personnel initiate monitoring and directed research activities as part of CEMP. Such problems may develop because of errors associated with developing new techniques, investigators' inexperience, or just unfortunate mistakes made in the course of research activities. Even for those techniques that are well-developed, minor changes in the recognised procedure may cause problems. For example, it was noted that improper techniques for capturing (holding the bird or seal too tightly), bird banding and seal tagging (fastening bands incorrectly or placing tags in the wrong place on the flipper), penguin stomach pumping (using the wrong diameter of tubing or inserting the tube too far) might result in harming or even killing the bird or seal being studied.

84. The Working Group recognised that in the course of any field research operation, occasional mistakes are almost inevitable. To help minimise such errors, the Working Group agreed that it would attempt to enhance the exchange of information on the finer points of handling techniques, problems to avoid, problems encountered and solutions developed.

85. The Working Group agreed that, for the purposes described above, it would be desirable to produce a videotape recording demonstrating some of the bird and seal handling techniques utilised in CEMP activities. Members were requested to prepare video recordings of these field activities, with the view to editing these recordings into a single tape at a future workshop on field techniques.

86. It was also agreed that arranging demonstrations of various types of field equipment and techniques (e.g. stomach pumping, tagging, banding, determination of sex and the use of electronic instruments and recording equipment) at such a workshop would be an effective way to increase the efficiency of studies and data quality while decreasing the probability of potentially adverse impacts on the study animals.

87. Members were encouraged to bring more detailed proposals for such a workshop to the next meeting of the Working Group.

Standardising Activity Budget Methods

88. Noting that a Standard Method for activity budgets of birds and seals at sea might be proposed in the future, the Working Group considered convening a workshop to standardise sampling protocols, set-up, use and data analysis from instruments used in these studies (i.e. time-depth recorders and satellite transmitters). The Working Group agreed that such a workshop, attended by both scientists using these instruments and instrument manufacturers, should be held and noted that Seattle might be a desirable venue because a major manufacturer of such devices is located there. The Working Group welcomed an invitation from the US National Marine Mammal Laboratory to hold the workshop in Seattle. It was noted it would involve specialists who may not normally attend WG-CEMP meetings and that it might be necessary to seek CCAMLR funds to assist some of them to attend.

89. It was agreed that the Convener should write to scientists currently using instruments as described above to seek their views on the timing, duration and organization of the proposed workshop and to inquire about likely funding requirements. He should report to the next meeting of the Working Group.

Other Field Research Procedures

90. Dr Kerry described an unattended monitoring system for penguins that weighs and logs arrivals and departures of birds and also identifies specially tagged birds as they pass the detector (WG-CEMP-90/24). The tags are 'domino-sized' electronic tags that are glued to the feathers. Data recorded by the system are transmitted from the remote monitoring station via VHF radio and satellite. Smaller surface acoustic wave (SAW) tags are anticipated to be available in the future. They could be permanently attached by fixing them to a flipper band. The present cost of the monitoring system, which includes an automated weather station, is about A$25 000. The Working Group agreed that the method appears promising and looks forward to hearing of new developments, especially regarding the availability of SAW tags.

91. Because several national directed research programs on seals use different standard measurements, the Working Group encouraged SCAR to expedite the publication of the Manual on Research Methods for Antarctic Seals. The Working Group also agreed that, until such a manual is available, standard measurements of seals should follow, where appropriate, those approved by the American Society of Mammalogists (American Society of Mammalogists. 1967. Standard Measurements of Seals. *J. Mammal*. *48*).

PREY MONITORING

Review of the Working Group on Krill Report

92. Mr Miller (Convener of WG-Krill) reviewed the report of WG-Krill's recent meeting in Leningrad from 27 August to 3 September 1990 (Annex 4). Among the items considered at this meeting were various questions raised by WG-CEMP at its 1989 Meeting (SC-CAMLR-VIII, Annex 7, paragraph 88). Specifically those questions address the problem of developing suitable survey designs for prey (especially krill) monitoring surveys.

93. WG-Krill agreed that acoustic surveys offer the most practical approach to assessing krill biomass over large areas. Consequently WG-Krill recognised the need for accurate krill acoustic target strength values in order to obtain absolute estimates of krill biomass. WG-Krill is therefore undertaking further work on krill acoustic target strength in order to standardise the values to be used in surveys of krill biomass.

94. WG-Krill also recognised the need to develop standard management procedures for krill resources in the context of the requirements of Article II of the Convention. Although there was some disagreement concerning the details of such an approach, the Working Group was able to develop four basic concepts underlying the development of a standardised krill management procedure. These concepts comprised:

(i) a basis for assessing the status of the krill resource in areas of interest;

(ii) suitable algorithms for specifying appropriate regulatory mechanisms as a function of such assessments as carried out under (i);

(iii) a basis for testing performance of any selected management procedure (i.e. (i) and (ii) above); and

(iv) an operational definition of CCAMLR Article II to provide criteria against which performance can be assessed (Annex 4, paragraph 55).

95. Although WG-Krill was unable to develop detailed operational definitions derived from Article II in the time available to its meeting, four general concepts on which such definitions might be based were developed (Annex 4, paragraph 61). Two of these concepts were of direct relevance to the work of WG-CEMP and are aimed at:

- ensuring that any reduction of food to predators which may arise because of krill harvesting is not such that land-breeding predators with restricted foraging ranges are disproportionately affected in comparison with predators present in pelagic habitats; and

- examining what level of krill escapement would be sufficient to meet the reasonable requirements of krill predators.

96. WG-CEMP understood the second concept in paragraph 95 to refer to food requirements of krill predators at broad temporal and spatial scales (e.g. year-round within subareas) and the first concept to refer to the special circumstances of predators with restricted foraging ranges while breeding on land.

97. On a broad scale, WG-Krill has already suggested an approach to the determination of appropriate yields from krill populations (Annex 4, paragraph 63) which includes a term for **M**, the natural annual mortality rate of krill. Determining the production surplus to the requirements of predators would require quantifying that element of **M** which comprises mortality of krill due to predation. WG-CEMP thought it unlikely that estimates of year-round subarea-wide krill consumption by all predators would be available in the near future.

98. On a smaller scale, for predators with restricted foraging ranges during their breeding seasons, the models being developed within WG-CEMP (Agenda Item 9, Estimates of prey requirements for krill predators) would offer considerable assistance in the development of operational definitions of Article II.

99. Other items considered by WG-Krill and specifically pertaining to the work of WG-CEMP were contained in paragraphs 87 through to 126 of WG-Krill's report (Annex 4). In particular, WG-CEMP considered WG-Krill's suggestions concerning:

- basic requirements for prey surveys (Annex 4, paragraph 91);

- the degree of precision required for krill biomass estimates, compilation of data on krill areal distribution and methods for assessing relationships between survey design, effort and resultant precision of biomass estimates (Annex 4, paragraph 93);

- the formation of a subgroup to undertake intersessional work on a variety of problems associated with the general problems of prey (i.e. krill) survey design as well as the statistical combination of line transect data measurements of animal density to estimate biomass over a region and provide an associated variance estimate (Annex 4, paragraph 97);

- interim guidelines for prey surveys (Annex 4, paragraph 100);

- the consideration of suitable parameters to be derived from acoustic survey data for prey monitoring requirements; and

- the need for advice from WG-CEMP on changes in predator foraging ranges, behaviour and diet likely to occur during predator breeding cycles (Annex 4, paragraph 104) with a view to refining prey survey requirements with respect to spatial and temporal integration of surveys.

100. In particular, WG-CEMP noted and accepted the conclusion of WG-Krill that krill surveys within the foraging ranges of selected land-breeding predators will best be undertaken using acoustics combined with an underlying net sampling program for target identification. It was also agreed that data on the relative abundance of krill on a subarea scale, which is also very relevant to predators, are more likely to become available from fisheries-dependent indices (e.g. catch-per-unit-effort) or indices of relative krill abundance (e.g. the Composite Index of Krill Abundance discussed by WG-Krill at its 1989 Meeting).

101. With respect to the basic requirements for prey monitoring surveys developed by WG-Krill (Annex 4, paragraphs 91 and 100), WG-CEMP agreed that such surveys should cover the period December to February annually and should be located within a radius of 100 km of land-based monitoring sites. For operational reasons related to attenuation at the recommended acoustic frequencies (120 kHz or higher) combined with limited capability for detecting near-surface targets, acoustic surveys would effectively be confined to between 5 m (transducer depth) and 150 m from the sea surface.

102. WG-CEMP welcomed the formation of the WG-Krill subgroup to undertake the detailed development of krill surveys for prey monitoring purposes (Annex 4, paragraph 97). Members of WG-CEMP were encouraged to participate in the subgroup's work during the intersessional period. An important outcome of the subgroup's work would be some indication of survey requirements, particularly the commitment of ship time, in relation to levels of expected precision from survey results. There was also recognition of the

importance of the subgroup's task in considering the characteristics of krill aggregations (specifically including vertical distribution, density within and outside swarms) in the development of various sampling regimes.

103. WG-CEMP agreed that until the subgroup is able to provide detailed krill survey specifications to assess prey availability in predator foraging areas, Members should follow WG-Krill's interim operational guidelines for the implementation of such surveys (Annex 4, paragraph 100). These guidelines suggest that surveys be conducted by spacing as many transects as possible over the area being surveyed and if possible repeating individual transects several times during the two-and-half-month survey period (i.e. December to February). As far as possible surveys should also be undertaken during a period of six to eight hours either side of solar noon and combined with net sampling at approximately three-hourly intervals.

104. In response to WG-Krill's question concerning changes in predator foraging ranges, diet and behaviour likely to occur during predator breeding cycles (paragraph 99 above), WG-CEMP agreed that it was not in a position to provide detailed information. At present, in any consideration of prey survey design, the information contained in Table 3 of Annex 4 should be assumed to be constant over the spatial and temporal scales identified in paragraph 101 above. As more detailed information for predators becomes available, WG-CEMP will recommend changes, if any, which might be appropriate for both prey survey design and subsequent data analysis.

Other Species

105. The Working Group noted the importance of prey distribution and abundance in any consideration of prey-switching by predators. In this connection, it was agreed that further directed research in particular on *P. antarcticum* and *Euphausia crystallorophias* as prey items should be encouraged.

106. With respect to *P. antarcticum*, WG-CEMP supported the Working Group on Fish Stock Assessment (WG-FSA) in calling for the reporting of fine-scale data on this species and especially improvement of catch locality information (SC-CAMLR-VIII, Annex 6, paragraph 144).

107. Prof. Lubimova reported that the USSR has provided two years of catch data on *P. antarcticum* to CCAMLR. Papers are also being prepared by Soviet scientists on the population structure of the species and maturity stage development in the Sodruzhestva, Davis and Mawson Seas and at Prydz Bay.

ENVIRONMENTAL MONITORING

108. Environmental features identified as having both indirect (through effects on prey) and direct (through effects on predators) importance to the CEMP program were considered.

109. The Working Group agreed with WG-Krill (Annex 4, Table 5) in its assessment of the most important environmental parameters (i.e. water movements, physical/chemical properties of water and sea-ice) to be monitored when considering prey surveys. The Working Group encouraged the collection of these types of environmental data by Members.

110. The Working Group also noted that WG-Krill considered data on large-scale hydrographic processes to be information needed for understanding krill distribution, and supported the approaches recommended by WG-Krill (Annex 4, paragraphs 107 to 110 and 129).

111. Prof. Lubimova informed the Working Group that Soviet surveys conducted around the Antarctic continent in 1989/90, examining large-scale oceanographic processes, had collected information on the distribution of seals and birds especially in relation to the distribution of drifting sea-ice and local polynya formation.

112. Dr R. Holt (USA) informed the Working Group of US intentions to analyse in detail temperature, chlorophyll, cloud cover and ice conditions obtained from recent satellite imagery from the Antarctic Peninsula Integrated Study Region. He agreed to report on progress with this analysis at the next meeting of the Working Group.

Standard Methods

113. Three papers concerning the monitoring of environmental parameters of direct importance to predator monitoring (identified in SC-CAMLR-VIII, Annex 7, Table 6) were

discussed. The papers addressed draft standard methods for monitoring environmental parameters (Methods F1 to F4) (WG-CEMP-90/5), sea-ice observations (WG-CEMP-90/10) and meteorological observations (WG-CEMP-90/19) at CEMP sites.

114. Some revisions were made to the data collection section of the draft standard methods document (WG-CEMP-90/5) but it was decided that no detailed recommendations concerning analysis and reporting of environment data would be formulated until the Working Group has had the opportunity to examine actual data from CEMP sites.

115. It was agreed that, at this stage in the development of the program, Members be requested to collect the data specified in Methods F1, F3 and F4. These data should be held at national data centres. Investigators should note the occurrence of sudden, abrupt changes in environmental conditions of potential importance to predators on the appropriate data submission forms for predator parameters.

116. It was noted that there may be existing meteorological stations in the vicinity of CEMP sites already collecting the data specified in Method F3. In these cases, it would be sensible to leave it to the local investigators to judge whether or not the information being gathered at such stations was adequate for CEMP purposes.

117. A specific analysis of sample sizes required for recording meteorological data (Method F3) (WG-CEMP-90/19) was discussed in some detail. Investigators were encouraged to consider the implications of this paper when developing sampling regimes.

118. The Secretariat was asked to investigate procedures for acquiring and archiving summary data on sea-ice distribution (Method F2) available from organisations which process and supply satellite imagery. The Working Group also asked the Secretariat to prepare a paper on the information and analysis techniques available for these data that would be of use in the routine monitoring of sea-ice distribution for CEMP.

119. The Working Group noted the importance of obtaining data on sea-ice and sea-surface conditions from survey vessels to complement satellite data. Information from vessels would also provide valuable ‘ground truth’ information for data derived from satellite imagery.

120. As amended, the Standard Methods for Monitoring Environmental Parameters were adopted. Because the methods specified in F1 to F4 have not yet been developed to the same

degree of detail as the predator methods, it was agreed that for the present time they would be appended to the 'Standard Methods for Monitoring Parameters of Predatory Species' as 'Standard Approaches for Monitoring Environmental Parameters'.

REVIEW OF SUBMITTED DATA

121. The Working Group noted that four types of information are currently being reported to CCAMLR relevant to CEMP:

(i) brief references to CEMP work in 'Reports of Members' Activities' in the Convention Area;

(ii) identification of future CEMP activities in reports of Members' research plans;

(iii) summary tables listing CEMP activities (i.e. Tables 3, 7 and 8 of SC-CAMLR-VIII, Annex 7); and

(iv) summaries of CEMP predator data to be submitted in the formats agreed by WG-CEMP.

122. It was agreed that the information contained in the summary Tables 3, 7 and 8 (SC-CAMLR-VIII, Annex 7) should be updated each year as part of the Reports of Members' Activities to CCAMLR. Since this same information will be of value to WG-CEMP at future meetings it was agreed that a request for updated versions of Tables 3, 7 and 8 would also be made at the time that the WG-CEMP Provisional Agenda was circulated.

123. It was noted that Table 7 of SC-CAMLR-VIII, Annex 7 had been updated during the intersessional period and presented in the Secretariat's paper WG-CEMP-90/6 as Table 3. The Working Group examined Table 3 for each parameter, noting that data from Argentina, Brazil (WG-CEMP-90/26), Chile, UK and USA were available for some predator parameters and would be submitted to the CCAMLR Data Centre by the 30 September 1990 deadline. Additional data were expected to be submitted after the deadline of 30 September.

124. The Working Group noted that since data access protocols and reporting formats had been agreed (SC-CAMLR-VIII, paragraph 5.11), both recent and historic data on predator parameters should be submitted to the CCAMLR Data Centre. The Working Group noted that the decision taken by the Scientific Committee concerning the submission of CEMP data

placed an obligation on Members of CCAMLR under Article IX of the Convention to meet these commitments according to agreed formats and schedules.

125. Members agreed that it would be desirable in maintaining the efficient conduct of the program for the Working Group to have the opportunity to review the data submitted for the most recent Antarctic season. Some Members suggested that, in order to meet this requirement, the deadline for the submission of CEMP data should be brought forward from 30 September to 30 June.

126. It was agreed, however, that because some Members had not felt in a position to recommend a change in the deadline until they had had a chance to consult with their colleagues involved in their national programs, input from the appropriate investigators should be sought prior to the Ninth Meeting of the Scientific Committee so that their comments could be considered before a decision is taken.

ESTIMATES OF PREY REQUIREMENTS FOR KRILL PREDATORS

Review of Current Information

127. Analyses of fine-scale catch data for Subareas 48.1, 48.2 and 48.3 indicated that a substantial proportion of krill harvesting had occurred within the foraging ranges of breeding predators being monitored by CEMP (SC-CAMLR-VIII, paragraph 5.24). The WG-CEMP (SC-CAMLR-VIII, Annex 7, paragraphs 91 and 92), Scientific Committee (SC-CAMLR-VIII, paragraphs 5.26 and 5.27) and Commission (CCAMLR-VIII, paragraph 59) asked Members to synthesise data on predator population size, diet and energy budgets in order to provide estimates of krill requirements of predators in Integrated Study Regions.

128. The Scientific Committee requested that advice be obtained from relevant specialists on the best way to proceed towards this goal. The SCAR Bird Biology Subcommittee and the SCAR Group of Specialists on Seals (WG-CEMP-90/32 and WG-CEMP-90/27, respectively) provided advice to WG-CEMP. The advice from the former group can be summarised as follows:

(i) the task of estimating prey consumption is complex but uncertainties in predator data are not necessarily greater than those associated with other important parameters such as prey abundance. Therefore, the apparent complexity should not prevent the Working Group from moving forward on the more tractable aspects of the problem;

(ii) the most effective approach will be to limit the scope of the early analyses to the best studied parts of Integrated Study Regions (ISRs), to the foraging ranges of breeding predators, and to the predators for which the greatest amount of relevant information is available (penguins and fur seals). Subsequent analyses can be extended to complete ISRs and to a large suite of species. Members should be encouraged to synthesise information on the distribution and abundance of seabirds in the ISRs in preparation for these steps; and

(iii) in order to evaluate potentially suitable models and to define appropriate parameter values CCAMLR should convene a workshop.

129. The SCAR Group of Specialists on Seals offered the following advice to the Working Group:

(i) studies should focus on Antarctic fur seals, crabeater seals, and perhaps leopard seals, at Prydz Bay, the Antarctic Peninsula, and South Georgia; and

(ii) many crucial parameters have not been estimated for the ice seals. Therefore, the Working Group should consider beginning with models that incorporate values known for northern phocids. These models will help to identify important gaps in the data. Information on fur seal females will be easier to include in models because more is known about their energetics and activity budgets.

130. Dr Croxall summarised WG-CEMP-90/31, describing a model used by the UK to estimate food consumption of predators in the South Georgia Integrated Study Region. The model includes improvements over previous versions (used to produce the papers tabled as SC-CAMLR-VIII/BG/12 and BG/15), in the form of improved diet data, and in allowing for within-season fluctuations in energy content of prey, in diet composition, and in body weight of predators. The model is in the form of a general program that accepts inputs of parameters for a variety of predator and prey populations. It was also noted that the prey portion of the model, though currently being run with a suite of prey species, could be used to identify predators' consumption of various sex and age components of the krill population.

131. Another model, for energy and prey requirements of breeding Adélie, chinstrap, and gentoo penguins, and Antarctic fur seal females breeding in the Antarctic Peninsula Integrated Study Region was tabled by the US Delegation (WG-CEMP-90/30 Rev. 1). This model incorporated recent empirical estimates of energetic parameters and some allowances for weight fluctuations in a similar fashion to the model in WG-CEMP-90/31. The results of calculations using this model estimated that these predators consume 345 000 metric tonnes of krill from 1 December to 30 March. Recent commercial harvests for Subarea 48.1 have been equal to approximately 15% of this estimated prey requirement.

132. WG-CEMP agreed that these models represented substantial steps towards estimating krill consumption of penguins and fur seals during their breeding seasons within the Integrated Study Regions. Such models were seen as valuable tools for identifying data needs and planning research.

Action Needed for Further Progress

133. The Working Group noted the concern expressed by Prof. Lubimova that every effort be made to use inputs for such models that are appropriate for the particular Integrated Study Region considered. It was acknowledged that as new empirical parameter estimates become available, the models can be made more precise for specific areas.

134. The Working Group discussed the importance of broad-scale krill movements, residence times, and swarm structure in providing estimates of krill availability to relate to the models described above. It was agreed, however, that details of krill distribution and abundance would remain within the purview of WG-Krill until such time as better information becomes available.

135. The Working Group noted that the estimation of prey consumption in the Integrated Study Regions would form an important contribution to addressing the question posed by WG-Krill (Annex 4, paragraph 61), concerning 'levels of krill escapement sufficient to meet the reasonable requirement of krill predators' (see also paragraph 95 above).

136. WG-CEMP agreed to establish a subgroup under the coordination of Dr Croxall to correspond during the intersessional period with the aim of:

(i) formulating a more detailed outline of the precise models and data sets to be investigated during a workshop along the lines of that indicated in paragraph 128;

(ii) determining the necessary preparatory work required in advance of such a workshop; and

(iii) identifying suitable places and times for a workshop.

137. In the meantime, Members working in each Integrated Study Region who possess data relevant to the models presented are encouraged to collaborate in making these available to CCAMLR and in planning research designed to provide additional priority data.

GENERAL MATTERS

Interdependence Between Predator and Prey Monitoring

138. In 1988 the Scientific Committee requested Members to consider four questions pertaining to the analysis of interdependence between sampling methods and results of monitoring activities (SC-CAMLR-VII, paragraph 5.43). Responses to these questions were not received in 1989 (SC-CAMLR-VIII, paragraph 5.32), and Members were encouraged to reconsider these questions (SC-CAMLR-VIII, Annex 7, paragraph 67; SC-CAMLR-VIII, paragraph 5.33) so that these issues could be addressed at the 1990 Meeting of WG-CEMP.

139. (a) The origin of the four questions referred to above is in SC-CAMLR-VII, paragraph 5.22, subparagraphs (iii) and (iv) where two broad topics of relevance to CEMP were addressed, viz:

(iii) the power to detect inter-dependencies, which might be time and space varying and non-linear (e.g. how does the trade-off between the number of penguin colonies sampled, and the intensity of sampling at each, change the ability to use inter-annual variability of krill to distinguish possible relationships between breeding success and krill abundance?); and

(iv) the potential adequacy of the data and estimates to meet the requirements of CCAMLR in distinguishing between natural variations in prey abundance and those induced by fishing activity.

(b) The second of these topics was extensively addressed by WG-CEMP at its 1990 Meeting under Agenda Item 4 (Relevance of CEMP to the work of the Commission).

140. The first question noted above (paragraph 139(a) (iii)) was further elaborated in SC-CAMLR-VII, paragraph 5.43 where Members were requested to:

(i) identify precise questions relating to analyses of these types of inter-dependent relationships;

(ii) suggest appropriate analyses for investigating these relationships;

(iii) indicate which data are needed adequately to conduct such analyses; and

(iv) indicate the extent to which such data are currently available.

141. Some progress has been made in addressing these questions (paragraphs 139(a) (iii) and 140) in relation to sampling intensity and design, and results have been incorporated in the advice on data collection and analysis in the Standard Methods document. In respect of the ability to use interannual variability of krill to examine relationships between monitored predator parameters and krill availability, WG-CEMP reiterated its comments (SC-CAMLR-VIII, paragraph 5.30(b)) that these are complex issues, which are currently under study.

Approaches to Integrated Analyses of Predator/Prey/Environmental Data

142. The Working Group noted that progress in identifying appropriate techniques for integrated analyses of predators, prey, and environmental conditions has been limited and the use of models might be helpful in this regard. Indeed, the models discussed under Agenda Item 9 (Estimates of Prey Requirements for Krill Predators) demonstrate this point. Thus, the difficulties in answering the questions discussed in the previous paragraphs does not imply that it will not be possible to progress with integrated analyses prior to completing empirical

studies of important ecological relationships. Furthermore, models could be used to make designs of those studies more efficient and to identify data needs.

143. It was felt that efforts to integrate predator, prey and environmental data should focus on matters of priority concern to CEMP (e.g. in terms of species, parameters and areas) and not attempt to explain how Antarctic ecosystems function.

144. The Working Group discussed the possible application of Geographic Information Systems (GIS) in comparing data from different national programs and examining relationships among CEMP parameters. The Working Group accepted an offer from Dr Holt to examine the potential utility of such a system, possible arrangements for its use by CCAMLR or individual Members and the costs involved, and report to the next meeting.

DESIGNATION AND PROTECTION OF SITES

145. At its Seventh Meeting, the Scientific Committee developed detailed guidelines in respect of registration and protection (including management plans) of approved CEMP land-based monitoring sites (SC-CAMLR-VII, paragraphs 5.17 to 5.20).

146. The Commission has not yet decided how it wishes to implement the formal designation and protection of land-based CEMP monitoring sites.

147. WG-CEMP agreed that it should confine its discussion to a review of the tabled proposals for the designation of CEMP monitoring sites in order to determine whether they conformed to the guidelines approved by the Scientific Committee.

Magnetic Island (Prydz Bay Integrated Study Region)

148. Subject to a number of suggested minor modifications, this proposal, by Australia, was agreed to conform to the guidelines (WG-CEMP-90/23).

Cape Shirreff, Livingston Island (Antarctic Peninsula Integrated Study Region)

149. Subject to minor changes, this proposal, by Chile and USA, was agreed to conform to the guidelines (WG-CEMP-90/29).

Seal Islands, Elephant Island (Antarctic Peninsula Integrated Study Region)

150. Subject to two minor changes, improving the delineation of the area under designation, it was agreed that this proposal, by the USA, conformed to the guidelines (WG-CEMP-90/28).

151. As a general rule, and in the specific cases of the three proposals above, WG-CEMP reiterated the general understanding of the Scientific Committee (SC-CAMLR-VII, paragraph 5.20(v)) that, at present, the duration of monitoring studies conducted according to CEMP methods should be regarded as indefinite and that the full proposal (including management plan) should be reviewed and resubmitted for approval at five-year intervals from the date of its entry into force.

152. The Working Group recommended that the corrected versions of the three site designation proposals above be submitted to the Secretariat by 30 September 1990.

153. The Working Group was pleased to note the progress in designation of CEMP sites and development of management plans and encouraged the prompt submission of similar proposals for the other approved CEMP monitoring sites.

AWARENESS OF CEMP

154. The Ecosystem Monitoring Program is an important initiative of CCAMLR in implementing the ecosystems approach implicit in Article II of the Convention. In recognition of this, the Working Group last year began discussion on the need to promote awareness of CEMP among CCAMLR Members and in the scientific community generally. The Scientific Committee, at its 1989 Meeting, carried the discussion further and, taking up a suggestion of WG-CEMP, asked the Secretariat to prepare a brief article describing the aims and principles adopted in the development of CEMP (SC-CAMLR-VIII, paragraph 5.38).

155. The Secretariat prepared a draft text for an information brochure suitable for general distribution and submitted it for consideration to WG-CEMP (WG-CEMP-90/20). It was agreed that, with some minor editing, the draft text contained an informative, accurate description of the program at the required level of detail. It was recommended that the amended text be submitted to the Ninth Meeting of the Scientific Committee with a recommendation that it form the basis of an information brochure to be published in the four languages of the Commission. Participants at the Working Group were invited to make

available photographs that might help the Secretariat to make the brochure colourful and interesting. It was emphasised that the brochure should be made available to all Members and be distributed widely.

156. The attention of the Working Group was drawn to the Antarctic Science Conference, to be held in Bremen in September 1991. The Conference is being convened to commemorate the 30th anniversary of the coming into force of the Antarctic Treaty. The Working Group suggested that CCAMLR, as an important element of the Antarctic Treaty System, should be represented and should take advantage of the Conference to increase awareness of its scientific activities. The Working Group recommended that the Scientific Committee consider the possibility of including a CCAMLR poster in the Poster Session of the Conference. It was suggested that the proposed brochure on CEMP would be a useful means of providing background information on CCAMLR at meetings such as this Conference.

FUTURE WORK OF WG-CEMP

157. The Working Group reviewed progress made at the meeting and felt that there were a number of issues that would benefit from further consideration during the next year and agreed that an intersessional meeting in 1991 would be desirable.

OTHER BUSINESS

158. The Working Group discussed the current status of the proposed Workshop on the Feeding Ecology of Southern Baleen Whales (SC-CAMLR-VIII, paragraph 5.36). The Workshop was originally planned to have been held in 1988/89, with funds being provided by CCAMLR and the IWC, assisted by a special grant from the USA. At the request of the IWC, the Workshop was postponed. WG-CEMP agreed that the Workshop is still of potential value in the development of CEMP, but before making any recommendation on its future, the Working Group asked the Executive Secretary to write to the Secretary of the IWC, to enquire about the current status of the proposed Workshop within the activities of the IWC.

159. The Working Group noted that, throughout its discussions, many references had been made to work being undertaken by scientists from Member countries of CCAMLR who were not represented at the meeting. It was agreed that the future development of CEMP would benefit from the widest possible range of expertise. The Working Group asked the Scientific

Committee and the Commission to encourage more Member countries to have their scientists involved in the work of WG-CEMP.

160. Dr Vergani informed the Working Group of the recent recommendations of the SCAR Group of Specialists on Seals regarding declining populations of southern elephant seals in some sectors of the Antarctic. SCAR has proposed that, in order to consider adequately these population trends and to respond effectively to questions asked by the Scientific Committee (SC-CAMLR-VIII, paragraph 6.6), it would be helpful to convene a workshop to address this issue. The Working Group noted that this matter was of interest to CEMP and endorsed the proposal for a workshop. It further noted that this topic would be discussed under the 'Marine Mammal and Bird Populations' agenda item at the forthcoming meeting of the Scientific Committee.

ADOPTION OF THE REPORT

161. The report of the meeting was adopted.

CLOSE OF THE MEETING

162. The Convener thanked the participants for their assistance in making good progress at this meeting. He thanked the rapporteurs and the CCAMLR Secretariat and finally expressed his thanks on behalf on the Working Group to the Polar Research Secretariat, the Royal Academy of Sciences and the Museum of Natural History, not only for providing the facilities for the meeting but for the excellent support and assistance provided by their staff.

Table 1: Summary of Members' CEMP activities on monitoring approved predator parameters.

Method Sheet Number	Parameter	Species: A-Adélie penguin M-Macaroni penguin C-Chinstrap penguin B-Black-browed albatross F-Fur seal					Country	Site name/ Integrated Study Region/ Network Site	Site Location	Year Started	1989/90* Data Submission
		A	M	C	B	F					
-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-
Penguins											
A1	Weight on arrival at breeding colonies	X					Australia	Magnetic Is Davis Station/ Prydz Bay	68°33'S 77°54'E	1983/84	Being prepared
		X					Argentina	King George Is Stranger Point/ S. Shetland Is	62°14'S 58°30'W	1987/88	Being prepared
		X					Argentina	Laurie Is Mossman Peninsula/ S. Orkney Is	60°45'S 44°44'W	1987/88	Being prepared
							Argentina	Esperanza Station/ Ant. Peninsula	63°24'S 57°00'W	1990/91	
			X				UK	Bird Is/ South Georgia	52°00'S 38°02'W	1988/89	Submitted
A2	Length of the first incubation shift	X					Australia	Magnetic Is Davis Station/ Prydz Bay	68°33'S 77°54'E	1983/84	Submitted
		X					Argentina	King George Is Stranger Point S. Shetland Is	62°14'S 58°30'W	1987/88	Being prepared
							Argentina	Esperanza Station/ Ant. Peninsula	63°24'S 57°00'W	1990/91	
A3	Annual trends in breeding population size	X					Australia	Magnetic Is Davis Station/ Prydz Bay	68°33'S 77°54'E	1983/84	Being prepared
		X					Argentina	King George Is Stranger Point/ S. Shetland Is	62°14'S 58°30'W	1987/88	Being prepared
			X	X			Brazil	Elephant Is S. Shetland Is/ Ant. Peninsula	61°04'S 55°21'W	1986	No inf. available
		X		X			Chile	Ardley Is S. Shetland Is/ Ant. Peninsula	62°11'8"S 58°55'W	1982	Being prepared
		X					Japan	Syowa Station/ Network site	69°00'S 39°30'E	1970	No inf. available
			X				UK	Bird Is/ South Georgia	52°00'S 38°02'W	1975/76	Submitted
		X		X			UK	Signy Is/ Network site	60°43'S 45°38'W	1978/79	Submitted
			X	X			USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5'S 55°24.5'W	1987/88	No inf. available
		X					USA	Anvers Is. Palmer Station/ Ant. Peninsula	64°06'S 64°03'W	1987/88	No inf. available
A4	Demography			X			CHILE	Ardley Is S. Shetland Is/ Ant. Peninsula	62°11'8"S 58°55'W	1982	Being prepared
			X	X			Brazil	Elephant Is S. Shetland Is/ Ant. Peninsula	61°04'S 55°21'W	1986	No inf. available
			X	X			USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5'S 55°24.5'W	1987/88	No inf. available
		X					USA	Anvers Is Palmer Station/ Ant. Peninsula	64°06'S 64°03'W	1987/88	No inf. available
A5	Duration of foraging trips	X					Australia	Magnetic Is Davis Station/ Prydz Bay	68°33'S 77°54'E	1983/84	Being prepared
				X			USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5'S 55°24.5'W	1987/88	Submitted

Table 1 (continued)

-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-
A6	Breeding success	X					Australia	Magnetic Is Davis Station/ Prydz Bay	68°33’S 77°54’E	1983/84	Being prepared
		X					Argentina	King George Is Stranger Point/ S. Shetland Is	62°14’S 58°30’W	1987/88	Being prepared
			X	X			Brazil	Elephant Is S. Shetland Is/ Ant. Peninsula	61°04’S 55°21’W	1986	Submitted
				X			Chile	Ardley Is S. Shetland Is/ Ant. Peninsula	62°11’8”S 58°55’W	1982	Being prepared
			X				uk	Bird Is/ South Georgia	52°00'S 38°02'W	1975/76	Submitted
		X		X			uk	Signy Is/ Network site	60°43'S 45°38'W	1978/79	Submitted
			X	X			usa	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5’S 55°24.5’W	1987/88	Submitted
		X					usa	Anvers Is Palmer Station/ Ant. Peninsula	64°06’S 64°03’W	1987/88	Being prepared
A7	Fledging weight	X					Australia	Magnetic Is Davis Station/ Prydz Bay	68°33'S 77°54'E	1983/84	Being prepared
		X					Argentina	King George Is Stranger Point/ S. Shetland Is	62°14’S 58°30’W	1987/88	Being prepared
		X					Argentina	Laurie Is Mossman Peninsula/ S. Orkney Is	60°45’S 44°44’W	1987/88	Being prepared
							Argentina	Esperanza Station/ Ant. Peninsula	63°24’S 57°00’W	1990/91	
			X	X			Brazil	Elephant Is S. Shetland Is/ Ant. Peninsula	61°04’S 55°21'W	1986	Submitted
			X				uk	Bird Is/ South Georgia	52°00'S 38°02'W	1988/89	Submitted
				X			usa	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5’S 55°24.5’W	1987/88	Submitted
		X					usa	Anvers Is Palmer Station/ Ant. Peninsula	64°06’S 64°03’W	1987/88	Being prepared
A8	Chick diet	X					Australia	Magnetic Is Davis Station/ Prydz Bay	68°33’S 77°54’E	1983/84	Being prepared
		X					Argentina	King George Is Stranger Point/ S. Shetland Is	62°14’S 58°30’W	1987/88	Being prepared
		X					Argentina	Laurie Is Mossman Peninsula/ S. Orkney Is	60°45’S 44°44’W	1987/88	Being prepared
							Argentina	Esperanza Station/ Ant. Peninsula	63°24’S 57°00’W	1987/88	Being prepared
			X	X			Brazil	Elephant Is S. Shetland Is/ Ant. Peninsula	61°04’S 55°21’W	1986	Submitted
				X			Chile	Ardley Is S. Shetland Is/ Ant. Peninsula	62°11’8”S 58°55’W	1982	No inf. available
			X				UK	Bird Is/ South Georgia	52°00'S 38°02'W	1985/86	Submitted
				X			USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5’S 55°24.5”W	1987/88	Submitted
		X					USA	Anvers Is Palmer Station/ Ant. Peninsula	64°06’S 64°03’W	1987/88	Being prepared
A9	Breeding chronology	X					Australia	Magnetic Is Davis Station/ Prydz Bay	68°33’S 77°54’E	1983/84	No inf. available
		X					Argentina	Laurie Is Mossman Peninsula/ S. Orkney Is	60°45’S 44°44’W	1987/88	Being prepared
			X				UK	Bird Is/ S.Georgia	52°00'S 38°02'W	1978/79	Being prepared

Table 1 (continued)

-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-
A9 (cont.)				X			USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5'S 55°24.5"W	1987/88	Submitted
Flying Birds											
B.1	Breeding population size				X		UK	Bird Is/ South Georgia	52°00'S 38°02'W	1976/77	Being prepared
B.2	Breeding success				X		UK	Bird Is/ South Georgia	52°00'S 38°02'W	1976/77	Being prepared
B.3	Age-specific annual survival and recruitment				X		UK	Bird Is/ South Georgia	52°00'S 38°02'W	1976/77	Being prepared
Seals											
C1.0	Pup Growth					X	Chile	Cape Shirreff/ Ant. Peninsula	62°28'S 60°47"W	1984/85	No inf. available
						X	UK	Bird Is/ South Georgia	52°00'S 38°02'W	1972/73 1977/78	No inf. available
						X	USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5'S 55°24.5'W	1987/88	Submitted
C2.0	Cow foraging/ attendance cycles					X	Chile	Cape Shirreff/ Ant. Peninsula	62°27'S 60°47'W	1987/88	No inf. available
						X	UK	Bird Is/ South Georgia	52°00'S 38°02'W	1978/79	
						X	USA	Seal Is S. Shetland Is/ Ant. Peninsula	60°59.5'S 55°24.5W	1987/88	Submitted

[*] "submitted" - data were available at the Meeting of the WG-CEMP or confirmed to be submitted to the Secretariat before 30 September 1990.

Table 2: Summary of Members' directed programs on assessing the utility of potential predator parameters.

Parameter	Areas[(a)] from which data are available for analysis/ evaluation	Members' Research Activity					
		Undertaken 1988/89		Undertaken 1989/90		Proposed for 1990/91	
		Analysis of existing data	Acquisition of new data	Analysis of existing data	Acquisition of new data	Analysis of existing data	Acquisition of new data
-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-
Penguins[(b)]							
- Macaroni incubation shift	4,5,11,14	UK (11)	Brazil (2)	Brazil (2)	Brazil (2)	S.Africa (14,M)	S.Africa (14,M)
- Macaroni weight prior to moult	2,15,14,4,5?	Brazil (2)	Brazil (2)	Brazil (2)	Brazil (2)	S.Africa (14,M)	S.Africa (14,M)
- At-sea diving behaviour and activity patterns (a,c,m)	2,4,6	Australia (6,A) USA (2,C,M)	Australia (6,A) UK (4,M) USA (2,C,M)	Australia (6,A) UK (4,M) USA (2,C,M)	Australia (6,A) USA (2,C,M)	Australia (6,A) USA (2,C,M)	UK (4,M) USA (2,C,M)
- Weight recovery during incubation (a,c,m)	4,6	Australia (6,A)	Australia (6,A)	Australia (6,A)	Australia (6,A)	Australia (6,A)	
- Survival (a,c,m)	1,2,6,11	Australia (6,A) Brazil (2) Chile (12) UK (4,M)	Australia (6,A) Brazil (2) Chile (12) UK (4,M) USA (2,C;11,A)	Australia (6,A) UK (4,M) USA (2,C;11,A)	Australia (6,A) UK (4,M) USA (2,C;11,A)	UK (4,M) USA (2,C;11,A)	UK (4,M) USA (2,C;11,A)
- Chick growth rate	2,11	USA(2,C;11,A)	USA (2,C;11,A)	UK (4,M) USA (2,C;11,A)	USA (2,C)		UK (4,M)
- Bioenergetics						USA (2,C,M)	USA (2,C,M)
Flighted seabirds							
Black-browed albatross							
- Breeding population size	4,9?,15	UK (4)	UK (4)		UK (4)		UK (4)
- Breeding success	4,9?,15		UK (4)		UK (4)		UK (4)
- Duration of foraging trips	4				UK (4)		
- Activity budget at sea	4		UK (4)		UK (4)		
- Prey characteristics/ diet	4				UK (4)		

Table 2 (continued)

-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-
Flighted seabirds (continued)							
Antarctic/Cape petrel							
- Breeding success	3,6,8,11,2	UK (3,CP) Chile (11) Brazil (2)	Chile (11) Brazil (2)		UK (3,CP)		UK (3,CP)
- Chick weight at fledging	2,6,8,11	Brazil (2) Chile (11)	Brazil (2) Chile (11) USA (2)	Brazil (2) USA (2)	Brazil (2)	USA (2)	
- Prey characteristics/ diet	2,6,8,11	Australia (6) Brazil (2) Chile (11)	Australia (6) Brazil (2) Chile (11)	Brazil (2)	Brazil (2)		
Fur seals							
- Reproductive success	4,2		UK (4) USA (2)		UK (4) USA (2)		UK (4) USA (2)
- Prey characteristics/ diet	4,2		UK (4) USA (2)	USA (2)	UK (4) USA (2)	USA (2)	UK (4) USA (2)
- At-sea diving behaviour and activity pattern	2,4	USA (2)	UK (4) USA (2)	UK (4) USA (2)	UK (4) USA (2)	UK (4) USA (2)	UK (4) USA (2)
- Bioenergetics						USA (2)	USA (2)
- Indices of physiological condition	11	Chile (11)	Chile (11)		UK (4)		
- Fine structure of teeth	4		UK (4)	UK (4)	UK (4)		UK (4)
Crabeater seal							
- Reproductive rates	2,3,8,10-12		USA (11,12) Sweden (11,12)	USA (11,12)	USA (12)	USA (11,12)	
- Age at sexual maturity	2,3,8,10-12		USA (11,12) Sweden (11,12)	USA (10,11,12)	USA (12)	USA (11,12)	
- Cohort strength	2,3,8,10-12	USA (10,11,12)	USA (11,12) Sweden (11,12)	USA (10,11,12)	USA (12)	USA (11,12)	
- Indices of physiological condition	11,12		USA (11,12) Sweden (11,12)	USA (11,12)	USA (12)	USA (11,12)	
- Instantaneous growth rate	11,12				USA (12)		

Table 2 (continued)

-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-
Crabeater seal (continued)							
- Prey characteristics/ diet	11,12		USA (11, 12)	USA (11)	USA (11)	USA (11)	
- At-sea diving behaviour and activity pattern	11,12	USA (11,12)		USA (11,12)	USA (11,12)	USA (11,12)	
- Satellite telemetry			USA (11) Sweden (11)	USA (11,12)	USA (11,12)	USA (11,12)	
Minke whales							
- Reproductive rate	13,1	Japan	Japan				
- Age of sexual maturity	13,1						
- Cohort strength	13,1	Japan	Japan				
- Analyses of existing data:							
- stomach contents	13,1	Japan	Japan				
- blubber thickness	13,1	Japan	Japan				
- density/patchiness	13,1	Japan	Japan				
- school size	13,1	Japan	Japan				
- Feeding activity patterns	13,1	Japan	Japan				

(a) Areas:

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

(b) Penguin species: A - Adélie, C - Chinstrap, M - Macaroni/Royal

(c) Petrel species: CP - Cape petrel, AP - Antarctic petrel

Table 3: Summary of Members' directed research on predator parameters required to provide essential background information needed to interpret changes in monitored predator parameters.

Research Topic	Countries Proposing Directed Research: Programs Currently Underway	Countries Proposing Directed Research: Programs Proposed to Commence (season of initiation)
PENGUINS		
- Foraging areas	Chile, Japan USA, South Africa	Australia (1990/91)
- Energy requirements		UK (1990/91) USA (1990/91)
- Seasonal movements	South Africa	
- Relationships between monitored parameters and physical environment (e.g. distribution and structure of sea ice and frontal systems)	Chile UK (Frontal systems) USA South Africa (Frontal systems)	Australia (1990/91) UK (1992/93)
FUR SEALS		
- Local abundance/population structure	Argentina, Chile, UK, USA	Brazil Chile (1990/91)
- Energy requirements/life history	UK	Sweden (1990/91, with UK)
- Foraging areas	Chile, USA	UK (1992/93) Japan (1990/91, with USA)
- Relationships between monitored parameters and physical environment (e.g. distribution and structure of sea-ice and frontal systems)	Chile (partial), USA	
CRABEATER SEALS		
- Foraging areas	USA	Sweden (1990/91, with USA)
- Energy requirements/life history		Sweden (1990/91, with Australia)
- Stock discreteness/seasonal movements	USA	Sweden (1990/91, with USA)
- Relationships between monitored parameters and physical environment (e.g. distribution and structure of sea-ice and frontal systems)	USA	
MINKE WHALES		
- Survey abundance (IWC/IDCR[a])		
- Relationships between monitored parameters and physical environment (e.g. distribution and structure of sea ice and frontal systems)		

[a] International Whaling Commission/International Decade of Cetacean Research

APPENDIX A

AGENDA

Working Group for the
CCAMLR Ecosystem Monitoring Program
(Stockholm, Sweden, 6 to 13 September 1990)

1. Opening of the Meeting

2. Adoption of the Agenda

3. Review of Members' Activities
   3.1 Monitoring
   3.2 Directed Research

4. Relevance of CEMP to the Work of the Commission

5. Predator Monitoring
   5.1 Sites and Species
   5.2 Data Collection Methods
      5.2.1 Revised Methods Sheets
      5.2.2 New Information
   5.3 Processing/Analysis Methods
   5.4 Reporting Formats and Requirements
   5.5 Evaluation of Proposed Methods

6. Prey Monitoring
   6.1 Review of WG-Krill Report
   6.2 Other Species

7. Environmental Monitoring
   7.1 Methods at Land-Based Sites
   7.2 Remote Sensing

8. Review of Submitted Data
9. Estimates of Prey Requirements for Krill Predators
   9.1 Review of Current Information
   9.2 Action Needed for Further Progress

10. General Matters
    10.1 Interdependence Between Predator/Prey/Environmental Monitoring
    10.2 Approaches to Integrated Analyses of Predator/Prey/Environmental Data

11. Designation and Protection of Sites
    11.1 Review of Proposed Management Plans
    11.2 Other Actions Required

12. Awareness of CEMP

13. Future Work of WG-CEMP

14. Other Business

15. Adoption of the Report

16. Close of the Meeting.

APPENDIX B

LIST OF PARTICIPANTS

Working Group for the
CCAMLR Ecosystem Monitoring Program
(Stockholm, Sweden, 6 to 13 September 1990)

J. BENGTSON	National Marine Mammal Laboratory National Marine Fisheries Service 7600 Sand Point Way NE Seattle, Washington 98115 USA
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SECRETARIAT:

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APPENDIX C

LIST OF DOCUMENTS

Working Group for the
CCAMLR Ecosystem Monitoring Program
(Stockholm, Sweden, 6 to 13 September 1990)

WG-CEMP-90/1	PROVISIONAL AGENDA
WG-CEMP-90/2	LIST OF PARTICIPANTS
WG-CEMP-90/3	LIST OF DOCUMENTS
WG-CEMP-90/4	AN APPROACH TO INTEGRATED ANALYSES OF PREDATOR/PREY/ENVIRONMENTAL DATA Stephanie N. Sexton and Jane E. Rosenberg (USA)
WG-CEMP-90/5	DRAFT STANDARD METHODS FOR MONITORING OF ENVIRONMENTAL PARAMETERS (METHODS F1 TO F4) Secretariat
WG-CEMP-90/6	DEVELOPMENT OF THE CCAMLR ECOSYSTEM MONITORING PROGRAM 1982 TO 1990 Secretariat
WG-CEMP-90/7	SEXING OF ADULT ADELIE PENGUINS BY DISCRIMINANT ANALYSIS OF MORPHOMETRIC MEASUREMENTS J.A. Scolaro *et al*. (Argentina)
WG-CEMP-90/7 Rev. 1	SEXING OF ADULT ADELIE PENGUINS BY DISCRIMINANT ANALYSIS OF MORPHOMETRIC MEASUREMENTS J.A. Scolaro *et al*. (Argentina)
WG-CEMP-90/8	RAW DATA AND DEVELOPMENT OF AN ANNUAL INDEX FOR PARAMETER A1, ADULT WEIGHT ON ARRIVAL AT BREEDING COLONY Z.B. Stanganelli *et al*. (Argentina)
WG-CEMP-90/9	OPTIMIZATION OF THE SAMPLING DESIGN IN THE DETECTION OF INTERANNUAL VARIABILITY AND PREY SIZE SELECTIVITY IN THE DIET OF PENGUINS E. Marschoff and B. Gonzalez (Argentina)

WG-CEMP-90/10	MEASURING METEOROLOGICAL AND ICE CONDITIONS WITHIN THE CCAMLR ECOSYSTEM MONITORING PROGRAM M. Whitehead (Australia)
WG-CEMP-90/11	SURFACE WATER MASSES, PRIMARY PRODUCTION, KRILL DISTRIBUTION AND PREDATOR FORAGING IN THE VICINITY OF ELEPHANT ISLAND DURING THE 1989-90 AUSTRAL SUMMER Anthony F. Amos *et al*. (USA)
WG-CEMP-90/12	TEMPORAL AND SPATIAL SCALES FOR MONITORING CEMP PREDATOR PARAMETERS (WG-CEMP)
WG-CEMP-90/13	IS CHICK FLEDGING WEIGHT A GOOD INDEX OF FOOD AVAILABILITY IN SEABIRD POPULATIONS? T.D. Williams and J.P. Croxall (UK)
WG-CEMP-90/14	THE GENTOO PENGUIN AS A CANDIDATE SPECIES FOR THE CCAMLR ECOSYSTEM MONITORING PROGRAM J.P. Croxall and T.D. Williams (UK)
WG-CEMP-90/15	CHICK GROWTH AND SURVIVAL IN GENTOO PENGUINS (*PYGOSCELIS PAPUA*): ROLE OF HATCHING ASYNCHRONY AND VARIATION IN FOOD SUPPLY T.D. Williams and J.P. Croxall (UK)
WG-CEMP-90/16	FORAGING ECOLOGY AND DIET OF GENTOO PENGUINS (*PYGOSCELIS PAPUA*) AT SOUTH GEORGIA DURING WINTER AND AN ASSESSMENT OF THEIR WINTER PREY CONSUMPTION T.D. Williams (UK)
WG-CEMP-90/17	FACTORS AFFECTING VARIATION IN FORAGING AND ACTIVITY PATTERNS OF GENTOO PENGUINS (*PYGOSCELIS PAPUA*) DURING THE BREEDING SEASON AT BIRD ISLAND, SOUTH GEORGIA T.D. Williams and P. Rothery (UK)
WG-CEMP-90/18	ANNUAL VARIATION IN BREEDING BIOLOGY OF MACARONI PENGUINS (*EUDYPTES CHRYSOLOPHUS*) AT BIRD ISLAND, SOUTH GEORGIA T.D. Williams and J.P. Croxall (UK)
WG-CEMP-90/19	INVESTIGATIONS OF REQUIRED SAMPLING REGIMES FOR ENVIRONMENTAL PARAMETERS D. Agnew and E. Sabourenkov (Secretariat)

WG-CEMP-90/20	THE CCAMLR ECOSYSTEM MONITORING PROGRAM (CEMP) Secretariat
WG-CEMP-90/21	AN EFFECT OF INSTRUMENT ATTACHMENT ON THE BEHAVIOUR OF CHINSTRAP PENGUINS Donald A. Croll, Stephen D. Osmek and John L. Bengtson (USA)
WG-CEMP-90/22	UNITED STATES 1989/90 MARINE MAMMAL AND BIRD STUDIES IN SUPPORT OF THE CCAMLR ECOSYSTEM MONITORING PROGRAM Delegation of the United States
WG-CEMP-90/23	CCAMLR ECOSYSTEM MONITORING PROGRAM (CEMP), LAND-BASED SITE, PRYDZ BAY INTEGRATED STUDY REGION, MAGNETIC ISLAND 1. PROPOSAL FOR REGISTRATION 2. MANAGEMENT PLAN Delegation of Australia
WG-CEMP-90/24	AUTOMATED PENGUIN MONITORING SYSTEM K.R. Kerry (Australia)
WG-CEMP-90/25	STANDARD MEASUREMENTS ON ADELIE PENGUINS K.R. Kerry, R. Weatherly and G. Else (Australia)
WG-CEMP-90/26	INFORMATION ON BRAZILIAN CEMP ACTIVITIES Janice Trotte and Martin Sander (Brazil)
WG-CEMP-90/27	COMMENTS ON THE CEMP STANDARD METHODS AND ESTIMATING THE PREY REQUIREMENTS OF PINNIPEDS SCAR Group of Specialists on Seals
WG-CEMP-90/28	PROPOSAL FOR THE DESIGNATION OF SEAL ISLAND, ELEPHANT ISLAND, SOUTH SHETLAND ISLANDS, AS A MONITORING SITE UNDER THE CCAMLR ECOSYSTEM MONITORING PROGRAM Delegation of the USA
WG-CEMP-90/29	PROPOSAL FOR THE DESIGNATION OF CAPE SHIRREFF, LIVINGSTON ISLAND, SOUTH SHETLAND ISLANDS, AS A MONITORING SITE UNDER THE CCAMLR ECOSYSTEM MONITORING PROGRAM Delegations of Chile and the USA
WG-CEMP-90/30	ESTIMATION OF THE ENERGY AND PREY REQUIREMENTS OF PREDATORS BREEDING ON THE SOUTH SHETLAND ISLANDS Donald A. Croll (USA)

WG-CEMP-90/30 Rev. 1	ESTIMATION OF THE ENERGY AND PREY REQUIREMENTS OF PREDATORS BREEDING ON THE SOUTH SHETLAND ISLANDS Donald A. Croll (USA)
WG-CEMP-90/31	FOOD CONSUMPTION BY PREDATORS IN CCAMLR INTEGRATED STUDY REGIONS J.P. Croxall (UK)
WG-CEMP-90/32	COMMENTS ON THE CCAMLR REQUESTS RELATED TO CEMP SCAR Bird Biology Subcommittee
WG-CEMP-90/33	OBSERVATION OF BIRDS IN THE SOUTHERN OCEAN IN THE SEASON OF 1988/89 A.A. Vagin, V.V. Popkov (USSR)
WG-CEMP-90/34	INTER-ANNUAL COMPARISONS OF GROWTH OF ANTARCTIC FUR SEALS PUPS, SEAL ISLAND, 1988-1990 Peter Boveng, Michael E. Goebel and John L. Bengtson (USA)
WG-CEMP-90/35	ANTIBODIES TO CANINE DISTEMPER VIRUS IN ANTARCTIC SEALS J.L. Bengtson *et al*. (USA and Sweden)
WG-CEMP-90/36	INTERDEPENDENCE AMONG SAMPLING METHODS AND RESULTS OF PREDATOR MONITORING AND CHANGES IN PREY ABUNDANCE Delegation of the USA
WG-CEMP-90/37	ANNUAL FLUCTUATIONS IN PRODUCTIVITY AND BREEDING SUCCESS OF ADELIE PENGUINS AND FULMARINE PETRELS IN PRYDZ BAY, EAST ANTARCTICA Whitehead, M.D. *et al.* (In press). *Proc. V SCAR Symp. Polar. Biol.*
WG-CEMP-90/38	ANNUAL VARIATION IN BREEDING BIOLOGY OF GENTOO PENGUINS, (*PYGOSCELIS PAPUA*) AT BIRD ISLAND, SOUTH GEORGIA Williams, T.D. (In press). *J. Zool., Lond.* (1990)
WG-CEMP-90/39	ANNUAL VARIATION IN THE TIMING OF REPRODUCTION IN ANTARCTIC FUR SEALS (*ARCTOCEPHALUS GAZELLA*) AT BIRD ISLAND, SOUTH GEORGIA Duck, C.D. (In press). *J. Zool., Lond.* (1990)

WG-CEMP-90/40	A NEW METHOD FOR THE MEASUREMENT OF ANTARCTIC KRILL *EUPHAUSIA SUPERBA* DANA FROM PREDATOR FOOD SAMPLES Hill, H.J. 1990. *Polar Biology*. Springer-Verlag.
WG-CEMP-90/41	ABUNDANCE OF ANTARCTIC FUR SEALS IN THE SOUTH SHETLAND ISLANDS, ANTARCTICA, DURING THE 1986/87 AUSTRAL SUMMER Bengtson, J.L., L.M. Ferm, T.J. Härkönen and B.S. Stewart. (In press). *Proc. V SCAR Symp. Polar. Biol*.
WG-CEMP-90/42	SEXING FLEDGLINGS AND YEARLINGS OF MAGELLANIC PENGUINS BY DISCRIMINANT ANALYSIS OF MORPHOMETRIC MEASUREMENTS. Scolaro, J.A. 1987. *Colonial Waterbirds* 10(1): 50-54.
WG-CEMP-90/43	DRAFT SECOND EDITION – STANDARD METHODS FOR MONITORING PARAMETERS OF PREDATORY SPECIES
SC-CAMLR-IX/4	REPORT OF THE SECOND MEETING OF THE WORKING GROUP ON KRILL
WG-KRILL-90/3	LIST OF DOCUMENTS
WG-KRILL-90/7	UNITED STATES AMLR PROGRAM 1989/90 FIELD SEASON REPORT
WG-KRILL-90/8	FINE-SCALE CATCHES OF KRILL IN SUBAREA 48.2 Secretariat
WG-KRILL-90/10	FINE-SCALE CATCHES OF KRILL SUBAREA 48.3 Secretariat
WG-KRILL-90/28	MEASUREMENTS OF DIFFERENCES IN THE TARGET STRENGTH OF ANTARCTIC KRILL (*EUPHAUSIA SUPERBA*) SWARMS AT 38 AND 120 KHZ I. Hampton (South Africa)
WG-KRILL-90/29	ACOUSTICALLY ESTIMATING KRILL ABUNDANCE IN THE SOUTHERN OCEAN Charles H. Greene, Sam McClatchie, Peter H. Wiebe and Timothy K. Stanton (USA).
WG-KRILL-90/30	DISCUSSION OF SATELLITE IMAGERY APPLIED TO CAMLR REGIONS Robert E. Dennis (USA)

SC-CAMLR-VIII/9	USE OF INDICES OF PREDATOR STATUS AND PERFORMANCE IN CCAMLR FISHERY MANAGEMENT STRATEGIES Delegation of United Kingdom
SC-CAMLR-VIII/BG/10	ASSESSMENT OF KRILL BIOMASS IN FISHING GROUNDS USING THE DATA ON FISHING INTENSITY AND HYDROACOUSTIC METHOD Delegation of USSR
SC-CAMLR-VIII/BG/12	IMPACT OF SEABIRDS ON MARINE RESOURCES, ESPECIALLY KRILL, OF SOUTH GEORGIA WATERS Delegation of United Kingdom
SC-CAMLR-VIII/BG/13	FORAGING ENERGETICS OF ANTARCTIC FUR SEALS IN RELATION TO CHANGES IN PREY AVAILABILITY Delegation of United Kingdom
SC-CAMLR-VIII/BG/14	THE REPRODUCTIVE ENERGETICS OF GENTOO (*PYGOSCELIS PAPUA*) AND MACARONI (*EUDYPTES CHRYSOLOPHUS*) PENGUINS AT SOUTH GEORGIA Delegation of United Kingdom
SC-CAMLR-VIII/BG/15	SEABIRDS AS PREDATORS ON MARINE RESOURCES, ESPECIALLY KRILL, AT SOUTH GEORGIA Delegation of United Kingdom
SC-CAMLR-VIII/BG/44	THE FINE-SCALE DISTRIBUTION OF KRILL IN AREA 48 DURING 1987 AND 1988 Secretariat

ANNEX 7

SCIENTIFIC COMMITTEE BUDGET FOR 1991
AND FORECAST BUDGET FOR 1992

SCIENTIFIC COMMITTEE BUDGET FOR 1991
AND FORECAST BUDGET FOR 1992

The Scientific Committee's program is mainly comprised of working group meetings and workshops for which a significant part of the expenditure is for translation and preparation for publication of reports. In order to minimise publication costs and to improve translation quality, both of these functions are carried out by contracted staff in the Secretariat. Thus, although the Scientific Committee's budget is presented as a list of distinct projects (e.g. working group meetings) some of the costs would be incurred whether or not particular projects were approved.

2. Annex 8 of SC-CAMLR-VIII contains forecasts of funding requirements for the scientific program in 1991 and has been used as a basis for estimating expenditure in this item. The budgeted amount of A$93 900 includes allowance for the following:

1991		1992
19 000	Working Group on Krill	20 200
24 400	Working Group on Fish Stock Assessment	26 000
22 200	Ecosystem Monitoring Program	23 600
31 100	Travel for Scientific Committee Program	33 100
9 000	Southern Elephant Seal Workshop	0
2 600	CCAMLR Exhibit at Antarctic Science Conference	0
7 600	Contingency	7 200
115 900	Sub Total	110 100
22 000	Less drawings from the Norwegian Contribution Special Fund	14 100
A$93 900	Total from Commission Budget	A$96 000

3. At its Eighth Meeting the Commission agreed that the Working Group on Krill (WG-Krill) should meet in 1990. The WG-Krill will need to meet in 1991.

4. The Working Group on Fish Stock Assessment (WG-FSA) has responsibility to provide expert advice to the Scientific Committee on the status of finfish in the Convention Area. A meeting of WG-FSA will be needed in 1991.

5. The Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) is considering a number of substantive topics particularly addressing experimental design and data analysis techniques following its adoption of the Second Edition of the Standard Methods and the submission of data to the CCAMLR Data Centre. Its work is closely linked

with that of the WG-Krill. There will be a need for a meeting of WG-CEMP in 1991. The budget of A$22 200 includes an amount for the translation and publication of the Second Edition of the CEMP Standard Methods.

6. As a result of a decision taken at the Fifth Meeting of the Commission, travel for Secretariat staff associated with the Scientific Committee program is included in the Scientific Committee budget. The amount provides for travel by staff members to give necessary support to WG-Krill and WG-CEMP.

7. The Scientific Committee has supported a SCAR recommendation that CCAMLR support a workshop to examine the reasons for the decline in the southern Indian Ocean population of elephant seals (SC-CAMLR-IX/BG/22). A SCAR Symposium is already scheduled for May 1991 in Santa Cruz, California to discuss elephant seal biology in general and advantage should be taken of the presence at this meeting of elephant seal specialists to hold a short workshop to discuss the problem of southern elephant seals. The Scientific Committee recommends that this workshop be held for four days in conjunction with the SCAR Symposium. Funds are sought to support the attendance of three southern elephant seal experts not already present at the Symposium for the four-day workshop and to provide subsistence for three people for these four days. The total cost of this will be A$9 000.

8. The Scientific Committee has recommended that CCAMLR should participate in the Antarctic Science Conference to be held in Bremen in September 1991. It is anticipated that travel by a member of the Secretariat to this meeting could be linked with travel to one of the Working Group meetings and therefore funds are sought only for the production of a suitable exhibit for the poster session of the Conference and subsistence for three days (A$2 600).

9. Annex 8 of SC-CAMLR-VIII forecasts the amount to be drawn from the Norwegian Contribution Special Fund at A$2 000. However, due to savings in expenditure and the deferral of the Joint CCAMLR/IWC Workshop, no drawings were made from the fund in 1989. This results in A$22 000 being available to be drawn from the fund in 1991.

ANNEX 8

PROPOSED AMENDMENT TO PART X OF THE SCIENTIFIC COMMITTEE RULES OF PROCEDURE

PROPOSED AMENDMENT TO PART X OF THE SCIENTIFIC COMMITTEE RULES OF PROCEDURE

PART X OBSERVERS

Amendment to Rule 19

RULE 19

The Scientific Committee may extend an invitation to any organisation referred to in paragraphs 2 and 3 of Article XXIII of the Convention or to any of those with which the Commission has entered into agreements in accordance with paragraph 4 of the same Article, to attend the meetings of the Scientific Committee as Observers. **Representatives nominated by the Organisation to attend the Scientific Committee Meeting must have suitable scientific qualifications. The Scientific Committee may also invite observers to the meetings of any subsidiary body of the Committee.**

Additional Rules

RULE 20

Subject to Article XII of the Convention on the Conservation of Antarctic Marine Living Resources the Committee may:

(a) extend an invitation to any signatory of the Convention to participate, in accordance with Rules 22, 23 and 24 below, as observers in meetings of the Scientific Committee;

(b) extend an invitation to any State party to the Convention which is not entitled to be a member of the Commission under Article VII of the Convention to attend, in accordance with Rules 22, 23 and 24 below, as observers in meetings of the Scientific Committee;

(c) invite as appropriate, any other state to attend, in accordance with Rules 22, 23 and 24 below, as observers in the meetings of the Scientific Committee unless a Member of the Scientific Committee objects;

(d) invite, as appropriate, organisations named in Article XXIII 2 and 3 of the Convention to attend, in accordance with Rules 22, 23 and 24 below, as observers in the meetings of the Scientific Committee;

(e) invite, as appropriate, other inter-governmental and non-governmental organisations, to which Article XXIII 3 of the Convention may apply, to attend in accordance with Rules 22, 23 and 24 below, as observers in the meetings of the Scientific Committee unless a Member of the Scientific Committee objects.

RULE 21

(a) The Chairman may, when preparing with the Executive Secretary the preliminary agenda for a meeting of the Scientific Committee draw to the attention of Members of the Scientific Committee his view that the work of the Scientific Committee would be facilitated by the attendance at its next meeting of an observer referred to in Rule 20, an invitation to which was not considered at the previous meeting. The Executive Secretary shall so inform Members of the Scientific Committee when transmitting to them the Preliminary Agenda under Rule 7;

(b) The Committee shall take a decision on the Chairman's suggestion and the Executive Secretary shall so inform Members of the Scientific Committee when transmitting to them the Provisional Agenda under Rule 7.

RULE 22

(a) Observers may be present at public and private sessions of the Committee;

(b) If a Member of the Committee so requests, sessions of the Committee at which a particular agenda item is under consideration shall be restricted to its Members and Observers referred to in Rule 20(a).

RULE 23

(a) The Chairman may invite observers to address the Committee unless a Member of the Committee objects;

(b) Observers are not entitled to participate in the taking of decisions.

RULE 24 (Scientific Committee - Rule 20)

(a) Observers may submit documents to the Secretariat for distribution to Members of the Committee as information documents. Such documents shall be relevant to matters under consideration in the Committee;

(b) Unless a Member or Members of the Committee request otherwise such document shall be available only in the language or languages and in the quantities in which they were submitted;

(c) Such documents shall only be considered as Committee documents if so decided by the Committee.