

**REPORT OF THE WORKING GROUP
ON FISH STOCK ASSESSMENT**

(Hobart, Australia, 11 to 19 October 1994)

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REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 11 to 19 October 1994)

INTRODUCTION

1.1 The meeting of the Working Group on Fish Stock Assessment (WG-FSA) was held at CCAMLR Headquarters, Hobart, Australia from 11 to 19 October 1994. The Convener, Dr I. Everson (UK), chaired the meeting.

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

2.1 The Convener welcomed participants to the meeting and introduced the Provisional Agenda which had been circulated prior to the meeting. He noted that Item 3.3 had been introduced this year to enable a thorough consideration of papers of general biological and ecological interest having implications for management. The Agenda was adopted with the inclusion of two sub-items, 4.10 and 4.11, concerning assessments in Division 58.5.2 and Subarea 48.4.

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

2.3 The report was prepared by Drs D. Agnew (Secretariat) and A. Constable (Australia), Prof. G. Duhamel (France), Drs G. Kirkwood (UK) and K.-H. Kock (Chairman, Scientific Committee), Mr D. Miller (South Africa), Drs G. Parkes (UK), G. Watters (USA) and Mr R. Williams (Australia).

REVIEW OF AVAILABLE INFORMATION

DATA REQUIREMENTS ENDORSED BY THE COMMISSION IN 1993

3.1 Various data were requested by the Working Group in 1993 (SC-CAMLR-XII, Annex 5, Appendix D). Data submitted to the Secretariat in response to this are listed in Appendix D.

FISHERIES INFORMATION

Catch, Effort, Length and Age Data

3.2 This year the date for reporting STATLANT data to the Secretariat was brought forward to 31 August (CCAMLR-XII, paragraph 4.18). The Data Manager reported that this change had significantly improved the ability of the Secretariat to acquire all STATLANT data prior to the Working Group meeting, with the result that all catches could be reported to the group in SC-CAMLR-XIII/BG/1.

3.3 The only commercial fisheries which had been in operation in the 1993/94 season were the fisheries for *Dissostichus eleginoides* in Subarea 48.3 and Division 58.5.1. Other species were taken as by-catch in these fisheries, or as research or exploratory catches by Argentina, Australia, France, South Africa and the UK.

3.4 A TAC of 1 300 tonnes had been set in Conservation Measure 69/XII for the *D. eleginoides* fishery in Subarea 48.3. Only 603 tonnes were caught in the fishery. No catches were reported from the fisheries for *Champsoccephalus gunnari*, crabs (*Paralomis* spp.) or *Electrona carlsbergi* in Subarea 48.3, *D. eleginoides* in Subarea 48.4, or the fishery for *Notothenia squamifrons* in Division 58.4.4, all of which had been subject to conservation measures with TACs (Conservation Measures 66/XII, 67/XII, 71/XII, 73/XII and 59/XI).

3.5 Haul-by-haul and length frequency data from the fishery for *D. eleginoides* in Subarea 48.3 were reported in accordance with Conservation Measure 69/XII. France reported fine-scale and length frequency data from the fishery for *D. eleginoides* in Division 58.5.1 and Subarea 58.6. Various other biological data were reported from research cruises in the 1993/94 season.

3.6 It was noted that a number of inspections were carried out this year under the CCAMLR System of Inspection. Reports of these inspections indicated that some *D. eleginoides* may have been caught in Subarea 48.3, and that this had not been officially reported as catch data to the Secretariat. The Working Group requested clarification of these reports in order to record the catches of this species correctly.

Scientific Observer Information

3.7 Participation in the 1993/94 *D. eleginoides* fishery in Subarea 48.3 was conditional on having a scientific observer under the CCAMLR Scheme of International Scientific Observation (Conservation Measure 69/XII). The UK, USA and Russia had provided observers for Korean and Chilean (UK), Russian (USA) and Bulgarian (Russia) vessels. The Working Group expressed its regret that there was no participant from Russia at the meeting to provide a report from the observer on the Bulgarian vessel.

3.8 Drs R. Holt (USA) and Parkes reported on difficulties experienced by observers. Dr Parkes reported that observers from the UK had found that the fishing vessel captains had not always been fully aware of their obligations under Conservation Measure 69/XII, particularly with respect to fishing within the experimental depletion site, and that this had led to some difficulties on board ship. The Working Group recommended that fishing nations be requested to ensure that the operators of their vessels are made fully aware of the implications of their obligations under conservation measures, especially when they are expecting to host international observers.

3.9 Dr Holt reported that the US observer had collected a great deal of detailed data additional to that reported to CCAMLR under Conservation Measure 69/XII. Dr Parkes reported that the UK and Chilean observers had also collected such data, but that it had yet to be fully analysed. He also reported that the observer data collected on the *Friosur V* had regrettably been lost in the tragic fire on that vessel.

3.10 The Working Group recognised that providing an observer under the scheme was a major exercise, requiring careful planning, a qualified observer, and provision at the planning stage of sufficient resources for subsequent data analysis and reporting work.

3.11 The Working Group emphasised that the data collection forms provided in the CCAMLR *Scientific Observers Manual* should be used as a guide for the collection of relevant data. However, to make best use of the information collected by observers, the Working Group recommended that all data that could be reported in CCAMLR format (for instance in research data format C4, length frequency format B2 and age composition format B3) should be submitted to the Secretariat for entering into the CCAMLR Database. The Data Manager confirmed that other data, whether on the *Scientific Observers Manual* forms or not, could be sent to the Secretariat for safe keeping, but that only data in the recognised CCAMLR formats would be accepted for entry into the CCAMLR Database.

3.12 The scientific observers on board vessels taking part in the 1994 fishery for *D. eleginoides* in Subarea 48.3 (the FVs *Ihn Sung 66*, *Maksheevo* and *Friosur V*) reported some interaction between the longline fishery and killer whales and sperm whales. Whales were observed foraging for fish caught on longlines, taking fish, hooks and sometimes destroying the line itself. On some occasions when killer whales were present in large numbers, hauling was stopped and the vessel moved to another area, returning after some time to resume hauling. The Working Group considered that the influence of this interaction on the CPUE in the longline fishery should be investigated.

Research Surveys

3.13 Three research surveys of finfish took place in the 1993/94 season; by the UK (January 1994, Subarea 48.3), Argentina (February to March 1994, Subareas 48.3 and 48.2) and Australia (September, Division 58.5.2).

3.14 The Argentinian survey of South Georgia, Shag Rocks and the South Orkneys was reported in WG-FSA-94/29. A novel survey design, based on the random selection of a number of 'chains' of stations within each of three depth strata, was used to optimise ship time.

3.15 The UK survey was described in WG-FSA-94/18. It used the same design as previous surveys, and produced biomass estimates which were generally lower than those found in 1992.

3.16 The Working Group decided that since it generally uses survey results as indices of abundance, it would be most appropriate to use the UK survey results, in conjunction with previous results from the UK, as its primary index of abundance in Subarea 48.3 (see paragraph 4.96 and Tables 7 and 8).

3.17 It was noted that the UK survey had found a rather even distribution of *C. gunnari* over the shelf area of South Georgia and Shag Rocks, whereas the later Argentinian survey had found a persistent high-density region close to Shag Rocks. Differences in other characteristics, such as representative length frequencies and diet of various species, were also identified and are further discussed in paragraphs 3.28, 3.33 and 4.73 to 4.75.

3.18 Discussing the two approaches to survey design, the Working Group noted that one of the main difficulties in surveys around South Georgia lies in locating survey stations on grounds suitable for trawling. The stations used for the UK surveys were chosen according to a stratified random design during the first survey year, and then the same set of stations was used in subsequent surveys.

Randomly selecting a new set of stations each year was considered infeasible. Using a fixed set of stations may introduce some bias, but this is not important when the results are used as indices of abundance.

3.19 On the Argentine survey, a smaller number of stations was chosen in a stratified random way and these were then used as starting points for selecting further ‘chains’ of stations by searching for further suitable trawling grounds in a random direction from the starting points. This procedure is described in WG-FSA-94/29. In part, this approach was followed in order to reduce the searching time for survey sites on suitable trawling grounds. The other reason for adopting this approach to site selection was a desire to take account of the expected heterogeneity in the distribution of the fish when determining the design and analysis of the survey. It was anticipated that it would be possible to reduce the CV of the abundance estimate and thereby optimise ship time. Because not all sites are randomly chosen in this method of site selection, methods of analysis need to be used which differ from those used by the Working Group to analyse the UK survey results. The analysis reported in WG-FSA-94/29 did suggest that some reductions in CV might be achieved by treating the ‘chains’ as a nested factor in the analysis. The comparison used, however, was difficult to interpret because of the non-random site selection procedure.

3.20 Maximising the information obtained from surveys is a common goal and the approach taken on the Argentine survey was felt to be interesting and innovative. However, several members of the Working Group felt that further development and investigation was needed. They wondered whether the difficult grounds around South Georgia provided the best testing area. The Working Group agreed that if proper account could be taken of the spatial heterogeneity, it should be possible to reduce the CV of the abundance estimate below that calculated in the normal way from random stratified surveys. In this context it would be useful if an analysis of the UK survey results incorporating spatial variability could be attempted.

3.21 The Australian survey was reported in WG-FSA-94/10 which included the results of two previous surveys of Heard Island conducted using similar survey designs. The results of the surveys are described in paragraph 4.148.

Experiments Affecting Catchability

3.22 Paper WG-FSA-94/23 reported experiments on the FP-120 trawl used during the UK survey in Subarea 48.3. ‘Scanmar’ trawl monitoring equipment was used to make *in situ* measurements of trawl dimensions and derive a multiple regression equation relating opening width to depth of trawling and tow speed (this had a high correlation coefficient).

3.23 Mr Williams commented that the good correlations among various trawl parameters, depth and tow speed in this study contrasted with Australian experiences around Heard Island. It was suggested that the relatively greater current speeds in the Heard Island area may have acted to distort the net dimension relationships to a greater extent than in the study around South Georgia.

3.24 The times of the start and end of each tow during the UK trawl surveys are recorded as the times at which the captain estimates that the trawl arrives at and leaves the seabed. The 'Scanmar' equipment provided the opportunity to compare these times with observations from the trawl itself. The comparison was undertaken for six tows, all of which showed that the trawl actually reached the seabed after the captain considered that it had. The average difference was two minutes, representing a 6.7% error on a standard 30-minute tow. The largest difference was 3 minutes 20 seconds. Differences between the estimated and observed times when the trawl left the bottom were much less. It was noted that whilst these differences were small, the effect might be significant if the trawl duration was much less than 30 minutes.

FISH AND CRAB BIOLOGY/DEMOGRAPHY/ECOLOGY

3.25 The Working Group considered a number of background papers dealing with various aspects of the biology and demography of selected species.

Age and Growth

3.26 The first of three Ukrainian papers (WG-FSA-94/4) dealt with the dynamics of *Notothenia rossii rossii* on the Kerguelen Island shelf.

3.27 The two other Ukrainian papers (WG-FSA-94/6 and 8) reported on the determination of age of *C. gunnari* at Heard and McDonald Islands using otolith weights. The Working Group looked forward to further submissions on the topic.

3.28 An age/length key for *C. gunnari* from Subarea 48.3 was presented in WG-FSA-94/11. Mostly small and medium sized specimens were found in the whole subarea, while age groups 1-4 and 2-3 were well represented at South Georgia and Shag Rocks respectively. The mean length-at-age values for fish collected around South Georgia were in line with results from previous surveys (see also paragraph 4.54).

3.29 Paper WG-FSA-94/12 reported results of a validation method for age determination of *Notothenia coriiceps* based on a tag-recapture experiment at Potter Cove, South Shetland Islands. Scale samples were taken from fish on tagging and when recaptured. The annulus count on scales corresponded well with the elapsed time between tagging and recapture. Good agreement was found on age readings from the scales and otoliths of recovered specimens. The method was recognised as having promise and the Working Group encouraged further work of this kind.

Reproduction and Early Life

3.30 The first of three papers on this topic (WG-FSA-94/14) described the early life of *D. eleginoides* in the western Atlantic sector. This species spawns over the shelf slope between July and September, with eggs being observed primarily in the upper reaches of the water column in water depths between 2 200 and 4 400 m. The paper described Stages III and IV of embryonic development and concluded that hatching is likely to occur in October/November. Scales do not form until animals are about 64 to 74 mm in length.

3.31 In considering these results, Prof. Duhamel noted that at Kerguelen growth rates during the first two years of life for *D. eleginoides* and *C. gunnari* are remarkably similar, as are their distribution and feeding preferences.

3.32 Paper WG-FSA-94/16 described the results of sampling *C. gunnari* at South Georgia and Shag Rocks. The mean and median sizes of fish at the two locations were significantly different, with two size modes being evident at Shag Rocks compared to one at South Georgia. The Working Group agreed that such conditions may arise from a number of different circumstances which may include different spawning times in the two localities, different spawning patterns, different growth rates and/or be the result of sampling a patchily distributed resource. The Working Group thought it unlikely that the results were indicative of two separate stocks.

3.33 A histological description of the ovaries of *C. gunnari* was presented in WG-FSA-94/28. Six stages of oocyte development were identified, and these are similar to those described for other species. A stage of generalised atresia of oocytes was described and was found to be similar to the regression stage reported for the 1991 year of krill shortage. A revision of the gonad maturation scale was presented. The Working Group agreed that the revised scale set out in Appendix E should be used for future studies.

Trophic Relationships

3.34 Papers WG-FSA-94/15 and 27 reported on the diet of *C. gunnari* at South Georgia during the period January to March 1994. Both concluded that in the absence of large concentrations of krill, the hyperiid amphipod *Themisto gaudichaudii* was the major component in the diet of *C. gunnari*. Further discussion of these papers is given in paragraphs 4.73 and 4.74.

3.35 Paper WG-FSA-94/17 suggested that predation by fur seals could potentially exert a more profound effect on stocks of *C. gunnari* at South Georgia than hitherto appreciated, particularly in the absence of krill concentrations such as occurred during the 1993/94 austral summer (see also paragraphs 4.77 and 5.5).

Management Units

3.36 Paper WG-FSA-94/10 highlighted possible stock differences for *C. gunnari* in Division 58.5.2. The Working Group agreed that these results may have some application in the allocation of management units in the respective areas and further work was encouraged.

Seabed Areas

3.37 The Working Group welcomed WG-FSA-94/13, which presented a revised bathymetric map of the Elephant Island area and estimates of seabed areas around the island, as an addition to the CCAMLR data on seabed areas.

3.38 The Data Manager reported that following the request of the Working Group in 1993 (SC-CAMLR-XII, Annex 5, paragraph 5.24), the Secretariat has written a program to calculate areas of seabed within selected depth ranges for all subareas within the Convention Area. This program is available on request from the Secretariat.

ASSESSMENT WORK AND MANAGEMENT ADVICE

4.1 Both the Scientific Committee and the Commission have requested more work on the question of management under conditions of uncertainty (SC-CAMLR-XII, paragraph 3.95 and CCAMLR-XII, paragraph 4.26). The Working Group looked at this question on a stock-by-stock

basis and its advice is contained in the management advice for individual stocks where appropriate. General conclusions are given in paragraphs 4.161 to 4.164.

NEW FISHERIES

4.2 CCAMLR has had no notifications under Conservation Measure 31/X that Members intend to initiate a new fishery. The Working Group therefore had nothing to consider under this item.

SOUTH GEORGIA (SUBAREA 48.3) - FINFISH

4.3 Summaries of assessments presented in the following section are given in Appendix F.

Reported Catches

4.4 The catch history for Subarea 48.3 is shown in Table 1. The only finfish to be targeted in this subarea was *D. eleginoides*; catches of other species were taken as by-catch in these fisheries or as research catches.

Table 1: Catches of various finfish species from Subarea 48.3 (South Georgia subarea) by year. Species are designated by abbreviations as follows: KCV (*Paralomis spinosissima*), SSI (*Chaenocephalus aceratus*), ANI (*Champscephalus gunnari*), SGI (*Pseudochaenichthys georgianus*) and ELC (*Electrona carlsbergi*), TOP (*Dissostichus eleginoides*), NOG (*Notothenia gibberifrons*), NOR (*Notothenia rossii*), NOS (*Notothenia squamifrons*), NOT (*Patagonotothen guntheri*). 'Others' includes Rajiformes, unidentified Channichthyidae, unidentified Nototheniidae and other Osteichthyes.

Split year	KCV	SSI	ANI	SGI	ELC ^e	TOP	NOG	NOR	NOS	NOT	Others	Total
1970	0	0	0	0	0	0	0	399704	0	0	0	399704
1971	0	0	10701	0	0	0	0	101558	0	0	1424	113713
1972	0	0	551	0	0	0	0	2738	35	0	27	3351
1973	0	0	1830	0	0	0	0	0	765	0	0	2595
1974	0	0	254	0	0	0	0	0	0	0	493	747
1975	0	0	746	0	0	0	0	0	1900	0	1407	4053
1976	0	0	12290	0	0	0	4999	10753	500	0	190	28732
1977	0	293	93400	1608	0	441	3357	7945	2937	0	14630 ^a	124611
1978	0	2066	7557	13015	0	635	11758	2192	0	0	403	37626
1979	0	464	641	1104	0	70	2540	2137	0	15011	2738 ^b	24705
1980	0	1084	7592	665	505	255	8143	24897	272	7381	5870	56664
1981	0	1272	29384	1661	0	239	7971	1651	544	36758	12197 ^c	91677
1982	0	676	46311	956	0	324	2605	1100	812	31351	4901	89036
1983	0	0	128194	0	524	116	0	866	0	5029	11753 ^d	146482
1984	0	161	79997	888	2401	109	3304	3022	0	10586	4274	104742
1985	0	1042	14148	1097	523	285	2081	1891	1289	11923	4238	38517
1986	0	504	11107	156	1187	564	1678	70	41	16002	1414	32723
1987	0	339	71151	120	1102	1199	2844	216	190	8810	1911	87882
1988	0	313	34620	401	14868	1809	5222	197	1553	13424	1387	73794
1989	0	1	21359	1	29673	4138	838	152	927	13016	55	70160
1990	0	2	8027	1	23623	8311	11	2	24	145	2	40148
1991	0	2	92	2	78488	3641 ^f	3	1	0	0	1	82423
1992	0	2	5	2	46960	3703 ^g	4	1	0	0	1	50678
1993	299	0	0	0	0	3049 ^h	0	0	0	0	0	3348
1994	0	2	13	1	0	604 ⁱ	4	2	0	1	13	640

^a Includes 13 724 tonnes of unspecified fish caught by the Soviet Union

^b Includes 2 387 tonnes of unspecified Nototheniidae caught by Bulgaria

^c Includes 4 554 tonnes of unspecified Channichthyidae caught by the GDR

^d Includes 11 753 tonnes of unspecified fish caught by the Soviet Union

^e Before 1988, it is not confirmed that these were *E. carlsbergi*

^f Includes 1 440 tonnes taken before 2 November 1990

^g Includes 1 tonne taken as research catch by the UK, 132 tonnes taken as research catch by Russia before 30 June

^h 59 tonnes taken by Russian research cruise July 1992, 2 990 tonnes by the longline fishery December 1992 to February 1993

ⁱ Includes 179 tonnes taken in the 1994 fishing season but after 1 July 1994, 1 tonne taken by research cruises

Dissostichus eleginoides (Subarea 48.3)

4.5 In the 1993/94 season, Subarea 48.3 was designated as a Special Area for Protection and Scientific Study. Fishing during the season was undertaken by one vessel from each of the Republic of Korea, Russia, Chile and Bulgaria, with one vessel operating in each of five 55-day periods. Detailed operational statistics are given in WG-FSA-94/20. Catches by vessel and month during the season are shown in Table 2. A site for local depletion experiments was specified for each fishing period. Figure 1 shows the positions of catches and the local depletion sites. The site originally allocated to the Korean vessel was found to be unsuitable for fishing and was changed to that shown in Figure 1.

Table 2: Catches by vessel and month during the 1993/94 season.

Period	Allocated Periods	Actual Fishing	Catch (tonnes)	Month	Catch (tonnes)
1	15 December 93 - 7 February 94	22 December 93 - 7 February 94	99	December	32
2	8 February - 3 April 94	27 February - 29 March 94	103	January	32
3	4 April - 28 May 94	7 April - 6 May 94	151	February	39
4	29 May - 22 July 94	1 June - 22 July 94	115	March	80
5	23 July - 15 September 94	23 July - 10 September 94	135	April	147
				May	23
				June	70
				July	73
				August	72
				September	35
Total			603		603

4.6 The Working Group felt that the catches reported to the Secretariat may not represent all of the catches taken in Subarea 48.3. Lack of this information will hamper assessments. In addition, it was recalled that detailed information on catches to the north and west of Subarea 48.3 had been available last year and had proved very useful in assessment. The Working Group noted that it had no information on catches outside the Convention Area for other years and agreed that acquisition of these data would greatly assist its work.

4.7 Dr C. Moreno (Chile) explained that the discrepancy between the 5-day reported catch and the final reported catch for the Chilean vessel (WG-FSA-94/20, Table 1) was due to use in the final reported catch of an updated conversion factor from processed to whole weight. The updated conversion factor (0.50) had been estimated from data collected during the fishing period. The previous value was 0.48. The Working Group agreed that information on the conversion factors used should be requested along with each catch report.

Review of 1992/93 Estimates of Local Densities

4.8 Assessments of the toothfish fishery in Subarea 48.3 undertaken by the Working Group at its meetings in 1992 and 1993 were based on estimates of local densities calculated using CPUE data for single commercial longline vessels fishing in small areas over a limited period of time. The stock depletion estimation method involved fitting a linear regression of CPUE against cumulative catch. Valid estimates can only be obtained if this regression has a negative slope. Paper WG-FSA-94/24 reported the results of a review of the stock depletion analyses undertaken at the 1993 Working Group meeting and of a re-analysis of the 1992/93 longline data for Chilean vessels.

4.9 Paper WG-FSA-94/24 found that the method used at the 1993 Working Group meeting to select CPUE data for analysis was not in full accordance with the assumptions of the stock depletion method of analysis. It also found that in some cases the cumulative catch had not been calculated appropriately. The resulting estimates of local densities were therefore not correct. An attempt was then made to re-analyse the 1992/93 Chilean data both from Subarea 48.3 and from the North and Rhine banks.

4.10 Series of data were selected for analysis on the basis of single vessels operating in localised areas for periods of three consecutive days or more. The size of the localised areas was restricted to an area of similar size to the circle of 10 n miles diameter specified for the 1993/94 Experimental Protocol. A total of 23 series was selected for Subarea 48.3 and a further 12 and 13 for North and Rhine Banks respectively. All catches during the selected time periods in the selected localised areas were included in the calculation of the accumulated catch, regardless of which vessel had taken them. Linear regressions of CPUE against accumulated catch were then performed and a one-tailed t-test was used to test whether the slope was significantly less than zero.

4.11 For the 23 series identified in Subarea 48.3, at the 5% level only three regressions had slopes significantly less than zero, and 11 had positive slopes. Of the 12 series from North Bank, none of the slopes were significantly less than zero and seven were positive. Of the 13 series from Rhine Bank, two had slopes significantly less than zero and five were positive. Since most of the series in the 1992/93 data set with potential for showing significant local stock depletion did not show depletion, it was concluded that on the scale of single longline vessels operating in localised areas the stock depletion method cannot be applied.

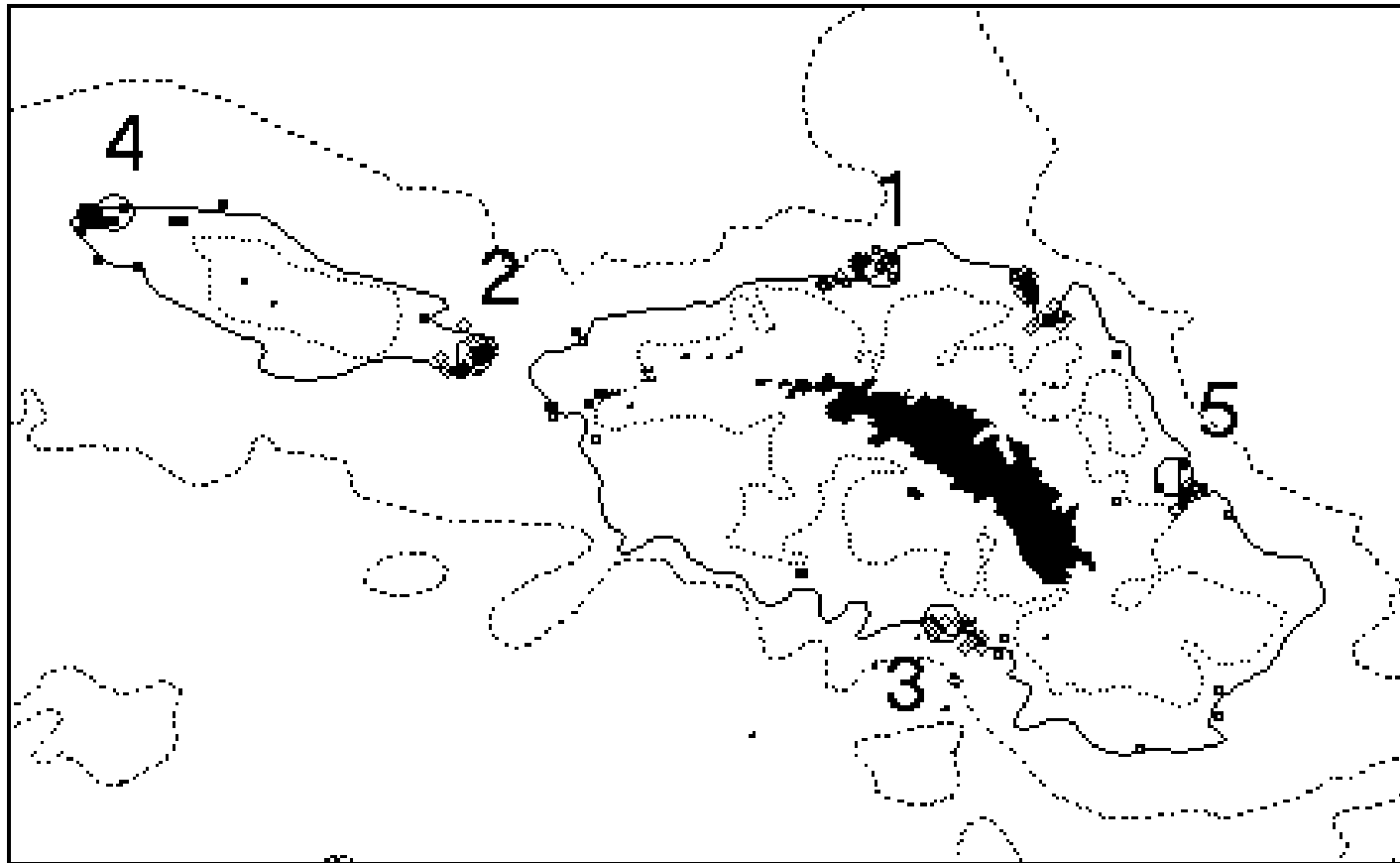


Figure 1: Location of catches in the *D. eleginoides* fishery, Subarea 48.3: squares = Republic of Korea, diamonds = Russia, crosses = Chile, dots = Bulgaria. Positions of experimental sites are numbered

4.12 The Working Group accepted the conclusions of WG-FSA-94/24 and agreed that it was not possible to calculate estimates of stock densities from the 1992/93 data using the stock depletion method, at least on the temporal and spatial scales it had originally envisaged would be appropriate.

Analysis of the 1993/94 Local Depletion Experiments

4.13 Local depletion experiments were conducted on five vessels in Subarea 48.3 during 1993/94 in accordance with Conservation Measure 69/XII and the experimental protocol in COMM CIRC 93/50.

4.14 Paper WG-FSA-94/22 reported an analysis of the local depletion experiment conducted on the Korean vessel *Ihn Sung 66*. Ten longline sets were undertaken on successive days at site 1 (see Figure 1). Of these, the set on the first day had a much longer soak time than the others, the line set on the fourth day was broken and tangled, and the set on the sixth day was made in water shallower (725 m) than on the other days (1 000 to 1 500 m). CPUE data for these three days were omitted from the analysis. A linear regression of CPUE data against accumulated catch was then undertaken. Significant stock depletion was found, and an estimate of local density was calculated. In discussion of this paper, it was agreed that it would be more appropriate not to omit the CPUE with the long soak time, given that the measure of effort was the number of hooks. Similarly, the depth of the shallower set was still within the depth range of the commercial fishery, and it was believed that this datum should also have been included. It was therefore agreed that the data should be re-analysed.

4.15 Paper WG-FSA-94/31 reported an analysis of the local depletion experiment conducted on the Chilean vessel *Friosur V*. Longline sets were made on 10 consecutive days at site 3. When all the data were included, the regression slope was neither significant nor negative. However, when the data for the last longline set were omitted, a regression of CPUE (tonnes) against accumulated catch (tonnes) indicated that depletion had occurred. The Working Group agreed that there was no *a priori* reason to omit the last datum, and therefore it should be included, despite the fact that no density estimate could then be calculated. An interesting feature of the data was that there was a considerable decline in mean weight over the 10 days. No reason was identified as to why this should have occurred.

4.16 Data from the local depletion experiment conducted on the Russian vessel *Maksheevo* at site 2 were reported in SC-CAMLR-XII/BG/9 Rev. 1. No analysis of these data had been attempted prior to the Working Group meeting. In all, 11 longline sets were made within the site on five consecutive days. Three sets were hauled on the third day and five on the fourth day. The Working

Group noted that, while multiple sets on a single day were entirely in accordance with the experimental protocol, the possibility existed that there may have been interactions between these longlines. This would have to be allowed for when analysing the data.

4.17 The final local depletion experiments were undertaken on the Bulgarian vessel *RK-1* over two periods. The experimental protocol had envisaged that two experiments would be undertaken, one at site 4 and one at site 5. In actuality, all fishing was undertaken at site 4, and data satisfying the experimental protocol were available for three time periods of 10, 23 and 13 days duration. Data from these experiments were reported to the CCAMLR Secretariat. No analyses had been undertaken prior to the Working Group meeting.

4.18 Noting some minor differences in the methods of analysis used in WG-FSA-94/22 and 31, as well as the need to include some data that had been omitted in the analyses tabled, the Working Group agreed that the data from all of the experiments should be re-analysed using a consistent methodology.

4.19 Plots of CPUE in numbers per hook against accumulated catch in numbers (calculated using the Ricker 1975 correction) are shown in Figure 2, along with the fitted regression lines. These plots show clear positive slopes for both the Russian and Chilean data, clear negative slopes for the Korean data and the Bulgarian data in period 4, and close to zero slopes for the Bulgarian data for the next two periods. Two of the slopes were significantly less than zero at the 5% level.

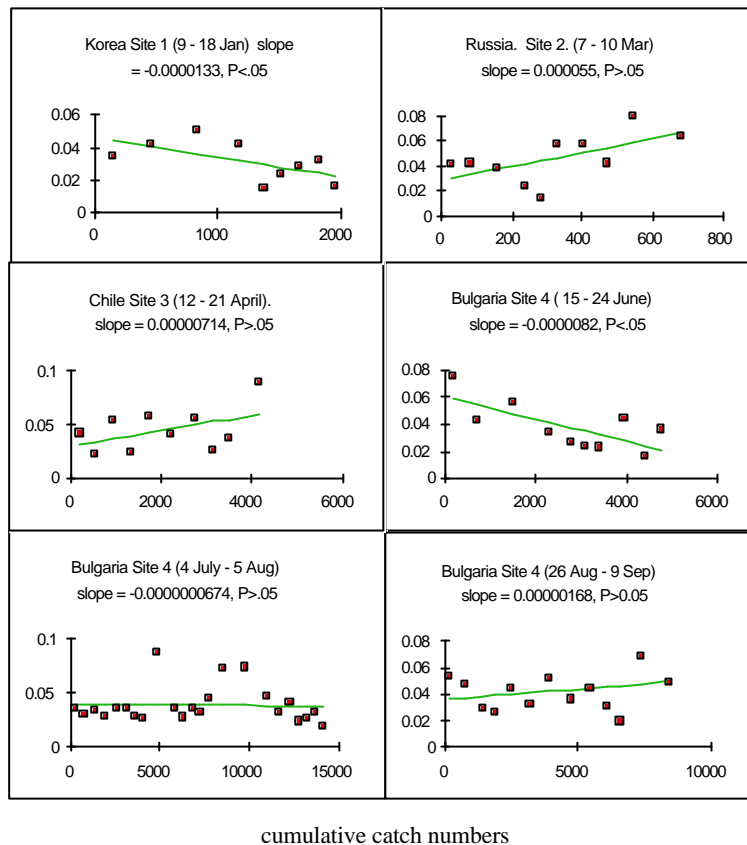


Figure 2: Plots of CPUE in numbers/hook against accumulated catch in numbers for the six depletion experiments.

4.20 Despite the fact that all of these local depletion experiments had been conducted in full accordance with the experimental protocol, the analyses indicate that the assumptions underlying the experiments and the analyses have not been satisfied. Significant local depletion at this temporal and spatial scale has not been consistently detected. Consequently, no estimates of local densities and, therefore, estimates of abundance in Subarea 48.3 can be calculated from these data. This matches the conclusion reached after re-analysing the 1992/93 commercial longline data.

4.21 Dr Moreno reported that a similarly designed local depletion experiment for toothfish undertaken in the 1992 season in southern Chile, involving seven vessels and a total catch of close to 7 000 tonnes, had also failed to detect stock depletion.

Review of Other Data

4.22 The Working Group reviewed the annual mean CPUE data by fleet for 1991/92, 1992/93 and 1993/94 given in WG-FSA-94/20. For the Russian and Bulgarian fleets, the annual CPUE either remained level or rose slightly. Only for the Chilean fleet did the CPUE decline over the three

seasons, however, it is known that there have been significant changes in the Chilean fleet over that time period, and the mean CPUE data are therefore not comparable across seasons. It was believed that CPUE data for some vessels in the Chilean fleet would be comparable across seasons, however the data held by the CCAMLR Secretariat do not allow identification of individual vessels. The Working Group agreed that attempts should be made to obtain information sufficient to identify individual Chilean vessels across seasons, while still retaining the anonymity required for commercial confidentiality.

4.23 Plots of length frequencies for catches taken by Russian vessels for the four seasons 1990/91 to 1993/94 were also examined. There were no obvious changes in the length frequencies for the first three seasons, although there was an increased frequency of smaller fish and slightly lower frequencies of fish around 130 cm in 1994.

4.24 An attempt was made to estimate the abundance of pre-recruit *D. eleginoides* from recent UK surveys. These, in conjunction with size frequency distributions, were used to estimate the abundance of 2-, 3- and 4-year-old fish for 1990, 1991, 1992 and 1994 to provide indications of levels of recruitment in recent years using the approach in WG-FSA-91/20.

4.25 Because the surveys were designed primarily to assess *C. gunnari*, the number of *D. eleginoides* which were caught was low for each survey. Consequently the results of this analysis gave no indication of any trend in recruitment in recent years.

Stock Status and Research Needs

4.26 None of the data (CPUE, length frequency) examined by the Working Group, either on the short temporal and spatial scale of the local depletion experiments or on an annual time scale for the whole subarea, have provided any clear indications of trends in stock abundance. Accordingly, the Working Group was unable to conduct a formal stock assessment. Possible reasons for this were discussed.

4.27 On the short temporal and spatial scale, movement into and out of the local areas of the experiments was identified as a possible reason for no depletion having been observed; the toothfish, a large mobile predator, can move at a sufficient speed and over sufficient distances to violate the assumption that there was no migration into or out of the localised area for the duration of the period analysed. At the subarea level, it is also possible that the waters around South Georgia form only part of the range of a single stock of toothfish that may extend over a much wider area. Existing information about the life history and biology of the toothfish suggests that it is capable of large-scale migrations.

4.28 Little is known about the stock structure of toothfish, which have a circumpolar distribution in sub-Antarctic waters. It is believed that separate stocks probably exist in Atlantic and Indian Ocean waters, and there is evidence that the fish around Crozet Island and Kerguelen come from different stocks. However, the stock structure in the Atlantic is unknown. It was noted that the presence of jellymeat, especially in larger fish, has been observed both at South Georgia and in southern Chile, but not in northern Chile.

4.29 The Working Group was advised by Mr Williams that a mitochondrial DNA study of toothfish from a number of different areas was soon to commence. Progress on this and similar studies was strongly encouraged by the Working Group.

4.30 No data on migrations of toothfish are available, and this is clearly of major importance. The Working Group agreed that this could be addressed through tagging studies, probably using snap-off hooks, and it encouraged such experiments.

4.31 Another possible reason for the failure to detect fishery-induced changes in stock indicators in the depletion experiments is simply that the current catches are small in relation to the available local stock of fish. While this could by no means be ruled out, the Working Group was very reluctant to adopt it as a working hypothesis. The Working Group has previously expressed concerns about the probable high vulnerability to over-exploitation of a long-lived and slow-growing fish like the toothfish. It is also quite possible that the relationship between CPUE and abundance may be such that changes in abundance only become apparent when the stock has been reduced to low levels. The Working Group reiterated its view that a conservative approach should be taken to the management of toothfish in this subarea.

4.32 The Working Group reviewed the requirements for data reporting in this fishery. In addition to the required information listed in the *Inspectors Manual*, the following information should be requested from commercial fishing operations:

- (i) conversion factors from processed to whole weight;
- (ii) bottom depths at both start and end of a longline set;
- (iii) direction of haul;
- (iv) percentage of hooks baited;
- (v) by-catch of birds and marine mammals;
- (vi) amounts of discarded fish;
- (vii) design of longline gear (e.g., Spanish, traditional);
- (viii) an unequivocal measure of the depth at which hooks were set off the bottom; and

- (ix) information allowing unique identification of individual vessels across years within the CCAMLR Database.

4.33 There is a clear need for the collection of length frequency data and of otoliths and scales for age reading. These data should be collected in such a way as to ensure full coverage of fishing throughout the season and throughout the subarea. It was recognised that these data could only be collected by qualified observers, and therefore the Working Group recommended that all vessels fishing in the subarea should have a scientific observer on board. The observer should also collect biological data on, for example, sex and maturity stage of fish caught.

4.34 With regard to future research, the need for studies of stock identity and of migrations has already been identified. The Working Group noted that there had been insufficient time during the meeting to undertake as thorough an analysis of the CPUE and length frequency data as would be desirable. It recommended that such an analysis be undertaken in the intersessional period. This analysis should take full account, *inter alia*, of both the area fished within the zone and the depths fished.

4.35 Another possible new source of data for stock assessment is properly designed longline surveys. These would need careful consideration and planning, as would any future possible depletion experiments, given the disappointing results of the ones conducted during the 1993/94 season.

4.36 Since a certain amount of time is needed to consider fully the results of analyses to be conducted in the coming year, to plan the collection of new data and to review possible new assessment methods for this stock, the Working Group recommended that a three-day meeting be scheduled prior to next year's Working Group meeting to address these issues with the following terms of reference:

- (i) to review catch information, including the location and size of catches both in and outside the Convention Area;
- (ii) to review and evaluate available information on stock identity over the entire range of the species and in particular the relationships between stocks in Subarea 48.3 and neighbouring areas;
- (iii) to review and evaluate methods for conducting surveys of stocks targeted using longlines;

- (iv) to review and evaluate methods for assessing the status of stocks and for determining appropriate yields, including the utility of CPUE data from the longline fishery in these assessments;
- (v) to identify the data requirements from the longline fishery; and
- (vi) to provide advice to the Working Group on stock identity and on stock survey and assessment procedures.

4.37 In order to help decide whether to hold the workshop and when it should be held in relation to the meeting of the Working Group, haul-by-haul longline fishery data, results of stock identification analyses, and papers relevant to the terms of reference (i) to (iv) should be submitted to the Secretariat by 1 August 1995. At that time, the work of the Working Group regarding stock assessments can be reviewed to see whether the workshop can be held during the meeting of the Working Group or whether it should be held three days prior to that meeting.

4.38 The Working Group agreed that the workshop would require the assistance of experts who have been involved with the assessment of longline fisheries elsewhere in the world, in particular, the fisheries for *D. eleginoides* in South America. Therefore, the Working Group recommended that the Scientific Committee request funds be provided for two experts to participate in the workshop.

Management Advice

4.39 The Working Group has been unable this year to carry out a stock assessment of the toothfish in Subarea 48.3 and is therefore unable to advise appropriate TACs. It therefore is faced by a position similar to that of two years ago.

4.40 In none of the data examined were there indications that the current and recent levels of catches had had any detectable effect on the fishery. However, given the concerns expressed previously about the interpretation of longline CPUE and the probable high vulnerability of toothfish to overfishing, the Working Group agreed that a precautionary approach should be taken to the setting of any TACs until a reliable stock assessment has been completed.

4.41 In view of this, the Working Group is not in a position to advise on particular levels of TAC for the 1994/95 season. It noted the following TACs and catches from past years:

	TAC	Catch
1991	2 500	3 641 ^a
1992	3 500	3 703 ^b
1993	3 350	3 049 ^c
1994	1 300	604 ^d

^a Includes 1 440 tonnes taken before 2 November 1990

^b Includes 1 tonne taken as research catch by the UK, 132 tonnes taken as research catch by Russia before 30 June

^c 59 tonnes taken by Russian research cruise July 1992, 2 990 tonnes by the longline fishery December 1992 to February 1993

^d Includes 179 tonnes taken in the 1994 fishing season but after 1 July 1994, 1 tonne taken by research cruises

4.42 To better assess *D. eleginoides* stocks in the future, the Working Group recommends, pending the submission of data and appropriate papers, that a three-day workshop be scheduled to run immediately prior to, or during, the 1995 WG-FSA meeting to discuss stock identity, survey designs, assessment methodologies and data requirements.

4.43 The Working Group requests that prior to the workshop the Secretariat compile comprehensive haul-by-haul data from all longline catches in Subarea 48.3.

4.44 It also requested that data on catches of *D. eleginoides* taken in areas of the southwest Atlantic which are outside the Convention Area be sought and compiled by the Secretariat.

Champscephalus gunnari (Subarea 48.3)

Commercial Catch

4.45 There was no reported commercial catch of *C. gunnari* in Subarea 48.3 during the 1993/94 season, despite a TAC of 9 200 tonnes (Conservation Measure 66/XII). The season lasted from 1 January 1994 to 1 April 1994, when it was closed in accordance with Conservation Measure 66/XII until the end of the Commission meeting on 4 November 1994. There has now been no reported commercial catch of *C. gunnari* in Subarea 48.3 since March 1990. A total of 8 027 tonnes was reported in that season.

Research Surveys

4.46 Two research surveys aimed at estimating the abundance of *C. gunnari* in Subarea 48.3 were conducted during the 1993/94 season. The results of these surveys were reported in documents WG-FSA-94/18 (UK survey on MV *Cordella*) and WG-FSA-94/29 (Argentine survey on *Dr Eduardo L. Holmberg*). The methods used during these surveys are discussed in paragraphs 3.18 to 3.20.

4.47 The start of the 1993/94 season for *C. gunnari* in Subarea 48.3 was delayed to coincide with the trawl survey undertaken by the UK in January 1994. The TAC was agreed on the condition that any significant trend which would affect current estimates of the stock size would be immediately brought to the attention of the Commission. The preliminary results of the survey indicated that there was a substantially smaller biomass of *C. gunnari* in Subarea 48.3 than had been predicted by the projections conducted by the Working Group in 1993. This information was communicated to the Commission and circulated to Members in COMM CIRC 94/11 on 17 February 1994.

4.48 Estimates of the standing stock of *C. gunnari* from the two surveys are presented in Tables 3 and 4. Estimates from the UK survey were calculated using two estimators: the Minimum Variance Unbiased Estimate (MVUE) (de la Mare, 1994¹) and the sample mean (WG-FSA-94/18). WG-FSA-94/29 presented results based on a log transform within a nested model. Due to the non-random survey design the standing stock estimates from WG-FSA-94/29 were not recalculated using the MVUE model. The results presented in the paper are therefore recorded in Table 4.

Table 3: Comparison of biomass estimates (tonnes) for *C. gunnari* for the UK survey in Subarea 48.3.

Area and Estimation Method	Depth Strata (m)			Entire Depth Range	CV	95% Confidence Limits	
	50-150	150-250	250-500			Lower	Upper
South Georgia							
MVUE ¹	6 050	9 073	965	16 088	0.24	10 365	39 207
Sample Mean	6 254	7 699	970	14 923	0.22	-	-
Shag Rocks							
MVUE ¹	506	4 364	-	4 870	0.25	2 930	29 046
Sample Mean	453	4 358	20	4 831	0.24	-	-

¹ de la Mare, 1994

¹ de la Mare, W.K. 1994. Estimating confidence intervals for fish stock abundance estimates from trawl surveys. *CCAMLR Science*, Vol. 1: 203-207.

Table 4: Biomass estimates (tonnes) for *C. gunnari* for the Argentine survey in Subarea 48.3.

Area and Estimation Method	Depth Strata (m)			Entire Depth Range	95% Confidence Limits	
	50-150	150-250	250-500		Lower	Upper
South Georgia Log transform, nested model	375	1 608	29	2 012	252	8 246
Shag Rocks Log transform, nested model	-	-	-	67 259	23	14 x 10 ⁶

4.49 The standing stock estimates from the two surveys could not be compared directly due to differences in the survey design, sampling equipment and estimation methods.

4.50 The UK survey was a continuation of the series of surveys undertaken by the UK in Subarea 48.3 during recent years, using the same methodology as before. The results of this survey were therefore used as the basis for an assessment of the current status of the stock.

4.51 No concentrations of *C. gunnari* were detected during the UK survey. The population was comparatively evenly distributed over the shelf at low densities. The use of both methods of estimation (MVUE and sample mean) resulted in low standing stock estimates. The CVs were also low, although the confidence limits provided by the MVUE program were considered to present a more realistic indication of the uncertainty in the estimates.

4.52 The Argentine survey also did not detect any concentrations on the South Georgia shelf. However, one very large catch on the Shag Rocks shelf at the start of the survey resulted in a high abundance estimate for that area, with very large confidence limits.

Stock Status

4.53 The standing stock estimates from the UK survey were considerably lower than expected from cohort projections made at last year's meeting.

4.54 Age data from the UK survey had not been fully analysed prior to the meeting and preliminary examination of these data during the meeting indicated that they could not be used in their present form. The age structure of the samples taken on the UK survey was estimated from the catch weighted length frequency from that survey and the age/length key from the Argentine survey, reported in WG-FSA-94/11. This age/length key was considered to be applicable to the samples taken on the UK survey due to the short time difference between the two surveys.

4.55 Figures 3 and 4 provide comparisons between the biomass-at-age projected at last year's meeting and that observed during the UK survey. Two projections were performed at last year's meeting: projection 1 starting from the median estimate of biomass from the UK survey in 1991/92 and projection 2 starting from the lower 95% confidence bound (MVUE). Projection 2 was re-run at this year's meeting using the q s from the VPA to adjust the biomass estimate used as the starting point in accordance with the comments in last year's Working Group report (SC-CAMLR-XII, Annex 5, paragraph 6.52).

4.56 Both projections conducted at last year's meeting assumed no fishing took place up to 1993/94 and a constant coefficient of natural mortality (M) of 0.48.

4.57 In order to compare the current estimate from the survey directly with the projections, the former was back-calculated to 1 July 1993. To provide estimates of absolute abundance a value of M of 0.48 was used, taking into account catchability (q) at age from run 5 of the VPA performed at last year's meeting (SC-CAMLR-XII, Annex 5, Table 10). The error bars shown on the figures for ages 2 and 3 represent the uncertainty in the projections derived purely from the simulation of recruitment variability (SC-CAMLR-XII, Annex 5, paragraph 6.53).

4.58 The total discrepancy between observed and median expected biomass over all age classes was 113 500 tonnes and 83 100 tonnes for projections 1 and 2 respectively.

4.59 The Working Group recalled the similar drop in biomass between 1989/90 and 1990/91 described in the 1991 Working Group report (SC-CAMLR-X, Annex 6, paragraphs 7.28 to 7.36). The decline in standing stock between 1989/90 and 1990/91 was indicated by the bottom trawl surveys undertaken in those seasons by the UK and the former USSR. The current decline, however, was indicated by the discrepancy between the cohort projections from the survey in January 1992 and the survey in January 1994. There was no survey in the 1992/93 season.

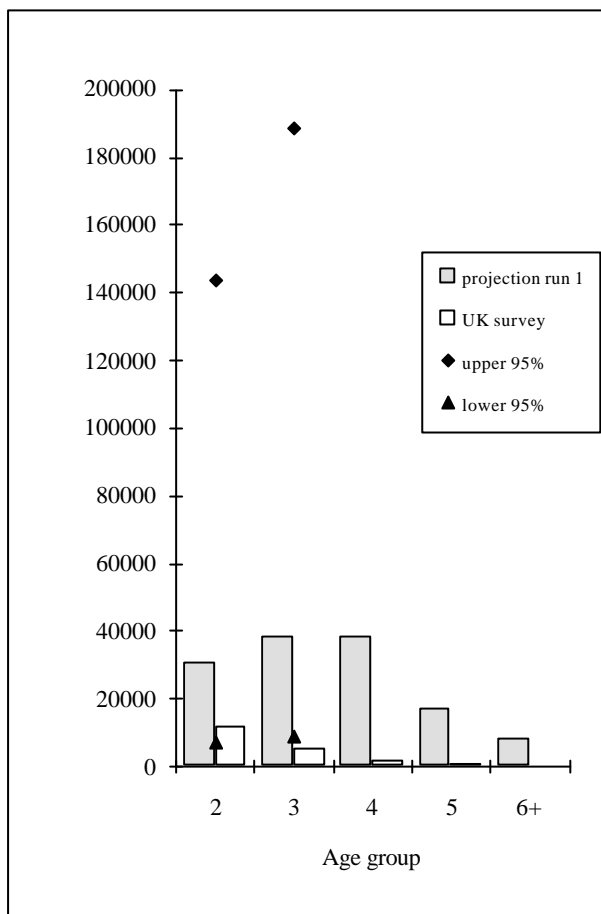


Figure 3: Projections of biomass of *C. gunnari* by age group (projection 1), with confidence intervals for the first two ages, compared with results from the UK survey in 1994.

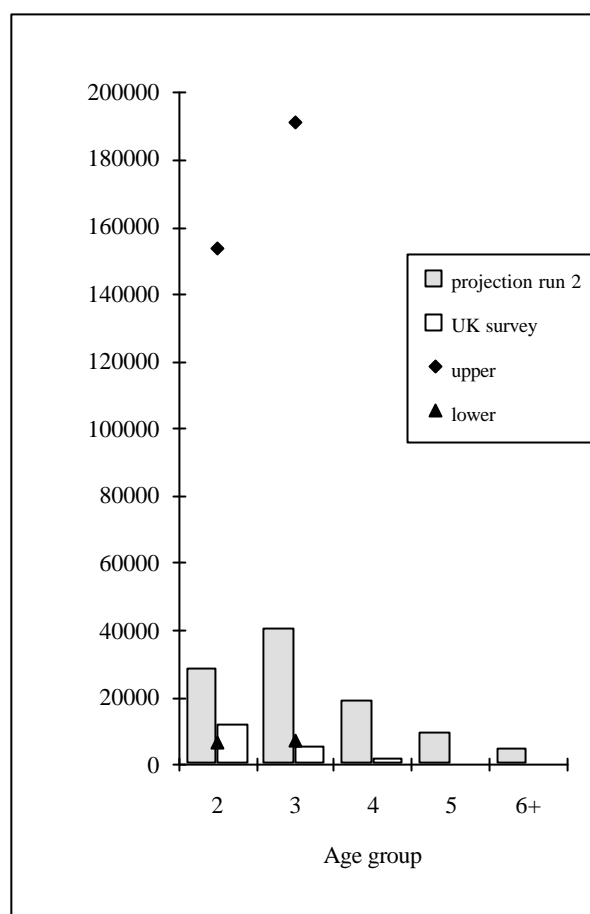


Figure 4: Projections of biomass of *C. gunnari* by age group (projection 2), with confidence intervals for the first two ages, compared with results from the UK survey in 1994.

4.60 In 1991 the Working Group considered a number of possible explanations for the apparent decline. These were reconsidered at the present meeting under the following headings:

- (i) unreported fishing mortality;
- (ii) recruitment failure;
- (iii) uncertainty in the estimates from the surveys including uncertainty caused by possible dispersal; and
- (iv) natural mortality in the recruited population above the level assumed in the projection.

Unreported Fishing Mortality

4.61 The Working Group had received no information which suggested that unreported fishing on a scale necessary to account for the observed discrepancy had taken place.

Recruitment Failure

4.62 The observed biomass of 2-year-olds in 1993/94 was within the 95% confidence bounds of the projections (Figures 3 and 4). The number of 2-year-olds in 1993/94 was projected back to the recruitment of 1-year-olds in 1992/93, assuming an M of 0.48. The absolute level of recruitment was in the region of 300 million individuals, which was at the lower end of the range of recruitment indicated by the VPA results at last year's meeting (SC-CAMLR-XII, Annex 5, Figure 7). These recruits would have resulted from the spawning event in March/April 1991, just after the UK survey in that year which indicated some abnormality in the ovarian maturation cycle of some fish, possibly linked to the low availability of krill in Subarea 48.3 at that time (SC-CAMLR-X, Annex 6, paragraph 7.31).

4.63 The observed biomass of 3-year-olds in 1993/94 was lower than the lower 95% confidence bounds of the projections (Figures 3 and 4). The number of 3-year-olds in 1993/94 was projected back to the recruitment of 1-year-olds in 1991/92. This implied an absolute level of recruitment of 1-year-olds in 1991/92 of only 80 million individuals. This would be considerably lower than the lowest recruitment estimated over the history of the fishery by the VPA performed at last year's meeting.

4.64 The Working Group concluded that the abundance of 2-year-olds observed in 1994 could be explained by a poor recruitment in 1992. However, the level of recruitment required to explain the observed number of 3-year-olds in 1994 was lower than would reasonably be expected. The current low abundance could not therefore be explained solely by poor recruitment.

Uncertainty in the Estimates from the Surveys

4.65 Uncertainty in the stock estimates from the surveys arises from the patchy distribution of fish within strata and the consequent variation in density estimates between sampling stations. The confidence limits for the 1992 and 1994 UK surveys, shown in Table 3 and in Table 7 of last year's report (SC-CAMLR-XII, Annex 5), are comparatively narrow for trawl surveys of this type, reflecting the relatively even distribution of fish encountered.

4.66 The Working Group pointed out that these confidence limits do not take into account the possibility that there were patches of high density *C. gunnari* in Subarea 48.3 which were not detected by the UK surveys. For example, the Argentine survey in 1994 detected a high concentration of fish at Shag Rocks which apparently persisted for the few weeks during which the vessel was in Subarea 48.3. This patch was not detected during the UK survey which sampled in the Shag Rocks area only a few weeks before. The data could be re-analysed - to include the probability of encountering a patch - based on the results of the whole survey series. This would provide more realistic upper confidence limits regardless of whether a patch was encountered or not.

4.67 There were substantial uncertainties in the estimates of abundance from the surveys and recruitment, which may account for the observed discrepancy. However, the Working Group considered that this was unlikely given that the observations are based on best estimates. It was further considered that there could be serious implications for stock status if the observed decline was a genuine occurrence, but had been dismissed as an artefact of the analysis. Therefore other possible explanations were investigated.

4.68 Dr Everson recalled that the possibility of changes in distribution of *C. gunnari*, resulting in changes in availability to the trawl survey in Subarea 48.3, was considered at the Working Group meeting in 1991 as an explanation of the observed decline in abundance in that year. Such changes may also be responsible for the apparent decline in 1993/94.

4.69 There is no evidence that *C. gunnari* undertakes migrations away from Subarea 48.3 to other shelf areas on the scale necessary to account for the apparent decline.

4.70 Temporary dispersal of the population across the shelf and throughout the water column in Subarea 48.3 could reduce the availability of the fish to the bottom trawl survey, thus resulting in an artificially low estimate of standing stock. This could reasonably be expected to be followed by a corresponding increase in abundance associated with the fish returning to their normal distribution close to the seabed when conditions became favourable again. The increase in abundance indicated by the survey in the 1991/92 season was broadly in line with cohort projections from the 1990/91 survey. There was no indication that a substantial number of fish, absent in 1990/91, had returned to the shelf in 1991/92. The Working Group considered that the observations in 1991 and 1994 were sufficiently similar to infer that changes in distribution were probably not responsible for the apparent decline in 1993/94.

Natural Mortality in the Recruited Population Above the Level Assumed in the Projection

4.71 There are two components to variation in M: an interannual component and an inter-age component. The historical low abundance of older fish (>5 years old) in the population shown by the VPA suggests that M may be increasing with age. The recent stock dynamics indicated by the surveys and cohort projections suggest that there may also be considerable variation in M between years.

4.72 The projections undertaken at last year's meeting were re-run at this year's meeting, incorporating variable M-at-age to investigate the level of M which would be required to match the projection with the observation in 1993/94. The variation in M around the normally assumed level of 0.48 was assumed to apply between 1992/93 and 1993/94. The implied change in M was substantial, ranging from 2.5 on 2- to 3-year-old fish to 4.5 on 4- to 5-year-old fish.

4.73 In considering the possible causes of such a change in M, the Working Group recalled the tentative link in 1991 made between the decline in *C. gunnari* abundance and the low availability of krill in Subarea 48.3 in that year. 1993/94 has also been characterised as a season of low krill availability at South Georgia. Discussions on the reliance of *C. gunnari* on krill as a food supply have been presented in previous Working Group reports. Information on the feeding status of *C. gunnari* during the UK survey was presented in WG-FSA-94/15. Overall feeding intensity was low, and the occurrence of krill in the diet was the lowest recorded since 1967. The main prey item in the absence of krill was *T. gaudichaudii*.

4.74 According to the diet analysis from the Argentine survey presented in WG-FSA-94/27, krill was the main food item in terms of frequency of occurrence, however a large proportion of empty stomachs were found and those stomachs containing food had a high proportion of *T. gaudichaudii*. The difference between both surveys may be due to methodological differences and their timing, as well as changes in plankton composition associated with water movements indicated in WG-FSA-94/29.

4.75 The occurrence of patches of high concentrations of *C. gunnari* has been linked to the fish feeding on krill concentrations in the past. The overall lack of krill concentrations in Subarea 48.3 during this period may explain the absence of high concentrations of *C. gunnari* in the UK survey. Lic. E. Marschoff (Argentina) suggested that the presence of a high concentration of *C. gunnari* around Shag Rocks in the Argentine survey may be explained by a localised aggregation of krill, perhaps resulting from oceanographic changes, given the higher frequency of occurrence of krill in the diets of fish in this area during its survey (see paragraphs 4.73 and 4.74).

4.76 The Working Group agreed that the repeat occurrence of an apparent drop in biomass at the same time as a low availability of krill was interesting, however in the absence of information on the stock in 1992/93, it was not possible to assess over what period the increase in M might have been occurring and whether the short-term shortage of krill could be responsible.

4.77 Information was presented to the Working Group in WG-FSA-94/17, suggesting that Antarctic fur seals (*Arctocephalus gazella*) might be responsible for periodic increases in mortality of *C. gunnari* in poor krill years. *A. gazella* feed substantially on krill and, to a smaller extent, on fish. When krill are scarce they change diet and feed predominantly on fish (North *et al.*, 1983²). The population of *A. gazella* has been increasing rapidly over the past three decades to the point where the current estimate of population size is 4.2 million animals (Boyd, 1993³). A change in the proportion of fish in the diet of fur seals, as might be expected when krill are scarce, would be sufficient to account for the observed decline in *C. gunnari* (see paragraph 5.5). Further work is required to refine the understanding of the spatial and temporal scales of the interaction between icefish, krill and fur seals before any firm conclusions can be drawn. The Working Group noted that the prey requirements of fur seals, particularly during periods of low krill availability, may need to be considered in future management advice for the *C. gunnari* fishery in Subarea 48.3.

Development of a Longterm Management Approach

4.78 On the basis of the uncertainties in the current stock status, the Working Group agreed that calculations of yield based on the approach developed for krill would be appropriate for this fishery. It was further agreed that work should begin on a longterm management plan for the fishery which accounts for uncertainty in biomass estimates, variability in recruitment, variability in M with age and between years, and variability in growth. In particular, the Working Group noted that the calculations of yield will need to incorporate the possibility of major mortality events occurring every few years. This estimate of a longterm annual yield should have a low probability of causing depletion in the stock.

4.79 The Working Group agreed that decision rules need to be developed for this fishery for deciding (i) what levels of longterm yield are appropriate, and (ii) under what circumstances the longterm yield may be varied (e.g., the use of pre-season surveys for setting annual TACs). An

² North, A.W., J.P. Croxall and D.W. Doidge. 1983. *British Antarctic Survey Bulletin*, 61: 27-37.

³ Boyd, I.L. 1993. *Antarctic Science*, 5: 17-24.

important component of this work is to determine the features of the stock that needs to be protected according to the objectives of the Convention.

Management Advice

4.80 The Working Group considered that developing a longterm management plan should be accorded a high priority. Uncertainty over many of the parameter values means that such an approach will take some time to develop. In the meantime, the Working Group provided advice solely on short-term management options.

4.81 The Working Group agreed that the calculation of yield on the basis of $F_{0.1}$, as done in the past, is no longer appropriate for this fishery given the uncertainty in stock biomass estimates, recruitment variability and possible large interannual variation in M and the potential for M to increase with age. Also, the recent apparent decline in stock abundance and the potential influence of predation by seals in some years suggest that the level of escapement of the spawning stock should be much greater than that which would occur under an $F_{0.1}$ strategy. This is necessary in order to prevent a significant depletion of the stock and possible recruitment failure in poor krill years. The Working Group agreed that escapement of the spawning stock should be high for the 1994/95 season.

4.82 Given the uncertainties in M and other characteristics of the stock, the Working Group is unable to determine with any confidence the level of yield that would avoid significant depletion. Consequently, the Working Group recommends the fishery be closed for the 1994/95 season.

4.83 The Working Group strongly recommended that a survey be carried out during the coming season to monitor the status of the stock and provide more information for the development of the longterm management approach.

Electrona carlsbergi (Subarea 48.3)

4.84 The TAC for *E. carlsbergi* for the 1993/94 season was set at 200 000 tonnes in this subarea, and a local TAC for the Shag Rocks region was set at 43 000 tonnes (Conservation Measure 67/XII). No commercial catches were reported for the 1993/94 season.

4.85 No new survey or fishery information on the stock had been submitted to CCAMLR since last meeting.

4.86 A new assessment of yield for *E. carlsbergi* was presented to the Working Group in WG-FSA-94/21. This assessment was undertaken because:

- (i) previous assessments of WG-FSA showed that determining yield at $F_{0.1}$ was not appropriate for this species (SC-CAMLR-X, Annex 6, paragraph 7.139);
- (ii) the biological and survey data available for the stock are now much older than the life expectancy of fish in the stock (SC-CAMLR-X, Annex 6, paragraph 7.133; SC-CAMLR-XII, Annex 5, paragraph 6.69); and
- (iii) WG-FSA has identified that a greater escapement of *E. carlsbergi* may be required to meet the needs of predators (SC-CAMLR-XII, Annex 5, paragraph 6.68).

4.87 An approach based on stock projections was used to estimate yields for *E. carlsbergi* given the uncertainties in the characteristics of the stock and in line with the objectives in Article II of the Convention. This approach has been endorsed by the Scientific Committee (SC-CAMLR-IX, paragraph 8.11) and developed further by WG-Krill with a krill yield model (SC-CAMLR-XII, paragraphs 2.66 to 2.75; Annex 5, paragraph 5.1). WG-Krill has developed three decision rules for adopting a yield estimate (where $Y = \gamma \cdot B_0$):

- (i) choose γ_1 , so that the probability of the spawning biomass dropping below 20% of its pre-exploitation median level over a 20-year harvesting period is 10%;
- (ii) choose γ_2 , so that the median escapement over a 20-year period is 75%;
- (iii) select the lower of γ_1 and γ_2 as the level of γ for calculation of yield.

4.88 These decision rules and the use of the krill yield model as the basis for the analysis were used for estimating an appropriate γ for *E. carlsbergi* because this species and krill share a number of attributes, including population dynamics, behaviour and their importance as prey in the Antarctic ecosystem.

4.89 Paper WG-FSA-94/21 discusses the modifications made to the krill yield model to use it for estimating γ for fish stocks generally. The basic attributes of the krill model were retained in the generalised model, i.e. the timing of growth, options for fishing and the general projection structure (see Annex 5, paragraphs 4.51 to 4.110 for discussion of this work). The model was updated to allow input of biological and survey parameters and to allow variation of the simulation characteristics. The input parameters used to estimate γ with this generalised model are shown in

Table 5. Table 6 shows the values for γ for each decision rule. On the basis of the decision rules, the estimate of γ for calculating a TAC for *E. carlsbergi* was 0.091.

Table 5: Input parameters used to estimate γ for *E. carlsbergi*.

Parameter	Estimates	Source
Natural mortality (M)	0.65 to 0.98	SC-CAMLR-X, Annex 6, paragraph 7.138
Maximum age	5 years	SC-CAMLR-X, Annex 6, paragraph 7.136
L_8	95 mm	SC-CAMLR-X, Annex 6, paragraph 7.136
von Bertalanffy K	0.771	Derived using non-linear regression - SYSTAT, 1992 - of standard von Bertalanffy model with age and mean length from SC-CAMLR-X, Annex 6, Table 10
Age-at-maturity	3	SC-CAMLR-X, Annex 6, paragraph 7.131
Length-at-maturity	81.8 mm	Knife-edge maturity - taken as mean length-at-age of maturity minus one standard deviation (data from SC-CAMLR-X, Annex 6, Table 10)
Age-at-recruitment	2	SC-CAMLR-X, Annex 6, paragraph 7.131
Length-at-recruitment	60 mm	Knife-edge recruitment (SC-CAMLR-X, Annex 6, paragraph 7.131)
Range in recruitment variability	0.4 to 0.6	No data are available to determine variation in recruitment (SC-CAMLR-X, Annex 6, paragraph 7.133). This range has been adopted from Butterworth <i>et al.</i> (1994)* for krill.
CV of biomass estimate	0.3	SC-CAMLR-X, Annex 6, paragraph 7.134
Fishing season	All year	Consistent with Conservation Measure 67/XII
Selectivity	Ages 1,4,5 = 0 Age 2 = 1 Age 3 = 0.2	SC-CAMLR-X, Annex 6, paragraph 7.138

* Butterworth, D.S., G.R. Gluckman, R.B. Thomson, S. Chalis, K. Hiramatsu and D.J. Agnew. 1994. Further computations of the consequences of setting the annual krill catch limit to a fixed fraction of the estimate of krill biomass from a survey. *CCAMLR Science*, Vol. 1: 81-106.

Table 6: γ values derived for *E. carlsbergi*.

Decision Rule 1	Decision Rule 2	Decision Rule 3
γ_1 0.091	γ_2 0.102	γ to calculate yield 0.091

4.90 The Working Group agreed that the approach and decision rules adopted for estimating krill yields by WG-Krill are appropriate for estimating yield for *E. carlsbergi*. On this basis, the Working Group agreed that the estimate of γ of 0.091 was the best available. However, the

Working Group also noted that the estimate will be influenced by the variability in the pre-exploitation biomass estimate, range of recruitment variability, estimates of M and von Bertalanffy K , the timing of the period of fish growth (punctuated versus continuous growth) and the relationship between the fishing season and the growth and reproductive periods. For these reasons, the Working Group noted that the estimate of γ will need to be refined following (i) investigations of the sensitivity of the model to uncertainty in these parameters, and (ii) acquisition of refined estimates of those model parameters, such as and in particular, recruitment variability.

Management Advice

4.91 The Working Group agreed that, pending refined estimates of the stock parameters and biomass, the decision rules adopted for estimating krill yield are appropriate for *E. carlsbergi* and that the estimate of γ of 0.091 is the best available.

4.92 The most recent estimate of *E. carlsbergi* biomass was from a survey in 1987/88. This was used as the basis for calculating a TAC of 200 000 tonnes (Conservation Measure 67/XII) in 1993/94. Using this estimate of biomass and the new estimate of γ from the generalised krill yield model, the corresponding catch levels would be 109 100 tonnes for Subarea 48.3 and 14 500 tonnes for the region around Shag Rocks.

4.93 The Working Group reiterated its concern that the biomass estimate is out of date and that, as a consequence, the recalculated catch levels should be viewed with caution. The Working Group requests that in the event that a fishery should recommence on this stock, a new biomass survey and revision of the biological parameters should be undertaken in accordance with Conservation Measure 67/XII, paragraph 4, in order to be able to refine the estimates of yield for this stock.

Other Species (Subarea 48.3)

4.94 Biomass estimates and length compositions were available from the UK (WG-FSA-94/18) and Argentine (WG-FSA-94/29) bottom trawl surveys around South Georgia. Due to methodological differences in survey design and analysis between the two surveys, the Working Group based its assessments primarily on results from the UK surveys for which comparable data are available for a number of recent years (Tables 7 and 8).

Table 7: Comparison of biomass estimates (tonnes) with the results from previous UK surveys around South Georgia.

Species	Season									
	1988/89		1989/90		1990/91		1991/92		1993/94	
	A	CV%	B	CV%	C	CV%	D	CV%	E	CV%
<i>C. gunnari</i>	31700	45	95435	63	22089	16	37311	21	14923	21
<i>C. aceratus</i>	5770	14	14226	37	13474	15	12459	15	9685	19
<i>P. georgianus</i>	8278	53	5761	28	13948	19	13469	15	5707	18
<i>N. gibberifrons</i>	8510	17	12417	28	28224	18	29408	15	23459	20
<i>N. rossii</i>	2439	54	1481	76	4295	49	7309	61	6600	45
<i>D. eleginoides</i>	326	66	335	39	885	37	2460	21	2219	24
<i>N. squamifrons</i>	131	98	1690	-	1374	43	1153	60	1148	79

A = Parkes *et al.* (1989) WG-FSA-89/6

B = Parkes *et al.* (1990) WG-FSA-90/11

C = UK *Falklands Protector* survey (1991) WG-FSA-91/14

D = UK *Falklands Protector* survey (1992) WG-FSA-92/17

E = UK *FPV Cordella* survey (1994) WG-FSA-94/18

Table 8: Comparison of biomass estimates (tonnes) with the results from previous UK surveys around Shag Rocks. Surveys as for Table 7.

Species	Season							
	1989/90		1990/91		1991/92		1993/94	
	B	CV%	C	CV%	D	CV%	E	CV%
<i>C. gunnari</i>	279000	83*	3919	75	2935	35	4601	24
<i>C. aceratus</i>							10	100
<i>P. georgianus</i>	37	73	15	62				
<i>N. gibberifrons</i>	267	39	117	34	166	26	107	35
<i>D. eleginoides</i>	9631	55	19315	94	3353	35	1767	25
<i>N. squamifrons</i>	120	44	631	33	83	74	618	56
<i>P. guntheri</i>	13608	90	584	45	12764	61	4589	36

* with large-scale adjustment added (SC-CAMLR-X, Annex 6)

4.95 Biomass estimates provided in WG-FSA-94/18 were based on the 'traditional' method of calculating biomass by using sample means (Saville, 1977⁴). Re-analysis of these results using the MVUE model (WG-FSA-93/20) resulted in higher biomass estimates for all species; the trend in biomass over time was similar to results presented in Table 7.

4.96 The difference in biomass estimates obtained using the 'traditional' method and the MVUE approach varied among species, sometimes to a larger extent than was expected from the assumed comparatively even spatial distribution of the species. The Working Group therefore recommended that the causes of these differences be explored in the intersessional period. For the time being the

⁴ Saville, A. (Ed.) 1977. Survey methods of appraising fisheries resources. *FAO Fish. Tech. Paper.*, 71: 76 pp.

Working Group decided that since it generally uses survey results as indices of abundance, it would be appropriate to use the results derived by the 'traditional' method from the UK surveys since 1989 as its primary index of abundance (Table 7).

Notothenia rossii (Subarea 48.3)

4.97 The biomass estimate of 6 600 tonnes was within the confidence limits of estimates from previous surveys since 1991 (Table 7). Length compositions, albeit based on sample sizes of a few hundred specimens only, were similar to those from previous surveys. Both observations suggest little change in stock composition in recent years.

Management Advice

4.98 The Working Group reiterated its advice from previous years that all conservation measures for this species should remain in force (Conservation Measures 2/III, 3/IV and 68/XII).

Notothenia gibberifrons, *Chaenocephalus aceratus*
and *Pseudochaenichthys georgianus* (Subarea 48.3)

4.99 Biomass estimates for these three species were lower than from previous surveys (Tables 7 and 8). The decrease in biomass of *N. gibberifrons* and *C. aceratus* fell within the confidence limits of estimates from previous surveys. However, the biomass estimate for *P. georgianus* was significantly below previous estimates (Table 7).

4.100 Length composition data for *N. gibberifrons* showed a steady increase in the proportion of adult fish (>34 cm) in the stock (Figure 5). The proportion of adult *C. aceratus* (>42 to 45 cm) has decreased from 1990 to 1992, but increased again in 1994 (Figure 6).

4.101 Length composition data for *P. georgianus* demonstrated that a strong year-class (1988 cohort) had recruited to the stock in 1990. Recruitment in subsequent years was much lower (Figure 7). The 1988 cohort was still dominant in the stock in 1991 and 1992. If this species is as short-lived as has been assumed in a previous assessment (Agnew and Kock, 1990⁵), part of the decline in biomass may be explained by the disappearance of this year-class from the stock.

⁵ Agnew, D.J. and K.-H. Kock. 1990. An assessment of *Chaenocephalus aceratus* and *Pseudochaenichthys georgianus* in Subarea 48.3. Document WG-FSA-90/6 (mimeo). CCAMLR, Hobart, Australia.

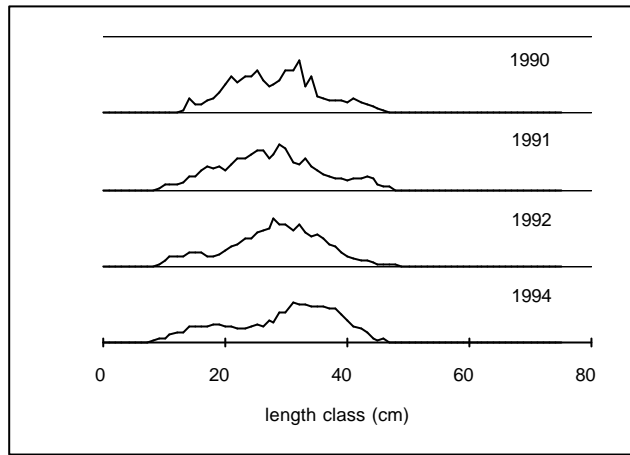


Figure 5: Length frequency distributions of *N. gibberifrons* from UK surveys in Subarea 48.3. There was no survey in 1993.

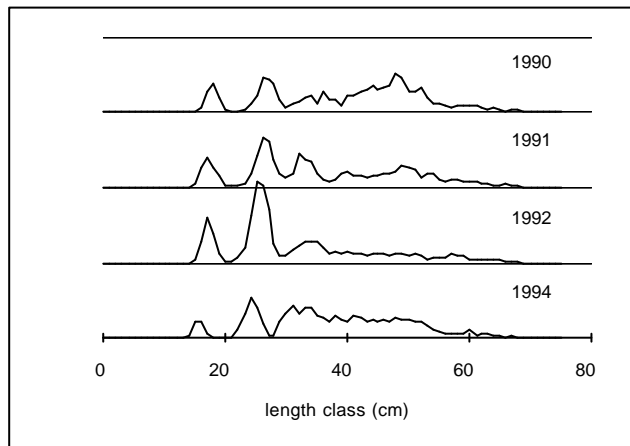


Figure 6: Length frequency distributions of *C. aceratus* from UK surveys.

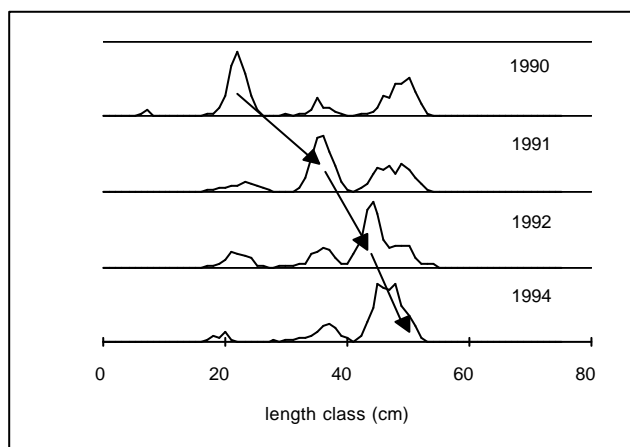


Figure 7: Length frequency distributions of *P. georgianus* from UK surveys.

Management Advice

4.102 The Working Group reiterates its advice from previous years (e.g., SC-CAMLR XII, Annex 5, paragraph 6.64). All these species have been taken in quantity only by the commercial bottom trawl fishery. None of them can be taken without a significant by-catch of other species. Given the current low potential yield of these species and the likely high by-catch of *C. gunnari* in a fishery of these species, the Working Group recommended that a directed fishery of these species should remain prohibited (Conservation Measures 48/XI and 68/XII).

Notothenia squamifrons, *Patagonotothen guntheri* (Subarea 48.3) - Management Advice

4.103 The distributional range of both species was not adequately covered during the survey. The bathymetric range of *N. squamifrons* extends considerably beyond 500 m. *P. guntheri* has a semi-pelagic mode of life. Consequently, both biomass estimates provided in WG-FSA-94/18 underestimate stock size to an unknown extent. In the absence of any new information which would allow an assessment of the two stocks, the Conservation Measures presently in force should be retained (Conservation Measures 48/XI and 68/XII).

SOUTH GEORGIA (SUBAREA 48.3) - CRABS (*Paralomis spinosissima* and *P. formosa*)

4.104 During the 1993/94 season no vessels fished for crabs in Subarea 48.3.

4.105 No new data were available for assessing the crab stock in Subarea 48.3. Consequently, there are still large uncertainties associated with the most recent estimates of the standing stocks of these species (SC-CAMLR-XI, paragraph 4.15).

4.106 Since it was not possible to reassess the crab stock, the Working Group recognised that a conservative management scheme is still appropriate for this fishery. In particular, the Working Group noted that the fishery should be controlled by direct limitations on catch and effort, as well as by limitations on the size and sex of individual crabs which may be retained in the catch. The Working Group agreed that Conservation Measure 74/XII contains such limitations, and that it should continue to be applied in the management of the crab fishery.

4.107 The Working Group recalled the Commission's view that 'an exploratory fishery should not be allowed to expand faster than the acquisition of information necessary to ensure that the

fishery can and will be conducted in accordance with the principles in Article II of the Convention' (CCAMLR-XI, paragraph 4.28; SC-CAMLR-XI, paragraph 3.49). Given this view, the Working Group agreed that Conservation Measure 75/XII could provide valuable information about the crab stock (SC-CAMLR-XII, Annex 5, paragraph 6.97) and should continue to be applied in the management of the fishery.

4.108 The Working Group also noted that the Commission has requested the Scientific Committee to develop a longterm management strategy for the crab fishery (CCAMLR-XI, paragraphs 9.48 to 9.50). The Working Group reviewed WG-FSA-94/26 in addressing this topic.

4.109 Paper WG-FSA-94/26 outlines the construction of a simulation model that might be useful for evaluating certain aspects of Conservation Measure 75/XII and facilitating the development of a longterm management plan for the crab fishery. The simulation model is spatially explicit and describes crab distribution and movement, recruitment and fishing strategy.

4.110 The Working Group welcomed the development of the crab fishery simulation model and encouraged further work. The Working Group recommended that data from other crab fisheries (e.g., the Alaskan King crab fishery) be used to refine parameter estimates and test various assumptions in the model. Since results from the simulation are likely to be sensitive to fishing strategy, the Working Group also agreed that alternative fishing models should be explored.

4.111 Given the lack of data available for assessing the crab stock, the Working Group reiterated its prior recommendation that fishery-independent surveys of the crab stock be given a high priority (SC-CAMLR-XII, Annex 5, paragraph 6.101).

Management Advice

4.112 High-priority topics for future research are identified in SC-CAMLR-XII, Annex 5, paragraph 6.89. These include:

- (i) consideration should be given to the use of time-release or biodegradable devices to reduce the effects of ghost fishing should pots be lost from a line;
- (ii) a minimum mesh size should be adopted and/or an escape port included in pots (usually a metal ring set into the side of the pot) following research on mesh or port selectivity. This will serve to select only crabs of harvestable size more effectively as

well as reducing the number of potential discards but will reduce the ability to monitor parasitic infection; and

- (iii) experiments should be conducted using pots with finer mesh or escape ports added to commercial pot lines in order to obtain more representative length frequency information from harvested stocks.

No data relating to these topics are currently available.

4.113 The current TAC of 1 600 tonnes and other regulations contained in Conservation Measure 74/XII should remain in force for the 1994/95 fishing season.

4.114 The Working Group recommended that Conservation Measure 75/XII should remain in force for the 1994/95 fishing season.

4.115 The data required for collection from the fishery are detailed in SC-CAMLR-XII, Annex 5, paragraph 6.102; these data should be submitted to CCAMLR in haul-by-haul form.

ANTARCTIC PENINSULA (SUBAREA 48.1)
AND SOUTH ORKNEY ISLANDS (SUBAREA 48.2)

Champocephalus gunnari, *Notothenia gibberifrons*, *Chaenocephalus aceratus*,
Pseudochaenichthys georgianus, *Chionodraco rastrispinosus*
and *Notothenia kempfi* - Management Advice

4.116 No new information was available to enable the Working Group to assess stocks in these subareas. Previous biomass assessments from research surveys have become completely out of date and although the Argentinian survey reported in paragraph 3.14 above (February 1994) did extend to Subarea 48.2, only two hauls were taken in this area, insufficient to provide a biomass estimate. Accordingly, the Working Group reiterated the advice offered in 1993 that the fisheries in Subareas 48.1 and 48.2 should remain closed until a survey is conducted to provide more accurate estimates of the status of these stocks (Conservation Measures 72/XII and 73/XII).

SOUTH SANDWICH ISLANDS (SUBAREA 48.4)

4.117 Although a small fishery of *D. eleginoides* was open in this area (TAC of 28 tonnes), no catches were reported. In the absence of further information the Working Group could not update its advice from last year and recommended that Conservation Measure 71/XII be retained.

STATISTICAL AREA 58

4.118 Catches from the 1994 season are shown in Table 9. Catches of *D. eleginoides* in Division 58.5.1 were taken in the directed French and Ukrainian trawl and longline fisheries.

4.119 Catches in Subarea 58.6 were taken in a French exploratory trawl fishery around the Crozet Islands. This exploratory fishery was part of a series of such expeditions conducted by France in 1983, 1987, 1988 and now 1994. Results will be presented at the next meeting of the Working Group.

Kerguelen Islands (Division 58.5.1)

Notothenia rossii (Division 58.5.1)

4.120 Dr P. Tankevich (Ukraine) suggested in WG-FSA-94/4 that data from small by-catches of *N. rossii* in fisheries directed at other species and from research cruises after the closure of the directed fishery for *N. rossii* in 1985 show that the age and size structure of the population are approaching those that existed in the early stages of the fishery. On this basis WG-FSA-94/4 suggested that a small fishery for this species would be appropriate.

4.121 Although Prof. Duhamel agreed that there was an increase in juvenile fish in their inshore nursery grounds according to the results of a scientific monitoring program between 1982 and 1992, these fish would not yet have been fully recruited to a fishery. Therefore, he considered it would be premature to re-open the fishery.

Table 9: Total catches by species and subarea in Statistical Area 58. Species are designated by abbreviations as follows: ANI (*Champsocephalus gunnari*), LIC (*Channichthys rhinoceratus*), TOP (*Dissostichus eleginoides*), NOR (*Notothenia rossii*), NOS (*Notothenia squamifrons*), ANS (*Pleuragramma antarcticum*), MZZ (Unknown), SRX (*Rajiformes spp.*), WIC (*Chaenodraco wilsoni*).

Split-Year	ANI		LIC	WIC	TOP				NOR			NOS			ANS		MZZ			SRX		
	58	58.5			58.5	58.4	58	58.4	58.5	58.6	58	58.4	58.5	58	58.4	58.4	58	58.4	58		58.4	58.5
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	-					4370	11308						239		
1981		1122	2			16	40	-		217	7924		2926	6239						375	21	
1982		16083				83	121	-		237	9812		785	4038		50				364	7	
1983		25852				4	128	17			1829		95	1832		229				4	17	1
1984		7127				1	145	-		50	744		203	3794							611 ¹	17
1985		8253		279		8	6677	-		34	1707		27	7394		966				11	7	4
1986		17137		757		8	459	-		-	801		61	2464		692						3
1987		2625		1099		34	3144	-		2	482			930	1641		28					
1988		159		1816		4	554	488		-	21			5302	41		66					

Split-Year	ANI		WIC	TOP		NOR	NOS		ANS		
	58.5.1	58.5.2		58.4.2	58.4.4		58.5.1	58.6	58.4.4	58.5.1	58.4.2
1989	23628	-	306	35	1630	21				30	17
1990	226	-	339	5	1062	-				-	-
1991	13283 ²	-	-	-	1944	-				-	-
1992	44	3	-	-	7492 ³	-				1	-
1993	-	-	-	-	2722	-				-	-
1994	12	3	-	-	5083	56				-	-

¹ Mainly *Rajiformes spp.*

² There are some discrepancies between the French statistics for the Soviet fishery under licence (12 644 tonnes) in Division 58.5.1 and the STATLANT A data provided by the USSR (13 268 tonnes). It may be explained by the inclusion of 826 tonnes of by-catch (mainly *Rajiformes*) in this total.

³ 1 589 tonnes - France; 5 903 tonnes - Ukraine, of which 705 tonnes were caught by longline.

NB: Before 1979/80 catches reported in Statistical Area 58 mainly concern Division 58.5.1 (Kerguelen subarea). Catch reporting was not divided into Divisions 58.5.1 and 58.5.2 until the 1989 season.

4.122 The most recent biomass survey for this species, in the 1987/88 season, indicated less than 10 000 tonnes total biomass. The current biomass is therefore very much less than the biomass before the fishery commenced, when 168 000 tonnes were taken in the first two years of the fishery. The Working Group also noted that the data were taken from a different part of the shelf to that on which the fishery was conducted, and therefore are not representative of the entire fished stock. To recommence the fishery now would be in contravention of Article II 3(a) which stipulates that the size of a population be prevented from falling below a level close to that which ensures greatest net annual increment.

Management Advice

4.123 The Working Group recommended that the fishery for *N. rossii* remain closed until a biomass survey demonstrates that the stock has recovered to a level that will support a fishery.

Notothenia squamifrons (Division 58.5.1)

4.124 As no data have been received on this species no new assessment can be made.

Management Advice

4.125 In the absence of new data and assessments, the Working Group recommended that the Kerguelen shelf fishery should remain closed.

Champscephalus gunnari (Division 58.5.1)

4.126 Following management advice from the 1993 meeting, no commercial fishing for this species was conducted. Some research trawls were made to investigate length frequency distribution.

4.127 Prof. Duhamel presented data from a monitoring program on *C. gunnari* stocks on the northern part of the Kerguelen inner shelf between 1989 and 1992 (WG-FSA-94/9). This confirmed previous ideas on the structure of the population:

- only one strong cohort exists in the fishery at any time;
- other cohorts exist, but their abundance is very low;
- each cohort lasts three years and then disappears from the fishery;
- recruitment seems to be very variable - there are great interannual differences in the number of spawners on the winter inshore spawning grounds, and abundance of juvenile fish is in proportion to the strength of the spawning cohort, which maintains a three-year cycle of abundance; and
- growth rate and size at maturity are not significantly different between cohorts.

4.128 In the 1994/95 season there should be a strong age 3+ cohort (born in 1991), which spawned for the first time during winter (July 1994). The 1991 cohort has been identified both in the inshore part of the shelf (1991/92) and subsequently on the usual fishing grounds during 1993/94.

Management Advice

4.129 The 1993 report recommended that fishing of the strong cohort being recruited should be delayed until the 1994/95 season, by which time it would have had the opportunity to spawn. Also, only restricted fishing in the 1994/95 season should be allowed, to enable sufficient escapement of fish to spawn a second time and because a declining trend in strength of previous strong cohorts has been detected. The first requirement of last year's recommendation, i.e. that no fishing take place in the 1993/94 season, has been met. The Working Group cannot, however, recommend a catch limit for the 1994/95 season because no data on the biomass of this cohort are available. The Working Group reiterates the advice that a proportion of the cohort be allowed to survive another year to spawn a second time, in the hope that this will contribute to establishing a population with more than one strong cohort and consequently reduce variability in biomass.

4.130 The Working Group recommended that the fishery in the 1994/95 season be kept to a low level to allow the present strong cohort to spawn a second time.

Dissostichus eleginoides (Division 58.5.1)

4.131 Fishing for this species continued in the 1993/94 season in the two traditional areas, a longline fishery on the western slope and a trawl fishery on the northern shelf. In the area on the western slope of the plateau, 942 tonnes were caught by three Ukrainian longliners. This catch was less than the 1 400 tonnes recommended in the 1993 report. French authorities have already set a 1994/95 limit of 1 000 tonnes in the western area for the longline fishery.

4.132 In the northern area, 4 141 tonnes were caught by two French trawlers. The 1993 report recommended limitation of catches for this area, but as this fishery is only three years old the trend in the abundance index (CPUE) is not yet defined enough to give any clear indication of what a catch limit might be. A precautionary catch limit of 3 000 tonnes in the northern area for the trawl fishery has been set by French authorities for the 1994/95 season.

4.133 No other new data were provided.

Management Advice

4.134 In the absence of any new data, the Working Group endorses the French conservation measures (paragraphs 4.131 and 4.132). These are consistent with the Working Group's previous advice that a longterm sustainable yield for the western area is estimated at 1 400 tonnes, and that a precautionary approach should be taken with the northern area to prevent the spawning stock size falling to low levels before the stock has been adequately assessed.

4.135 The Working Group reiterates its previous advice that for proper assessment of these stocks, trawl surveys of the entire stocks would provide indices of abundance to model the stock dynamics and sustainable yield.

Ob and Lena Banks (Division 58.4.4)

4.136 In 1992 the Working Group stated that the stocks of *N. squamifrons* on the Ob and Lena Banks are likely to sustain a fishery of only a few hundred tonnes. It recommended that a survey to determine age structure and stock size on both banks should be undertaken before the fishery is reopened. This view was endorsed by the Scientific Committee (SC-CAMLR-XI, paragraph 3.94).

4.137 During the same meeting of the Scientific Committee, Ukraine stated that it intended to conduct a survey to estimate the biomass of fish species on both banks in 1993 (SC-CAMLR-XI, paragraph 3.95). As a consequence, the Commission implemented Conservation Measure 59/XI limiting the catch of *N. squamifrons* on both banks for the 1992/93 and 1993/94 seasons. No survey was undertaken in either of these two seasons although a proposal for a survey had been submitted for review to WG-FSA in 1993 (WG-FSA-93/10). The conservation measure expired on 30 June 1994.

4.138 Paper WG-FSA-94/7 has provided amended catch statistics and given age and length composition data for *N. squamifrons* from Lena Bank in the 1990/91 season. The paper also states that interannual fluctuations in mean length and age in the catch were more a result of sampling variations than of real change in the population structure. The Working Group requests the author to provide more evidence for his assertion because, if true, it would invalidate previous assessments.

4.139 Paper WG-FSA-94/7 also reports a catch of 29 tonnes of *D. eleginoides* in the 1990/91 season.

4.140 During the meeting Ukraine submitted revised catch figures for both banks for 1978 to 1991 as part of SC-CAMLR XIII/BG/13. However, this new information did not arrive in time for the Working Group to attempt to revise previous assessments.

Management Advice

4.141 The Working Group reaffirms its position of 1992 and 1993 that a biomass survey is likely to improve considerably assessments of the fish stocks on the two banks.

4.142 The Working Group recommended that Ukraine should conduct the proposed survey on the Ob and Lena Banks as outlined in paragraphs 6.9 to 6.15. However, it was noted that the survey vessel will have to use a net monitor cable (see paragraph 6.13).

4.143 Given the uncertainties associated with stock size and stock structure of the fish stocks on both banks, the Working Group recommended that a TAC of 1 150 tonnes for *N. squamifrons* (715 tonnes for Lena Bank and 435 tonnes for Ob Bank) - as previously set in Conservation Measure 59/XII - be re-instituted for the seasons 1994/95 and 1995/96 combined.

4.144 Data reporting should follow the CCAMLR Database format and data recording should be in accordance with the requirements set out in Conservation Measure 64/XII. This information should include all species caught.

4.145 In the event that the proposed survey is postponed by one year, the TAC recommended may need to be revised in the light of new assessments by the Working Group based on the revised catch figures provided in SC-CAMLR-XIII/BG/13.

4.146 The presence of seabirds close to the ship should be monitored and any incidental mortality caused by the net monitor cable must be reported.

Heard and McDonald Islands (Division 58.5.2)

4.147 No commercial catches have ever been reported for this area. However, some exploratory Polish fishing occurred in 1975 and some of the Soviet catch from the early 1970s in Subarea 58.5 may have come from this division before separate statistics were kept for each division.

4.148 The results of three trawl surveys conducted in the area since 1990 were reported in WG-FSA-94/10. Estimates of abundance were derived from a swept-area trawl survey according to a random stratified survey design. Strata were by depth around Heard Island with the addition of a number of banks in the region - Shell, Discovery, Pike, Coral and Aurora Banks and Gunnari Ridge (see WG-FSA-94/10 for variation of the design between surveys). These surveys were undertaken in (austral) winter 1990, summer 1992 and spring 1993. The composition of fish fauna obtained during these surveys was very similar to that found around Kerguelen Island. The main species found were *C. gunnari*, *D. eleginoides*, *Channichthys rhinoceratus*, *N. squamifrons* and rays (*Bathyraja* spp.). These fish varied in their distribution around Heard Island from an even distribution across strata for *D. eleginoides* to a very patchy distribution of *C. gunnari* concentrating in the shelf areas and banks between 200 and 300 m depth. A summary of biomass estimates for each survey (with 95% confidence intervals (CI) and CV) is shown in Table 10. These estimates and confidence intervals were derived using de la Mare's (1994)⁶ method for obtaining MVUES.

4.149 For *C. rhinoceratus* and rays, there are no reliable biological parameters that can be used in a yield analysis.

⁶ de la Mare, W.K. 1994. Estimating confidence intervals for fish stock abundance estimates from trawl surveys. *CCAMLR Science*, Vol. 1: 203-207.

Table 10: Summary of estimates and 95% confidence intervals of total abundance by species and survey in tonnes. Survey 1 = winter 1990; survey 2 = summer 1992; survey 3 = spring 1993.

	Lower CI	Estimate	Upper CI	CV (%)
<i>C. gunnari</i>				
Survey 1	2606	4585	113019	25.7
Survey 2	944	3111	427728	53.5
Survey 3	4112	31701	14712200	80.1
<i>C. rhinocerotus</i>				
Survey 1	1249	2019	4924	25.6
Survey 2	1485	2765	24649	30.8
Survey 3	1397	2210	6629	24.8
<i>D. eleginoides</i>				
Survey 1	11210	17714	45004	25.2
Survey 2	2220	3179	8488	19.2
Survey 3	8375	11880	19284	18.6
<i>L. squamifrons</i>				
Survey 1	1310	2844	58658	41.8
Survey 2	4249	41378	9586070	87.0
Survey 3	14	31	94	39.2
Rays				
Survey 1	735	5370	26771	35.6
Survey 2	7060	10506	46280	21.2
Survey 3	850	2369	25453	52.9

4.150 Paper WG-FSA-94/30 presents yield estimates for two stocks, *C. gunnari* and *D. eleginoides*, based on the generalised version of the krill yield model used for estimating yield for *E. carlsbergi* (WG-FSA-94/21; paragraphs 4.87 to 4.90). The same decision rules adopted for krill and for *E. carlsbergi* have been used to estimate γ in the equation $Y = \gamma \cdot B_0$. The input parameters are shown in Table 11 and the estimates of γ for each survey estimate of these two species are shown in Table 12.

4.151 The Working Group agreed that this approach for estimating yield was a useful way of deriving precautionary TACs for these stocks. It was noted that the estimates of γ may be subject to the following sources of error:

- (i) the length and timing of fishing season (estimates in WG-FSA-94/30 were based on a summer fishing season);
- (ii) estimates of M and K (estimates in Table 11 are from stocks other than Heard Island);
- (iii) the potential correlation between M and K; and

- (iv) the number of years in the pre-exploitation period, because fishing in the simulation should begin in a year where the stock composition is independent of the initial stock structure in the simulation.

Table 11: Parameters used to determine gamma (γ) in the generalised krill yield model for *C. gunnari* and *D. eleginoides* around Heard Island.

Parameter	Value	Source
<i>C. gunnari</i>		
M	0.3 to 0.5	(1)
L_{inf}	39cm	(2)
K	0.3702	(3)
Maximum age	6 years	(4)
Length-at-maturity	25cm	(2)
Age-at-maturity	3 years	(2)
Length-at-recruitment (Nov)	28cm	(2)
Age-at-recruitment (Nov)	3 years	(2)
Recruitment variability	10 to 90%	(4)
CV of biomass estimate	(Survey 1) 0.257	(5)
	(Survey 2) 0.535	(5)
	(Survey 3) 0.801	(5)
<i>D. eleginoides</i>		
M	0.1 to 0.2	(1)
L_{inf}	204cm	(1)
K	0.0563	(1)
max. age	20 years	(2)
Length-at-maturity	94cm	(2)
Age-at-maturity	10 years	(2)
Length-at-recruitment (Nov)	35cm	(4)
Age-at-recruitment (Nov)	3 years	(4)
Recruitment variability	40 to 60%	(4)
CV of biomass estimate	(Survey 1) 0.252	(5)
	(Survey 2) invalid - survey omitted major area of distribution	
	(Survey 3) 0.186	(5)

Sources: (1) estimates based on Kock *et al.* (1985); (2) from Kerguelen data of Duhamel (various publications); (3) Kerguelen data from Kock *et al.* (1985); (4) authors' estimate, based on behaviour of Kerguelen population and data from Heard Island region; (5) this paper.

Table 12: Values of γ from WG-FSA-94/30, determined to satisfy the two decision rules discussed in the text for *C. gunnari* and *D. eleginoides* in three surveys around Heard Island. These estimates are based on a fishing season over summer only. The length of pre-exploitation period is 10 years in all calculations. Column 1 is that γ for which the probability of depletion to 0.2 of the pre-exploitation spawning biomass over 20 years harvesting = 0.1. Column 2 is that γ for which the median spawning stock biomass after 20 years fishing will be 0.75 of the median pre-exploitation spawning stock biomass.

Species	Survey	1	2
<i>C. gunnari</i>	Survey 1	0.112	0.120
<i>C. gunnari</i>	Survey 2	0.093	0.129
<i>C. gunnari</i>	Survey 3	0.080	0.149
<i>D. eleginoides</i>	Survey 1	0.043	0.027
<i>D. eleginoides</i>	Survey 3	0.046	0.027

4.152 The program for estimating yield was modified to embrace the last point. New estimates of γ were derived for both stocks for a fishing season lasting the whole year, which is likely to be more realistic. Also, the effect of different levels of M and K on γ was explored. These results are shown in Table 13.

Table 13: Estimates of γ for different input parameters in the yield model for *C. gunnari* and *D. eleginoides* at Heard Island. The fishing season is all year. 'Source parameters' refers to estimates of γ using the parameters in Table 11, but with a fishing season covering the whole year. Model parameters indicated in the table are those which differ from those in Table 11. Numbers in parentheses refer to the % difference of that γ from the baseline. The number of years in the simulations before fishing begins is 10 for *C. gunnari* and 20 for *D. eleginoides*.

Model	Survey 1 Winter 1990	Survey 2 Summer 1992	Survey 3 Spring 1993
<i>C. gunnari</i>			
Source parameters	0.119	0.100	0.094
M: 0.2-0.6	0.120 (1)	0.099 (1)	0.090 (4)
M: 0.2-0.4	0.117 (-2)	0.096 (-4)	0.083 (-12)
M: 0.4-0.6	0.125 (5)	0.108 (8)	0.101 (7)
K = 0.32	0.103 (-13)	0.090 (-10)	0.077 (-18)
K = 0.42	0.143 (20)	0.136 (36)	0.135 (44)
<i>D. eleginoides</i>			
Source parameters	0.026	-	0.025
M: 0.05-0.25	0.026 (0)	-	0.026 (4)
M: 0.2-0.3	0.028 (8)	-	0.028 (12)
K = 0.045	0.025 (-4)	-	0.024 (-4)
K = 0.065	0.026 (0)	-	0.026 (4)
Re-run of summer fishing with 20-year pre-fishing period	0.026 (0)	-	0.025 (0)

4.153 For *C. gunnari*, the lowest estimate of γ resulting from application of the decision rules was always that associated with Decision Rule 1, i.e. that the probability of the spawning stock becoming depleted to less than 20% of the median pre-exploitation spawning biomass during a 20-year fishing period was not to exceed 0.1. These estimates showed little sensitivity to variation in M (<10% variation) according to alternatives available in the literature (e.g., Kock *et al.*, 1985⁷), except for the third survey in which the CV was greatest. Sensitivity to von Bertalanffy K was greater (up to 44% greater than sensitivity derived using parameters from the literature). These variations in estimates of γ were considered to be unimportant compared to the variation in biomass estimates.

4.154 For *D. eleginoides*, the lowest estimate of γ resulting from application of the decision rules was always that associated with Decision Rule 2, i.e. that the median spawning biomass after 20 years of fishing would not be less than 0.75 of the median pre-exploitation biomass. Variation in M

⁷ Kock, K.-H., G. Duhamel and J.-C. Hureau. 1985. Biology and status of exploited Antarctic fish stocks: a review. *BIOMASS Scientific Series*, 6: 143 pp.

and K had only small effects on the values of γ (up to 12% for increasing the potential values of M from 0.1-0.2 to 0.2-0.3).

4.155 The Working Group agreed that consideration of precautionary TACs on the basis of the current estimates of γ was still valid following these analyses. It was noted that estimates of M and K for Heard Island would be available by the next meeting of the Working Group. In the absence of these estimates, the Working Group accepted that the levels of γ estimated using the source parameters (Table 11) were appropriate as interim estimates until refined values for the input parameters are obtained.

4.156 The Working Group considered the biomass estimates in WG-FSA-94/10 for use as B_0 in the calculations of yield. The Working Group noted there was sufficient evidence to consider the stock of *C. gunnari* around Heard Island to be separate from those around Kerguelen Island. It was recognised that the survey results for *C. gunnari* are likely to be due to interannual variation in stock size (as observed for this species in other areas), but could to some degree represent variation in catchability between different seasons because the surveys were done at different times of the year.

4.157 For *D. eleginoides*, there were no data to determine whether stocks around Heard Island are different from those around Kerguelen Island. In the absence of such information, the Working Group treated these stocks as being separate. They noted that the survey results for *D. eleginoides* are appropriate for a trawl fishery but not for a longline fishery. Trawling was not undertaken in deeper waters where longline activities usually take place.

4.158 The pre-exploitation biomass will vary naturally through time in the absence of fishing. Consequently, the determination of B_0 will involve accounting for variation of biomass through time as well as the errors associated with biomass surveys at different points in time. In the absence of methods to deal with this calculation, the Working Group recommends that a conservative approach be taken to the estimates of yield. Therefore, the Working Group adopted the lowest biomass estimates for the two species and the respective estimates of γ to calculate precautionary TACs. The Working Group recognised that these would be refined when better estimates of the input parameters are obtained and variability in estimates of B_0 is incorporated into the calculations.

Management Advice

4.159 The Working Group recommends that precautionary TACs be set for *C. gunnari* and *D. eleginoides* around Heard Island according to the principles outlined above. For *C. gunnari*, the lowest biomass was in survey 2 (3 112 tonnes), with a corresponding γ of 0.1, which gives a

precautionary TAC of 311 tonnes. For *D. eleginoides*, the lowest biomass was in survey 3 (11 880 tonnes), with a corresponding γ of 0.025, giving a precautionary TAC of 297 tonnes.

Coastal Areas of the Antarctic Continent (Divisions 58.4.1 and 58.4.2)

4.160 No new data on the fish stocks in these areas were available. Therefore, no management advice could be provided for these areas.

MANAGEMENT UNDER CONDITIONS OF UNCERTAINTY CONCERNING STOCK SIZE AND SUSTAINABLE YIELD

4.161 At their 1993 meetings, the Scientific Committee and Commission requested that more work be undertaken on this topic (CCAMLR-XII, paragraph 4.26; SC-CAMLR-XII, paragraph 3.96).

4.162 This year the Working Group has considered this topic for a number of species (for instance, in the assessments of *E. carlsbergi*, *C. gunnari* and other species in Subarea 48.3) and has provided management advice which reflects various levels of uncertainty. For instance, the state of the stocks in Subareas 48.1 and 48.2 is practically unknown, and a continued closure is recommended, and the assessment of *C. gunnari* in Subarea 48.3 incorporates much uncertainty about current stock size, population structure, and mortality.

4.163 The Working Group has this year applied the approach developed by WG-Krill (the krill yield model) to estimating potential yield for a number of fish stocks. This approach allows for the incorporation of uncertainty in many demographic parameters, stock size and recruitment, into a calculation of potential yield. This development reflects the Working Group's increasing use of techniques that take account of uncertainty, and could be applied to other species in the future.

4.164 It is worth pointing out that these techniques and models operate in such a way that calculated yields and catch limits usually decrease as uncertainty in any of the parameters increases.

CONSIDERATIONS OF ECOSYSTEM MANAGEMENT

MONITORING OF COASTAL FISH POPULATIONS

5.1 Three papers presented at this year's meeting of WG-CEMP (WG-CEMP-94/29, 31 and 32) extended studies on the diet composition and feeding of blue-eyed shags (*Phalacrocorax atriceps*) in the South Shetland Islands from the previous year (SC-CAMLR-XII, Annex 6, paragraphs 4.29 to 4.34; Annex 5, paragraphs 7.7 to 7.10). The objective of these studies was to investigate the regular occurrence of fish otoliths in shag pellets as a means of monitoring the dynamics of coastal fish species over time. Comments provided by WG-CEMP are given in Annex 6, paragraphs 4.31 to 4.33.

5.2 The results of the stomach content analysis and the feeding trials on a captive shag (WG-CEMP-94/29 and 31) confirmed the experience obtained in other areas that fish species are differentially represented by otoliths in the pellets. Species with small and brittle otoliths, such as *N. coriiceps* and *N. rossii*, were either largely under-represented or not represented at all. For species represented in sufficient numbers in the feeding trials, preliminary correction factors both for the under-representation in the pellets and for the reduction in otolith size due to erosion could be established. The authors of the studies concluded that their investigations still bear a considerable potential for improvement by increasing sample size and more realistically simulating natural feeding conditions.

5.3 The Working Group welcomed this effort to monitor coastal fish species which are not accessible by trawl surveys. The Working Group encouraged the authors to undertake further investigations on the applicability of this method.

INCIDENTAL MORTALITY OF BIRDS IN LONGLINE FISHERIES

5.4 The Working Group did not discuss subjects related to the incidental mortality of seabirds in longline fisheries in the Southern Ocean. Extensive discussions on this matter can be found in the Report of the *Ad Hoc* Working Group on Incidental Mortality Arising from Longline Fishing (WG-IMALF) (Annex 8).

INTERACTIONS WITH FUR SEALS

5.5 Paper WG-FSA-94/17 investigated the potentially substantial influence of fur seals on the abundance of *C. gunnari* in Subarea 48.3, particularly in seasons of low krill availability. Further discussion is given in paragraph 4.77.

BY-CATCH OF YOUNG FISH IN THE KRILL FISHERY

5.6 Two papers reported on the by-catch of young fish in the krill fishery. One (WG-Krill-94/25) assessed the by-catch in the Japanese commercial krill fishery off the South Shetland Islands in January/February 1994, the other (WG-FSA-94/25) the occurrence of fish in commercial krill catches taken by a Polish trawler in the vicinity of the South Orkney Islands and South Georgia from March to May 1993. They have been the first two studies after the introduction of CCAMLR's *Scientific Observers Manual*. However, only WG-FSA-94/25 used the subsample size and extrapolated total catch figures standardised to numbers per one tonne of krill caught and numbers per tonne/hour, as recommended in the *Scientific Observers Manual*. Comments on WG-Krill-94/25 are also given in Annex 5, paragraphs 3.12 to 3.15.

5.7 The results of these studies show that the proportion of analysed hauls containing fish and the species composition of the by-catch of fish during krill fishing operations differed considerably between areas. In addition to early life stages, juvenile and adult specimens were also caught, although in lower numbers. The proportion of krill catches containing fish varied between 25% off the South Shetland Islands and 43% in the vicinity of South Georgia. The predominant species were *Lepidonotothen larseni*, *C. aceratus* and *Chaenodraco wilsoni* off the South Shetland Islands, unidentified Myctophidae in the South Orkney Islands and unidentified Myctophidae, *L. larseni* and *C. gunnari* in the vicinity of South Georgia.

5.8 Although estimations of the abundance of fish in krill catches were not directly comparable in the two studies, results suggest that the amount of by-catch per hour of trawling was of the same order of magnitude in all three fishing grounds. This finding is in contrast to observations made by WG-Krill (Annex 5, paragraph 3.12) that the level of by-catch in the South Shetland Islands was an order of magnitude less than the by-catch reported by the Ukrainian fishery in the vicinity of South Georgia last year (WG-FSA-93/8).

5.9 Both recent studies tend to confirm earlier conclusions by the Working Group that the largest by-catch occurred when the krill catch was comparatively low.

5.10 The Working Group welcomed these studies and recommended that they be continued in the future, following closely the instructions set out in the *Scientific Observers Manual*. The Working Group reiterated its recommendations from last year's meeting (SC-CAMLR-XII, Annex 5, paragraphs 7.1 to 7.5) that future studies should preferably provide information on spatial, seasonal and diurnal differences in the by-catch of fish to assess when fish are most vulnerable to the krill fishery. The Working Group stressed that appropriate statistical procedures should be applied to the analysis of the data (see SC-CAMLR-XII, Annex 4, paragraph 3.32).

INTERACTIONS WITH WHALES

5.11 Interactions between the longline fishery and marine mammals, including killer and sperm whales, were reported by observers in the 1993/94 season and are discussed in paragraph 3.12.

RESEARCH SURVEYS

TRAWL SURVEY SIMULATIONS

6.1 At both its 1991 and 1992 meetings, WG-FSA attached high priority to addressing the difficulties associated with the application of the swept-area method in trawl surveys to species with patchy distributions, such as *C. gunnari*. The need to undertake simulation studies of a range of fish behaviours to determine the possible forms of underlying statistical distributions was reiterated by the Working Group at its 1993 meeting (SC-CAMLR-XII, Annex 5, paragraphs 8.1 to 8.3).

6.2 As no new submissions have been received on the above, the Working Group again called for work on trawl survey simulations as a matter of high priority. It was agreed that current efforts to validate the models already submitted to WG-FSA (WG-FSA-93/20) should continue.

RECENT AND OTHER SURVEYS

6.3 The Working Group noted that the United Kingdom has notified CCAMLR of its intention to undertake a fish survey in Subarea 48.3 in January/February 1995 along the lines of previous years.

6.4 Lic. Marschoff indicated that Argentina hopes to undertake, at some time between January and March 1995, a demersal fish survey in Subarea 48.3. If favourable ice conditions prevail, the cruise will also investigate krill in Subarea 48.2.

6.5 The Working Group was informed that the USA intends to conduct a survey of the crab stock in Subarea 48.3. During the survey, to be conducted during March 1995, a remotely operated vehicle (ROV) will be used to take video pictures of the crabs. Line transect theory will be used to estimate the abundance of crabs around South Georgia. The survey design includes a bathymetric mapping component to correlate crab densities with different types of habitat.

6.6 The Working Group welcomed the proposed crab survey, and suggested that the data resulting from the survey be analysed to estimate the abundance of fishes as well as crabs. In particular, the Working Group suggested that the ROV could be used to look for the presence of spawning aggregations of fish in some of the fjords surrounding South Georgia.

6.7 Certain members of WG-FSA indicated that they had found the six-month lead-in-time required for the notification of intended survey activity (CCAMLR-V, paragraph 60) to be restrictive. The Working Group agreed to review this requirement at its next meeting.

6.8 In response to the Commission's request (CCAMLR-XII, paragraph 6.10) to review the applicability of a 50-tonne catch limit for research prescribed by Conservation Measure 64/XII, the Working Group agreed that this limit appears appropriate for crabs, given the relatively tight provisions under Conservation Measures 74/XII and 75/XII.

Ob and Lena Banks

6.9 A bottom trawl survey design for the Ob and Lena Banks was proposed by Ukraine in WG-FSA-94/32. This proposal was identical to a proposal submitted to the Working Group in 1993. Discussion of the paper clarified a number of points already addressed during last year's deliberations (SC-CAMLR-XII, Annex 5, paragraph 8.5).

6.10 The timing of the survey is still unknown and will depend on the availability of the survey vessel. The participation of observers from Members is welcomed and arrangements may be made on a bilateral basis.

6.11 The survey will be conducted using a commercially-sized bottom trawl with a mesh size (diamond mesh) of 40 mm in the codend. To be consistent with previous surveys, the duration of hauls will be 60 minutes. The survey will be conducted in two phases as outlined in CCAMLR-XI/BG/21, paragraph 5. Phase 1 will comprise of a bottom trawl survey with a stratified random

survey design. During phase 2 it is intended to map areas of high fish density by carrying out hauls randomly in areas of high concentrations.

6.12 Data will be collected and reported according to the standard methods set out in the CCAMLR *Scientific Observers Manual*. Data reporting will follow the CCAMLR research database format and recording will be done in accordance with the requirements set out in Conservation Measure 64/XII.

6.13 Despite the prohibition of net monitor cables from the 1994/95 season onwards (Conservation Measure 30/X), the survey vessel will have to use a net monitor cable. The vessel has no hull-mounted transducer. She is only equipped with a towed transducer which, if used, would constantly be at risk of being lost due to the severe weather conditions. No incidental mortality of birds has been reported during previous surveys. The presence of seabirds close to the ship will be monitored with each haul and any incidental mortality caused by the net monitor cable will be reported.

6.14 The total catch anticipated is 1 150 tonnes in accordance with the TAC set in Conservation Measure 59/XI for a period of two seasons.

6.15 It is intended to conduct such surveys regularly, although not on an annual basis.

FUTURE WORK

DATA REQUIREMENTS

7.1 Data requirements carried over from those requested last year are listed in Appendix D.

7.2 In addition to these requirements, the Working Group recalled that it had requested that:

- (i) data collected by observers be submitted to the Secretariat in approved reporting formats whenever possible (paragraph 3.11); and
- (ii) the format for reporting longline data to CCAMLR (Format C2) be updated to include the items identified in paragraph 4.32.

SOFTWARE AND ANALYSES REQUIRED

7.3 The Working Group requested that the trawl survey analysis program developed last year (WG-FSA-93/30) continue to be validated. In addition to test simulation runs, the method and its assumptions should be examined in the light of actual survey results from various parts of the CCAMLR Convention Area (paragraph 4.96).

7.4 The Working Group noted that several assessments had made use of a modified version of the krill yield program developed by WG-Krill and agreed that a more general version of this program, applicable to fish stocks, would be of use. Dr Constable agreed to coordinate an intersessional group which would prepare a modified version by correspondence.

WORKING GROUP ORGANISATION

7.5 The Chairman informed the Working Group that the Joint Meeting of WG-CEMP and WG-Krill (South Africa, July 1994) had recommended that the two groups meet as a joint group from now on. It had commented, however, that it saw no immediate requirement to consider joint meetings between itself and WG-FSA (Annex 7, paragraph 6.4).

7.6 The Working Group agreed that whilst its work included consideration of biological information of use in providing advice on management in addition to assessments, it was important that these two aspects of its work remained under the umbrella of a single group. It was agreed, therefore, that no change to its terms of reference was necessary at this time.

7.7 The Working Group considered that the work of WG-IMALF was closely linked to its own. Should WG-IMALF continue its work in future years, it would be important to maintain a close liaison between the groups, although a joint meeting would not be necessary in the foreseeable future. However, there was some concern that if WG-IMALF took place between the WG-FSA meeting and the meeting of the Scientific Committee, there would be no opportunity for WG-FSA to act on the results of the deliberations of WG-IMALF in formulating its advice to the Scientific Committee.

7.8 The Working Group noted that many assessments within WG-FSA and other groups are moving in similar directions, both in methodology and operational considerations such as decision rules and consideration of escapement. This trend was helpful for the development of sound advice by all of the Scientific Committee's working groups, and has been considerably assisted by the continuing good communication between the groups.

FUTURE MEETINGS

7.9 A workshop to consider assessment of the *D. eleginoides* fishery in Subarea 48.3 was proposed in paragraph 4.36. The terms of reference for this group are also given in paragraph 4.36.

OTHER BUSINESS

8.1 The Convener of WG-Krill, Mr Miller, introduced WG-Krill-94/19 which aimed to clarify the issue of access to data in CCAMLR. The Working Group endorsed the approach outlined in the paper, which conforms with current Working Group and CCAMLR practice. In principle, this reiterates that:

- (i) analyses presented as Working Group documents are not considered to be public documents; and
- (ii) if the final aim of the analysis is formal publication, then the onus is on the person(s) undertaking the analysis to obtain the necessary permission from the originators of the data at the outset of any collaborative undertaking.

ADOPTION OF THE REPORT

9.1 The report of the meeting was adopted.

CLOSE OF THE MEETING

10.1 In closing the meeting the Convener thanked the rapporteurs, Secretariat and all participants for cooperating well to complete the Working Group's business smoothly and effectively. He also thanked all participants who had worked hard intersessionally to produce analyses and reports which had contributed to the Working Group's business.

10.2 Mr Miller congratulated the Convener for conducting the meeting efficiently in his inimitable fashion.

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 11 to 19 October 1994)

1. Opening of the Meeting
2. Organisation of the Meeting and Adoption of the Agenda
3. Review of Available Information
 - 3.1 Data Requirements Endorsed by the Commission in 1993
 - 3.2 Fisheries Information
 - (a) Catch, Effort, Length and Age Data
 - (b) Scientific Observer Information
 - (c) Research Surveys
 - (d) Mesh/Hook Selectivity and Related Experiments Affecting Catchability
 - 3.3 Fish and Crab Biology/Demography/Ecology
 - 3.4 Seabed Areas
4. Assessment Work and Management Advice
 - 4.1 New Fisheries
 - 4.2 South Georgia (Subarea 48.3) - Finfish
 - 4.3 South Georgia (Subarea 48.3) - Crabs
 - 4.4 South Orkney Islands (Subarea 48.2)
 - 4.5 Antarctic Peninsula (Subarea 48.1)
 - 4.6 Kerguelen Islands (Division 58.5.1)
 - 4.7 Ob and Lena Banks (Division 58.4.4)
 - 4.8 Coastal Areas of Antarctic Continent (Divisions 58.4.1 and 58.4.2)
 - 4.9 Pacific Ocean Sector (Area 88)
 - 4.10 Heard Island (Division 58.5.2)
 - 4.11 South Sandwich Islands (Subarea 48.4)
5. Considerations of Ecosystem Management
 - 5.1 Interactions with other CCAMLR Working Groups
 - 5.2 Other Interactions (e.g. Multispecies, Benthos, etc.)

6. Research Surveys
 - 6.1 Trawl Survey Simulation Studies
 - 6.2 Recent and Proposed Surveys

7. Future Work
 - 7.1 Data Requirements
 - 7.2 Software to be Prepared or Developed Prior to the Next Meeting and Data Analyses Required
 - 7.3 Future Organisation and Work of WG-FSA

8. Other Business

9. Adoption of the Report

10. Close of the Meeting.

LIST OF PARTICIPANTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 11 to 19 October 1994)

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LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 11 to 19 October 1994)

WG-FSA-94/1	PROVISIONAL AGENDA AND ANNOTATION TO THE PROVISIONAL AGENDA FOR THE 1994 MEETING OF THE WORKING GROUP ON FISH STOCK ASSESSMENT (WG-FSA)
WG-FSA-94/2	LIST OF PARTICIPANTS
WG-FSA-94/3	LIST OF DOCUMENTS
WG-FSA-94/4	DYNAMICS OF <i>NOTOTHENIA ROSSII ROSSII</i> SIZE-AGE STRUCTURE ON THE KERGUELEN ISLANDS SHELF P.B. Tankevich (Ukraine)
WG-FSA-94/5	ANALYSES PERFORMED AT THE 1993 MEETING OF THE WORKING GROUP ON FISH STOCK ASSESSMENT Secretariat
WG-FSA-94/6	PRELIMINARY RESULTS OF MACKEREL ICEFISH, <i>CHAMPSOCEPHALUS GUNNARI</i> AGE DETERMINATION BY WEIGHT METHOD I.B. Russelo (Ukraine)
WG-FSA-94/7	COURSE OF FISHERIES IN THE LENA BANK AREA (DIVISION 58.4.4) IN THE SEASON OF 1990-91 A.K. Zaitsev (Ukraine)
WG-FSA-94/8	PRELIMINARY RESULTS OF AGE DETERMINATION BY OTOLITH MASS IN MACKEREL ICEFISH <i>CHAMPSOCEPHALUS GUNNARI</i> LONNBERG 1905 IN THE HEARD ISLAND AREA (AUSTRALIA) I.B. Russelo (Ukraine)
WG-FSA-94/9 Rev. 1	NEW DATA ON SPAWNING, HATCHING AND GROWTH OF THE KERGUELEN ISLANDS <i>CHAMPSOCEPHALUS GUNNARI</i> SHELF STOCK G. Duhamel (France)
WG-FSA-94/10	FISH DISTRIBUTION AND BIOMASS IN THE HEARD ISLAND ZONE (DIVISION 58.5.2) R. Williams and W.K. de la Mare (Australia)

- WG-FSA-94/11 AGE-LENGTH KEY FOR *CHAMPSOCEPHALUS GUNNARI* FROM SUBAREA 48.3, DR EDUARDO HOLMBERG SURVEY, FEBRUARY/MARCH 1994
E. Barrera-Oro, E. Marschoff and R. Casaux (Argentina)
- WG-FSA-94/12 VALIDATION OF AGE DETERMINATION IN *NOTOTHENIA CORIICEPS*, BY MEANS OF A TAG-RECAPTURE EXPERIMENT AT POTTER COVER, SOUTH SHETLAND ISLANDS
Esteban R. Barrera-Oro and Ricardo J. Casaux (Argentina)
- WG-FSA-94/13 AREAS OF SEABED WITHIN THE 500 M ISOBATH AROUND ELEPHANT ISLAND (CCAMLR STATISTICAL SUBAREA 48.1)
Karl-Hermann Kock and Urte Harm (Germany)
- WG-FSA-94/14 THE EARLY LIFE HISTORY OF THE PATAGONIAN TOOTHFISH *DISSOSTICHUS ELEGINOIDES* SMITT, 1898
S.A. Evseenko (Russia), K.-H. Kock (Germany) and M.M. Nevinsky (Russia)
- WG-FSA-94/15 THE DIET COMPOSITION AND FEEDING INTENSITY OF MACKEREL ICEFISH (*CHAMPSOCEPHALUS GUNNARI*) AT SOUTH GEORGIA IN JANUARY/FEBRUARY 1994
K.-H. Kock (Germany), I. Everson, L. Allcock, G. Parkes (UK), U. Harm (Germany), C. Goss, H. Daly (UK), Z. Cielniaszek and J. Szlakowski (Poland)
- WG-FSA-94/16 EVIDENCE OF TWO STOCKS OF *CHAMPSOCEPHALUS GUNNARI* IN THE SOUTH GEORGIA REGION, CCAMLR FISHING AREA 48.3
A.W. North (UK)
- WG-FSA-94/17 LARGE VARIATIONS IN MACKEREL ICEFISH (*CHAMPSOCEPHALUS GUNNARI*) STANDING STOCK AT SOUTH GEORGIA; ARE ANTARCTIC FUR SEALS (*ARCTOCEPHALUS GAZELLA*) THE CAUSE?
Inigo Everson, Graeme Parkes, Ian Boyd (UK) and Karl-Hermann Kock (Germany)
- WG-FSA-94/18 FISH STOCK ASSESSMENT SURVEY IN SUBAREA 48.3
I. Everson, G. Parkes (UK), K.-H. Kock (Germany), C. Goss (UK), D. Cielniaszek, J. Szlakowski (Poland), H. Daly, L. Allcock and G. Pilling (UK)
- WG-FSA-94/19 SOFTWARE FOR FSA-94
Secretariat
- WG-FSA-94/20 SUMMARY OF THE *DISSOSTICHUS ELEGINOIDES* FISHERY IN SUBAREA 48.3 IN THE 1993/94 SEASON
D.J. Agnew (Secretariat)

- WG-FSA-94/21 REVISSED ESTIMATES OF YIELD FOR *ELECTRONA CARLSBERGI* BASED ON A GENERALISED VERSION OF THE CCAMLR KRILL YIELD MODEL
A.J. Constable and W.K. de la Mare (Australia)
- WG-FSA-94/22 DETERMINATION OF LOCAL DENSITY OF *DISSOSTICHUS ELEGINOIDES* IN SUBAREA 48.3 - CCAMLR PROTOCOL LOCAL DEPLETION EXPERIMENT *IHN SUNG 66* - JANUARY 1994
Caradoc Jones and Graeme Parkes (UK)
- WG-FSA-94/23 PERFORMANCE AND GEOMETRY OF THE FP-120 TRAWL USED DURING THE UK 1993/94 FISH STOCK ASSESSMENT SURVEY AROUND SOUTH GEORGIA, SUBAREA 48.3
Graham Pilling and Graeme Parkes (UK)
- WG-FSA-94/24 COMMENTS ON THE USE OF STOCK DEPLETION MODELS FOR THE ASSESSMENT OF LOCAL ABUNDANCE OF TOOTHFISH IN SUBAREA 48.3 AND ADJACENT WATERS
Graeme Parkes and Graham Pilling (UK)
- WG-FSA-94/25 PRELIMINARY RESULTS ON BY-CATCH OF FISH DURING KRILL FISHERY IN MARCH TO MAY 1993 ON THE POLISH TRAWLER M/T *LEPUS*
Zdzislaw Cielniaszek and Roman Pactwa (Poland)
- WG-FSA-94/26 PRELIMINARY ASPECTS OF A SIMULATION MODEL TO BE USED FOR EVALUATING THE EXPERIMENTAL CRAB FISHERY
George Watters (USA)
- WG-FSA-94/27 DIET COMPOSITION OF *CHAMPSOCEPHALUS GUNNARI* IN SUBAREA 48.3, *DR EDUARDO HOLMBERG* SURVEY, FEBRUARY/ MARCH 1994
E. Barrera-Oro, R. Casaux and A. Roux (Argentina)
- WG-FSA-94/28 PRELIMINARY STUDY ON REPRODUCTION IN *CHAMPSOCEPHALUS GUNNARI* FROM SUBAREA 48.3, *DR EDUARDO HOLMBERG* SURVEY, FEBRUARY/MARCH 1994
Gustavo J. Macchi and Esteban R. Barrera-Oro (Argentina)
- WG-FSA-94/29 PRELIMINARY RESULTS OF THE *E.L. HOLMBERG* 1994 CRUISE TO SUBAREAS 48.3 AND 48.2
E.R. Marschoff, Bruno Prenschi, Beatriz Gonzalez, Claudio Remaggi and Carlos Balestrini (Argentina)
- WG-FSA-94/30 ADDENDUM TO DOCUMENT WG-FSA-94/10
R. Williams and W.K. de la Mare (Australia)
- WG-FSA-94/31 DEPLETION EXPERIMENT OF *DISSOSTICHUS ELEGINOIDES* STOCK IN THE SOUTH OF SOUTH GEORGIA ISLAND (ANTARCTICA)
P. Rubilar, C.A. Moreno (Chile) and J. Ashford (UK)

WG-FSA-94/32 BOTTOM TRAWLING SURVEY ON THE OB AND LENA BANKS
Observer (Ukraine)

OTHER DOCUMENTS

SC-CAMLR-XIII/BG/1 STATUS OF CATCHES IN THE CONVENTION AREA 1993/94 SEASON
Rev. 1 Secretariat

SC-CAMLR-XIII/BG/9 CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION -
Rev. 1 PRELIMINARY REPORT OF THE SCIENTIFIC OBSERVER *ŔV MAKSHEEVO*, 7
FEBRUARY TO 18 APRIL 1994
Delegation of USA

WG-CEMP-94/29 PRELIMINARY RESULTS OF A FEEDING TRIAL ON THE BLUE-EYED SHAG
PHALACROCORAX ATRICEPS
R. Casaux, M. Favero, E. Barrera-Oro and P. Silva (Argentina)

WG-CEMP-94/31 ANALYSIS OF THE STOMACH CONTENT IN THE BLUE-EYED SHAG
PHALACROCORAX ATRICEPS BRANSFIELDENSIS AT NELSON ISLAND,
SOUTH SHETLAND ISLANDS
N. Coria, R. Casaux, M. Favero and P. Silva (Argentina)

WG-CEMP-94/32 FISH AS DIET OF THE BLUE-EYED SHAG, *PHALACROCORAX ATRICEPS*
BRANSFIELDENSIS AT HALF-MOON ISLAND, SOUTH SHETLAND ISLANDS
Esteban R. Barrera-Oro and Ricardo J. Casaux (Argentina)

WG-Krill-94/19 ACCESS TO AND USE OF DATA WITHIN CCAMLR
(Prepared by Convener, WG-Krill)

WG-Krill-94/25 FISHES CAUGHT ALONG WITH THE ANTARCTIC KRILL IN THE VICINITY OF
THE SOUTH SHETLAND ISLANDS DURING THE AUSTRAL SUMMER MONTHS
OF 1994
Tetsuo Iwami (Japan)

DATA REQUIREMENTS FOR THE WORKING GROUP

I Data Required by WG-FSA-93	II Data Received by WG-FSA-94	III Data Requested by WG-FSA-94
1. <i>D. eleginoides</i> , Subarea 48.3 <ul style="list-style-type: none"> studies on hook selection factors required studies on loss rates of fish 	None received Some information	<i>D. eleginoides</i> , Subarea 48.3 <ul style="list-style-type: none"> studies on hook selection factors required studies on loss rates of fish
2. <i>D. eleginoides</i> , Subarea 48.3 <ul style="list-style-type: none"> age and maturity determination required for an expanded range of lengths from historical and current commercial and research catches 	None received	<i>D. eleginoides</i> , Subarea 48.3 <ul style="list-style-type: none"> age and maturity determination required for an expanded range of lengths from historical and current commercial and research catches
3. Representative length frequency from the commercial catch of <i>C. gunnari</i> in Subarea 48.3 should be reported for the most recent years of the fishery	None received	Representative length frequency from the commercial catch of <i>C. gunnari</i> in Subarea 48.3 should be reported for the most recent years of the fishery and required from historical fishery
4. Trawl fisheries in Subarea 48.3: <ul style="list-style-type: none"> detailed data on the by-catch in pelagic (midwater) and demersal (bottom) trawl fisheries in Subarea 48.3 are urgently required to establish management advice research data should be submitted to the Secretariat 	None received Being done by UK and Argentina (WG-FSA-94/18 and 29)	Trawl fisheries in Subarea 48.3 <ul style="list-style-type: none"> detailed data on the by-catch in pelagic (midwater) and demersal (bottom) trawl fisheries in Subarea 48.3 are urgently required to establish management advice. Historical data required
5. <i>E. carlsbergi</i> <ul style="list-style-type: none"> clarification of position and time of catch of 1 518 tonnes reported for Subarea 48.2 in 1990/91 clarification of position and time of catch of 50 tonnes in Subarea 48.1 in 1991/92 	No information	<i>E. carlsbergi</i> <ul style="list-style-type: none"> clarification of position and time of catch of 1 518 tonnes reported for Subarea 48.2 in 1990/91 clarification of position and time of catch of 50 tonnes in Subarea 48.1 in 1991/92
6. Call for historic information from surveys to assist the Workshop on the Design of Bottom Trawl Surveys in investigating the interannual variability in the occurrence of fish aggregations	Heard Island (WG-FSA-94/10)	Call for historic information from surveys to assist the Workshop on the Design of Bottom Trawl Surveys in investigating the interannual variability in the occurrence of fish aggregations. Also required for validation of MVUE methods (paragraph 7.3)
7. <i>D. eleginoides</i> , Subarea 48.3 <ul style="list-style-type: none"> stock identification studies data on the position or bearing of each end of longlines 	WG-FSA-94/14	<i>D. eleginoides</i> , Subarea 48.3 <ul style="list-style-type: none"> stock identification studies data on the position or bearing of each end of longlines especially in preparation for workshop
8. Crab fishery, Subarea 48.3 Investigations on the use of time-release devices, escape ports and pot selectivity	No information	Crab fishery, Subarea 48.3 Investigations on the use of time-release devices, escape ports and pot selectivity
9.		Additional data from <i>D. eleginoides</i> fishery (paragraph 4.32)
10.		All observer data should be reported if possible (paragraph 3.11)
11.		<i>D. eleginoides</i> : Data requested from outside CCAMLR Convention Area (paragraphs 4.6 and 4.44)

MATURATION SCALE USED FOR OVARIES
OF *CHAMPSOCEPHALUS GUNNARI* *

	Maturity Stage	General Histological Features
1	Immature	Compact ovigerous lamellas with oocytes I and II
2	Early maturation	Oocytes I, II and III elements starting secondary vitellogenesis (IV)
3	Advanced maturation	Oocytes I, II, III and V
4	Total maturation	Oocytes I, II, III and VI
5	Post-spawning	Lax ovigerous lamellas, with oocytes I, II and III. Residual components V in resorption and post-ovulatory follicles.
6	Pre-reproductive regression	Compact ovigerous lamellas, with oocytes I and II. Yolky elements (V) in different resorption phases.

* WG-FSA-94/28

1994 ASSESSMENT SUMMARIES

Assessment Summary: *Notothenia rossii*, Subarea 48.3

Source of Information: This report

Year:	1989	1990	1991	1992	1993	1994	Max ²	Min ²
Recommended TAC		0						
Agreed TAC		300	300	0				
Landings	152	2	1	1	0			
Survey Biomass	2439	1481 ^a 3915 ^b 3900 ^b	4295 ^c 10022 ^d	7309		6600		
Surveyed by	UK/POL	UK/POL ^a USSR ^b	UK ^c USSR ^d	UK		UK		
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 1982 to 1992
- 3 From VPA using (.....)

Conservation Measures in Force: 2/III, 3/IV and 68/XII

Catches:

Data and Assessment: No new assessment was performed for this species.

Fishing Mortality:

Recruitment:

State of Stock: Little change in stock composition in recent years.

Forecast for 1994/95: Recommend continued closure.

Assessment Summary: *Champsocephalus gunnari*, Subarea 48.3

Source of Information: This report

Year:	1989	1990	1991	1992	1993	1994	Max ²	Min ²
Recommended TAC	10200	12000		8400-61900	9200-15200	0		
Agreed TAC	4	8000	26000	0	9200			
Landings	21359	8027	92	5	0	13		
Survey Biomass	24241	72090 ^a 442168 ^b	27111 ^a 192144 ^b	43763 ^a		16088 ^{+a} 4870 ^{*a} 2012 ^{+b} 67259 ^{*b}		
Surveyed by	UK/POL	UK/POL ^a USSR ^b	UK ^a USSR ^b	UK ^a		UK ^a Arg ^b		
Stock Biomass ³	50	50	50.5					
Recruitment (age 1)	500	(millions)						
Mean F (.....) ¹				0				

Weights in '000 tonnes

- 1 ... weighted mean over ages (...) * Shag Rocks
 2 Over period 1982 to 1992 + South Georgia
 3 From VPA (2+)
 4 Prohibition from 4 November 1988

Conservation Measures in Force: 19/IX and 66/XII

Catches: Research catches only - 13 tonnes.

Data and Assessment: Surveys in 1993/94 indicated significantly lower biomass than predicted by projections made at the 1993 Working Group meeting. Decline in biomass in the absence of fishing may be linked to the low availability of krill in Subarea 48.3 during the 1993/94 season.

Fishing Mortality: None.

Recruitment: Recruitment of 1-year-olds in 1992/93 projected back from the UK survey was at the lower end of the range in the VPA at last year's meeting. Poor recruitment was not considered to explain the low biomass of age 3+ in the 1993/94 surveys.

State of Stock: Overall biomass is low according to the 1993/94 UK survey, but there is a high degree of uncertainty and reliable projections could not be made.

Forecast for 1994/95: Closure and survey recommended.

Assessment Summary: *Patagonotothen guntheri*, Subarea 48.3

Source of Information: This report

Year:	1989	1990	1991	1992	1993	1994	Max ²	Min ²
Recommended TAC	-	-	20-36000	0				
Agreed TAC	13000	12000	0	0				
Landings	13016	145	0	0	0			
Survey Biomass			584 ^a	12764		4589		
Surveyed by			16365 ^b					
			UK ^a	UK		UK		
			USSR ^b					
Sp. Stock Biomass ³		na						
Recruitment (age 1)		na						
Mean F (3 - 5) ¹		na						

Weights in tonnes

- 1 ... weighted mean over ages (...)
- 2 Over period 1982 to 1992
- 3 From VPA using (.....)
- 4 Maximum catch in 1989

Conservation Measures in Force: 48/XI

Catches:

Data and Assessment: No new assessment was performed for this species.

Fishing Mortality:

Recruitment:

State of Stock: Biomass estimates provided by surveys above may underestimate stock size because they do not sample its complete depth range.

Forecast for 1994/95: Recommend conservation measures presently in force be retained.

Assessment Summary: *Dissostichus eleginoides*, Subarea 48.3

Source of Information: This report

Year:	1989	1990	1991	1992	1993	1994	Max ²	Min ²
Recommended TAC		-						
Agreed TAC		-	2500 ⁵	3500	3350	1300		
Landings	4138	8311	3843	3703	2990	604		
Survey Biomass	326	9631 ^{*a}	335 ^{+a}	19315 [*]	3353 [*]	14923 ^{*a}	2012 ^{*b}	
		1693 ^{*b}	3020 ^{+b}	885 ⁺	2460 ⁺	4831 ^{+a}	67259 ^{+b}	
Surveyed by	UK/ POL ⁴	POL/UK ^a USSR ^b	UK	UK		UK ^a Arg ^b		
Stock Biomass ³		20745 - 435817			11000-17000			
Recruitment (age...)		na						
Mean F (.....) ¹		na						

Weights in tonnes

- | | |
|-------------------------------------|---|
| 1 ... weighted mean over ages (...) | 5 TAC from 1 November 1990 to 2 November 1991 |
| 2 Over period 1982 to 1992 | 6 Estimated from various methods |
| 3 Estimated from cohort projections | * Shag Rocks |
| 4 Survey excluding Shag Rocks | + South Georgia |

Conservation Measures in Force: 69/XII, 70/XII and 71/XII

Catches: TAC of 1 300 tonnes, 603 tonnes taken during five depletion experiments, 1 tonne research catch.

Data and Assessment: 1992/93 haul-by-haul data were re-analysed and 1993/94 depletion experiment data were analysed with the aim of estimating local density. No consistent depletion observed, so no density estimates calculated. No stock assessment possible.

Fishing Mortality:

Recruitment:

State of Stock: Unknown. A precautionary approach should be taken in setting any TACs.

Forecast for 1994/95:

Assessment Summary: *Notothenia gibberifrons*, Subarea 48.3

Source of Information: This report

Year:	1989	1990	1991	1992	1993	1994	Max ²	Min ²
Recommended TAC				500-1500				
Agreed TAC				0				
Landings	838	11	3	4	0			
Survey Biomass	8500	17000	25000	29600		23566		
Surveyed by	UK	UK USSR	UK USSR	UK		UK		
Sp. Stock Biomass ³	3300	4300	6200					
Recruitment (age 2)	21000	27000	25000					
Mean F (.....) ¹	0.54	0.014	0.0002					

Weights in tonnes

- ¹ Weighted mean over ages 2 to 16
- ² Over period 1975/76 to 1991/92
- ³ From VPA using survey $q = 1$ model

Conservation Measures in Force: 48/XI and 68/XII

Catches:

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock: Biomass decreased from last survey; potential yield currently low.

Forecast for 1994/95: Recommend directed fishery remain prohibited.

Assessment Summary: *Chaenocephalus aceratus*, Subarea 48.3

Source of Information: This report

Year	1989	1990	1991	1992	1993	1994	Max ²	Min ²
Recommended TAC	1100	0	300	300-500				
Agreed TAC	0	300	300	0				
Landings	1	2	2	2	0		1272	1
Survey Biomass	5770	14226 ^a 14424 ^b 17800 ^b	13474 ^c 18022 ^d	12500		9695		
Surveyed by	UK/POL	UK/POL ^a USSR ^b	UK ^c USSR ^d	UK		UK		
Sp. Stock Biomass ³	4404	5098 ⁴						
Recruitment (age 2)	6717	4047 ⁴						
Mean F (.....) ¹	0.002							

Weights in tonnes, recruits in '000s

- 1 ... weighted mean over ages 3 to 11
- 2 Over period 1982 to 1992
- 3 From VPA using revised VPA from WG-FSA-90/6
- 4 Predicted

Conservation Measures in Force: 48/XI and 68/XII

Catches:

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock: Biomass decreased from last survey; potential yield currently low.

Forecast for 1994/95: Recommend directed fishery remain prohibited.

Assessment Summary: *Pseudochaenichthys georgianus*, Subarea 48.3

Source of Information: This report

Year	1989	1990	1991	1992	1993	1994	Max ²	Min ²
Recommended TAC	1800	0	300	300-500				
Agreed TAC		300	300	0				
Landings	1	1	2	2	0		1661	1
Survey Biomass	8278	5761 ^a 12200 ^b 10500 ^b	13948 ^c 9959 ^d	13469		5707		
Surveyed by	UK/POL	UK/POL ^a USSR ^b	UK ^c USSR ^d	UK		UK		
Sp. Stock Biomass ³	8889 ⁴							
Recruitment (age 1)								
Mean F (.....) ¹								

Weights in tonnes, recruits in '000s

- 1 ... weighted mean over ages 3 to 6
- 2 Over period 1982 to 1992
- 3 From VPA described in WG-FSA-90/6
- 4 Predicted

Conservation Measures in Force: 48/XI and 68/XII

Catches:

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock: Biomass significantly lower than last survey; potential yield currently low.

Forecast for 1994/95: Recommend directed fishery remain prohibited.

Assessment Summary: *Notothenia squamifrons*, Subarea 48.3

Source of Information:

Year	1989	1990	1991	1992	1993	1994	Max ²	Min ²	Mean ²
Recommended TAC		0	300	300					
Agreed TAC		300	300	0					
Landings	927	0	0	0	0		1553	0	563
Survey Biomass	131	1359 ^a	1374	1232					
		534 ^b							
Surveyed by	UK/PO L	UK/POL ^a USSR ^b	UK	UK					
Sp. Stock Biomass ³									
Recruitment (age...)									
Mean F (.....) ¹									

Weights in tonnes, recruits in

¹ ... weighted mean over ages (...)

² Over period 1982 to 1992

³ From VPA using (.....)

Conservation Measures in Force: 48/XI and 69/XII

Catches:

Data and Assessment: No new assessment was performed for this species.

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1994/95: Recommend conservation measures presently in force be retained.

Assessment Summary: *Electrona carlsbergi*, Subarea 48.3

Source of Information:

Year	1989	1990	1991	1992	1993	1994	Max ²	Min ²	Mean ²
Recommended TAC	-	-	-	-					
Agreed TAC	-	-	-	245000	200 000 ⁶				
Landings	29673	23623	78488	46960	0	0			
Survey Biomass	USSR ⁴								
Surveyed by	USSR ⁵								
Sp. Stock Biomass ³									
Recruitment (age...)									
Mean F (.....) ¹									

Weights in tonnes, recruits in

¹ ... weighted mean over ages (...)

² Over period 1982 to 1992

³ From VPA using (.....)

⁴ WG-FSA-90/21 large portion of Subarea 48.3

⁵ WG-FSA-90/21 Shag Rocks region

⁶ 43 000 tonnes at Shag Rocks (Conservation Measure 67/XIII)

Conservation Measures in Force: 54/XI, 67/XII; TAC 200 000 tonnes

Catches: Nil

Data and Assessment: Use of generalised krill yield model to estimate γ in $Y = \gamma B_0$ gave $\gamma = 0.091$. [Program FYIELD.EXE Input File 94ECYLD.DAT (use as IN.DAT)]

Fishing Mortality:

Recruitment: No estimate.

State of Stock: No new estimates of biomass. Using old estimates of biomass: yield = 109 100 for Subarea 48.3 and 14 500 for Shag Rocks.

Forecast for 1994/95:

Assessment Summary: *Notothenia rossii*, Division 58.5.1

Source of Information: This report

Year	1989	1990	1991	1992	1993	1994	Max ²	Min ²	Mean ²
Recommended TAC									
Agreed TAC									
Landings	245	155	287	0	0	0			
Survey Biomass									
Surveyed by									
Sp. Stock Biomass ³									
Recruitment (age...)									
Mean F (.....) ¹									

Weights in tonnes, recruits in

1 ... weighted mean over ages (...)

2 Over period 1982 to 1992

3 From VPA using (.....)

Conservation Measures in Force: Conservation Measure 2/III. Resolution 3/IV. Limitation of trawlers allowed on fishing grounds each year. Arrêté N^o: 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: Still low compared with initial levels. Most recent survey (1987/88) estimated total biomass at 10 000 tonnes. In the first two years of the fishery 168 000 tonnes of this species were taken.

Forecast for 1994/95:

Assessment Summary: *Notothenia squamifrons*, Division 58.5.1

Source of Information: This report

Year	1989	1990	1991	1992	1993	1994	Max ²	Min ²	Mean ²
Recommended TAC									
Agreed TAC	2000 ⁴								
Landings	1553	1262	98	1	0	0			
Survey Biomass									
Surveyed by									
Sp. Stock Biomass ³									
Recruitment (age...)									
Mean F (.....) ¹									

Weights in tonnes, recruits in

- 1 ... weighted mean over ages (...)
- 2 Over period 1982 to 1992
- 3 From VPA using (.....)

Conservation Measures in Force:

Catches:

Data and Assessment: No new assessment was performed for this species.

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1994/95:

Assessment Summary: *Champscephalus gunnari*, Division 58.5.1

Source of Information: This report

Year	1989	1990	1991	1992	1993	1994	Max ²	Min ²	Mean ²
Recommended TAC									
Agreed TAC									
Landings (Kerguelen)	23628	226	12644	44	0	12	25852	0	
Landings (Combined)									
Survey Biomass									
Surveyed by									
Sp. Stock Biomass ³									
Recruitment (age...)									
Mean F (.....) ¹									

Weights in tonnes, recruits in

- 1 ... weighted mean over ages (...)
- 2 Over period 1982 to 1994
- 3 From VPA using (.....)

Conservation Measures in Force: None. Recommendation that no fishery be conducted during the 1993/94 season and a limited fishery during the 1994/95 season (CCAMLR-XII, paragraph 4.21).

Catches: 12 tonnes to assess the length frequency distributions of the stock. No fishery.

Data and Assessment: No new assessment was performed for this species.

Fishing Mortality:

Recruitment: Pre-recruit abundances highly variable from one year to another (results of 1989 to 1992 inshore monitoring program).

State of Stock: Biomass in relation to the strength of a three-year abundant cohort. Presently the 1991 normally strong cohort is coming and has spawned for the first time during 1994.

Forecast for 1994/95: Low level of catches to allow the present cohort to spawn a second time.

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.1

Source of Information: This report

Year	1989	1990	1991	1992	1993	1994	Max ²	Min ²	Mean ²
Recommended TAC									
Agreed TAC									
Landings	1630	1062	1848	7492	2722	5083	7492	121	
Survey Biomass									
Surveyed by									
Sp. Stock Biomass ³									
Recruitment (age...)									
Mean F (.....) ¹									

Weights in tonnes, recruits in

1 ... weighted mean over ages (...)

2 Over period 1982 to 1994

3 From VPA using (.....)

Conservation Measures in Force: None. Recommendation not to exceed 1 400 tonnes in western fishing grounds (CCAMLR-XII, paragraph 4.21).

Catches: Western grounds: 942 tonnes, longline only by Ukraine. Northern grounds: 4141 tonnes, trawling only by France.

Data and Assessment: 1987/88 biomass survey mainly for the western sector. No new assessment was performed for this species.

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1994/95:

Western stock: $F_{50\%SSB}$ gives 1 400 tonnes longterm yield.

Northern stock: Precautionary limitation of catches to prevent spawning stock size falling to low level before the stock has been adequately assessed.

Assessment Summary: *Champscephalus gunnari*, Division 58.5.2

Source of Information: This report

Year	1989	1990	1991	1992	1993	1994	Max ²	Min ²	Mean ²
Recommended TAC						311			
Agreed TAC									
Landings	0	0	0	0	0				
Survey Biomass			4585	3111		31701			
Surveyed by			Australia						
Sp. Stock Biomass ³									
Recruitment (age...)									
Mean F (....) ¹									

Weights in tonnes, recruits in

¹ ... weighted mean over ages (...)

² Over period 1982 to 1992

³ From VPA using (.....)

Conservation Measures in Force:

Catches:

Data and Assessment: Biomass surveys by Australia according to random stratified design and calculated by MVUE. Precautionary TACs calculated by estimating γ from modified krill yield program.

Fishing Mortality:

Recruitment:

State of Stock: Presently unexploited.

Forecast for 1994/95:

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.2

Source of Information: This report

Year	1989	1990	1991	1992	1993	1994	Max ²	Min ²	Mean ²
Recommended TAC						297			
Agreed TAC									
Landings	0	0	0	0	0	0			
Survey Biomass			17714	3179		11880			
Surveyed by			Australia						
Sp. Stock Biomass ³									
Recruitment (age...)									
Mean F (....) ¹									

Weights in tonnes, recruits in

- 1 ... weighted mean over ages (...)
- 2 Over period 1982 to 1992
- 3 From VPA using (.....)

Conservation Measures in Force:

Catches:

Data and Assessment: Biomass surveys by Australia according to random stratified design and calculated by MVUE. Precautionary TACs calculated by estimating γ from modified krill yield program. Assessment only applicable to trawl fishery on younger part of population.

Fishing Mortality:

Recruitment:

State of Stock: Presently unexploited.

Forecast for 1994/95:

Assessment Summary: *Notothenia squamifrons*, Division 58.4.4

Source of Information: This report

Year	1989	1990	1991	1992	1993	1994	Max ²	Min ²	Mean ³
Recommended TAC (Lena Bank)									
Agreed TAC									
Landings (Ob Bank ^a)	850	867	?	0	0	0	4999	0	1151
Landings (Lena Bank ^a)	3166	596	?	0	0	0	6284	0	1335
Landings (Combined ^b)	4016	1463	575	0	0	0	11283	027	2487
Survey Biomass (Ob Bank)	12700								
Survey Biomass (Lena Bank)									
Surveyed by	USSR								
Sp. Stock Biomass ⁴		na							
Recruitment (age...)		na							
Mean F (.....) ¹									

Weights in tonnes, recruits in

¹ ... weighted mean over ages (...)

² Over period 1982 to 1992

³ Assumes TAC of 267 tonnes for Ob Bank and 305 tonnes for Lena Bank was taken in 1991

⁴ From VPA using (.....)

^a From WG-FSA-92/5

^b From SC-CAMLR-IX/BG/2

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Conservation Measures in Force: 2/III and 4/V

Catches: No catches since 1991

Data and Assessment: No new assessments performed for this species since 1992.

Fishing Mortality:

Recruitment:

State of Stock: Unknown

Forecast for 1994/95: