ANNEX 5

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 13 to 22 October, 1992)

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INTRODUCTION

1.1 The meeting of the Working Group on Fish Stock Assessment (WG-FSA) was held at the CCAMLR Headquarters, Hobart, Australia from 13 to 22 October, 1992. The Convener, Dr I. Everson (UK) was unable to attend and Dr K.-H. Kock (Germany) chaired the meeting.

1.2 The Working Group noted with regret that scientists from Russia and France had not been able to attend the meeting. The Working Group also expressed its regret that Dr Everson had been unable to attend the meeting.

1.3 The Chairman informed the Working Group that Mr Wieslaw Slosarczyk of Poland had died during the last year. Wieslaw had participated in WG-FSA between 1984 and 1989. In addition, he had been very active in the BIOMASS program. The Working Group paused for a moment of silence in memory of a dear friend and valued colleague.

GENERAL MATTERS AND ORGANISATION OF THE MEETING

2.1 A List of Participants is given in Appendix A.

2.2 The following were appointed rapporteurs:

Dr R. Holt (USA), Agenda Items 1 to 6.1;
Conveners of Assessment Groups, Agenda Items 6.2 to 6.8;
Mr D. Miller (South Africa), Agenda Item 7;
Dr K.-H. Kock (Germany), Agenda Item 8; and
Dr D. Agnew (Secretariat), Agenda Items 9 to 12.

2.3 The Working Group noted that several papers presenting assessments had been delivered to the Secretariat and no scientists familiar with the contents of these papers were present at the meeting. Concern was expressed that it may not be possible to fully use these papers. The Working Group agreed to take account of the information contained in the papers as far as was possible and, where needed, to refer the papers back to the authors for further clarification. Mr Miller noted that this was the same practice adopted by the Working Group on Krill (WG-Krill).

ADOPTION OF THE AGENDA

3.1 The adopted Agenda is attached as Appendix B, and a List of Documents presented to the meeting is attached as Appendix C.

CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

4.1 The Working Group again emphasised the urgent need for the implementation of a scheme of international scientific observation on commercial fishing vessels. The deployment of observers would improve data collection generally and much of the data which are essential for WG-FSA assessments, could only be collected in this way. It was stressed that data collected under the scheme would not be a substitute for fisheries data requested from Members.

4.2 The Scientific Committee in 1991 endorsed the priorities identified by WG-FSA for allocation of activities under the observation scheme and accepted the Working Group's offer to assist in the preparation of a manual for observers in consultation with the Secretariat (SC-CAMLR-X, paragraphs 10.6 and 10.7).

4.3 Although the Scientific Committee had reviewed the scientific objectives and priorities of a scheme of observation and had reported to the Commission, consensus on the scheme was not reached by the Commission in 1991 and it had been agreed that discussions would continue at the next meeting (CCAMLR-X, paragraphs 7.7 and 7.8). During the intersessional period, the EEC has provided an amended draft text for an observer scheme (CCAMLR-XI/6).

REVIEW OF EEC PROPOSAL

4.4 Members of the Working Group felt it was appropriate to comment only on the data format section (CCAMLR-XI/6, Annex 1). It was noted that the functions and tasks of international scientific observers as defined in Annex 1 have been modified to include observers engaged in scientific research (Annex 1, subtitle). During the meeting of the Scientific Committee in 1991, concern was expressed about observation aboard research vessels. The Scientific Committee clearly identified observation on commercial vessels as the priority and it was pointed out that the research activities of Members already involved some degree of international cooperation (SC-CAMLR-X, paragraph 10.3).

4.5 The Working Group agreed with the general intent of Annex 1, noting that the detailed description of data to be collected and the methods to be used would be specified in an observers manual. The Working Group also suggested that Annex 1, paragraph 2(vii) should be modified to specifically inform the observers as to where the data and biological samples should be deposited, and who will be responsible for subsequent analysis of biological samples. Data and results of each survey should be made available to CCAMLR in the standard data formats for subsequent use by working groups.

REVIEW OF CCAMLR SCIENTIFIC OBSERVERS MANUAL (DRAFT)

4.6 The data collection scheme on commercial vessels should be flexible to enable the changing research priorities identified by the Scientific Committee to be addressed. In addition, the priorities for collection of data would vary according to the vessel and fishery involved (SC-CAMLR-X, paragraph 10.4).

4.7 The Working Group agreed that collection of observer data on the crab fishery was of priority and additions were made to the draft observer manual accordingly.

4.8 Comments were received from Members during the intersessional period and at the Working Group's meeting. Comments made at the meeting included:

(i) Form 1A should be modified to include observations on the incidence and volume of benthos as by-catch in bottom trawls.

(ii) The item 'Weather' on Forms 1A, 1B and 1C should be replaced by 'Sea State'. A table of sea state classifications as defined by the World Meterological Organization (WMO) should be appended to the report.

(iii) The research priorities for *Dissostichus eleginoides* (page 5 of draft manual) should include collection of otoliths and scales.

(iv) Generally total length should be used to record fish lengths. In the case of *Electrona carlsbergi*, standard length should be recorded, as the delicate tail fin rays are often broken.

4.9 The Working Group expressed its appreciation to the Secretariat for preparing the draft manual. It was recognised that considerable effort had been expended to produce the manual in a timely fashion.

REVIEW OF MATERIAL FOR THE MEETING

DATA REQUIREMENTS ENDORSED BY THE COMMISSION IN 1991

5.1 Various data were specifically requested by the Working Group in 1991 (SC-CAMLR-X, Annex 6, Appendix E). Data submitted to the Secretariat in response to this request are listed in Appendix D.

5.2 Some of the data requested by the Working Group had been submitted, however, there is a substantial amount of data still required (Appendix D).

CATCH AND EFFORT STATISTICS

5.3 Complete STATLANT A and B forms had not been received from Russia and Chile at the time of the meeting. However, as Conservation Measures 35/X through 40/X (catch limitations and reporting requirements for *D. eleginoides* and *E. carlsbergi* in Subarea 48.3) had been complied with, the Data Manager was able to construct catch statistics for *D. eleginoides* and *E. carlsbergi* (from fine-scale catches and monthly reported statistics). It was noted that there were some discrepancies between the five-day reported statistics for *D. eleginoides* and the subsequently reported fine-scale catch and effort data; the fine-scale data were considered more accurate and were used to compile the catch statistics.

5.4 Fishing for *D. eleginoides* in Subarea 48.3 commenced on 6 December 1991 and by its closure on 10 March, 3 559 tonnes had been taken by vessels from Chile, Russia and Bulgaria. A further 11 tonnes was taken by Bulgaria before it ceased fishing. Additional data were reported to the Secretariat from Russian and UK research cruises. The Russian cruise reported a total of 191 tonnes (132 tonnes taken between 10 March and 30 June 1992 and 58.8 tonnes taken in July 1992), and the UK cruise reported 1 tonne. All catches were by longline except the UK research cruise. The total catch of *D. eleginoides* in Subarea 48.3 was therefore 3 762 tonnes.

5.5 A fishery targetted at *E. carlsbergi* in Subarea 48.3 from July to November 1991 inclusive took 46 960 tonnes (catches by month: July - 2 515, August - 7 413, September - 22 418, October - 10 981, November - 3 633).

5.6 Catch statistics from Division 58.5.1 (Kerguelen) were incomplete, the Secretariat only having received reports for the whole split-year from France.

5.7 The Working Group draws the attention of the Scientific Committee to the continuing problem of late submission of STATLANT catch data; the deadline is 30 September. However, reporting data by five-day periods and in fine-scale format in accordance with the conservation measures had been successful and proved extremely useful to the Working Group.

MESH/HOOK SELECTIVITY AND RELATED EXPERIMENTS AFFECTING CATCHABILITY

5.8 Although no document was presented that directly investigated this topic, it was noted that some information was available from the Chilean longline fishery (WG-FSA-92/28).

5.9 Dr C. Moreno (Chile) indicated that differences between Chilean and Russian catch rates of *D. eleginoides* may be, in part, because of the use of different types of hooks. Normalised length frequencies of *D. eleginoides* caught by Chilean vessels were substantially different for different shaped and sized hooks (see Table 9 following paragraph 6.116).

5.10 Mr G. Parkes (UK) presented a video made during the UK research trawl survey around South Georgia which showed the retrieval of *D. eleginoides* longlines by Russian and Chilean vessels. Catch rates from Chilean vessels appeared to be higher than from Russian vessels, which was also evident from the reported data.

OTHER DOCUMENTS

5.11 The Working Group welcomed the recent publication of:

Kock, K.-H. 1992. *Antarctic Fish and Fisheries*. Cambridge University Press. 359 pp.

The book gives a comprehensive description of Antarctic fish biology and ecology and presents the history of finfish exploitation and a thorough discussion of the assessment and current state of exploited fish stocks in the Southern Ocean until 1991.

5.12 An update of the Antarctic fish bibliography (Kock, 1989) was made available to the Working Group.

ASSESSMENT WORK AND MANAGEMENT ADVICE

NEW FISHERIES

Crab Fisheries in Subarea 48.3

Description of Fishery

6.1 Dr R. Otto (USA) presented a report of crab fishing by a US vessel in Subarea 48.3 during 1992 (WG-FSA-92/29).

6.2 Fishing operations for Antarctic crabs by the US vessel FV *Pro Surveyor* were conducted in waters around South Georgia and Shag Rocks from 10 July to 1 August, 1992. Operations were conducted in accordance with the Plan for Research and Data Collection During Exploratory Crab Fishing in the Antarctic (SC-CAMLR-X/BG/20). Fishing operations are presently proceeding and only limited data are available from the first 22-day trip.

6.3 Data on fishery operations were recorded using the US crab logbooks (SC-CAMLR-X/BG/20). Copies of the logbooks will be archived at the headquarters of the US AMLR Program in La Jolla, California and at the US NMFS Laboratory at Kodiak (Alaska). Biological data and specimens will be archived at the Kodiak Laboratory until final research projects are completed. Specimens for taxonomic studies will be forwarded to the US National Museum. All data will be made available in accordance with CCAMLR requirements.

6.4 Two species were caught: *Paralomis spinosissima* and *P. formosa*. *P. spinosissima* was the major species targetted by the fishery and few data were recorded for *P. formosa*. Lines of 50 to 60 pots were used for all fishing during the first trips. "Commercial" crabs were male *P. spinosissima* that exceeded 102 mm in carapace width. With the exception of a few (about 500) male *P. formosa*, all other crabs were discarded. Discarded crabs were immediately returned to the sea with apparently minimal mortality.

6.5 Fishing grounds were divided between South Georgia and Shag Rocks at 40°W latitude. Catches taken during the first trip are summarised in Table 1 along with incidental catches of fish. The mean incidental catch rate of all fish was approximately 2.26 individuals per tonne of commercial crab caught. The mean incidental catch rate of *D. eleginoides* was 1.23 individuals per metric tonne of commercial crabs.

Table 1: Estimated total catch of crabs, fish and cephalopods during the first US exploratory crab fishing trip to Subarea 48.3.

Item	South Georgia		Shag Rocks		Grand Total	
	Sampled	Total	Sampled	Total	Sampled	Total
Lines	46	138	7	13	53	151
P. spinosissima						
Commercial	451	51 728	8	758	459	52 486
Discarded	4 519	83 239	908	8 203	5 427	91 442
P. formosa	668	34 768	0	2 152	668	36 920
Total crabs	5 638	169 735	916	11 113	6 554	180 848
Toothfish	22	65	4	8	26	73
Other rock cods	18	46	0	0	18	46
Rays	1	3	0	0	1	3
Flounders	1	3	0	0	1	3
Moray cod	1	3	0	0	1	3
Octopus	1	3	0	0	1	3

6.6 The size at sexual maturity for male *P. spinosissima* was determined using the allometric relationship of chela (claw) height to carapace length. Carapace lengths (CL) were converted to carapace widths (CW) using regression techniques (WG-FSA-92/29). The size at maturity was 75 mm CL at South Georgia and 66 mm CL at Shag Rocks. Assuming that growth per moult is 15% in CL and allowing males at least one opportunity to breed before becoming vulnerable to the fishery, minimum size limits should be 94 mm CW at South Georgia and 84 mm at Shag Rocks. A size limit of 102 mm carapace width was established, based largely on the size of crab desired for processing. This size limit would ensure escapement of a proportion of sexually mature males. Although little information is available, it appears that *P. formosa* matures at smaller sizes than *P. spinosissima*. A size limit of 90 mm CW for *P. formosa* would be likely to be adequate.

6.7 The Working Group noted that the apparently high incidence of rhizocephalan parasites in *P. spinosissima* is likely to limit growth and reproduction in this species. Because only a small area

(less than 220 n miles^2) was fished during the first trip, it is not known if the incidence of parasites is widespread or localised to this area.

Estimation of Standing Stock for *Paralomis spinosissima*

6.8 The Working Group noted that growth rates of Antarctic crabs are unknown. Apparently high initial catches may reflect an accumulated biomass and lead to an overestimate of sustainable yield.

6.9 The Working Group agreed that reliable estimates of sustainable yield of Antarctic crabs could not be calculated from the limited data available. Two methods were examined which might provide guidance in setting conservative levels of catch to be applied in the early stages of the fishery while the data necessary for more precise estimates are being acquired and analytical methods are being developed.

6.10 The first method is based on the fact that catch rates and the depths at which crabs are taken in Antarctic waters are similar to those in the Aleutian Islands (Bering Sea) fishery for golden king crab (*Lithodes aequispinum*). Using estimates of annual production of golden king crabs in the Aleutian Islands suggests that Subarea 48.3 might have an annual potential yield of 2 210 tonnes between 200 and 1 000 m (0.243 tonnes of crabs per n mile^2 (WG-FSA-92/29) times 9 096 n miles^2 (Appendix E; Everson and Campbell, 1991[1])).

6.11 In the second method, a rough calculation of the standing stock of commercially sized male *P. spinosissima* was made by determining the vessel's average catch per n mile^2 and multiplying this value by the total fishable area in Subarea 48.3. Results are presented in Table 2 and the method is described below.

1 EVERSON, I. and S. CAMPBELL. 1991. Areas of seabed within selected depth ranges in CCAMLR Subarea 48.3, South Georgia. In: *Selected Scientific Papers, 1990 (SC-CAMLR-SSP/7)*. CCAMLR, Hobart, Australia: 459-466.

Table 2: Calculation of the standing stock of commercially sized male *P. spinosissima* in Subarea 48.3.

	Calculation	Result
Distance between pots		46 m
Effective fishing radius	(45.72)/2	23 m
Effective pot fishing area	$\pi(22.86)^2$	0.00048 n mile^2
Average crabs per pot		7.2
Average crab weight		1.1 kg
Average crab weight per pot	7.21 x 1.13 kg	0.0082 tonnes
Average density	0.00818 tonnes/0.00048 n mile^2	17.1 tonnes/n mile^2
Fishable area		9 096 n miles^2
Standing stock	17.08 tonnes/n mile^2 x 9 096 n miles^2	155 000 tonnes

6.12 The pot lines were rigged so that the crab pots were spaced 46 m (25 fathoms) apart. Assuming that the pot lines were spaced so that adjacent pots did not compete for crab, the effective fishing radius of a single crab pot was assumed to be half the distance between adjacent pots. Therefore, the effective fishing area of a single crab pot was 0.00048 n mile^2.

6.13 During the first trip, 7 282 pot lifts were made, and, on average, each pot contained 7.2 commercially sized *P. spinosissima*. The average weight of commercially sized individuals in the catch was 1.1 kg. Multiplying the average weight of a commercially sized individual by the average number of individuals caught per pot yields an average of 8.2 kg (0.00818 tonnes) of *P. spinosissima* per pot.

6.14 The Working Group assumed that the catchability of a crab pot equals 1.0 (i.e., all crabs within the effective fishing area of a pot are captured) and divided the average catch rate (0.0082 tonnes/pot) by the assumed fishing area of a single pot (0.00048 n mile^2) to obtain an estimate of the average density of *P. spinosissima* around South Georgia and the Shag Rocks. The average density was estimated to be 17.1 tonnes/n mile^2.

6.15 If it is assumed that the total fishable area in Subarea 48.3 is 9 096 n miles^2 and that the average density of *P. spinosissima* of 17.1 tonnes/n mile^2 is representative of the average density of commercially sized crab around all South Georgia and the Shag Rocks, the standing stock was calculated to be approximately 155 000 tonnes.

6.16 The Working Group identified a number of potential biasses with this method of calculating the standing stock. The results depend on:

- the assumed effective fishing radius of each pot;
- the catchability coefficient for pots being 1.0;
- the assumption that the pots randomly sampled local crab density; and
- the local density as calculated being representative of the entire depth stratum.

6.17 The effect of assuming that catchability is 1.0 will be conservative because it is unlikely that a pot will catch all the crabs in its vicinity at one setting. The biasses from the other assumptions could be upwards or downwards, and they may be potentially large. If the effective fishing radius of each pot is less or greater than 23 m the calculations will be biassed upwards and downwards respectively. If pots are placed only in places identified as likely to contain concentrations of crab, the apparent density may be greater than the density of crabs over a wider range. Finally, if a suitable crab habitat is only a proportion of the entire depth stratum of 200 to 1 000 m, the calculations will be biassed upwards. The effect of this last assumption was examined by assuming that the distribution of crabs was restricted to 50% and 30% of the depth stratum. This reduced the calculated stock estimate to 78 000 and 48 000 tonnes respectively.

6.18 A catch of 2 210 tonnes, based on calculations of the Aleutian Island fishery potential yield (paragraph 6.10), would correspond to less than 5% of exploitable standing stock estimates given in paragraphs 6.15 and 6.17.

Management Advice

6.19 Given the large uncertainties associated with estimating standing stock the Working Group recommended that a conservative management strategy should be followed. This would involve the immediate application of precautionary measures and the simultaneous commencement of work on the development of a longterm management plan for the fishery.

6.20 It was recommended that pending the development of a longterm management plan for the crab fishery in Statistical Area 48 the following measures should be applied:

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

(ii) the crab fishery should be limited to sexually mature male crabs - all female crabs caught should be released unharmed. In the case of *P. spinosissima* and *P. formosa*, males with a carapace width of 102 mm and 90 mm, respectively, shall be considered sexually mature and may be retained in the catch;

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

(iv) the exploratory crab fishery should be limited to a few vessels (i.e., one to three vessels);

(v) as far as practical, the following data should be collected and submitted to CCAMLR:

(a) observation on fishing operations;
(b) collection of haul-by-haul catch and effort data;
(c) representative length frequency distributions;
(d) representative sex and maturity stage distributions;
(e) samples of ovaries and eggs;
(f) representative length frequency distributions by sex and maturity stage from both the crab fishery concerned and from bottom trawl surveys.

The format for submission of such data should be in accordance with the provisions of the Draft Scientific Observers Manual (see Appendix F).

(vi) the following data should be reported to CCAMLR by 30 September 1993 for all crabs caught prior to 30 July 1993:

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

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

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

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

6.21 The first stage in the development of a longterm management plan is the convening of a workshop during the intersessional period to specify the data needed and the actions required to acquire the data from the exploratory crab fishery that will allow the estimation of appropriate harvest levels and methods in accordance with Article II of the Convention. The Working Group envisions that the workshop would produce a plan to implement an experimental/adaptive harvest strategy. It was agreed that results of the workshop should be conveyed to Members so that during the 1992/93 season data could be collected according to guidelines agreed at the workshop.

New Fisheries

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

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

6.24 The Working Group supported the application to conduct the exploratory fishery, noting that the minimum effort possible was being applied (i.e., use of one vessel conducting only one trip of 40 days) and a maximum of 240 tonnes would be taken. It was felt that if the standing stock was low, catch rates would be low and less than the planned catch of 240 tonnes would be taken.

6.25 The Working Group agreed that the list of data to be collected should include information on the amount and composition of by-catch in the fishery. It was agreed that the participation of scientific observers aboard the vessel was essential.

6.26 It was noted that levels of abundance and sustainable yield of a species are generally unknown during the initial phases of the development of a new fishery. Two documents that addressed this problem were provided by Dr Moreno (WG-FSA-92/22 and 23).

SOUTH GEORGIA AND SHAG ROCKS (SUBAREA 48.3)

6.27 Summaries of the assessments presented in the following section are given in Appendix I.

Reported Catches

6.28 The catch history of Subarea 48.3 (South Georgia and Shag Rocks) since 1970 is shown in Table 3. This illustrates the collapse of the *Notothenia rossii* fishery following landings in excess of 500 000 tonnes in the first two years of the reported fishery. This was followed by its replacement in the mid-1970s by *Champsocephalus gunnari* as the most important finfish resource on the South Georgia shelf. In recent years the *C. gunnari* catch has declined and is currently overshadowed by the landings of myctophids, notably *Electrona carlsbergi*, from the northern part of Subarea 48.3. The total catch of all species in 1991/92 was 50 678 tonnes, which compares to 82 423 tonnes in 1990/91, the difference being largely due to a drop in myctophid landings.

Table 3: Catches of various finfish species from Subarea 48.3 (South Georgia subarea) by year. Species are designated by abbreviations as follows: SSI (*Chaenocephalus aceratus*), ANI (*Champsocephalus gunnari*), SGI (*Pseudochaenichthys georgianus*) and ELC (*Electrona carlsbergi*), TOP (*Dissostichus eleginoides*), NOG (*Notothenia gibberifrons*), NOR (*Notothenia rossii*), NOS (*Notothenia squamifrons*), NOT (*Patagonotothen guntheri*). "Others" includes Rajiformes, unidentified Channichthyidae, unidentified Nototheniidae and other Osteichthyes.

Split year	SSI	ANI	SGI	ELC[e]	TOP	NOG	NOR	NOS	NOT	OTHERS	TOTAL
1970	0	0	0	0	0	0	399704	0	0	0	399704
1971	0	10701	0	0	0	0	101558	0	0	1424	113713
1972	0	551	0	0	0	0	2738	35	0	27	3351
1973	0	1830	0	0	0	0	0	765	0	0	2595
1974	0	254	0	0	0	0	0	0	0	493	747
1975	0	746	0	0	0	0	0	1900	0	1407	4053
1976	0	12290	0	0	0	4999	10753	500	0	190	28732
1977	293	93400	1608	0	441	3357	7945	2937	0	14630[a]	124611
1978	2066	7557	13015	0	635	11758	2192	0	0	403	37626
1979	464	641	1104	0	70	2540	2137	0	15011	2738[b]	24705
1980	1084	7592	665	505	255	8143	24897	272	7381	5870	56664
1981	1272	29384	1661	0	239	7971	1651	544	36758	12197[c]	9167
1982	676	46311	956	0	324	2605	1100	812	31351	4901	89036
1983	0	128194	0	524	116	0	866	0	5029	11753[d]	146482
1984	161	79997	888	2401	109	3304	3022	0	10586	4274	104742
1985	1042	14148	1097	523	285	2081	1891	1289	11923	4238	38517
1986	504	11107	156	1187	564	1678	70	41	16002	1414	32723
1987	339	71151	120	1102	1199	2844	216	190	8810	1911	87882
1988	313	34620	401	14868	1809	5222	197	1553	13424	1387	73794
1989	1	21359	1	29673	4138	838	152	927	13016	55	70160
1990	2	8027	1	23623	8311	11	2	24	145	2	40148
1991	2	92	2	78488	3641[f]	3	1	0	0	1	82423
1992	2	5	2	46960	3703[g]	4	1	0	0	1	50678

[a] Includes 13 724 tonnes of unspecified fish caught by the Soviet Union
[b] Includes 2 387 tonnes of unspecified Nototheniidae caught by Bulgaria
[c] Includes 4 554 tonnes of unspecified Channichthyidae caught by the GDR
[d] Includes 11 753 tonnes of unspecified fish caught by the Soviet Union
[e] Before 1988, it is not confirmed that these were *E. carlsbergi*
[f] Includes 1 440 tonnes taken before 2 November 1990
[g] Includes 1 tonne taken as research catch by the UK, 132 tonnes taken as research catch by Russia before 30 June

6.29 The total catch in 1991/92 was dominated by 46 963 tonnes of *E. carlsbergi*, which was about 60% of the catch in 1990/91 and considerably less than the precautionary TAC of 245 000 tonnes set by the Commission for the period commencing 2 November 1991 (Conservation Measure 38/X). The remainder included 3 703 tonnes of Patagonian toothfish, *D. eleginoides*, which was in excess of the TAC of 3 500 tonnes set by the Commission for the period commencing 2 November 1991 (Conservation Measure 35/X) (see paragraph 5.4). A research catch of 59 tonnes of *D. eleginoides* was taken after 30 June 1992, and is therefore not included in the total in Table 3.

6.30 No commercial catch of *C. gunnari* in Subarea 48.3 was reported for the 1991/92 season, due to the closure of the fishery by the Commission in November 1991 until the end of the Commission meeting in 1992 (Conservation Measure 33/X). Research landings amounted to 5.3 tonnes reported from the UK survey in January 1992.

6.31 Catches of other species in Subarea 48.3, including *N. rossii*, *P. guntheri*, *N. gibberifrons*, *C. aceratus*, *P. georgianus* and *N. squamifrons*, were limited to a research vessel catch from the UK survey in January 1992 and amounted to 10 tonnes. Directed fishing on these species was prohibited in 1991/92 (Conservation Measures 3/IV and 34/X).

Notothenia rossii (Subarea 48.3)

6.32 *N. rossii* was severely affected by fishing primarily in the early 1970s but also in the late 1970s. Conservation Measures have been in force since 1985 (Conservation Measures 2/III and 3/IV). These prohibited directed fishing of *N. rossii* and aimed to keep by-catches of the species to as low a level as possible. The reported catch in 1991/92 was only 1 tonne (Table 3) which originated from a research vessel survey. It is unlikely to have been higher due to the absence of commercial trawling on demersal species in the subarea (Conservation Measure 34/X).

6.33 Length compositions from research vessel catches (*Falklands Protector*, WG-FSA-92/17) did not exhibit significant differences in comparison with previous years. Catches consisted mostly of fish 40 to 65 cm long, with a mean length of 52 to 53 cm (WG-FSA-92/17). The biomass estimate of 7 309 tonnes (CV 60.7%) was within the range of biomass estimates from previous cruises since the mid 1980s. This suggests that the stock has remained at a low level.

6.34 The distribution of *N. rossii* is extremely patchy and the fish often appear to be concentrated in underwater canyons. This contagious distribution is not adequately taken into account in the design of surveys which are currently undertaken. These surveys aim to provide estimates of stock size of *C. gunnari* and other, more evenly distributed species, such as *N. gibberifrons* and *C. aceratus*. The CCAMLR Workshop on the Design of Bottom Trawl Surveys (Annex H) therefore felt that a survey targetting this species should be stratified to better survey these areas of high aggregation. The design of such a survey must make use of haul-by-haul information from historical catches in determining sampling localities. This information has not been made available to CCAMLR. The Working Group recommended that this information should be submitted and that a survey on the species be undertaken in the near future in order to obtain a more accurate estimate of the standing stock of *N. rossii* in this subarea.

Management Advice

6.35 In view of the likely low stock size of *N. rossii* at present, all conservation measures for this species should remain in force.

Champsocephalus gunnari (Subarea 48.3)

Fisheries Surveys

6.36 A bottom trawl survey of the same design as that in January 1991 was undertaken by the *Falklands Protector* in January 1992 with scientists from the UK, Germany and Poland on board (WG-FSA-92/17). No large aggregations of *C. gunnari* of the type seen during surveys in 1989/90 (WG-FSA-90/13) were encountered during this survey. The total standing stock was estimated by the 'swept area' method to be 37 311 tonnes (CV 18.3%) around South Georgia and a further 2 935 tonnes (CV 35%) around Shag Rocks. The comparatively low CV of the estimate for South Georgia is indicative of the relatively even distribution of fish over the shelf encountered during the survey.

6.37 No other surveys aimed at *C. gunnari* in Subarea 48.3 during 1991/92 were reported to the Working Group.

6.38 The estimate of standing stock of *C. gunnari* in Subarea 48.3 from the survey is in accordance with the predicted growth of the population since the *Falklands Protector* survey in January 1991.

6.39 The Working Group considered that the results of the 1992 trawl survey served to substantiate the hypothesis that the dramatic drop in biomass between 1989/90 and 1990/91 indicated by trawl surveys (Table 4) was a genuine reflection of the stock abundance over that period. It was agreed that, in view of this, the conservative management approach adopted by the Commission in 1991/92 was the most appropriate.

Table 4: Reported catches and summary of biomass estimates of *C. gunnari* from surveys in Subarea 48.3.

Season	Reported Catch (tonnes)	Stock Assessment Surveys				Source
		South Georgia		Shag Rocks		
		Biomass	CV%	Biomass	CV%	
1986/87	71 151	151 293	95	62 867	84	Balguerías *et al.*, 1989[2]
1986/87		50 414[4]	18	10 023	55	SC-CAMLR-VI/BG/12
1986/87		51 017		4 229		SC-CAMLR-IX[1]
1986/87		47 312	-			Sosinski and Skora, 1987
1987/88	34 620	15 086[4]	21	1447	78	SC-CAMLR-VII/BG/23
1987/88		15 716		509		SC-CAMLR-IX[1]
1987/88		17 913	-			Sosinski (unpubl.)
1988/89	21 356	21 069	50			WG-FSA-89/6
1988/89		22 328				SC-CAMLR-IX[1]
1988/89		31 686[4]	45			Parkes (unpubl.)[3]
1989/90	8 027	95 405[4]	63	279 000	83	*Hill Cove* survey[6]
1989/90		878 000	69	108 653	31	*Akademik Knipovich* survey[6]
1989/90		887 000	31			*Anchar* survey[6]
1990/91	92	22 285[4]	16	3 919	75	WG-FSA-91/14
1990/91		172 920	44	19 225	23	WG-FSA-91/23
1991/92	5[5]	37 311	18	2 935	35	WG-FSA-92/17

1 Calculated at WG-FSA-90 to take account of new sea bed areas in WG-FSA-90/8
2 Semipelagic trawl used as a bottom trawl
3 Data from *Professor Siedlecki* survey, February 1989 re-worked according to model 3 in WG-FSA-90/13 and using seabed areas in Everson and Campbell (1991)
4 Survey indices used for tuning VPA in WG-FSA-92/27
5 Research vessel catch
6 SC-CAMLR-IX, Annex 5

6.40 Analysis of diet composition and feeding intensity of *C. gunnari* from data collected during the survey is reported in WG-FSA-92/26. Krill, the preferred prey item, was present in the stomachs

of 65% of fish at South Georgia compared to 22% in January 1991, indicating that it was available in greater quantities this year. Feeding intensity was also significantly higher in 1992 than in 1991. Preliminary results of a comparison of condition factor between samples collected during January 1991 and January 1992 is presented in WG-FSA-92/18. The mean condition factor of mature fish was significantly higher in 1992 than in 1991 at both South Georgia and Shag Rocks. Little difference between South Georgia and Shag Rocks was detected in either year.

6.41 The survey in January 1992 therefore suggests that there has been a general increase in the abundance and improvement of the condition of *C. gunnari* in Subarea 48.3 compared to 1991.

6.42 The distribution of *C. gunnari* around South Georgia and Shag Rocks from a series of eight trawl surveys by Soviet vessels between 1973/74 and 1989/90 was presented in WG-FSA-92/4. Considerable variation in catch rates between years was noted. Analysis of annual variation in distribution was confounded by variation in the timing of the surveys in different seasons. High localised catch rates in some years were indicative of the presence of aggregations on the shelf. The high catch rates encountered during April 1990 (*Anchar* survey) were also detected in similar locations during the *Hill Cove* survey in January of the same year. The Working Group stressed the need for the submission to CCAMLR of haul-by-haul data from random stratified surveys of this type (including surveys conducted in the past), which can be used for optimal allocation of sampling stations on future surveys.

6.43 WG-FSA-92/6 presents data on the abundance of juvenile *C. gunnari* around South Georgia from a series of surveys between 1984 and 1990. Most of this information has not been previously reported to CCAMLR. Unfortunately, with the exception of the 1985 survey reported in Boronin *et al.*[1] (1986), the details of the design and analysis of these surveys has not been reported to CCAMLR. The Working Group was therefore unable to assess the validity of the results shown in Figures 2 to 8 of WG-FSA-92/6.

6.44 The Working Group agreed that data of this type, which could potentially provide an index of recruitment, is of extremely high value and should be reported in the appropriate detail and format as soon as possible.

6.45 WG-FSA-92/6 also presents an analysis of data on the by-catch of juvenile *C. gunnari* in krill trawls collected by a scientific observer working on the fishing vessel *More Sodruzhestva.* A full discussion of this report is presented in paragraphs 7.2 to 7.4.

1 BORONIN, V.A., G.P. ZAKHAROV and V.P. SHOPOV. 1986. Distribution and relative abundance of juvenile icefish (*Champsocephalus gunnari*) from a trawl survey of the South Georgia shelf in June-July 1985. In: *Selected Scientific Papers 1986 (SC-CAMLR-SSP/3).* CCAMLR, Hobart, Australia: 58-63.

Stock Assessment

6.46 Attempts were made at last year's meeting to assess the status of the *C. gunnari* population in Subarea 48.3 using virtual population analysis (VPA). Two assessment papers were presented (WG-FSA-91/15 and 27) which showed highly divergent stock trajectories, largely due to differences in the use of tuning data. Two VPA runs were made at the 1991 meeting using the Laurec-Shepherd tuning method (MAFF VPA version 2.1), which followed the same general trend as the two tabled assessments (SC-CAMLR-X, Annex 6, Figure 3).

6.47 Concern was expressed at the Working Group meeting in 1991 that the large biomass of 5 year olds predicted by the VPA runs for 1991/92 might be an artefact of the analysis. In the absence of this year class, any TAC would be extracted from the younger, less abundant year classes, with potentially severe effects on a population already apparently under considerable stress from a shortage of krill, the preferred food of *C. gunnari* (WG-FSA-91/15 and 29). Concerns over the credibility of the VPA and resulting uncertainties in the estimation of total stock size lead to the closure of the fishery for *C. gunnari* in Subarea 48.3 for the 1991/92 season by the Commission (Conservation Measure 33/X).

6.48 The 5 year old age group, predicted as abundant by the VPAs presented at WG-FSA-91 comprised less than 5% of the fishable population biomass (age 2+) estimated from the survey in January 1992. Assuming the survey provided a representative sample of the population, it appears that the VPAs and projections presented to and performed at the 1991 Working Group meeting provided a misleading representation of the *C. gunnari* population structure in Subarea 48.3 in 1991/92.

6.49 An attempt to rework the VPA (starting from 1991 because catch in 1991/92 was zero), using both Laurec-Shepherd and ADAPT tuning methods was presented in WG-FSA-92/27. Data for tuning was derived from a series of surveys between 1987 and 1991 (see Table 4) and from CPUE data presented in WG-FSA-91/27. Criteria for the selection of the survey series were discussed in detail during last year's meeting (SC-CAMLR-X, Annex 6, paragraphs 7.42 to 7.52). Projections from the VPA estimates in 1991 consistently indicated that the population in 1991/92 would be composed of a large proportion of 5 year olds, despite the use of various combinations of survey and CPUE indices for tuning. Breakdown in the credibility of the VPA results in most recent years was attributed by WG-FSA-92/27 to the invalid assumption of constant **M** over a period when several surveys indicated a large reduction in stock size in the absence of fishing.

6.50 The Working Group used the CCAMLR version of ADAPT (FADAPT8.EXE) to confirm the VPA results presented in WG-FSA-92/27. Five runs were performed (Run 1 to Run 5) using tuning data inputs listed in Table 5. Catch-at-age and mean weight-at-age were as used at last year's meeting (SC-CAMLR-X, Annex 6, Appendix F).

Table 5: Tuning data inputs for FADAPT8 runs on *C. gunnari* in Subarea 48.3.

Run	Period	**M**	Tuning Indices (Ages 1-6)	Weighting of Indices	Reference
1	1977-1991	0.48	Survey indices 1987 to 1991	Equal weighting	WG-FSA-92/27
2	1977-1991	0.48	Survey indices 1987 to 1991	Inverse variance of surveys	WG-FSA-92/27 WG-FSA-91/15
3	1977-1990	0.48	CPUE indices 1981 to 1990	Equal weighting	WG-FSA-91/27
4	1977-1991	0.48	Combination of CPUE and survey indices	Equal weighting	WG-FSA-92/27
5	1977-1991	0.48	CPUE and survey indices input separately	Equal weighting	WG-FSA-91/27 WG-FSA-92/27

6.51 Figure 1 illustrates the total biomass (age 2+) from these five runs. The diagnostics provided by the program indicated that the final year parameters (**F** and **q**) of runs tuned to survey indices had coefficients of variation between 40% and 80%. The CVs of the **q**s estimated on runs tuned to CPUE indices were in the region of 20% due to the greater number of data points. The pattern of stock trajectories produced using the different tuning indices was similar to that produced by the Laurec-Shepherd tuned VPAs presented in WG-FSA-92/27; the estimated population size, however, was generally higher with the ADAPT method.

6.52 Cohort projections from 1990/91 to 1991/92 (two years, from 1989/90 to 1991/92 in the case of run 3) assuming zero catch, M = 0.48 and mean recruitment between 1985/86 and 1989/90 were made, in order to compare the projected age distribution with the observed age distribution from the 1992 survey (Figure 2). The projected age distribution over the most recent years was fairly consistent between runs, with a large proportion of the fishable biomass (>2 years) in 1991/92 in most runs consisting of 5 year olds. In runs 1 and 4, 4 year olds made up about 40% of the fishable biomass.

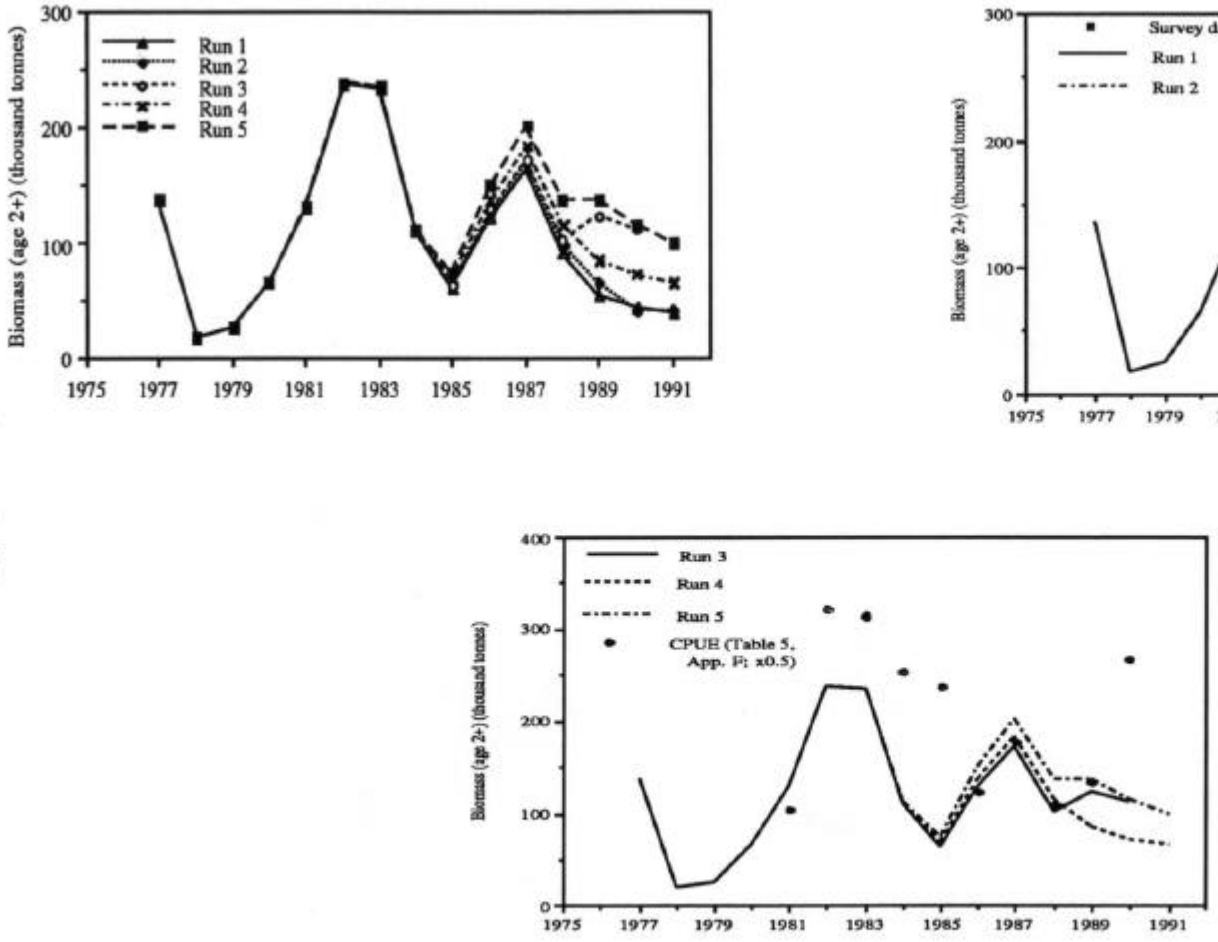

Figure 1: Total biomass derived from VPA tuning runs in Table 5. Survey data (from Table 4, superscript 4) and CPUE data (from SC-CAMLR-X, Annex 6, Appendix F, Table 5) are plotted with their various tuning runs.

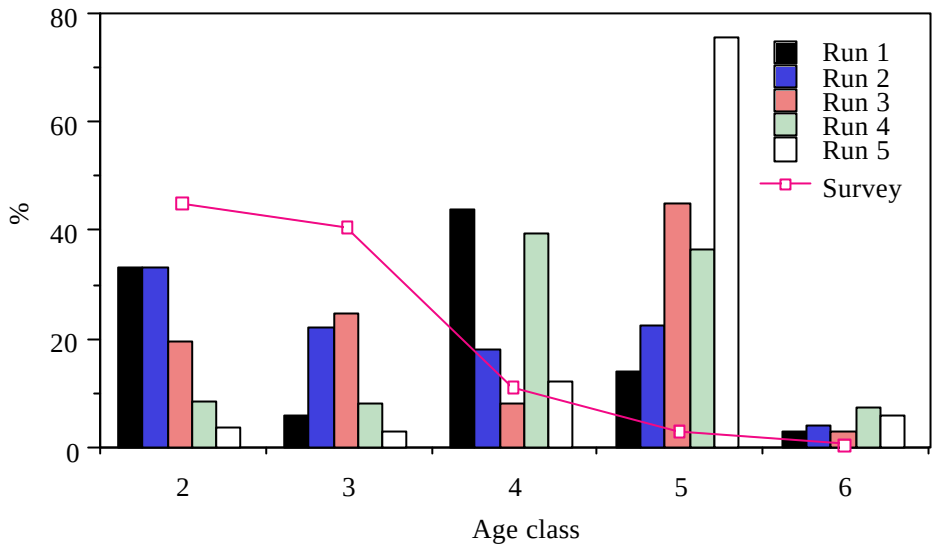

Figure 2: Age distribution of exploitable biomass (age 2+) of *C. gunnari* in 1991/92 estimated from the VPA runs (bars) and observed during a scientific survey in January 1992 (line) - WG-FSA-92/17.

6.53 The Working Group considered that the parameters of the VPAs were generally estimated with poor precision. The resulting projections of recent stock biomass and age structure were not consistent with the patterns observed from research vessel surveys over the past few years.

6.54 Trawl surveys in 1989/90 surveys indicated that two abundant year classes had entered the stock. Projections from the VPA predict that these fish are abundant in the population as 4 and 5 year olds in 1991/92. Trawl surveys in 1990/91 and 1991/92, however, indicate that these fish are no longer abundant.

6.55 The Working Group believed that this inconsistency is explained by the invalid assumption of constant **M** used in the VPA, the resulting projection, which did not take account of the large drop in biomass in the absence of substantial **F**, and uncertainties in the age structure of the input data. The Working Group was concerned that basing management advice for 1992/93 on the results of the VPA could result in damage to the stock, due to the apparent absence of the predicted abundance of older fish in the population.

6.56 The Working Group therefore concluded that the results of VPAs performed at this year's meeting should not be used as an assessment of the current status of the stock of *C. gunnari* in Subarea 48.3.

6.57 The only other information available to the Working Group for the assessment of the current status of the *C. gunnari* stock in Subarea 48.3 was the results of the stock assessment surveys performed by *Falklands Protector* in January 1991 (WG-FSA-91/14) and January 1992 (WG-FSA-92/17). The Working Group recognised that the catchability of the survey was unlikely to be 1 and that survey abundance indices are generally regarded as underestimates of true population size. However, given the obvious uncertainty in the current assessment, the trawl survey results represent the best measure of abundance.

6.58 The approach adopted was to use the results of the 1992 survey, which shows a picture of total biomass which is reasonably consistent with the previous year's survey, and project forwards to 1992/93 and 1993/94, assuming either no catch (maintenance of the current conservation measure) or a catch based on a target **F**, such as $\mathbf{F_{0.1}}$, in 1992/93. Projected recruitment of 1 year olds was input as a mean value with a log-normal error, which was used to simulate recruitment uncertainty. Mean recruitment and the variance of $\log_e$ recruitment were taken from the VPA between 1977 and 1986, prior to the period when the analysis apparently broke down. These parameters were highly consistent between runs, being equal to 900 million individuals and 0.45 respectively. $\mathbf{F_{0.1}}$ was calculated under the same assumptions used at WG-FSA-91 ($F_{0.1}$ = 0.39, with knife edge selection at age 2).

6.59 Annual recruitment **R**, was generated independently for each year on each run as follows:

$$R = \bar{R} \cdot e\left(x - \frac{\sigma^2}{2}\right)$$

where: $\bar{R}$ = mean recruitment

$\mathbf{X} = \sqrt{\sigma^2 \cdot Z}$

s^2 = variance of $\log_e$ recruitment

Z = normal (0,1) random variable

The value of s^2 was well within the range of values listed for other marine species (Beddington and Cooke, 1983[1]). Each projection was run 500 times to simulate recruitment uncertainty making it possible to obtain 95% confidence limits.

6.60 The values of $\bar{R}$ and s^2 were very similar to those given in WG-FSA-92/27. The Working Group agreed to accept the results of these projections to save re-running the simulation which would yield essentially the same results.

6.61 The results of all projections are presented in Table 6 and Figure 3.

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

Table 6: Results of cohort projections with variable recruitment for *C. gunnari* in Subarea 48.3, 1991/92 to 1993/94.

Total Biomass (tonnes), Age 2+, Subarea 48.3						
	1990/91 Survey	1991/92 Survey	1992/93 Projection	Without Catch in 1992/93	With Catch ($F_{0.1}$) in 1992/93	
				1993/94 Projection	1992/93 Catch	1993/94 Projection
Upper 95%	22 400 CV 16%	38 000 CV 18%	154 100	277 200	43 600	240 600
Mean			87 000	137 400	24 300	110 800
Lower 95%			52 000	62 700	15 200	49 400

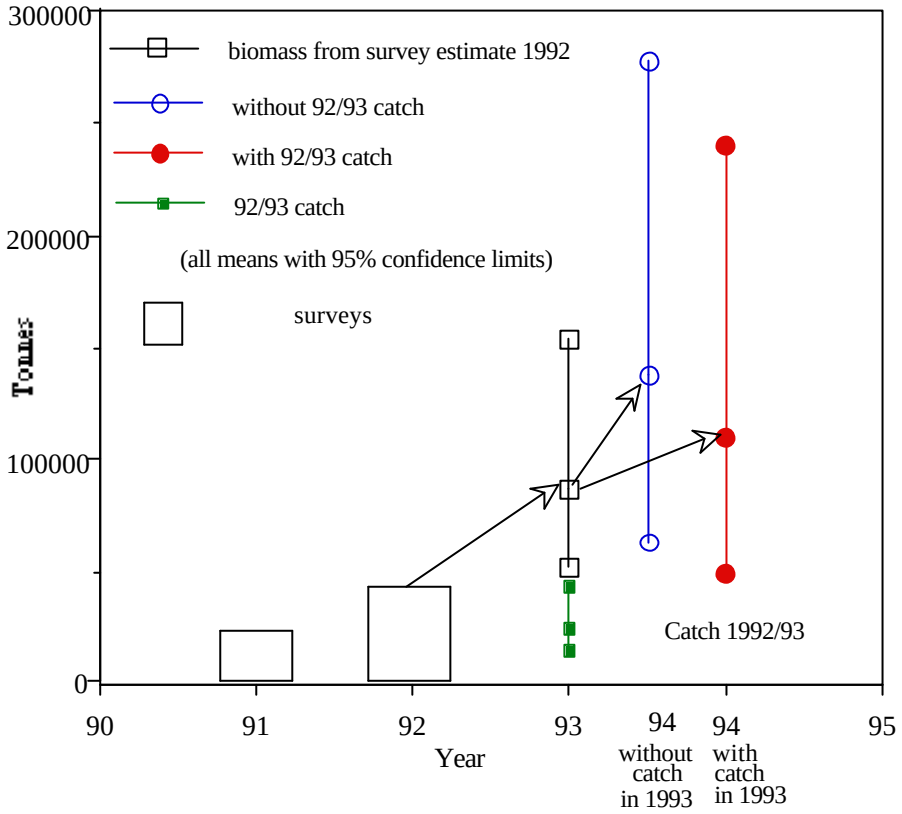

Figure 3: Projection scenarios for *C. gunnari* with variable recruitment.

6.62 In the absence of fishing, the mean biomass was projected to grow to about 137 400 tonnes (95% confidence limits 62 700 to 277 200) by 1993/94, with an increase in the biomass of 4 and 5 year olds.

6.63 The $\mathbf{F_{0.1}}$ catch level in 1992/93 was estimated to be of the order of 24 300 tonnes (95% confidence limits 15 200 to 43 600), however, about 50% of this was composed of 2 year olds and was thus highly dependent on the estimated recruitment of 1 year olds in 1991/92. It has been assumed that the recruitment in 1991/92 would be similar to those which occurred over the period 1977 to 1986. However, the observations of fish in poor condition which may have led to increased mortality and poor spawning performance mean that this assumption may not be justified. The Working Group thought that projections relying heavily on this mean recruitment should be treated with caution.

6.64 At the lower 95% confidence limit of the projected catch (15 200 tonnes), the assessed proportion of 2 year olds in the catch was 25%. At this level of TAC the fishery in 1992/93 would therefore be less dependent on the assumed size of the recruitment of one year olds in 1991/92.

6.65 Following a catch at $\mathbf{F_{0.1}}$ in 1992/93 the mean biomass was projected to grow to about 110 800 tonnes (95% confidence limits 49 400 to 240 600) in 1993/94. The lower bound of the 95% confidence interval on the total biomass, however, was lower in 1993/94, following the catch, than it was in 1992/93.

Considerations for a Re-opening of the *C. gunnari* Fishery

6.66 The Working Group recognised that a fishery for *C. gunnari* in Subarea 48.3 in 1992/93 could involve bottom trawling, pelagic trawling or both.

6.67 The implications of bottom trawling in relation to both the by-catch of demersal fish species and the adverse effect on the benthos have been considered during past meetings of the Working Group and the Scientific Committee (SC-CAMLR-X, Annex 6, paragraphs 7.189 to 7.197 and SC-CAMLR-X, paragraphs 8.39 and 8.40). Bottom trawl catches of *C. gunnari* usually contain a mixture of the by-catch species *N. gibberifrons, C. aceratus* and *P. georgianus*, the proportion in the catch probably varying considerably from one season to another and from one fishing ground to another. Quantitative information on the by-catch is available from the Polish fishery for a number of years, but not from the Soviet fishery, which has taken the bulk of the catches. During years when the Polish fishery targetted *C. gunnari*, the relative weights of major species in the catch were as given below (SC-CAMLR-X, Annex 6, Appendix H):

N. gibberifrons	1
C. aceratus	1
P. georgianus	1
C. gunnari	6

6.68 The TAC of *C. gunnari* in Subarea 48.3 of a fishery using bottom trawls could therefore be limited by by-catch considerations to six-times the TAC of either *N. gibberifrons*, *C. aceratus* or *P. georgianus*, whichever is the least.

6.69 No new projections of the potential yield of the three by-catch species were performed by the Working Group. The status of these stocks is thought to be little changed since 1990/91 (see paragraphs 6.95 and 6.96).

6.70 According to the calculations given at last year's meeting (SC-CAMLR-X, Annex 6, paragraph 7.196), the TAC of *C. gunnari* in Subarea 48.3 using bottom trawls would be limited to six-times the MSY for *N. gibberifrons*. This was calculated in 1991 as equal to about 8 800 tonnes of *C. gunnari*.

6.71 The working Group also reiterated its concerns over the potential adverse effects of bottom trawling on benthos, which in turn could affect fish communities in the medium or longterm.

6.72 There are also implications of by-catch of other finfish species in a pelagic trawl fishery for *C. gunnari*. Despite requests for data at last year's meeting (SC-CAMLR-X, Annex 6, Appendix E), no new information on this by-catch was made available to this year's meeting. Data analysed at the 1990 meeting showed that the by-catch of *N. gibberifrons* in pelagic trawls targetting *C. gunnari* is potentially of the order of 3 to 16%*. A TAC of 15 200 tonnes of *C. gunnari* (the lower 95% confidence interval given above), for instance, would therefore imply a by-catch of *N. gibberifrons* of between 460 and 2 432 tonnes. The by-catch of *C. aceratus* is likely to be of similar magnitude to the by-catch of *N. gibberifrons*, given its similar distribution in the water column. *P. georgianus*, however, is believed to undergo vertical migrations into the water column, which would make it more vulnerable to pelagic trawls. The by-catch of this species is therefore thought to be potentially considerably greater than that of *N. gibberifrons*. Future TACs of a pelagic fishery for *C. gunnari* in Subarea 48.3 will potentially be limited by the magnitude of this by-catch in relation to the potential yield of these species. The Working Group reiterated its request made last year for more detailed data on this subject.

* $\frac{\text{catch of } N.\ gibberifrons}{\text{catch of } C.\ gunnari} \times 100$

6.73 The potential MSY of *N. gibberifrons* in Subarea 48.3, estimated at last year's meeting was 1 470 tonnes (SC-CAMLR-X, Annex 6, Table 16). If the by-catch of *N. gibberifrons* is not to exceed 1 470 tonnes then the implications of the 3 to 16% range of by-catch percentage are as follows:

By-catch Percentage by Weight	By-catch Limit	Potential Ceiling of *C. gunnari* Catch
16%	1 470	9 200
3%	1 470	49 000

6.74 The Working Group considered that steps should be taken to investigate concerns over the potential impact of the *C. gunnari* fishery on by-catch species and benthos. For this to succeed, data on the by-catch in pelagic and bottom trawl fisheries should be reported and incorporated in simulation models which investigate the potential impacts on stock dynamics of different fishing strategies using pelagic and/or bottom trawls. An experimental design should be employed to look at the impact of different types of bottom gear on the benthic community. For these experiments to be possible, the Working Group agreed that control areas would need to be designated as soon as possible in a way that ensures that there are some areas in which the benthic communities are free from the disturbance of trawling (SC-CAMLR-X, paragraph 8.41).

Management Advice

6.75 Given the uncertainty surrounding the current status of the exploitable stock of *C. gunnari* in Subarea 48.3 the Working Group considered that a conservative approach to management is appropriate in the immediate future.

6.76 A conservative approach would be the maintenance of the current conservation measure prohibiting directed fishing for *C. gunnari* in Subarea 48.3 (Conservation Measure 33/X). Such an approach, however, should be supported by monitoring of the stock, ideally on an annual basis, to observe the rate of recovery in the absence of fishing.

6.77 The Working Group recommended that a scientific survey be carried out during the 1992/93 season. No plans for scientific surveys on *C. gunnari* in Subarea 48.3 during the 1992/93 season have been received by the Secretariat.

6.78 The Working Group considered a number of possible TAC levels which are given in Table 7.

Table 7: TAC levels and assumptions for *C. gunnari* in Subarea 48.3.

C. gunnari TAC (tonnes)	Assumptions/Rationale
15 200	Lower 95% confidence limit of projected catches at $\mathbf{F_{0.1}}$
9 200 - 15 200	Pelagic trawl fishery only Maximum by-catch of *N. gibberifrons* = 1 470 tonnes (SC-CAMLR-X, Annex 6, Table 16) and *N. gibberifrons* ≤16% of *C. gunnari* catch
8 800	Bottom trawl fishery only *C. gunnari* catch = 6 x maximum by-catch of *N. gibberifrons* (1 470 tonnes)

6.79 The Working Group stressed that biological information and information on by-catch from any commercial trawl fishery in Subarea 48.3 during 1992/93 is of vital importance for future assessments. If the fishery were to be re-opened in 1992/93, the Working Group felt that an effort and biological reporting system similar to that for *D. eleginoides* in Subarea 48.3 (Conservation Measure 37/X) would be appropriate for *C. gunnari* in Subarea 48.3.

6.80 In the event that the fishery is re-opened in 1992/93, the Working Group recommended the closure of directed fishing for *C. gunnari* between 1 April and the end of the Commission meeting in 1993 (as in the 1990/91 season; Conservation Measure 21/IX) to protect spawning.

6.81 The Working Group noted that a pelagic trawl fishery in Subarea 48.3 would allow both a higher TAC of *C. gunnari* and would also avoid the possible adverse affects of bottom trawling on the benthic community. It was therefore concluded that in the event of a TAC being set for *C. gunnari* in 1992/93 the ban on bottom trawling (as in Conservation Measure 20/IX) should be reinstated.

6.82 No new information was presented to the Working Group concerning *C. gunnari* mesh selectivity. The Working Group therefore had no reason to propose changes to the 90 mm mesh size regulation (Conservation Measure 19/IX).

Patagonotothen guntheri (Subarea 48.3)

6.83 Conservation Measure 34/X prohibited directed fishing for this species in the 1991/92 season. The only catch of *P. guntheri* (1.5 tonnes) reported to CCAMLR originated from a research vessel survey in January 1992 (WG-FSA-92/17).

6.84 The distribution of *P. guntheri* is confined to the waters around Shag Rocks. For the first time, an individual *P. guntheri* was caught on the western shelf of South Georgia at a depth of 365 to 392 m (WG-FSA-92/17).

6.85 A new biomass estimate of 12 764 tonnes (CV 61.4%) from a bottom trawl survey was available to the Working Group (WG-FSA-92/17). Due to the benthopelagic mode of life of this species, the Working Group reiterated its findings from previous years, notably that any biomass estimate from a bottom trawl survey is likely to be an underestimate.

6.86 No new information on natural mortality and recruitment of this species has been submitted to CCAMLR. At last year's meeting the Working Group expressed concern about the accuracy of fine-scale data reported to CCAMLR. This referred in particular to catch and effort data from the South Georgia area, an area in which this species has not been found in larger numbers during research vessel surveys (SC-CAMLR-X, Annex 6, paragraph 7.13), and asked the relevant authorities for clarification. However, no additional information was received.

Management Advice

6.87 The very low level of fishing in 1989/90 and the absence of commercial fishing in 1990/91 and 1991/92 would have been expected to result in an increase in the biomass of *P. guntheri*. However, the Working Group reiterates its statement from last year that it is unable to assess the current state of the stock due to the lack of information, such as an accurate biomass estimate, estimates of natural mortality and recruitment values for recent years. As the species is short-lived, the current state of the stock is critically dependent upon the strength of the year classes which have been recruited to the stock in very recent years.

6.88 The Working Group recommended that the present conservation measure (Conservation Measure 34/X which applied to the 1991/92 season) should be retained until information, which would allow a reassessment of the stock to be made, becomes available.

Notothenia squamifrons (Subarea 48.3)

6.89 Following the adoption of a by-catch provision of 300 tonnes in 1988/89 and 1989/90 (Conservation Measures 13/VIII and 20/IX), the directed fishery for the species was prohibited from 1990/91 onwards (Conservation Measures 22/IX and 34/X). In 1991/92, *N. squamifrons* were only taken in small numbers during a research vessel survey in January 1992 (WG-FSA-92/17).

6.90 Despite a request in 1991 for the provision of length and age data from past commercial catches (SC-CAMLR-X, Annex 6, Appendix E) no new information has become available to the Working Group. The Working Group was therefore unable to assess the current state of the stock.

Management Advice

6.91 In the absence of any information which would allow an assessment of the stock to be made, the Working Group recommended that the conservation measure presently in force (Conservation Measure 34/X) should be retained.

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

6.92 All three species have been common by-catch species particularly in the bottom trawl fishery for *C. gunnari* since the mid 1970s. In some years they have been targetted by the fishery. Both bottom trawling and directed fishing for the species have been prohibited since 1990/91 (Conservation Measures 20/IX, 22/IX and 37/X). A research vessel survey in January 1992 reported catches of 8 tonnes (WG-FSA-92/17).

6.93 No new information on by-catches of the three species in the fishery for *C. gunnari* from historic catches made either by bottom trawl or pelagic trawl have been made available to the Working Group. These were offered two years ago (CCAMLR-IX, paragraph 13.16) but not received, and have been repeatedly requested by the Working Group (SC-CAMLR-X, Annex 6, paragraph 8.10).

6.94 Since 1988/89 little or no commercial fishing has taken place for these three species. Due to the absence of catch-at-age information from commercial catches for the last four seasons, no new analytical assessments such as VPA have been carried out by the Working Group.

6.95 New biomass estimates were available from a research vessel survey in January 1992 (WG-FSA-92/17). These were:

N. gibberifrons	29 574 tonnes (CV 15.4%)
C. aceratus	12 466 tonnes (CV 14.9%)
P. georgianus	13 469 tonnes (CV 14.6%)

6.96 Biomass estimates were consistent with estimates from surveys carried out in 1990 and 1991 and the results of assessments by the Working Group in 1991 (Figure 4). They support the conclusions of last year's Working Group meeting that all three species show an upward trend in stock size since the introduction of more stringent conservation measures for these species by CCAMLR in 1989.

6.97 Length frequency distributions from UK surveys since 1990 show a steady increase in the proportion of adult *N. gibberifrons*, and small fluctuations in the stock structure and size of *C. aceratus* and *P. georgianus*. This is consistent with trends in biomass estimates from these surveys.

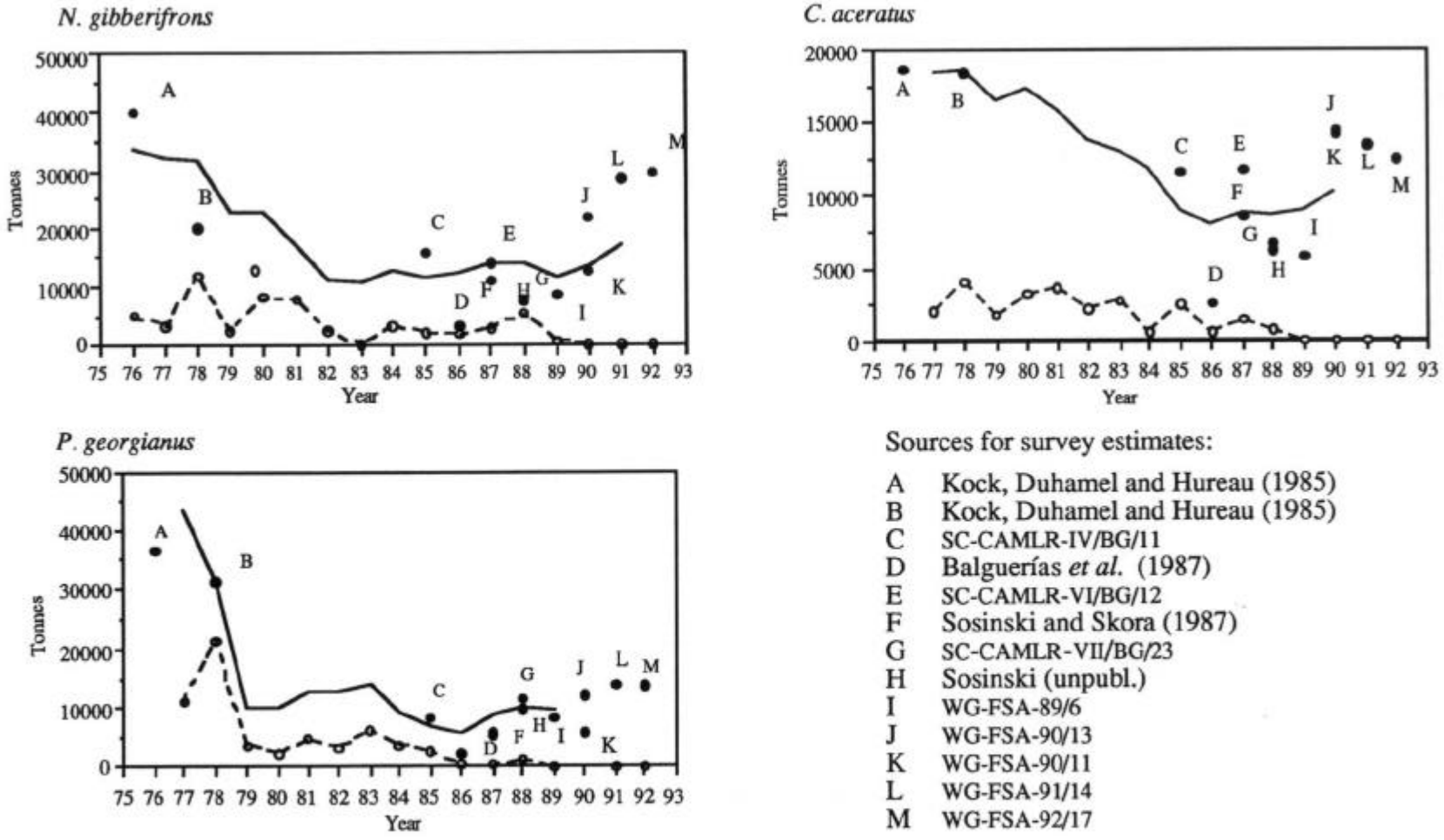

Figure 4: Abundance trends (VPA and survey biomass estimates) and catch history of *N. gibberifrons*, *C. aceratus* and *P. georgianus*.
——— VPA trajectory - - o - - Total catch • Survey biomass estimates

6.98 Biomass estimates (in tonnes) for the three species from the initial phase of the fishery (1975/76 for *N. gibberifrons* and 1976/77 for *C. aceratus* and *P. georgianus*) are given in the following table:

Table 8: Biomass estimates (tonnes) for *N. gibberifrons*, *C. aceratus* and *P. georgianus*.

	Date	Research Surveys	VPA	1992 Estimate as a Proportion of the Initial Level
N. gibberifrons	1975/76	40 094[1]	33 982[2]	73 - 87%
C. aceratus	1976/77	18 719[1]	18 365[3]	66 -67%
P. georgianus	1976/77	36 401[1]	43 580[3]	30 - 37%

1 from Kock, Duhamel and Hureau (1985)
2 from SC-CAMLR-X, Annex 6, Figure 12
3 from Agnew and Kock (1990)

These estimates suggest that *N. gibberifrons* and *C. aceratus* have recovered more than *P. georgianus*.

6.99 It is noteworthy that recovery of *N. gibberifrons* and *C. aceratus* has been faster than that of *P. georgianus*. The former are believed to be more long-lived than *P. georgianus*. One possible explanation is that the standing stock of *P. georgianus* in the mid 1970s was much higher than average, due to the presence of several strong year classes in the stock. After these had been fished out in the late 1970s no similarly strong year classes have occurred and the stock may now have stabilised at a much lower level.

Management Advice

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

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

Electrona carlsbergi (Subarea 48.3)

6.102 The reported catch of *E. carlsbergi* in 1991/92 was 46 960 tonnes in Subarea 48.3. This catch was less than the catch in 1990/91 and 19% of the TAC set in Conservation Measure 38/X. Although some fine-scale data has been submitted by Ukraine and Russia, not all fine-scale data for this catch has been submitted.

6.103 New data were available to the Working Group on species composition of by-catch in research trawls targetting *E. carlsbergi* in the Polar Frontal Zone north of South Georgia Island in 1987 to 1989 (WG-FSA-92/12). The catches in these trawls were dominated by myctophids, with *E. carlsbergi* dominating the catch (>90%) in catches greater than 0.5 tonnes. The presence of *E. carlsbergi* was more variable in smaller catches with other myctophids, particularly of the genus *Gymnoscopelus*, often making up significant proportions of the catch. The Working Group welcomed this information provided in response to a request last year for details of by-catch in this fishery (SC-CAMLR-X, Annex 6, paragraph 7.148). However, details of the by-catch in the commercial fishery are necessary for evaluating whether the fishery should be considered as a single species fishery on *E. carlsbergi* or whether it is a multispecies fishery on a number of myctophid species.

6.104 No description of the trawls used in this fishery were provided to this year's meeting as requested in SC-CAMLR-X, paragraph 4.76.

6.105 The Working Group noted that the stock assessments of last year were based on survey data from 1987/88. Data on length composition in the 1991/92 fishery showed a size structure in the fishery similar to that reported in 1990 (SC-CAMLR-X, Annex 6, paragraph 7.131) with sizes ranging between 62 to 85 mm. No other data to refine the uncertainties in the assessments from 1991 (SC-CAMLR-X, Annex 6, paragraph 7.149) have been submitted. As these fish are short lived (four to five years), there are no data on the current biomass of the stock. New surveys of the myctophid stocks in Subarea 48.3 are needed to provide an assessment of the current stock status.

Management Advice

6.106 The Working Group noted the difficulty in providing advice based on data and assessments which are no longer current.

6.107 On the basis of the known biological characteristics of the stock, the current level of fishing on *E. carlsbergi* in Subarea 48.3 may be sustainable. However, the fishery is now based on a stock for which the age structure and biomass are unknown and the catch and biological parameters of related species are also unknown. Thus, the Working Group was unable to advise on an appropriate TAC for the current fishery. The Working Group reiterated the need for further surveys to estimate current biomass (SC-CAMLR-X, Annex 6, paragraph 7.149).

Dissostichus eleginoides (Subarea 48.3)

6.108 Catches of *D. eleginoides* in Subarea 48.3 were initially reported in 1977. Until the mid 1980s, the fishery was carried out entirely by bottom trawls. The longline fishery probably began in April 1986 (WG-FSA-92/13). The annual catch data are summarised in Table 3.

6.109 In accordance with Conservation Measure 35/X, the total catch of *D. eleginoides* for the period from 4 November to the end of the Commission meeting in 1992 was limited to 3500 tonnes. Conservation Measures 36/X and 37/X, relating to the reporting of catch and effort and biological data, were also in force.

6.110 Catch and effort data were reported to the Secretariat by five-day period and in fine-scale longline format. In addition, length frequency data were reported by Chile and Russia.

6.111 The 1991/92 fishing season for *D. eleginoides* was shorter than previous seasons, mainly because of entry into the fishery of the Chilean fleet. The fishery opened on 4 November 1991. The TAC was reached on 10 March and the fishery closed. During the season the fishery was prosecuted by one Bulgarian, five Russian and eight Chilean vessels, fishing for different periods as shown in Figure 5.

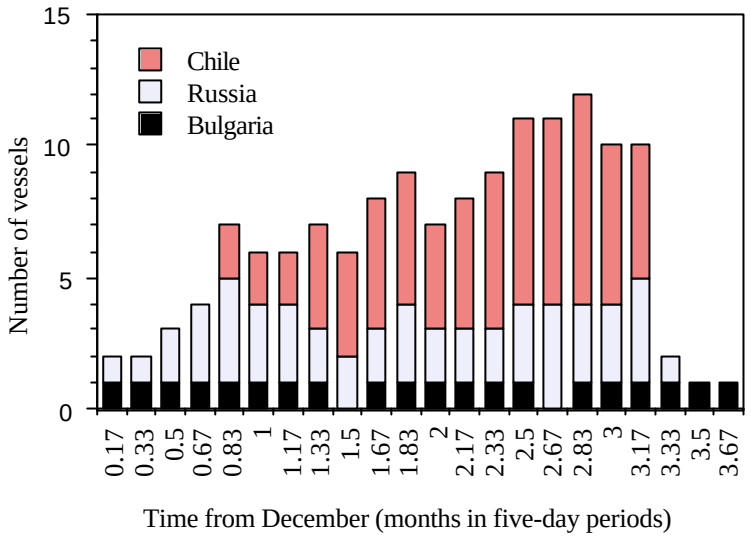

Figure 5: Number of vessels taking part in the fishery.

Review of Catch and Effort Data

Catch Location from Fine-Scale Data

6.112 The position of all catches by Russian and Chilean vessels is shown in Figure 6. In contrast to earlier fishing seasons the fishery took place all around Shag Rocks and South Georgia. The depth of fishing ranged from 500 to 2 000 m with highest effort between 1 300 and 1 400 m.

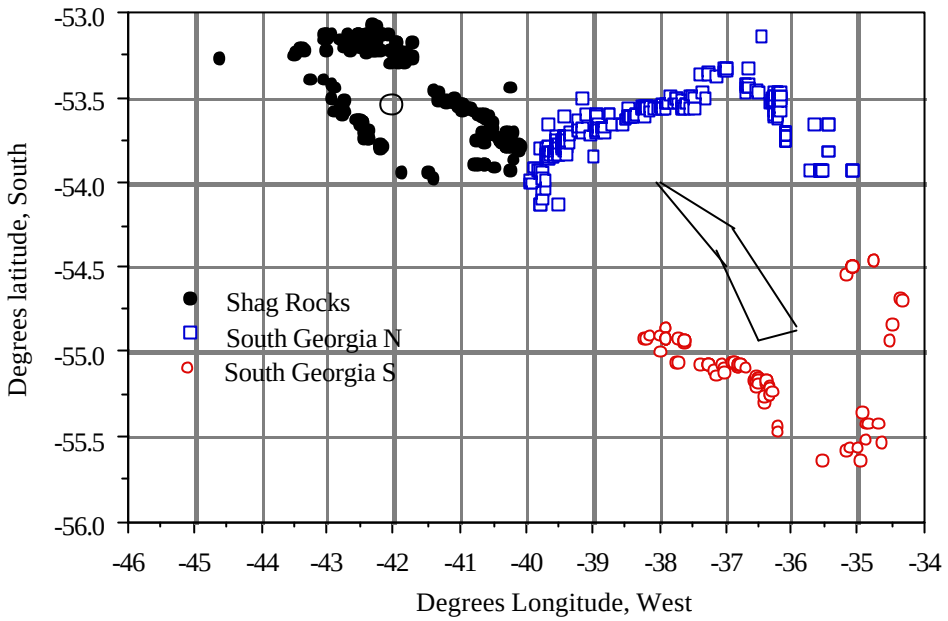

Figure 6: Position of catches of *D. eleginoides* around South Georgia and Shag Rocks.

Effort Data

6.113 Vessel size was reported as 300 to 1 000 tonnes (WG-FSA-92/28). The number of vessels taking part in the fishery per five-day period ranged from one (second half of March) to 12 (end of February).

6.114 The number of hooks varied considerably. The mean number of hooks/line was 8809 (Chile), 4 794 (Russia) and 3 630 (Bulgaria). The Chilean fleet used six different types and sizes of hooks, while only two types were used by Russian vessels.

Selectivity of Trawls

6.115 A trawl survey around South Georgia in the depth range 50 to 500 m reported catches of *D. eleginoides* ranging from 20 to 86 cm, with very rare occurrences of specimens larger than 46 cm (WG-FSA-92/17, Figure 17).

Selectivity of Hooks

6.116 The size of fish caught in the longline fishery ranged from 45 to more than 200 cm with the bulk of fish being between 70 and 120 cm long (WG-FSA-92/13, 24 and 28). The most important factor influencing mean length of *D. eleginoides* catches seems to be hook type. Seasons and fishing sites seem to have little or no effect (see Table 9).

Table 9: Mean length of *D. eleginoides* for different hook types (CCAMLR coding[1]), sites and fishing nations.

Fishing Nation	Area	Hook Type	$\bar{L}$ * (Total Length)	SD
Chile	South Georgia	5	95.4	14.1
Chile	South Georgia	9	99.0	15.2
Chile	South Georgia	6	117.1	14.0
Chile	South Georgia north of 54.2°S	6	116.4	13.6
Chile	South Georgia south of 54.2°S	6	117.9	13.4
Chile	Area west of 48.3	5	99.2	17.7
Russia	South Georgia		104.5	13.8
Russia (WG-FSA-92/31)	Kerguelen	?	92.95 - 93.4	

* Standard length converted to total length using TL = 1.247+1.118 (SL) (Kock *et al*., 1985)

6.117 Due to the use of different types of bait, it still remains unclear if the type of hook or bait have greater effect on the CPUE and selectivity for *D. eleginoides*. The Working Group recommends that research be undertaken to allow the estimation of selectivity factors for use in assessments.

Biological Information

Distribution and Stock Identity

6.118 *D. eleginoides* is widely distributed in sub-Antarctic waters from approximately 30°S off Chile and approximately 37°S off Argentina in the north and Shag Rocks and South Georgia in the

1 Code 5 = 20 to 25 mm width, 6 = 25 to 30 mm width, 9 = 40 to 45 mm width

south as well as around Crozet, Kerguelen, and Heard Islands, Ob and Lena Banks, an unnamed bank north of Kara Dag Bank in the Indian Ocean sector, and around Macquarie Island on the Indo-Pacific boundary. The southern limit of the distribution of *D. eleginoides* is currently thought to be 56°S. The bathymetric range of the species extends down to more than 2 500 m, with smaller fish being found above 500 m (Yukhov, 1982[1]; Salas *et al*.[2], 1987; De Witt *et al*.[3], 1990).

6.119 The location of spawning grounds of this species is unknown, but fish caught on the slope of Burdwood Bank from May to August 1978 (Kock, unpubl.) and fish caught in July 1992 around the northwest of South Georgia and Shag Rocks were found to be in pre-spawning condition (WG-FSA-92/13 and 14). This suggests that spawning may take place over the continental slope from June to August/September.

6.120 The relationship between the population of *D. eleginoides* around South Georgia and those in other areas is unknown. Genetic similarities of *D. eleginoides* caught in Subarea 48.3 and in areas around southern Chile, Falklands/Malvinas and the Indian Ocean are currently being evaluated. Zakharov[4] (1976) distinguished two separate populations, one on the Patagonian Shelf and the other around South Georgia, based on differences in morphological and meristic characters. However, statistical techniques employed in this discrimination (e.g., Student's t-test) appear to be inadequate (Kock, 1992[5]). The Working Group identified stock identity as an important issue to be resolved because fishing occurs on *D. eleginoides* in four areas in close proximity - South Georgia, Shag Rocks, southern Chile and around the Falklands/Malvinas. There are also proposals to carry out exploratory fishing around the South Sandwich Islands in Subarea 48.4 (Chile - CCAMLR-XI/7; USA - CCAMLR-XI/5). If *D. eleginoides* migrates easily between these shelf areas, constituting a single population, then an assessment of the status of the fishery in Subarea 48.3 should include the fisheries in these other locations, some of which are outside the Convention Area.

6.121 The presence of squid and myctophids in their diet (WG-FSA-92/13) and their regular occurrence in sperm whale stomachs in pelagic waters of the Southern Ocean (Yukhov, 1982) indicate that these fish are likely to spend time in the pelagic environment. The proportion of the stock found in the pelagic environment, compared with the benthic environment on the continental

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1 YUKHOV, V.L. 1982. Antarkticheskij Klyklach. Moscow: Nauka. 113 pp.

2 SALAS, R., H. ROBOTHAM and G. LIZAMA. 1987. Investigación del Bacalao en VIII Region Informe Técnico. Intendencia Región Bió-Bió e Instituto de Fomento Pesquero. Talcahuano. 183 pp.

3 DE WITT, W.H., P.C. HEEMSTRA and O. GON. 1990. Nototheniidae (notothens). In: GON, O. and P.C. HEEMSTRA (Eds). *Fishes of the Southern Ocean*. Grahamstown, South Africa: J.L.B. Smith Institute of Ichthyology.

4 ZAKHAROV, G.P. 1976. Morphological characterisation of Patagonian toothfish (*Dissostichus eleginoides* Smitt) in the Southwest Atlantic. Trudy Atlantic Research Institute of Marine Fisheries and Oceanography. Kaliningrad 65: 20-30.

5 KOCK, K.-H. 1992. *Antarctic Fish and Fisheries*. Cambridge University Press, Cambridge.

shelf and slope, is unknown. Further work on the distribution of these fish in the water column and the potential for movement between shelf areas would facilitate greatly the evaluation of stock identity.

Age, Length and Weight Data

6.122 Length frequency distributions have been provided from longlining activities (WG-FSA-92/13, 14, 15) and trawl surveys (WG-FSA-92/17). Ages were not determined for fish in these catches.

6.123 As requested last year (SC-CAMLR-X, Annex 6, paragraph 7.102) age/length keys from larger sample sizes have been derived for South Georgia and southern Chile from catches obtained by Chilean commercial longline vessels (WG-FSA-92/30) (Appendix G, Tables G.1 and G.2). Age/length keys have been provided for different areas of the Kerguelen Island area in three different years (WG-FSA-92/8). However, these keys are based on small numbers of fish and most of these fish are in the size range between 70 and 110 cm. Age/length keys for *D. eleginoides* around South Georgia (n = 133) and Shag Rocks (n = 123) from a trawl survey early in 1992 have been submitted to the CCAMLR Data Centre. Ages were determined from scales.

6.124 Two problems need to be addressed before these keys are accepted as representative of the stock around South Georgia. First, there is controversy on the age determinations in *D. eleginoides* and methods have not yet been validated. Lic. E. Barrera-Oro (Argentina) noted that in otolith-sections the ageing is difficult due to the presence of false checks, whereas in scales, the ages of large fish are often underestimated due to the blending of rings at the outer edges, a common problem in other fish (e.g., Beamish and McFarlane, 1983[1]). Dr Kock noted also that the ages of all *D. eleginoides* may be underestimated by one year because the formation of the first readable annulus in the scales is likely to occur in the second year. The Working Group agreed that refining the methods of age determination should be given a high priority. This could be facilitated by comparing age readings from growth rings in otoliths and scales taken from the same fish and, also, by comparing readings from different readers.

6.125 The second problem is that the age/length characteristics of the entire stock are unlikely to be represented in catches from longlining. This may result from the selectivity of hooks for particular sizes of fish. WG-FSA-92/28 described the influence of hook type on the size of fish caught and describes a number of hook types which are currently used in the fishery. If large fish are excluded from the catch then the length-at-age could be underestimated for older fish. Similarly, if small fish

1 BEAMISH and MCFARLANE. 1983. The forgotten requirement for age validation in fisheries biology. *Trans. Am. Fish. Soc. 112*: 735-743.

are excluded then the length-at-age could be overestimated for younger fish. The truncated distributions of size at the youngest and oldest ages in the samples from southern Chile and South Georgia suggest that these data may suffer from this problem. The data from Kerguelen Island shows an under-representation of the smaller (less than 70 cm) and larger (greater than 110 cm) sizes.

6.126 The reliability of age/length keys and growth parameters is dependent on the adequate representation of the range of lengths at each age in the stock.

6.127 Length-weight relationships for different size ranges of *D. eleginoides* in different areas have been compiled in Appendix G, Table G.3 and Figure G.1.

Growth Parameters

6.128 Estimates of von Bertalanffy growth parameters for *D. eleginoides* in different areas are shown in Appendix G, Table G.4 and Figure G.2. Most estimates are derived from Ford-Walford plots. This was considered by the Working Group to be a less reliable method than non-linear regression methods which are widely available. The Working Group recommends that non-linear methods of estimating von Bertalanffy parameters be used in future analyses.

6.129 A serious problem with estimating von Bertalanffy parameters arises when the age/length relationship in the samples is not representative of the stock (see above). Given the low likelihood of complete representation of younger and older age groups, these estimates should be treated with caution.

Natural Mortality

6.130 An evaluation of estimates of **M** (see Table G.5 in Appendix G) was submitted to the Working Group in WG-FSA-92/21. This evaluation compared estimates of **M** based on different growth curves, catch data from different areas (pooled across depths and different gear types) and different methods for estimating **M**.

6.131 The use of the Chapman-Robson age-based method can bias estimates of **M** if it is an increasing or decreasing function of age, i.e. **M** will be overestimated if **M** increases with age and underestimated if **M** decreases with age. Estimates using Heincke's estimator should also be considered in future, since this is insensitive to age-dependence in mortality rate, and may be less

affected by underestimation of age in older fish. The Working Group chose two models, which use only length data and growth curve parameters, to examine how estimates of **M** might vary with area, growth curve and method. Given the data available, the results indicate variation between 0.07 and 0.19. The mean for each method (see WG-FSA-92/21) was:

Beverton and Holt length-based method	= 0.10
Alverson-Carney method	= 0.16
Grand Mean	= 0.13

6.132 The Working Group accepted this range and the mean of 0.13 as the most suitable estimates of **M** to work with in the current assessments.

6.133 The Working Group emphasised that estimates of **M** are affected by gear selectivity and will need to be refined as more data on selectivity comes to hand (see paragraphs 6.115 and 6.116).

Diet

6.134 Stomach content analysis of *D. eleginoides* caught on longlines showed that most stomachs contained little or no food (WG-FSA-92/13). Fish were found to be the prevalent food item. This is corroborated by earlier findings that *D. eleginoides* feeds mostly on fish and to a lesser extent, on benthic invertebrates, such as octopus (Permitin and Tarverdiyeva, 1972[1]; Chechun, 1984[2]; Duhamel, 1987[3]). Species composition in the diet varied considerably locally and ranged from mesopelagic to demersal species. This suggests that the species is an opportunistic feeder taking advantage of any locally abundant fish resource.

Sexual Maturity

6.135 Three papers submitted to this year's Working Group meeting contain information on the size at sexual maturity and size at first spawning respectively: WG-FSA-92/13, 14 and 15.

6.136 WG-FSA-92/13 provides a size range over which most specimens become sexually mature. It is:

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1 PERMITIN, Y.Y., M.I. TARVERDIYEVA. 1972. The food of some Antarctic fish in the South Georgia area (in Russian). *Vopr. Ikhtiol. 12*(1): 120-132.

2 CHECHUN, I.S. 1984. Feeding and food interrelationships of some sub-Antarctic fishes of the Indian Ocean (in Russian). *Trudy Inst. Zool. Leningrad 127*: 38-68.

3 DUHAMEL, G. 1987. Ichthyofaune des secteurs indien occidental et atlantique oriental de l'océan austral: biogéographie, cycles biologiques et dynamique des populations. Ph.D. Thesis, P. et M. Curie University of Paris. 687 p.

72 - 90 cm (≅ 7 - 11 years) in males, and
90 - 100 cm (≅ 9 - 12 years) in females.

6.137 Tables 7 to 9 of WG-FSA-92/14 provide length/maturity tables by sex, fishing month and fishing grounds separately. These were combined to estimate size at first spawning. The Russian investigators used a maturity scale which is different from the one commonly used in CCAMLR, and was not available to the Working Group. It was assumed that maturity stages 3 and over contained those individuals which were likely to spawn in the current season. Due to size selectivity and a possible different bathymetric distribution, immature fish were poorly represented in the catches: a situation which is particularly likely to occur for males, which reach sexual maturity at a smaller size than females. The following estimates are thus biased to an unknown extent, the estimate for males having a larger bias than that for females:

L_m = 77 cm for males,
L_m = 92 cm for females.

Furthermore, the number of fish investigated in the size range in which size at first spawning is attained, was small (<150 fish). This further limits the value of these estimates.

6.138 WG-FSA-92/15 provides size compositions for sexes combined on several fishing grounds and on approximate proportion of immature fish in these catches. Assuming that these immatures were comprised of smaller fish, size at first spawning was estimated to be L_m = 95 cm.

6.139 The Working Group concluded that none of the three data sets provide an accurate estimate of size at sexual maturity and/or size at first spawning. A first approximation (of size at first spawning) may be to assume:

L_m = 85 cm for males, and
L_m = 95 cm for females

until better data become available. The estimated age at first spawning will depend on which growth function is to be used.

6.140 The Working Group recommended that the number of maturity stage determinations needs to be increased substantially in the size ranges 75 to 95 cm in males and 85 to 110 cm in females to estimate size at sexual maturity and size at first spawning more accurately.

Assessment Work

Length-based Cohort Analysis

6.141 Length-based cohort analyses were carried out according to Jones (1974) method. This method calculates the stock biomass under the assumption that it has been stable under exploitation. Given that this assumption cannot be verified, the calculated biomasses should not be considered as estimates of current biomass, but rather as estimates of the biomass which would occur if the stock was stable with the average catches at length used in the calculation. The method requires estimates of **M** and growth curve parameters, along with catch at length data. The latter were calculated from the available length frequency data from the catch and total catch data, averaged over the years 1989 to 1992. Thus, the annual average catch used in the calculations was approximately 5 000 tonnes. The results were calculated for the three values of **M**, and for the growth curves given by Shust *et al.* (1990)[1] and Aguayo (WG-FSA-92/30). The growth curve reported in Shust *et al.* is near the middle of the range of those presented in Table G.2 of Appendix G, while that of Aguayo is near the upper end of the reported growth curves. The results, given in Table 10 show that the method is very sensitive to the value of natural mortality and the growth curve used.

1 SHUST, K.V., P.S. GASIUKOV, R.S. DOROVSKIKH and B.A. KENZHIN. 1990. The state of *D. eleginoides* stock and TAC for 1990/91 in Subarea 48.3 (South Georgia). Document *WG-FSA-90/34*. CCAMLR, Hobart, Australia.

Table 10: Summary of biomass calculations of the exploitable biomass of *D. eleginoides* in Subarea 48.3.

Method (see text)	Parameter (see text)	Exploitable Biomass (tonnes)
De Lury over fishing season (WG-FSA-92/24)		12 000
De Lury (local density) (see paragraphs 6.156 to 6.159)		9 800
Area coverage (per longline) (see paragraph 6.160)	1.0 n mile	8 000
	0.5 n mile	16 000
	0.05 n mile	160 000
Area coverage (per hook) (see paragraph 6.169)	10 m	102 000
	15 m	45 000
	20 m	25 000
	25 m	19 000
Length cohort analysis (see paragraphs 6.141 and 6.142)	M=0.10, *GC=1	36 000
	M=0.13, GC=1	61 000
	M=0.16, GC=1	119 000
	M=0.13, GC=2	14 000

* GC - 1: L_∞ = 174.8, K = 0.0712, L_o = -0.005, GC - 2: L_∞ = 210.8, K = 0.0644, L_o = 0.783

6.142 Carrying out this analysis was unnecessarily time consuming because the length frequency data from different operations was submitted in different formats. It is recommended that in future length frequency data for this species be submitted as total lengths in 1 cm length classes. It would be desirable for the length measurements to be submitted in computer readable format for inclusion in the CCAMLR database.

ABUNDANCE ESTIMATES USING CPUE OR SURVEY DATA

6.143 At the 1991 meeting of the Working Group three types of analyses were attempted on the CPUE data from the longline fishery. Problems were encountered during the analyses mainly because no haul-by-haul data were submitted and the STATLANT B data did not allow for standardisation of the effort indices.

6.144 Haul-by-haul data were submitted to CCAMLR from all fishing Members for the 1991/92 season, in accordance with Conservation Measure 37/X.

6.145 Paper WG-FSA-92/24 presents a De Lury analysis of the haul-by-haul CPUE data from the Chilean fleet over the whole season. Two separate fishing grounds could be clearly distinguished from the locations of the hauls: one at the north of South Georgia, including Shag Rocks and the second at the south of the island. Results from the De Lury analysis suggest a recruited biomass of around 12 000 tonnes.

6.146 Application of the De Lury analysis to these data assumes that there is no substantial immigration or emigration during the period under consideration. If there is substantial immigration into the local area, the population size would be overestimated. Conversely, substantial emigration would lead to underestimation of population size. The locations of fishing from the haul-by-haul data, as well as the observation that the CPUE series for the three areas do not have strong trends, suggests that fishable aggregations persist throughout the season. Therefore, any substantial movements of fish into or out of the fishing grounds during the fishing season are unlikely.

6.147 An analysis of CPUE data also assumes that CPUE is proportional to the population size or a power function of population size. In the longline fishery, there are five potentially important factors that could affect the catch rates. These factors are: hook size and shape, soak time, depth of fishing, location of fishing and seasonality (i.e., timing of fishing). The analyses in WG-FSA-92/24 does not take these factors into account and the Working Group investigated the effects of these factors on catch rates using the haul-by-haul data from the Chilean and Russian fleets.

6.148 The hook type affects both the length frequency distribution (see paragraph 6.116) and the catch rate. This implies that the effort should be standardised for hook type before combining data to use in CPUE analyses. Unfortunately not all data records contained a code for the hook type and the Chilean data did not contain any records where vessels fished with different (known) hook types in the same location and at the same time. The Working Group could not calibrate or standardise the CPUE for hook type. The Russian data contains some records for two hook types in the Shag Rocks area and the same period but this sample is relatively small.

6.149 The Working Group encouraged the collection of haul-by-haul data from vessels fishing in the same local area at the same time for use in the calibration of effort data.

6.150 The current CCAMLR hook code only reflects size and not shape. Both these aspects of hooks affect the way they operate and the Working Group recommended that a new coding system which reflects both these aspects should be developed by the Secretariat.

6.151 Only a subset of the data (those from the Russian fleet) were used to investigate soak times and catch rates. These data did not show any relationship between catch rates and soak time. It is,

however, premature to conclude that there is no relationship and these data should continue to be collected.

6.152 Catch rates from the Chilean fishery did not show any clear relationship with depth (WG-FSA-92/28). At this stage, there does not seem to be a need to consider fishing depth when calibrating effort data. It is, however, still essential to record this information since the current analyses are only preliminary, representing a single fishing season.

6.153 As indicated in WG-FSA-92/24 and 28, the locations of the hauls clearly suggested two or three fishing grounds. The possible effect of location was investigated on a relatively coarse scale. The area around South Georgia was divided into three fishing grounds (Figure 6 above):

(i) Shag Rocks, west of 40°W;
(ii) South Georgia north, east of 40°W, north of 54.2°S; and
(iii) South Georgia south, east of 40°W, south of 54.2°S.

6.154 The CPUE series for these three areas are all of similar magnitude although the patterns over time are somewhat different (WG-FSA-92/24) (Figure 7). This suggests that, at least during the 1991/92 season, there was no need to adjust the effort for fishing ground. What is, however, very clear from all three series is the 'seasonality' which may be caused by various factors. The possible effects of weather conditions could not be considered. There may be seasonality in the population numbers on the grounds caused, for example, by migration or changes in aggregation. Investigation of the catch rates on a smaller area scale also shows that the vessels tend to move from one location to another. This sometimes occurs when local catch rates have declined after some days of fishing.

6.155 This effect was used to estimate local population densities in order to try and estimate overall fishable biomass. The advantage is that the CPUE of a single vessel or pair of vessels with similar gear can be used without the need for calibration or correction for seasonal effects. Three such examples of declining catch rates in a local area were identified:

(i) in the South Georgia north area, where two vessels with the same hook types were fishing over a period of nine days;

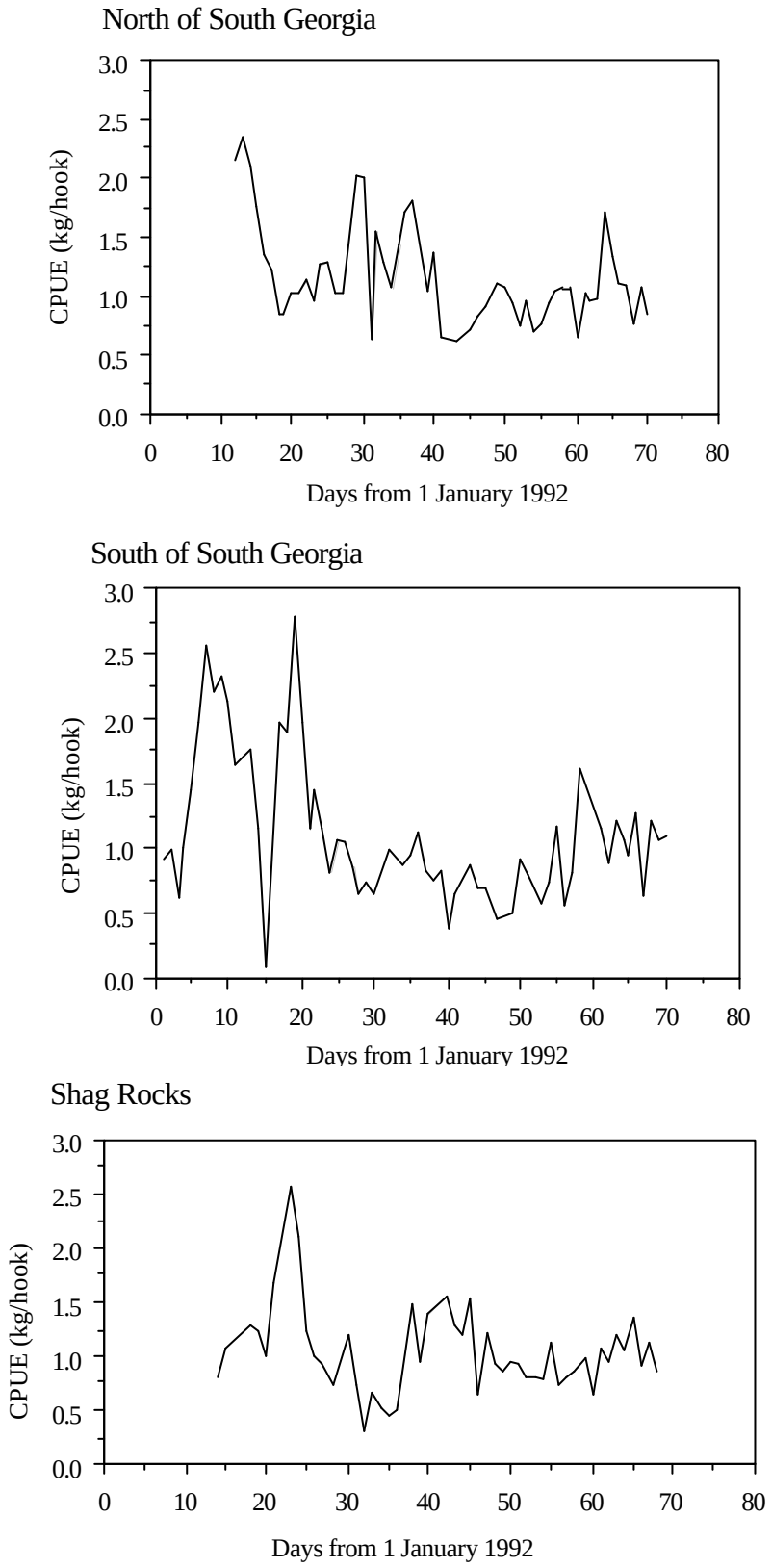


Figure 7: CPUE kg/hook for the Chilean fishery in the three major fishing areas of Subarea 48.3.

(ii) to the north of Shag Rocks area where a single vessel fished for a period of six days; and

(iii) to the west of Shag Rocks area where a single vessel fished for a period of 11 days.

6.156 The De Lury method was used to estimate the initial local population size from the CPUE (Figures 8a, b and c). The main assumption of this method is that, for the short period under consideration, the local population within the small region where the hauls were taken is 'closed' (i.e., there is no substantial movement of fish into or away from each location). It is thus also assumed that catches taken outside these localities do not affect the density of fish within them within the short period considered.

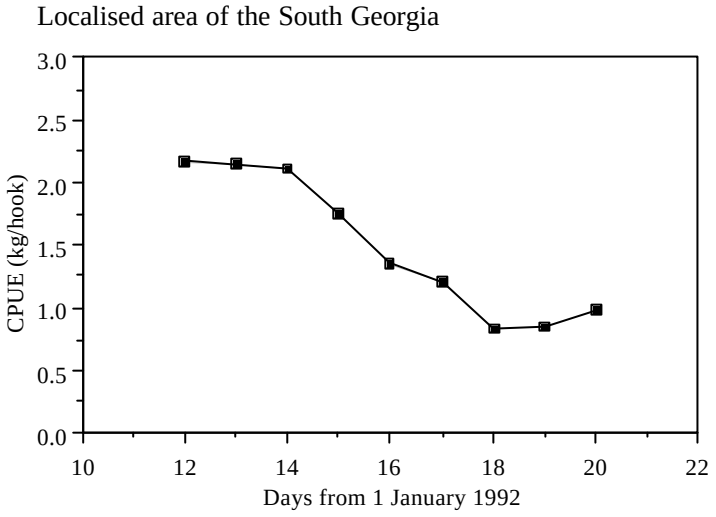


Figure 8a: CPUE for *D. eleginoides* in the localised area of South Georgia.

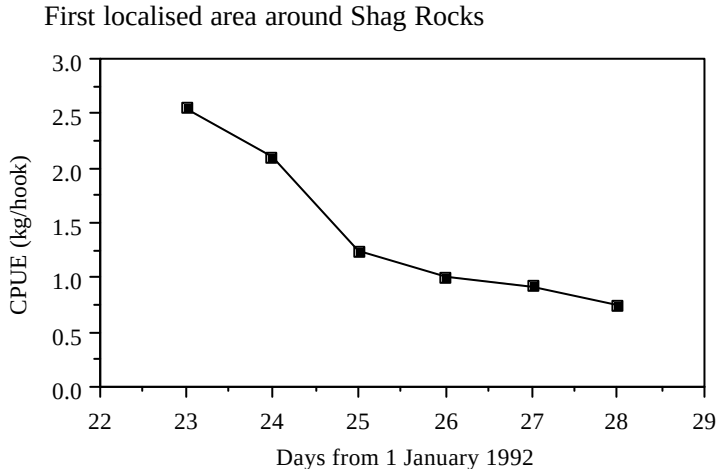


Figure 8b: CPUE for *D. eleginoides* in the first localised area around Shag Rocks (South Georgia).

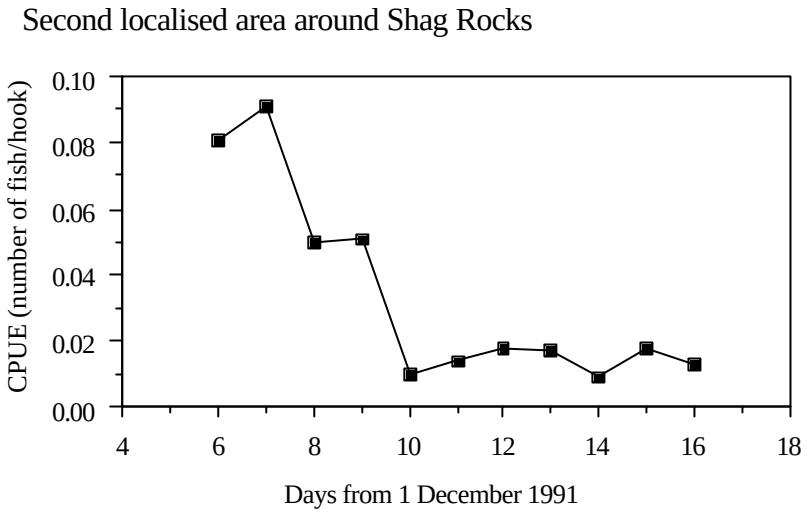


Figure 8c: CPUE for *D. eleginoides* in the second localised area around Shag Rocks (South Georgia).

6.157 Because daily CPUE-values were used, the value for natural mortality (**M**) is so small that there is no need to include this in the analysis. (If **M** is included, there is hardly any difference between results for the range of values given in paragraph 6.131). In all cases the regression fit was satisfactory although residuals for the third case did show some degree of non-randomness.

6.158 Local density is obtained by dividing the local population estimates by the effective area fished. This area should be seen as the area over which the population was affected by the fishing leading to the observed local decline in the CPUE.

6.159 The effective area fished was estimated using two methods. The first method involved calculating areas within boundaries which enclosed groups of hauls. These areas were chosen to be at least 0.05° latitude and 0.2° longitude. A square of 0.05° latitude by 0.2° longitude (at 53°S) is approximately 200 n miles^2. This method leads to an average density of about 1.09 tonnes/n mile^2 for the three cases.

6.160 The second method of estimating the effective fishing area considers the total length of each longline set (calculated from the number of hooks times the distance between hooks) multiplied by an effective width. The effective width is far more difficult to assess, especially since the fishing gear is left in the water for a period of time and fish are highly mobile. Three arbitrary values were therefore used: 0.05, 0.5, 1 n mile. Table 11 below summarises the density estimates obtained for the three cases.

Table 11: Density estimates (tonnes/n mile^2) for *D. eleginoides*.

	Method A	Method B		
		Effective Width of Longline		
		1.00	0.50	0.05
Shag Rocks west	0.43	0.40	0.81	8.10
Shag Rocks north	1.50	1.06	2.11	21.10
South Georgia north	1.33	1.19	2.39	23.90
Average	1.09	0.88	1.77	17.70

6.161 For comparison, the average density of *D. eleginoides* from the 1992 *Falklands Protector* trawl survey was 0.74 tonnes/n mile^2. It is of course known that the trawl survey mainly catches small fish at shallower depths, but the comparison suggests that the above estimates of around 1 to 2 tonnes/n mile^2 are not unrealistic.

6.162 Estimates of total exploitable biomass were obtained by multiplying the average density estimates by the total seabed area around South Georgia and Shag Rocks between depths of 500 to 2 000 m (see Appendix E). This total area was estimated to be 9 000 n miles^2. Results are given in Table 10.

6.163 There are many caveats associated with the above method and the estimates of exploitable biomass. First, Tables 10 and 11 clearly show that the method is very sensitive to the assumption about the effective width of the area fished by a longline. Knowledge about the soak time, swimming speed of fish and the distribution of fish on the hooks may throw further light on this problem in future.

6.164 Second, the calculation of biomass in the whole of Subarea 48.3 involves extrapolating from a local density to the whole area between in the 500 to 2 000 m depth range. Since fishing in the most recent season took place in about 70% of the 9 000 n miles^2 area and the calculation assumes the calculated density applies over the whole region, the above biomass values may tend to be overestimates. At this stage, the variance in density between locations is also unknown. Further analyses of the kind described above are necessary to try to estimate the seasonal and temporal variability in density.

6.165 A further potential problem with this analysis, as well as with the more conventional De Lury analysis presented in WG-FSA-92/24, is the possibility that the CPUE is not linearly related to population size but by a power function. This would imply that a relatively small change in CPUE could in fact reflect quite a substantial change in the population size.

6.166 Any saturation effect of the fishing gear would also affect CPUE analyses. However, the haul-by-haul data do not show any signs of saturation.

Estimates Based on Trawl Surveys

6.167 Paper WG-FSA-92/17 presents estimates of biomass around South Georgia and Shag Rocks from the *Falklands Protector* bottom trawl survey conducted in January/February 1992. These estimates are:

South Georgia	2 460 tonnes (CV 21%)
Shag Rocks	3 353 tonnes (CV 35%)

6.168 Bottom trawl surveys only estimate the biomass of young (juvenile) fish rather than exploitable biomass. The length frequency distribution from the survey consists almost entirely of fish between 20 and 50 cm total length. The above biomass estimates can be considered as indices of future recruitment to the fishery. Comparison with estimates from similar surveys since 1984, show that these values are in the middle of the range (Tables 15 and 16 in WG-FSA-92/17). No attempt was made to estimate exploitable biomass from the survey estimates, because of the problems associated with this method (SC-CAMLR-X, Annex 6, paragraphs 7.90 to 7.98).

Estimates Based on Area Fished by Each Hook

6.169 This method attempts to estimate density directly by assuming that fish are caught from within a certain radius of each hook. The data used came from the Chilean fishery, where the catch per hook averaged one fish per 10.7 hooks. The average fish weight was 11.3 kg, and so the catch per hook was 1.06 kg. The area fished per hook, in n miles^2, is given by:

$$A = \pi r^2/(1852^2)$$

where **r** is the radial distance of the influence of the hook in metres. The density of fish, in tonnes/n mile^2, is calculated as:

$$D = C/A*1000$$

6.170 As in the case of the local density De Lury estimates, biomass estimates are calculated by extrapolating the density estimated on the fishing ground to the whole bottom area in Subarea 48.3 within the appropriate depth range. The results are given in Table 12. Given that the average

distance between hooks is about 3 m and that one fish is taken per 10.7 hooks, it was suggested that the result for the influence radius of 15 m is likely to be the most appropriate. Density estimates using this approach are sensitive to the range of influence of each hook. Refinement of this parameter could be based on measurements of the swimming and foraging behaviour of the fish, or might be approached by varying the density of the hooks on a line.

Table 12: Densities and extrapolated estimates from the radius of influence of each hook.

Influence Radius (m)	Density (tonnes/n mile^{-2})	Density (fish/n mile^{-2})	Exploitable Biomass (tonnes)
10	11.30	1 000	101 700
15	5.02	424	45 180
20	2.82	249	25 380
25	2.08	184	18 720

Yield-Per-Recruit Analyses

6.171 Y/R analyses (Table 13) were conducted using weights-at-age calculated from the length-based growth curve for Subarea 48.3 in Shust *et al*. (1990) (see Table G.2 of Appendix G) and converted to weights using the lenght-weight relationship in Gasiukov *et al*.[1] (1991) (Table G.1 of Appendix G). These analyses were carried out for three values of **M** (see discussion on natural mortality, paragraph 6.131). These calculations have not taken into account the possibility of a lower selectivity in larger fish. Some difficulties arose with the current CCAMLR standard yield-per-recruit software at low values of **M** (see paragraph 9.6). The analyses were done using the software package MathCad.

1 GASIUKOV, P.S., R.S. DOROVSKIKH and K.V. SHUST. 1991. Assessment of the *Dissostichus eleginoides* stock in Subarea 48.3 for the 1990/91 season and calculation of TAC for the 1991/92 season. Document *WG-FSA-91/24*. CCAMLR, Hobart, Australia.

Table 13: Yield-per-recruit values for catch and stock-per-recruit at $\mathbf{F_{0.1}}$ for three levels of **M**. Spawning stock biomass in the absence of fishing is included.

	Natural Mortality		
	0.10	0.13	0.16
$\mathbf{F_{0.1}}$	0.104	0.119	0.138
Yield (kg)	2.164	1.538	1.131
Catch (**n**)	0.292	0.238	0.201
Stock (**n**)	7.478	6.342	5.501
Spawning Stock (**n**)	2.307	1.557	1.059
Stock (kg)	27.207	18.23	12.604
Spawning stock (kg)	21.664	13.413	8.416
Spawning stock biomass at F=0 (kg)	51.608	32.896	21.418

6.172 The selection pattern for fishing mortality was approximated from catch-at-length data from the commercial catches and converted to age. Full recruitment was considered to have occurred by age 10. The selection pattern for ages less than 10 used in the analyses was:

Age	1	2	3	4	5	6	7	8	9	10
Pattern	0	0	0.1	0.2	0.3	0.4	0.5	0.75	0.9	1.0

TAC CALCULATIONS

6.173 Table 14 gives the TACs corresponding to the three different values of $\mathbf{F_{0.1}}$ for each calculated biomass excluding the values calculated from the length-based cohort analysis. The results based on length cohort analysis were excluded because they are calculated under the assumption that the stock is in equilibrium with the average catch over recent years. Since the catch increased sharply only in 1990, it is too soon for this relatively long-lived population to stabilise under exploitation. The Working Group considered these analyses to be a cross-check on the results obtained by the methods which attempted to estimate density directly. Given that the length-cohort results lie within the range obtained by the other methods, little has been lost by excluding them.

Table 14: TACs corresponding to the calculated exploitable biomasses for *D. eleginoides* in Subarea 48.3.

Exploitable Biomass	TAC		
	$F_{0.1}$ = 0.104	$F_{0.1}$ = 0.119	$F_{0.1}$ = 0.138
12 000	1 130	1 260	1 430
9 800	920	1 030	1 170
8 000	750	840	950
16 000	1 500	1 690	1 910
160 000	15 000	16 900	19 090
102 000	9 600	10 070	2 170
45 000	4 230	4 740	5 370
25 000	2 350	2 630	2 980
19 000	1 790	2 000	2 270

Management Advice

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

6.175 In spite of the improvements in estimates of abundance, considerable uncertainty still remains about the size of this stock and its sustainable yield. Given the wide range of possible TACs the Working Group considered that a conservative approach should be taken in setting a TAC. The Working Group considered that a stock biomass in excess of 45 000 tonnes is unlikely. Accordingly, the Working Group recommends a TAC in the range 750 to 5 370 tonnes. Given that the most recent TAC is near the middle of this range, the Working Group agreed that a TAC similar to that set in 1992 would be appropriate. It was also agreed that it is better if large year to year variations in TAC can be avoided when possible. The Working Group noted that the TAC in 1992 was reached early in the fishing season. It was agreed that further expansion of the number of vessels taking part in the fishery would not be appropriate, as this would lead to even earlier closure of the fishing season, which could introduce extra complications into the CPUE and other fine-scale data, with consequent deleterious effects on assessments.

Data Requirements and Future Research Needs

6.176 The following matters were identified as requiring further data and research:

- the submission of fine-scale and haul-by-haul data should be continued;
- studies on hook selection factors should be carried out;
- data on loss rates of fish observed to drop off the line as it is retrieved, and which are not recovered, should be reported;
- intercomparisons between age-readings from scales and otoliths should be undertaken, along with intercomparisons between readers;
- full analyses of sexual maturation and other biological parameters from any fish taken during winter should be undertaken and reported; and
- investigations of stock identity in conjunction with studies on the Patagonian shelf.

SOUTH ORKNEY ISLANDS (SUBAREA 48.2)

Catch History

6.177 Catches in Subarea 48.2 were only significant in the 1977/78 and 1978/79 seasons when 169 000 tonnes were landed, consisting almost exclusively of *C. gunnari*. In subsequent years reported catches for the subarea have substantially decreased being of the order of a few thousand tonnes, except in 1982/83 and in 1983/84, when 34 000 tonnes were taken. The most abundant species in the catches have been *C. gunnari* and *N. gibberifrons*. A significant proportion of the catch has been reported under the classification of Pisces nei (fish not elsewhere included), that is believed to be composed of different species of channichthyids (mainly *C. aceratus*, *C. rastrospinosus* and *P. georgianus*) and *N. kempi*, but may have also included *N. gibberifrons*.

Table 15: Catch by species in Subarea 48.2.

Year	*C. gunnari*	*N. gibberifrons*	*N. rossii*	Osteichthyes nei	Total
1978	138 895	75	85	2 603	141 658
1979	21 439	2 598	237	3 250[1]	27 524
1980	5 231	1 398	1 722	6 217[2]	14 568
1981	1 861	196	72	3 274	5 403
1982	557	589		2 211	3 357
1983	5 948	1		12 463[3]	18 412
1984	4 499	9 160	714	1 583	15 956
1985	2 361	5 722	58	531	8672
1986	2 682	341		100	3 123
1987	29	3		3	35
1988	1 336	4 469			5 805
1989	532	601		1	1 134
1990	2 528	340			2 868
1991*	14	9		27	50
1992	-	-		-	-

* Catches from research activities
[1] Mainly *C. aceratus*
[2] *P. georgianus*, unidentified nototheniids and channichthyids
[3] Unknown species

6.178 A total of 1 518 tonnes of laternfish (Myctophidae) was reported in CCAMLR-X/MA/8 as being taken from Subarea 48.2 in 1990/91, but the correctness of the location of these catches was questioned (SC-CAMLR-X, paragraph 4.17). No clarification of this matter has yet been provided.

6.179 A conservation measure prohibiting fishing activities for finfish in Subareas 48.1 and 48.2 for the 1990/91 season (Conservation Measure 27/IX) remained in force during 1991/92 (Conservation Measure 41/X). No commercial catches have been reported for Subarea 48.2 in 1991/92.

6.180 The scarcity of historical data from the commercial fishery has made it very difficult to make any assessment of the fish stocks in Subarea 48.2. However, some attempts have been made to assess the stocks of *C. gunnari* and *N. gibberifrons* using VPA (SC-CAMLR-VII, Annex 5; SC-CAMLR-VIII/18; WG-FSA-88/18; WG-FSA-90/16). Standing stock biomass has been estimated by the swept area method from several surveys conducted in the subarea by the Federal Republic of Germany (1975/76, 1977/78, 1984/85) and Spain (1986/87, 1990/91).

Champsocephalus gunnari (Subarea 48.2)

6.181 No new information was available to the Working Group on *C. gunnari* in Subarea 48.2 during 1991/92. A series of simulations have been performed at this year's meeting to try to assess the state of the stock during the forthcoming season (1992/93) to give management advice on this species. In doing so it was necessary to make the following assumptions.

6.182 Total biomass in 1990/91 was taken as the estimate from the Spanish survey "ANTARTIDA 9101" calculated at last year's meeting following restratification of the sampling area, which gave an estimate of 9 620 tonnes (SC-CAMLR-X, Annex 6, paragraph 7.204). The length frequency distribution from the same cruise was extrapolated to this biomass estimate, and a pooled age/length key from the former Soviet Union fishery occurring in the area in the period from 1978 to 1989 was applied, in order to estimate an age structure of the stock in 1990/91.

6.183 It was noted that age groups 6 and older dominated the age structure at the time of the survey (Figure 9). Three possible explanations were considered:

(i) sampling problems during the survey (i.e., few hauls conducted in shallow water);

(ii) recruitment to the area occurring at age 6, as a result of migration; and

(iii) several strong year groups (cohort) were present in the fishery at the time of the cruise.

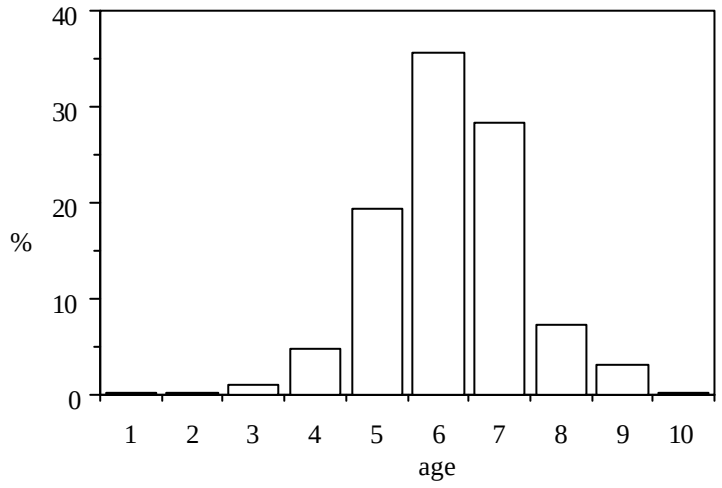


Figure 9: Estimated age distribution of *C. gunnari* in the 1991 Spanish survey, Subarea 48.2.

6.184 The potential bias in the length distribution from the survey resulting from the distribution of stations is unknown, however, Mr E. Balguerías (Spain) considered that this was likely to be insignificant.

6.185 Dr Kock pointed out that the presence of 1 and 2 year old fish in the commercial fishery in some years indicated that the hypothesis of fish recruiting to the stock at age 6 was unlikely to be correct.

6.186 Observations from the fishery and from several surveys conducted in Subarea 48.2, suggest that periods in the fishery with high catch rates are associated with the presence of several strong cohorts in the stock. Therefore the Working Group felt that the most plausible explanation for the high relative proportion of ages 6 and over in the survey catch was that described in paragraph 6.183(iii).

6.187 However, all three explanations given in paragraph 6.183 were taken into account in projecting stock abundance forwards from 1990/91. The first explanation was addressed by including age groups 2 to 10 in the projections (scenario 1). The second explanation was addressed by including age groups 6 to 10 in the projections (scenario 2). The third explanation was also addressed by considering age groups 6 to 10 in 1990/91 (scenario 3), but this scenario implies that the projection for 1991/92 (for example) only includes age groups 7 to 10 since the recruitment to age group 6 in subsequent years is assumed to be negligible.

6.188 The mean level of recruitment (age group 2) was calculated from estimates of the number of age group 2 individuals in the period 1978 to 1981 obtained from previous VPA analyses (WG-FSA-88/18). The numbers of individuals in age groups 2 to 5 in 1990/91 were reconstructed from the mean level of recruitment and assuming that M=0.35.

6.189 For scenario 1, the numbers in age groups 2 to 10 (in 1990/91) were taken to be the numbers in age groups 2 to 5 calculated from the mean recruitment plus the numbers in age groups 6 to 10 estimated from the survey. For scenarios 2 and 3, the numbers in age groups 6 to 10 in 1990/91 were those estimated from the survey.

6.190 The population numbers in 1990/91, associated with each of the three scenarios, were projected forwards to subsequent seasons (until 1995/96) assuming no fishing (F=0) and M=0.35. The assumptions for recruitment were as follows:

scenario 1: mean recruitment (age group 2) estimated from previous VPA analyses (paragraph 6.188);

scenario 2: mean recruitment (age group 6) estimated from mean recruitment age group 2, projected forwards to age group 6 using M=0.35;

scenario 3: no recruitment.

The third scenario does not include recruitment because of the assumption that there were one or more strong cohorts spawned in 1984/85 and before.

6.191 Results of these calculations are given in Table 16.

Table 16: *C. gunnari* , Subarea 48.2. Biomass projections (tonnes).

Scenario	Split-Year					
	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96
1	26 578	28 443	29 729	30 633	30 565	30 660
2	7 461	9 326	10 613	11 516	11 449	11 543
3	7 461	5 807	4 334	3 118	1 344	-

6.192 The evolution of both the expected total biomass (scenario 1 above) and the biomass of fish in the stock older than 6 with recruitment (scenario 2 above) show a similar trend with a slight increase in biomass up to 1992/93 reaching an equilibrium level of around 30 000 tonnes and 11 000 tonnes respectively.

6.193 Scenario 3 above illustrates the development of the biomass of the cohort born in 1984/85 (age group 6 in 1990/91) and older cohorts (age groups 7 to 10) until their extinction in 1994/95. The level of biomass calculated for these cohorts in 1992/93 was around 4 000 tonnes.

6.194 The two scenarios that represent the highest and lowest estimates of exploitable biomass (scenarios 1 and 3) were used to calculate the maximum and the minimum possible TACs of *C. gunnari* in Subarea 48.2 for 1992/93 by considering the maximum yield obtained from the Thompson and Bell method.

6.195 The exploitation pattern (fishing mortality vector) was assumed to be the mean **F**s in the fishery during the period from 1978 to 1981 obtained from past VPA analyses (WG-FSA-88/18).

6.196 Results of this analysis are shown in Figure 10.

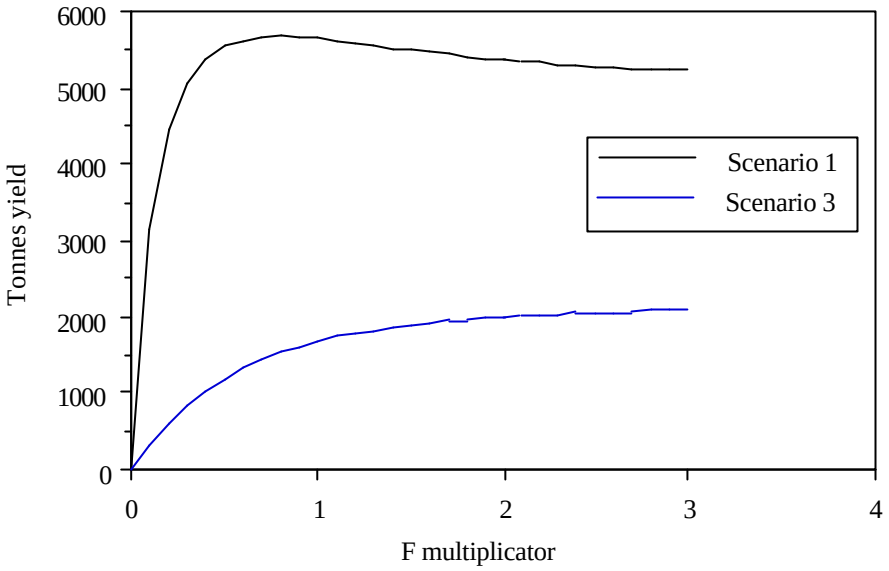


Figure 10: *C. gunnari* (Subarea 48.2) projected yield in 1992/93.

6.197 Estimated maximum yields range from 2 000 to 5 700 tonnes. The lower value was estimated from age group 8 and older (1984/85 cohort is age group 8 in 1992/93) which exhibited a flat-topped yield curve, from which it was very difficult to establish the maximum yield point and its corresponding optimum **F**. The higher value, obtained from age groups 2 to 10, shows a typical yield curve, with a well defined point of inflexion.

6.198 The exploitation pattern used in the yield calculations was estimated from the fishery prior to the introduction of the mesh regulation of 80 mm in 1985 (Conservation Measure 2/III) and is likely to be different from that which would be obtained if a fishery were to re-open. The fishing effort applied during the historical fishery (**F** multiplicator = 1) was above the MSY level (scenario 1). To reach the MSY objective while maintaining the same exploitation pattern it would be necessary to reduce the fishing effort by 20%.

Management Advice

6.199 The Working Group noted the large number of assumptions and the uncertainties associated with both the projections and the maximum yield calculations and concluded that a conservative approach would be appropriate. A conservative strategy would be to maintain the closure of the fishery for *C. gunnari* in Subarea 48.2 until a survey is conducted to provide a more accurate estimate of the status of the stock.

Notothenia gibberifrons, Chaenocephalus aceratus, Pseudochaenichthys georgianus, Chionodraco rastrospinosus and *Notothenia kempi* (Subarea 48.2)

6.200 No new information has been reported for any of these species during the last season.

6.201 The last research survey conducted in the area in 1990/91 ("ANTARTIDA 9101") suggested that the biomass of these species had significantly increased since the middle of the 1980s. Some species, such as *C. aceratus* and *C. rastrospinosus*, seemed to have reached a similar level to the pristine stock, although this information was regarded with caution by the Working Group because surveys from which the different biomass estimates were derived may not be comparable due to different gear types, vessels, etc. and also due to the uncertainty associated with the estimates (SC-CAMLR-X, Annex 6, paragraph 7.123).

Considerations for a Re-opening of the Mixed Species Fishery in Subarea 48.2

6.202 In the light of the recommended continued closure of the *C. gunnari* fishery in this subarea, the re-opening of a mixed species fishery in Subarea 48.2 was not considered. The Scientific Committee's attention is drawn to the Working Group's conclusions on this matter at its 1991 meeting (SC-CAMLR-X, paragraphs 7.218 to 7.224).

ANTARCTIC PENINSULA (SUBAREA 48.1)

6.203 The finfish fishery in the Antarctic Peninsula subarea has been closed during the 1991/92 season (Conservation Measure 41/X). The Working Group expressed its concern about the reported catch of 50 tonnes of *E. carlsbergi* taken in Subarea 48.1.

6.204 Document CCAMLR-XI/7 briefly mentions the research activity of the Chilean longliner *Frioaysén SA* between 60° and 62°S in the region of the Antarctic Peninsula during 1990/91. Dr Moreno reported that this activity was of an extremely limited nature and had resulted in a catch of only two specimens of *Dissostichus mawsoni*.

6.205 Pre-recruit monitoring in the South Shetland Islands (Barrera-Oro and Marschoff, pers. comm.) indicated that the proportion of juveniles of *N. rossii* and *N. gibberifrons* in fjord fish catches, remained at the low levels previously reported (SC-CAMLR-X, Annex 6, paragraphs 7.225 and 7.226).

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

STATISTICAL AREA 58

6.207 In 1991/92 fishing took place only in Division 58.5.1. The catch in the Kerguelen division (58.5.1) comprised 6 787 tonnes of *D. eleginoides* caught in the Ukranian and French trawl fisheries, 705 tonnes of *D. eleginoides* caught by Ukrainian longliners, 44 tonnes of *C. gunnari* and 1 tonne of *N. squamifrons* (Table 17).

Division 58.5.1 (Kerguelen)

6.208 Data are only available for *D. eleginoides* from the trawl fishery and from an experimental longline fishery. These include description of the longlining method and data on length frequency and sex of *D. eleginoides* caught by this method (WG-FSA-92/31). Data from the former Soviet Union and more recently, the Ukrainian trawl fishery (WG-FSA-92/8 and 9) include details of the age/length composition, and stock size and TAC estimates.

6.209 The catch of this species increased markedly over previous years to 7 492 tonnes. This is the highest catch of this species ever recorded in this area. The average annual catch between 1984/85 and 1990/91 has been 2 210 tonnes, and the previous largest catch was 6 677 tonnes in 1984/85 when the trawling grounds on the western shelf area were first exploited (Table 17). The trawl catch of 6 787 tonnes was caught mostly in the grounds in the northern part of the plateau which were discovered in the 1990/91 season. The exploratory longline fishery was conducted in the western part of the plateau (at 400 to 600 m; WG-FSA-92/31) by two vessels to assess the effects of this type of fishery on *D. eleginoides*, the efficiency of the regulations imposed and the measures to minimise incidental mortality of seabirds. 705 tonnes of fish were caught by this method.

6.210 At its 1991 meeting, the Working Group reiterated its advice of 1989 that the annual catch in the western sector should not exceed 1 100 tonnes in view of the steadily declining CPUE. It further recommended that catches in the new grounds in the northern sector be also

Table 17: Total catches by species and subarea in Statistical Area 58. Species are designated by abbreviations as follows: ANI (*Champsocephalus gunnari*), LIC (*Channichthys rhinoceratus*), TOP (*Dissostichus eleginoides*), NOR (*Notothenia rossii*), NOS (*Notothenia squamifrons*), ANS (*Pleuragramma antarcticum*), MZZ (Unknown), SRX (*Rajiformes spp.*), WIC (*Chaenodraco wilsoni*).

Split-Year	ANI		LIC	WIC	TOP				NOR			NOS			ANS		MZZ			SRX
	58	58.5	58.5	58.4	58	58.4	58.5	58.6	58	58.4	58.5	58	58.4	58.4	58	58.4	58	58.4	58.5	58.5.1
1971	10231				XX				63636			24545					679			
1972	53857				XX				104588			52912					8195			
1973	6512				XX				20361			2368					3444			
1974	7392				XX				20906			19977					1759			
1975	47784				XX				10248			10198					575			
1976	10424				XX				6061			12200					548			
1977	10450				XX				97			308					11			
1978	72643	250	82		196	-	2	-	46155			31582		98	234		261			
1979				101	3	-	-	-				1307					1218			
1980		1631	8	14		56	138	-			1742		4370	11308				239		
1981		1122	2			16	40	-		217	7924		2926	6239				375	21	
1982		16083				83	121	-		237	9812		785	4038		50		364	7	
1983		25852				4	128	17			1829		95	1832		229		4	17	1
1984		7127				1	145	-		50	744		203	3794					611[1]	17
1985		8253		279		8	6677	-		34	1707		27	7394		966		11	7	4
1986		17137		757		8	459	-		-	801		61	2464		692				3
1987		2625		1099		34	3144	-		2	482		930	1641		28		22		
1988		159		1816		4	554	488		-	21		5302	41		66				

Split-Year	ANI		WIC	TOP			NOR	NOS		ANS	
	58.5.1	58.5.2	58.4.2	58.4.4	58.5.1	58.6	58.5.1	58.4.4	58.5.1	58.4.2	58.4.4
1989	23628	-	306	35	1630	21	245	3660	-	30	17
1990	226	-	339	5	1062	-	155	1450	-	-	-
1991	13283[2]	-	-	-	1944	-	287	575	-	-	-
1992	44	3	-	-	7492[3]	-	-	-	1	-	-

1 Mainly *Rajiformes spp.*

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

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

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

limited to 1 100 tonnes per annum, at least until more data become available, to avoid a similar decline in abundance. The actual catch of nearly 7 500 tonnes is thus more than three-times that recommended and is an alarming increase.

6.211 New data on the fishery were scanty. WG-FSA-92/8 gives data on length and age composition on *D. eleginoides* from both fishing grounds. It confirms that fish size and age correlates well with depth, with deeper water (>500 m) producing larger fish than the shallower depth range of trawling (300 to 500 m). Taking this depth effect into account, there was little difference in length or age structure of the catches from the two areas. WG-FSA-92/9 gives figures for stock size, calculated from length composition data for the 1984/85 season (when the first exploitation of the western fishing ground took place) and for the 1991/92 season for the northern grounds, of 43 000 and 50 000 tonnes respectively. Estimates of TAC were 7 330 and 7 500 tonnes. The Working Group, however, was not able to repeat these results, because the annual average catch used in WG-FSA-92/9 was not specified. Insofar as the methodology in WG-FSA-92/9 could be followed, a spawning stock size of about 6 000 tonnes was calculated. Moreover, the CPUE in the 1991/92 season, in the northern area, had fallen from 2.5 to 1.0 tonnes/hour. This was a marked decrease from the 3.4 tonnes/hour recorded in the first year of exploitation of the northern grounds reported to last year's Working Group meeting and appears to follow the rapid decline in CPUE observed in the western grounds. This decline in CPUE applies to the shallower as well as the deeper waters.

Management Advice

6.212 The rapid increase in catches to unprecedented levels and simultaneous decline in CPUE, when viewed in the light of the caution urged at last year's meeting, is cause for concern.

6.213 The Working Group noted that a similar trend in catches of *D. eleginoides* had been evident in Subarea 48.3 with a peak catch of 8 311 tonnes in 1989/90. The rapid expansion of the Kerguelen fishery to a similar catch level may be of equal or greater significance since the catch contains a high proportion of immature fish.

6.214 Data from the fishery are now also seriously out of date, with few data available from the last two years of fishing. This leads to even greater uncertainty in assessments and forces the Working Group to recommended a TAC no greater than the 1 100 tonnes for each ground recommended last year.

Notothenia rossii (Division 58.5.1)

6.215 No data on this species were submitted. The very low catch of *C. gunnari* meant there was no reported by-catch of *N. rossii*. The further assessment of the results of a research survey conducted in May/June 1991 promised at last year's meeting were not available.

Management Advice

6.216 The existing regulation in force (no directed fishery) should continue in order to allow the adult stock to recover. Research on prespawner and spawner biomass should continue.

Notothenia squamifrons (Division 58.5.1)

6.217 In the 1991/92 season, no directed fishery occurred on this species. No biological data are available and no new assessment is possible.

Management Advice

6.218 Previous assessments to 1990 indicated the stock size was very low. In the absence of new data, the fishery should remain closed until new data on biomass and age structure indicate a fishery is possible.

Champsocephalus gunnari (Division 58.5.1)

6.219 A very low catch (44 tonnes) was taken during the 1991/92 season in the Kerguelen Division. It is not clear whether this was a result of lack of fish or low effort. Analyses made during last year's meeting of the Working Group demonstrated that a strong cohort of the species would be at age 3+ during the 1991/92 season and thus a significant catch could be expected. There was, however, some evidence that successive strong cohorts since the 1979 cohort had shown a gradual decline in abundance. The lack of data on the 3+ year old fish in the latest strong cohort is thus regrettable, as is the continued absence of information on the apparent disappearance of fish older than 3 years.

Management Advice

6.220 If the pattern observed in this fishery for over a decade continues, there is likely to be a low abundance of this species in the 1992/93 fishery, as the strong 1988 cohort has died out, and the next expected strong cohort of 1991 will not yet have been recruited to the fishery. It is difficult to suggest a TAC, but the fishery will probably be self limiting because of the low abundance of recruited fish.

Division 58.5.2 (Heard Island)

6.221 No fishery occurred in this area. Some data on distribution, abundance and biology of important species were collected during an Australian research cruise from January to March 1992 and will be presented at future meetings. No new advice can yet be provided.

Division 58.4.4 (Ob and Lena Banks)

6.222 No catches were reported from Ob and Lena Banks for the 1991/92 season, following the prohibition of directed fishing on *N. squamifrons* under Conservation Measure 43/X. In 1990/91, TACs of 267 tonnes and 305 tonnes were set for Ob and Lena Banks respectively (Conservation Measure 28/IX). A total catch of 575 tonnes was reported for these two areas together in the 1990/91 season.

6.223 A new catch history for *N. squamifrons* at Ob and Lena from 1977/78 to 1989/90 was presented in WG-FSA-92/5. The Working Group noted that these were markedly different to the catches reported to the Working Group two years ago (WG-FSA-90/37). In particular, the total catch from the two areas prior to 1985/86 was different and the reported areal division of catches was not consistent between the above two papers. These differences cannot be explained by a simple split-year as opposed to calendar year division and implies that at best, one of the reported catch series is incorrect. The total catch for 1977/78 to 1988/89 from Lena Bank is about 3 000 tonnes higher than previously reported, while some 2 500 tonnes less are attributed to Ob Bank (Table 18).

6.224 At its 1991 meeting, WG-FSA requested that both catch and biological data for the *N. squamifrons* fishery in Subarea 58.4 should be submitted to the Secretariat (SC-CAMLR-X, Annex 6, Appendix E). Length frequency and catch-at-age data from 1977/78 to 1989/90 were presented in WG-FSA-92/5, although no new data for 1990/91 were reported.

Table 18: Reported catches of *N. squamifrons* from Ob and Lena Banks.

Year:	1977/78	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	Total 1977/78 to 1988/89	Reference
Ob	4952	1511	2830	1586	70	313	341	513	4999	1457	2989	850	867	22411	WG-FSA-92/5
	4821	234	4167	41	56	588	40	1023	9531	1601	1971	913	-	24986	WG-FSA-90/37
Lena	1071	585	201	3073	514	426	822	57	6284	506	2013	3166	596	18718	WG-FSA-92/5
	1592	267	2616	1934	59	840	397	87	1977	441	2399	3003	-	15612	WG-FSA-90/37
Ob and Lena	6023	2096	3031	4659	584	739	1163	570	11283	1963	5002	4016	1463	41129	WG-FSA-92/5
	6413	501	6783	1975	115	1428	437	1107	11508	2045	4370	3916	-	40598	WG-FSA-90/37

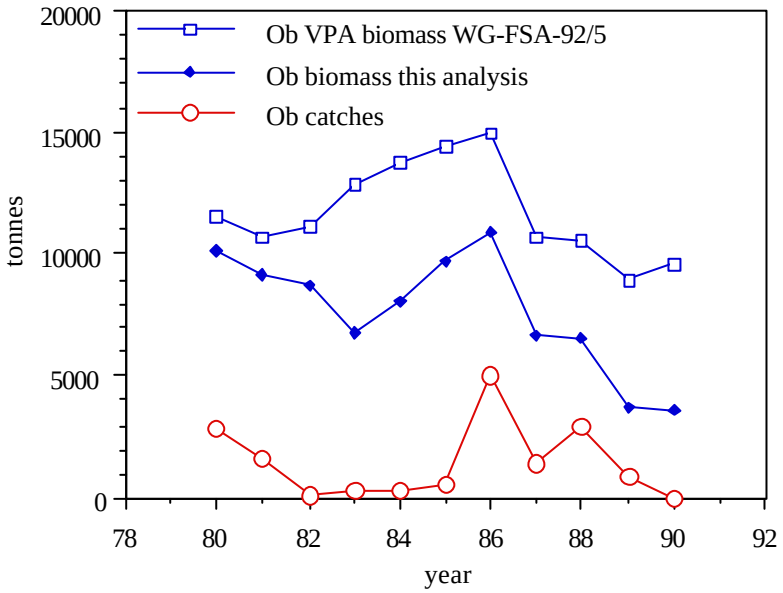
Stock Assessment

6.225 WG-FSA-92/5 presented assessments of *N. squamifrons* at Ob and Lena Banks based on VPA using CPUE to tune the model. Natural mortality (**M**) was assumed to be 0.36 and the VPA was fitted to data from 1977/78 to 1989/90. For the reasons discussed at its 1989 meetings, the Working Group felt that the above **M** value was too high for this species (SC-CAMLR-VIII, Annex 6, Appendix 5).

6.226 It was also not possible to recreate the VPA presented in WG-FSA-92/5 since details of the CPUE tuning procedures were not given. The Working Group reiterated the importance it has attached to ensuring that appropriate and necessary details underlying reported results are submitted in the agreed format for the reporting of stock assessments (SC-CAMLR-IX, Annex 5, Appendix F). Consequently, the authors of WG-FSA-92/5 were requested to provide the essential details of the methodologies they had employed in their paper.

6.227 Using the revised catch history presented in WG-FSA-92/5, the VPAs for Ob and Lena Banks were recalculated (Figure 11). Trawl survey estimates of abundance from 1980 and 1986 were used to fit the model in a similar fashion to that employed by WG-FSA in 1990 (SC-CAMLR-IX, Annex 4, paragraphs 246 to 261). The value of **M** was 0.15.

Ob Bank, Division 58.4.4



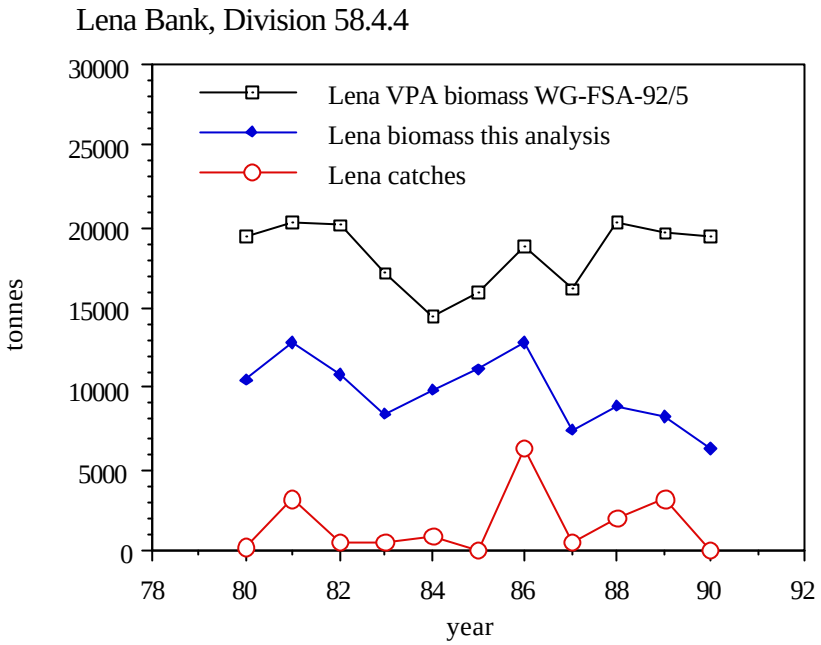


Figure 11: Results of VPAs of *N. squamifrons* in Division 58.4.4.

Lena Bank

6.228 Figure 11 shows the biomass trajectory for the VPA results calculated by the Working Group, compared with the VPA results and reported catches from WG-FSA-92/5 for 1979/80 to 1989/90. There is a wide discrepancy in the estimated stock sizes and particularly the biomass at the end of the period.

Ob Bank

6.229 Figure 11 illustrates the biomass trajectories for Ob Bank following the procedure above. The projected stock biomass decreases with increased catches between 1985/86 to 1989/90, but the end point projections differ markedly for the two alternative models.

Management Advice

6.230 The uncertainty surrounding the catch history of *N. squamifrons* for Ob and Lena Banks adds to the apparent discrepancies in the VPAs for the two areas. The Working Group therefore strongly recommends that the separate catch histories for these two banks should be verified. In addition, details of the method used to tune the VPA reported in WG-FSA-92/5 and catch-at-age data for 1990/91 are still required.

6.231 The divergent assessments for the period up to 1990/91 indicate different trends in stock biomass. The results calculated by the Working Group indicate a stock in 1990 of about 6 000 tonnes on Lena Bank and 3 500 tonnes on Ob Bank (Figure 11). As the species is relatively slow growing, the stock size is likely to have changed little since 1990. Although it appears that the stock could sustain a fishery of a few hundred tonnes, it is recommended that a survey to determine age structure and stock size at both Ob and Lena Banks should be undertaken before the fishery is re-opened.

Division 58.4.2 (Coast of the Antarctic Continent)

6.232 Fine-scale catch and effort data from research cruises for *Chaenodraco wilsoni* and *Trematomus eulepidotus* have been provided for 1990.

6.233 An outline of the biology of *Pleuragramma antarcticum* in this division is given in WG-FSA-92/11. Fish from various locations within the division have different parameters of the von Bertalanffy growth equation. As the only truly pelagic fish on the Antarctic continental shelf, its biology is significantly different from other species in the area. Sexual maturity is reached relatively early (13 to 16 cm, 4 to 6 years for females; 12 to 18 cm, 4 to 7 years for males) and the fecundity is relatively high. Estimates of **M** vary from 0.26 to 2.21.

6.234 Paper WG-FSA-92/11 reported that biomass in various areas and years varied widely, with values between 171 and 285 tonnes/km for Gunnerus Bank, 60 to 3 459 tonnes/km^3 for the Vernadsky Peninsula area, 1 560 to 2 599 tonnes/km^3 for Kemp Land, 21 to 2 327 tonnes/km^3 for the Mawson Coast area and 311 to 2 886 tonnes/km^3 for Prydz Bay. WG-FSA-92/11 proposed a series of TACs: Kemp Land, 14 500 tonnes; Prydz Bay, 5 800 to 28 100 tonnes; Kosmonavtov Sea, 37 900 tonnes; and Mawson Coast, 25 000 tonnes.

6.235 The Working Group noted that no detailed age structure is given, or details of how biomass figures were derived. The TACs are based on an age of fish entering a fishery at 2.62 to 3.45 years (7.5 to 10.0 cm length), which is well below the age (length) at maturity. These TACs should therefore be treated with extreme caution until more details of the assessment are available.

6.236 As *P. antarcticum* is very important in the diet of vertebrate predators, WG-FSA-92/11 recommends no fishery should be started in areas where monitoring is being conducted. The Working Group agreed with this recommendation.

6.237 The Working Group agreed that its deliberations on the US crab fishery had highlighted a number of issues pertinent to managing fishing mortality in a new fishery.

6.238 The Working Group noted that, as a general principle, the Commission had agreed in 1987 that the most direct ways to control fishing mortality (**F**) are to limit the amount of fishing effort or to establish a total allowable catch (TAC) (CCAMLR-VI, paragraph 60).

6.239 For the most part, the Commission has adhered to a management strategy whereby conservation measures on finfish have been established in accordance with a set level of **F** ($\mathbf{F_{0.1}}$) and the corresponding TAC applied.

6.240 In a new fishery, such as the crab fishery, estimates of current biomass and the strength of recruitment are required in order to manage the fishery using a TAC. The information necessary for this process will take some time to collect and consequently there is a possibility that unacceptably high levels of **F** may occur before information necessary for an initial assessment can be collected. The Working Group considered that such situations would be contrary to Article II and would also not be in accordance with the precautionary approach to management adopted by the Commission.

6.241 The Working Group agreed that control of fishing effort could offer a useful alternative to a TAC as a means of controlling **F**, despite the limitations imposed by a need for detailed knowledge about fishing power of vessels and operational constraints of the fishery.

6.242 The implementation of effort controls could also be viewed as "precautionary" insofar as they can be applied in the absence of the detailed information necessary to set an acceptable TAC. Such controls could thus not only be used to minimise the risk of an uncontrolled expansion in fishing effort on an under-exploited stock, they could also be applied in combination with an emergent TAC regime which would be modified as the necessary information for such a regime is collected from the fishery or through scientific research. This approach would be in direct accordance with "feedback" management control.

6.243 Effort controls may be useful adjuncts to TAC controls so that over-runs in TACs may be avoided. Without effort controls, TACs could be over-run when catch rates in the reporting periods are very high. The reliability of assessments can also be enhanced if the fishing season does not become truncated by excessive effort.

6.244 The Working Group therefore drew the Scientific Committee's attention to the potential utility of effort limitation as a method to control fishing mortality. The Working Group emphasised, however, that the implementation of effort controls has certain practical difficulties and that some guidance from the Commission is necessary.

6.245 Advice is required on policy matters such as effort levels, and how frequently and to what extent fishing effort can be modified. This is a necessary condition to the setting of appropriate effort levels. Similarly, the application of effort controls in a precautionary management approach should contribute to the selection of suitable effort levels.

CONSIDERATIONS OF ECOSYSTEM MANAGEMENT

INTERACTIONS WITH WG-KRILL

7.1 For a number of years, the Scientific Committee has highlighted the importance of investigating the significance of the by-catch of young fish in the krill fishery (e.g., SC-CAMLR-X, paragraph 3.22). This matter was also considered at the most recent meeting of WG-Krill (SC-CAMLR-XI/4, paragraphs 3.17 to 3.19) and a number of papers were presented to to this meeting of WG-FSA.

7.2 WG-FSA-92/6 presented an analysis of data on the by-catch of juvenile *C. gunnari* in krill trawls collected by a scientific observer working on a Russian krill fishing vessel around South Georgia. The mortality of *C. gunnari* juveniles was estimated to be very small, being equal to about 0.3 to 0.5% of fish that survived up to the age of one year. The by-catch was found to be greatest on the periphery of krill swarms and less internally. Data presented in WG-FSA-92/20 duplicated this information and had been presented in direct response to a request by WG-Krill (SC-CAMLR-XI/4, paragraph 3.18).

7.3 Several other papers were available to the Working Group on this subject; these included WG-Krill-91/25, Kompowski (1980)[1] and Slosarczyk (1983)[2]. It is generally believed that the by-catch of juvenile *C. gunnari* in krill trawls is greater over certain parts of the shelf (e.g., Clerke Rocks, east of South Georgia), and largest at low or moderate krill catch rates. It is thought that this process could have a significant and detrimental effect on recruitment of *C. gunnari*.

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1 KOMPOWSKI, A. 1980. On feeding of *Champsocephalus gunnari* Lönnberg, 1905 (Pisces, Chaenichthyidae) off South Georgia and Kerguelen Islands. *Acta Ichthyol.Piscat. 10*(1): 25-43.

2 SLOSARCZYK, W. 1983. Juvenile *Trematomus bernacchii* and *Pagothenia brachysoma* (Pisces, Nototheniidae) within krill concentrations off Balleny Islands (Antarctic). *Pol. Polar Res. 4*(1-4): 57-69.

7.4 In discussing the results presented in WG-FSA-92/6, members of the Working Group felt that the method of sampling (observing fish on a moving conveyor belt 4 m long) and the small sample sizes were inadequate to provide reliable results of the by-catch, particularly if these were to be extrapolated over the entire krill fishery. Concern was also expressed about the method of extrapolation which could result in an under-estimation of the potential overall by-catch. In addition, the assessed impact on recruitment was probably an underestimate, since the estimated average annual recruitment of 1 000 million 1 year olds, taken from the VPA assessment presented in WG-FSA-91/27, is probably an overestimate of current recruitment to the population (paragraph 6.63). The CV of this recruitment is high, being in the region of 0.67 to 0.71. Given these reservations, the paper was referred back to authors for further details of the sampling and the underlying analytical procedures.

7.5 Limited information was available on species other than *C. gunnari*, such as *Gymnoscopelus*.

7.6 Information on the juvenile fish by-catch in krill trawls was presented for the Indian Ocean sector in WG-FSA-92/10. A very useful set of haul-by-haul data was provided, but again details of the sampling methodology were unclear. In commercial catches between 114 and 1 million fish per tonne of krill were recorded. Most of the large by-catches (>100 000 fish per tonne of krill caught) were taken in relatively low to medium-sized krill catches (1 to 5 tonnes). The authors of the paper concluded that the juvenile fish by-catch could therefore be minimised by targetting dense krill aggregations. As *P. antarcticum* comprised the bulk of the by-catch, with the balance consisting of shelf-dwelling nototheniids and channichthyids, the authors recommended that to reduce the incidental by-catch of juvenile fish further, the area of krill fishing should be limited to water depths of 1 200 m or greater.

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

INTERACTIONS WITH WG-CEMP

7.8 In considering interactions with the Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP), the Working Group noted that these could be divided into those concerned with ecological relationships between fish and other species, and those dealing with the possible consequences of finfishing operations for marine mammals and birds.

Ecological Relationships Between Fish and Other Species

7.9 The Working Group noted that in addressing the need to incorporate krill predation by fish into estimates of prey requirements, WG-CEMP's priorities have shifted and no specific proposals have yet been made for scheduling a CEMP workshop on prey requirements (SC-CAMLR-XI, Annex 4, paragraph 7.20).

7.10 The Working Group also noted that WG-CEMP had suggested it considers Table 4 in WG-CEMP's report as an initial attempt to provide an inventory of fish data which could assist in interpreting changes in abundance and distribution (cf. SC-CAMLR-X, paragraph 6.57) of predator and prey species.

7.11 The Working Group saw Table 4 as a useful first, essentially qualitative, step in identifying the type of data required to assess key ecological properties of fish in the interests of improving the development of appropriate scientific advice to WG-CEMP and the Scientific Committee. In this context, the Working Group agreed that a clear distinction needs to be made as to whether fish are considered as predators in their own right or as prey for other species.

7.12 The Working Group agreed that when fish are viewed as predators, then certain of the headings in WG-CEMP Table 4 should be adapted. For example, "breeding success" should be replaced by "spawning condition", "year-class strength" and "age-at-first spawning". The Working Group did not pursue the matter further, however, since it felt that some time is required to refine the type of parameters to be included and to evaluate the applicability of the approach as a whole. Submissions on this topic to WG-FSA's next meeting were encouraged.

7.13 Both WG-FSA-92/18 and 11 contained information relevant to the consideration of ecological relationships between fish and other species.

7.14 WG-FSA-92/18 linked differences in the condition of *C. gunnari* around South Georgia and Shag Rocks to the availability of food in different years. Food quality and low feeding intensity may also affect ovarian development and gonadal maturation.

7.15 The reporting of biological data on *P. antarcticum* in WG-FSA-92/11 represents the first such comprehensive data presented on this species. WG-FSA drew WG-CEMP's attention to this significant development since *P. antarcticum* is a CEMP monitoring species and one for which information is currently lacking.

Possible Ecological Consequences of Finfishing

7.16 Various reports on the assessment and avoidance of incidental mortality in the Convention Area were reviewed. CCAMLR-XI/7 indicated that "no incidental mortality of birds or mammals was reported in association with commercial fishing operations and scientific sampling". A similar negative report was contained in CCAMLR-XI/8.

7.17 Since 1990, six records of entanglement with longline hooks and nylon line were reported for giant fulmars near Palmer Station (CCAMLR-XI/BG/6). This is the first time that such entanglement has been reported in the Palmer area and suggests that a longline fishery may now be operating within the foraging range of the species. The Working Group was of the opinion, however, that birds were likely to have become entangled farther afield either near South Georgia or even off the Patagonian coast where there are a large number of vessels carrying out longline operations. It was also felt that it would be useful to ascertain the type of nylon or polypropylene line concerned as this may enable identification of the particular fishery from which the line originated.

7.18 Several incidents of fur seal entanglement were observed during a survey off Bird Island between November 1991 and March 1992 (SC-CAMLR-XI/BG/9). Five of these entanglements were in plastic packaging bands while the remainder were in fishing net fragments.

7.19 Information contained in the report of an attempted inspection of a Russian longline vessel (CCAMLR-XI/BG/9) suggested the deployment of a tori pole (or streamer) in accordance with Conservation Measure 29/X had been effective in minimising incidental mortality of birds during longline fishing operations.

7.20 The Working Group noted that there had been some problems of interpretation of Conservation Measure 29/X. The major problem was seen to be that in implementing the five conditions of the measure, certain operators appear to consider that the setting of longlines at night

negates the need for a streamer line. The Working Group emphasised that streamer lines should be deployed during all daylight operations and that "daylight" for these purposes should include "nautical twilight" as defined in a nautical almanac, corrected for latitude and date. The Scientific Committee's attention was drawn to this definition which was provided in the interests of ensuring that a streamer line is deployed during the period when incident light levels are sufficient to allow foraging birds to be visually attracted to baited longline hooks.

Other Interactions

7.21 At its last two meetings, the Working Group has noted the potentially serious affect that bottom trawling may have on benthic assemblages (see WG-FSA-90/24 and SC-CAMLR-X/BG/19). No new information was submitted on this problem to the current meeting.

7.22 WG-FSA noted, however, that a major component of the SCAR-sponsored program of research on the Ecology of the Antarctic Sea Ice Zone (EASIZ) will focus on benthos. The Working Group urged the Scientific Committee to keep itself informed of developments in the SCAR program. It was also suggested that there may be some utility in seeking advice from SCAR on the potential of comparing benthic assemblages in coastal areas which have been subject to heavy demersal fisheries compared with other areas where no fishing has occurred.

7.23 The potential importance of studying benthic communities in the context of monitoring global environmental change was also recognised.

7.24 The Working Group noted that information presented in WG-FSA-92/12 suggests that at certain times the *E. carlsbergi* fishery may be targetting assemblages of myctophid species and that significant catches of species other than *E. carlsbergi* may be taken (paragraph 6.103). The need for further investigation of such effects was emphasised.

Proposals for Working Group Co-ordination Meeting

7.25 The Scientific Committee (SC-CAMLR-X, paragraph 12.4) has suggested that a meeting of the Conveners of the three Working Groups and other interested parties would serve to improve co-ordination of the Groups' activities prior to SC-CAMLR-XI. The Working Group saw such a meeting as being useful in the identification of common problems between the three Working Groups and in addressing matters of common concern.

7.26 The Working Group endorsed the principle of referring papers back to authors for clarification as well as the independent validation of methods, analytical procedures and computer programs used in the formulation of management advice. Similar principles have been established in WG-Krill.

7.27 The question of a common approach to the publication of information used during deliberations of the Working Groups, particularly in the formulation of management advice was considered to be a little more difficult to resolve. As such it was seen as a priority topic which the coordination meeting should address.

7.28 As a general rule, it was agreed that data which had been used in the formulation of management advice by WG-FSA should remain in the CCAMLR database and should be accessible to the Working Group, the Scientific Committee, the Commission and accredited members of these bodies as well as other working groups.

7.29 The classification of papers submitted to WG-FSA into Working Papers, Background Papers and papers of general scientific interest was seen as one way of ensuring that important information is not lost whilst also providing for the greatest possible access to information used in the formulation of management advice.

7.30 The final publication of papers was still seen to be the preserve of authors provided that the already agreed provisions concerning permission from data originators are met. As a unifying principle, therefore, the Working Group felt most strongly that in accordance with Article IX of the Convention, every effort should be made to facilitate the analysis, dissemination and publication of research information, data on the status of stocks and on fisheries catches.

RESEARCH SURVEYS

WORKSHOP ON THE DESIGN OF BOTTOM TRAWL SURVEYS

8.1 Difficulties associated with the design of bottom trawl surveys and the application of the swept area method (Saville, 1977[1]) and associated t-statistics on species with a patchy distribution, such as *C. gunnari*, have been a considerable problem to the Working Group in the past. Therefore the Working Group, at its meetings in 1990 and 1991, drew attention to the need for investigation of the problem as a matter of priority (SC-CAMLR-IX, Annex 5, paragraph 91).

1 SAVILLE. A. 1977. Survey methods of appraising fishery resources. *FAO Fish. Tech. Pap. 171*: 76 pp.

Because of the specialised and detailed examination required, this work could not be done during a regular meeting of the Working Group. It therefore recommended that a workshop on survey design and analyses of research vessel surveys be held in the intersessional period (SC-CAMLR-X, paragraph 4.108). The terms of reference for this workshop combine theoretical aspects, such as survey design for sampling different types of fish distribution, two-phase surveys and properties of estimators of biomass with practical aspects, such as sources of errors in comparisons between surveys, into a synthesis on survey design and cost effective allocation of sampling resources (SC-CAMLR-X, paragraph 4.109).

8.2 The Workshop was held at the Bundesforschungsanstalt für Fischerei (Federal Research Centre for Fisheries), Hamburg, Germany from 16 to 19 September under the convenership of Dr Kock. Despite the great interest of Members in the Workshop in its initial phase during SC-CAMLR-X only four scientists from three Member countries attended the Workshop. No statistician was present which limited the discussion on theoretical aspects. No scientist familiar with bottom trawl surveys in the Indian Ocean was present at the Workshop, so deliberations were mainly based on experience from the Atlantic Ocean sector. The Workshop reviewed:

(i) Factors affecting the accuracy of bottom trawl surveys:
- trawl geometry, rigging and performance;
- fish behaviour in relation to fishing gear;
- fish distribution in the area:
  (a) small-scale distribution; and
  (b) large-scale distribution.

(ii) Design of bottom trawl surveys:
- non-random (systematic) surveys;
- random surveys;
- stratification;
- two-stage surveys (three approaches).

(iii) Analysis of bottom trawl survey data.

(iv) Manual for bottom trawl surveys.

It was agreed that the main aim of the Workshop would be to begin the development of a manual describing the techniques to be used for bottom trawl surveys for fish stock assessment purposes within the Convention Area and the information from the surveys which need to be reported to CCAMLR.

8.3 The Report of the Workshop is given in Appendix H.

8.4 The Working Group welcomed the report as a useful first step in the further analysis of survey data for fish species with a contagious distribution, such as *C. gunnari*.

8.5 To proceed further, the Working Group recommended that historic information from surveys, such as those provided in WG-FSA-92/4 in a summarised form, as well as those from the commercial fishery should be made available to the Working Group in detailed form to investigate if regularities exist in the occurrence of aggregations from one year to another.

8.6 This information could then be used to formulate a range of hypotheses how fish may behave. These hypotheses would then be developed into a range of models of possible fish behaviour in the area. Properties of trawl surveys from the range of models should be tested by simulation studies and the most appropriate methods of analysis selected for application to historic and future trawl data sets.

8.7 The Working Group felt that these activities should be coordinated by a steering group consisting of the Convener of the Working Group, Dr W. de la Mare (Australia) and Dr Kock. A progress report on these activities will be submitted to next year's meeting.

8.8 The Working Group agreed that the 'Draft Manual for Bottom Trawl Surveys in the Convention Area' (Appendix H, Attachment E) should be circulated by the Secretariat among Members in the intersessional period to obtain further comments. A new draft including these comments would then be prepared by the Secretariat for next year's meeting for final approval by the Working Group.

8.9 Estimates of areas of seabed within selected depth ranges which are an important prerequisite for the design and analysis of bottom trawl surveys, have so far only been published for the Atlantic Ocean sector (Appendix H, Attachment E, Tables 1A to 1O). It was recommended that unpublished estimates of areas of seabed in the Indian Ocean sector (Kerguelen Islands, Heard and Macdonald Islands) be made available to CCAMLR to be included in the manual.

8.10 Estimates of areas of seabed within selected depth ranges for Subarea 48.3 were so far only available for the depth ranges 0 to 50 m, 50 to 150 m, 150 to 250 m and >500 m (Everson, 1987). In the course of the analysis of the *D. eleginoides* fishery, the Data Manager provided estimates of areas of seabed within selected depth ranges from 500 to 2 000 m.

8.11 Estimates of areas of seabed around the South Orkney Islands (Subarea 48.2) and in the Antarctic Peninsula region (Subarea 48.1) which have been based mostly on Admiralty Charts may not be very precise. More detailed bathymetric charts of the Peninsula region have been prepared in laboratories of some Member countries (Spain, Germany and Poland) by refining Admiralty Charts with soundings from their own research cruises. The Working Group recommended that these bathymetric charts be submitted to CCAMLR. The Secretariat should then extend its estimates of areas of seabed within selected depth ranges to other subareas and provide refined estimates for next year's meeting.

8.12 Mr Balguerías drew the attention of the Working Group to the existence of very detailed and precise bathymetric charts in use in the Russian fishery. The Secretariat was asked to approach the Russian authorities to see if these detailed charts could be made available to CCAMLR.

8.13 No information has been submitted to CCAMLR since 1987 to assess the state of fish stocks in the Peninsula region. WG-FSA-92/7 provided the survey design for bottom trawl surveys to be carried out in this region in the near future. The Working Group welcomed this initiative. However, it was noted that the proposed survey design did not take the meridional decrease in fish abundance into account. Fish abundance during surveys in the 1980s was usually highest along the north coast of Elephant Island and the South Shetland Islands. Most of the commercial fishery in the late 1970s/early 1980s had been carried out in this area. It was therefore recommended that most hauls during future surveys should be allocated to these areas and comparatively few need to be allocated to the shelf of the Antarctic Peninsula. Furthermore, experience from previous surveys indicates that only very limited areas are found suitable for trawling along the Peninsula. Any extended trawling in these areas are likely to result in a high loss of bottom gear and would require extended periods of searching to find grounds suitable for trawling.

8.14 The Working Group recommended that the proposed survey design should be modified accordingly. The number of hauls required to survey the area may be reduced and additional time might become available to extend the survey to Subarea 48.2.

RECENT AND PROPOSED SURVEYS

8.15 A bottom trawl survey was carried out around South Georgia in January 1992 by the UK in collaboration with scientists from Poland and Germany. The results of this survey have been used extensively by the Working Group during this year's meeting.

8.16 No research surveys have been proposed for the 1992/93 season. The Working Group noted that a Chilean company will carry out an exploratory longline fishery around the South Sandwich Islands to determine the feasibility of extending the *D. eleginoides* fishery to this subarea. This cruise will be accompanied by two scientific observers.

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

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

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

8.20 The Working Group concluded that information provided so far from these surveys contributed little to improve the assessments carried out by the Working Group during this year's meeting. It reiterates earlier statements and the Commission's decision from 1986 that research plans should be submitted at least six months in advance to allow careful review of research proposals to ascertain that they address specific requests by the Working Group.

FUTURE WORK

DATA REQUIREMENTS

9.1 The Commission in 1991 adopted several conservation measures to apply to the *D. eleginoides* fishery in Subarea 48.3 (Conservation Measures 35/X to 37/X). Chile had been

unable to comply with Conservation Measure 37/X and had objected to it within the objection period set out in Article IX(6)(c) of the Convention.

9.2 In CCAMLR-XI/11 the reasons for Chile's objection are presented. Dr Moreno explained that whilst Chile always intended to provide the detailed haul-by-haul and biological data requested it had not been possible to collate these data every five days because the vessels did not have facsimile facilities. The only opportunity to collect the data was therefore when the vessels completed a fishing cruise, the duration of which was usually 50 days. Because of this, and paragraph 3 of Conservation Measure 37/X which states that the fishery should be closed to any Contracting Party which did not supply these data to the Executive Secretary for three consecutive reporting periods, Chile objected to the Measure.

9.3 The Working Group agreed that the reason for requesting haul-by-haul and biological data to be reported as the fishery progresses is to ensure that these data are submitted to the CCAMLR Data Centre in time to be incorporated in the database and be available to the Working Group. It appreciated the difficulties that Chile had in acquiring these data. However, because of the volume of data to be submitted, entered into the CCAMLR database and validated, the Data Manager suggested that fixing data reporting to a single submission date, such as 30 September, would not allow enough time for the data to be entered before the Working Group meeting. Accordingly, the Working Group recommended that any reconsideration of Conservation Measure 37/X should include the requirement that reporting should proceed periodically throughout the course of the fishery.

9.4 Details of data requirements identified by the Working Group are given in Appendix D.

SOFTWARE AND ANALYSES REQUIRED FOR THE 1993 MEETING

9.5 Some problems had been encountered in running the yield-per-recruit program with long lived species and low **M**. These problems should be fixed for the next meeting.

9.6 Several *ad hoc* calculations had been performed during the meeting on MathCad. Using this software, it is easy to construct and run models which are subsequently well documented in standard mathematical notation. The Working Group recommended that the Secretariat acquire this program in the intersessional period.

9.7 During the past year the Secretariat had acquired the new version of the MAFF VPA and a FORTRAN-based ADAPT program as requested in (SC-CAMLR-X, Annex 6, paragraph 8.29). The Working Group expressed its gratitude for these additions to the Secretariat's software.

9.8 During the course of the meeting the Secretariat had provided the Working Group with data on seabed areas at selected depth ranges around South Georgia by fine-scale square (Appendix E). The Working Group requested the Secretariat to continue this work to compile data on other subareas in as much detail as available charts of the areas will allow, and down to 2 500 m. To facilitate this work, participants were encouraged to send copies of high resolution charts of relevant areas within the Convention Area to the Secretariat.

OTHER BUSINESS

10.1 The Working Group had received a paper on FISHBASE from Dr A. Jarre-Teichmann (Germany) (WG-FSA-92/25). FISHBASE is a database system designed to include biological information on fish on a global scale and is being developed by the International Centre for Living Aquatic Resources Management (ICLARM, Manilla, Philippines). The paper encouraged scientists wishing to contribute papers or reports containing relevant data on Antarctic fish, for inclusion in FISHBASE, to write to Dr Jarre-Teichmann.

10.2 A glossary of terms used in stock assessment, compiled by the Secretariat, was circulated. The Working Group agreed that this glossary could provide a useful guide to readers of its reports.

10.3 The Working Group noted that in previous years many papers had been submitted late (after 9 am on the first day of the meeting) and had therefore been unavailable for appraisal prior to the meeting. The Working Group was pleased to note that all papers considered at its present meeting had been submitted by the 9 am deadline. It was agreed that at any meeting, papers submitted after the 9 am deadline would not be considered at the meeting.

10.4 The Working Group noted the large amount of work now involved in assessing all the fish stocks and the difficulty in assessing stocks with no new data or methods that improve assessments of previous years. It was recommended that in future if no new data were available for a particular stock and there was no reported fishery or knowledge of intended fishing on that stock, then, in the absence of specific direction from the Scientific Committee or Commission, the stock should not be considered in the agenda of the Working Group at that meeting.

ADOPTION OF THE REPORT

11.1 The Report of the 1992 Meeting of the Working Group on Fish Stock Assessment was adopted.

CLOSE OF THE MEETING

12.1 In closing the meeting, Dr Kock expressed his gratitude to the Secretariat, Rapporteurs, Conveners of subgroups and to all members for their hard work during the meeting.

12.2 He noted that at the present meeting there had been no time to discuss some of the more philosophical aspects of stock assessment techniques, such as precautionary approaches and simulated management scenarios. Several members agreed that it would be useful to devote a day to this at the next meeting and the Working Group suggested that Members give some thought to the topics that could be discussed at such a time so that these could be incorporated in the annotated agenda.

12.3 Several members thanked Dr Kock for assuming chairmanship of the meeting at such short notice when Dr Everson was regrettably unable to attend. Dr Basson conveyed Dr Everson's thanks to Dr Kock for performing this task.

APPENDIX A

LIST OF PARTICIPANTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 13 to 22 October 1992)

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APPENDIX B

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 13 to 22 October 1992)

1. Opening of the Meeting

2. Organisation of the Meeting

3. Adoption of the Agenda

4. Observation and Inspection

5. Review of Material for the Meeting
   - 5.1 Data Requirements endorsed by the Commission in 1991
   - 5.2 Catch and Effort Statistics
   - 5.3 Mesh/Hook Selectivity and Related Experiments Affecting Catchability
   - 5.4 Other Documents

6. Assessment Work and Management Advice
   - 6.1 New Fisheries
   - 6.2 South Georgia (Subarea 48.3)
   - 6.3 South Orkney Islands (Subarea 48.2)
   - 6.4 Antarctic Peninsula (Subarea 48.1)
   - 6.5 Kerguelen Islands (Division 58.5.1)
   - 6.6 Ob and Lena Banks (Divisions 58.4.4)
   - 6.7 Coastal Areas of Antarctic Continent (Divisions 58.4.1 and 58.4.2)
   - 6.8 Pacific Ocean Sector (Area 88)

7. Considerations of Ecosystem Management
   - 7.1 Interactions with WG-Krill
   - 7.2 Interactions with WG-CEMP
   - 7.3 Other Interactions (e.g., Multispecies, Benthos, etc.)
   - 7.4 Proposals for Working Group Coordination Meeting

8. Research Surveys
   8.1 Workshop on Survey Design and the Analyses of Research Vessel Surveys
   8.2 Recent and Proposed Surveys

9. Future Work
   9.1 Data Requirements
   9.2 Software to be Prepared or Developed Prior to the Next Meeting and Data Analyses Required

10. Other Business

11. Adoption of the Report

12. Close of the Meeting.

APPENDIX C

LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 13 to 22 October 1992)

WG-FSA-92/1	AGENDA
WG-FSA-92/2	LIST OF PARTICIPANTS
WG-FSA-92/3	LIST OF DOCUMENTS
WG-FSA-92/4	*CHAMPSOCEPHALUS GUNNARI* LÖNNBERG DISTRIBUTION ON SOUTH GEORGIA SHELF FROM INVENTORY SURVEY DATA COLLECTED BY ATLANTNIRO I.A. Trunov (Russia)
WG-FSA-92/5	COLLECTED DATA AND STOCK ASSESSMENT RESULTS FOR *NOTOTHENIA SQUAMIFRONS* FROM OB AND LENA BANKS, DIVISION 58.4.4 A.K. Zaitsev and S.M. Pronenko (Ukraine)
WG-FSA-92/6	BY-CATCH OF JUVENILE *CHAMPSOCEPHALUS GUNNARI* IN KRILL FISHERY ON THE SHELF OF SOUTH GEORGIA ISLAND G.A. Frolkina, V.I. Latogursky, V.A. Sushin (Russian Federation)
WG-FSA-92/7	A FISH STOCK ASSESSMENT SURVEY DESIGN FOR SUBAREA 48.1 George Watters (USA)
WG-FSA-92/8	LENGTH-AGE COMPOSITION OF THE PATAGONIAN TOOTHFISH, *DISSOSTICHUS ELEGINOIDES*, FROM THE KERGUELEN ISLAND AREA V.G. Prutko and V.N. Chikov (Ukraine)
WG-FSA-92/9	STOCK SIZE AND TAC ESTIMATION FOR THE PATAGONIAN TOOTHFISH, *DISSOSTICHUS ELEGINOIDES*, FROM THE KERGUELEN ISLANDS AREA S.M. Pronenko, P.B. Tankevich, V.V. Gerasimchuk and V.N. Chikov (Ukraine)
WG-FSA-92/10	ON THE PROBLEM OF BY-CATCH OF JUVENILE FISH IN KRILL FISHERY C.A. Pankratov and E.A. Pakhomov (Ukraine)
WG-FSA-92/11	A BRIEF OUTLINE OF THE BIOLOGY OF THE ANTARCTIC SILVERFISH, *PLEURAGRAMMA ANTARCTICUM* BOULENGER, 1902 (NOTOTHENIIDAE) FROM THE ANTARCTIC INDIAN OCEAN V.V. Gerasimchuk (Ukraine)

WG-FSA-92/12 SPECIES COMPOSITION OF BY-CATCH IN CATCHES OF *ELECTRONA CARLSBERGI* TAKEN DURING COMMERCIAL/RESEARCH FISHING NORTH OF SOUTH GEORGIA ISLAND IN 1987-89
VNIRO (Moscow, Russia)

WG-FSA-92/13 PRE-SPAWNING AND SPAWNING BIOLOGY OF THE PATAGONIAN TOOTHFISH, *DISSOSTICHUS ELEGINOIDES*, AROUND SOUTH GEORGIA (SUBAREA 48.3)
I.N. Konforkin and A.N. Kozlov (VNIRO, Moscow, Russia)

WG-FSA-92/14 BRIEF REPORT OF RESEARCH CARRIED OUT BY THE VESSEL *MIRGOROD* IN THE SHAG ROCKS AND SOUTH GEORGIA AREAS DURING THE PERIOD MAY-JUNE 1992
Russia

WG-FSA-92/15 BRIEF REPORT OF RESEARCH CARRIED OUT BY THE VESSEL *MAKSHEEVO* IN THE SHAG ROCKS AND SOUTH GEORGIA AREAS DURING THE PERIOD JUNE-JULY 1992
Russia

WG-FSA-92/16 CCAMLR WORKSHOP ON DESIGN OF BOTTOM TRAWL SURVEYS
(Hamburg, Germany, 16 to 19 September 1992)

WG-FSA-92/17 FISH STOCK ASSESSMENT SURVEY IN SUBAREA 48.3
I. Everson, G. Parkes, S. Campbell (UK), K.-H. Kock (Germany), J. Szlakowski, D. Cielniaszek (Poland), C. Goss (UK), and S. Wilhelms (Germany)

WG-FSA-92/18 CONDITION FACTOR STUDY OF *CHAMPSOCEPHALUS GUNNARI*
I. Everson, G. Parkes, S. Campbell (UK), K.-H. Kock (Germany), J. Szlakowski, D. Cielniaszek (Poland), C. Goss (UK), and S. Wilhelms (Germany)

WG-FSA-92/19 SECRETARIAT STOCK ASSESSMENT SOFTWARE
Secretariat

WG-FSA-92/20 REPORTS OF JUVENILE FISH AS BY-CATCH IN THE KRILL FISHERY
Secretariat

WG-FSA-92/21 Rev. 1 REMARKS ON NATURAL MORTALITY OF *DISSOSTICHUS ELEGINOIDES* IN SUBAREA 48.3
Carlos A. Moreno and Pedro S. Rubilar (Chile)

WG-FSA-92/22 CATCH-AT-AGE ANALYSIS APPLIED TO NEW FISHERIES: THE CASE OF *DISSOSTICHUS ELEGINOIDES*
Alejandro V. Zuleta and Carlos A. Moreno (Chile)

WG-FSA-92/23 Rev. 1 AN ITERATIVE MODEL TO CONSTRUCT AN AGE-LENGTH KEY TO ASSESS THE AGE COMPOSITION OF A NEW FISHERY FOR *DISSOSTICHUS ELEGINOIDES* IN CHILEAN WATERS
Hugo Robotham V. and Zaida Young U. (Chile)

WG-FSA-92/24 FISHING OF THE PATAGONIAN TOOTHFISH (*DISSOSTICHUS ELEGINOIDES*) BY THE CHILEAN FLEET (1991/92) IN THE SUBAREA 48.3 (SOUTH GEORGIA ISLAND) AND PROPOSED TAC FOR THE 1991/1993 SEASON
Patricio Arana Espina, Marcelo Arredondo Araya and Vittorio Venturini Meniconi (Chile)

WG-FSA-92/25 DATABASE INFORMATION ON ANTARCTIC FISHES: CALL FOR COOPERATION
Astrid Jarre-Teichmann (Germany)

WG-FSA-92/26 VARIATIONS IN FOOD COMPOSITION AND FEEDING INTENSITY OF MACKEREL ICEFISH (*CHAMPSOCEPHALUS GUNNARI*) AT SOUTH GEORGIA
K.-H. Kock (Germany), I. Everson (UK), S. Wilhelms (Germany), S. Campbell (UK), J. Szlakowski (Poland), G. Parkes (UK), Z. Cielniaszek (Poland) and C. Goss (UK)

WG-FSA-92/27 NOTES ON THE USE OF VIRTUAL POPULATION ANALYSIS FOR STOCK ASSESSMENT OF THE MACKEREL ICEFISH, *CHAMPSOCEPHALUS GUNNARI* (LÖNNBERG, 1906) IN SUBAREA 48.3 FOR THE 1990/91 AND 1991/92 SEASONS
G. Parkes (United Kingdom)

WG-FSA-92/28 THE 1992 *DISSOSTICHUS* FISHERY IN SUBAREA 48.3
D.J. Agnew (Secretariat) and C.A. Moreno (Chile)

WG-FSA-92/29 A PRELIMINARY REPORT ON RESEARCH CONDUCTED DURING EXPERIMENTAL CRAB FISHING IN THE ANTARCTIC DURING 1992 (CCAMLR AREA 48)
Robert S. Otto and Richard A. MacIntosh (USA)

WG-FSA-92/30 PRELIMINARY ANALYSIS OF THE GROWTH OF *DISSOSTICHUS ELEGINOIDES* FROM THE AUSTRAL ZONE OF CHILE AND SOUTH GEORGIA
M. Aguayo H. (Chile)

WG-FSA-92/31 Rev. 1 EXPLORATORY LONGLINE FISHING AROUND THE KERGUELEN ISLANDS (DIVISION 58.5.1). DESCRIPTION OF THE FISHING EFFORT; CATCHABILITY AND TARGET SIZE OF *DISSOSTICHUS ELEGINOIDES*
G. Duhamel (France)

WG-FSA-92/32 CCAMLR GLOSSARY OF TERMS
Secretariat

OTHER DOCUMENTS

CCAMLR-XI/5	PLAN FOR RESEARCH AND DATA COLLECTION DURING EXPLORATORY FISHING FOR *DISSOSTICHUS ELEGINOIDES* IN CCAMLR SUBAREA 48.4 Delegation of the USA
CCAMLR-XI/6	PROPOSAL FOR A CCAMLR SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION Delegation of EEC
CCAMLR-XI/7	APPLICATION FOR PERMIT TO CARRY OUT EXPLORATION AROUND THE SOUTH SANDWICH ISLANDS IN ORDER TO DETERMINE THE FEASIBILITY OF A NEW FISHERY Delegation of Chile
CCAMLR-XI/11	COMMENTS ON THE APPLICATION OF CCAMLR CONSERVATION MEASURES 36/X AND 37/X WITH REGARD TO THE *DISSOSTICHUS ELEGINOIDES* FISHERY IN SUBAREA 48.3 Delegation of Chile
CCAMLR-XI/BG/6	REPORT ON THE ASSESSMENT OF INCIDENTAL MORTALITY, PALMER STATION, 1991-1992 Delegation of USA
SC-CAMLR-XI/BG/2	CCAMLR DATABASES AND DATA AVAILABILITY Secretariat
WG-KRILL-92/14 Rev.1	MANAGING SOUTHERN OCEAN KRILL AND FISH STOCKS IN A CHANGING ENVIRONMENT I. Everson (UK)
SC-CAMLR-X/BG/20	NEW AND DEVELOPING FISHERIES: A REVIEW OF US ACTIVITIES IN PERMITTING AN EXPLORATORY CRAB FISHERY IN STATISTICAL AREA 48 Delegation of USA

APPENDIX D

DATA REQUIREMENTS FOR THE WORKING GROUP

I Data Required by WG-FSA-91	II Data Received by WG-FSA	III Data Required by WG-FSA-92
1.		Data from the crab fishery should be collected and submitted (paragraphs 6.20 (v) and (vi))
2. Length and age data from *D. eleginoides* in Subarea 48.3. Continued requirement from historical fishery	Data reported to CCAMLR under item 4 below and in accordance with Conservation Measure 37/X	-
3. Data on size selectivity of longline fishery for *D. eleginoides* in Subarea 48.3	Fine-scale data submitted (Chile, USSR) in WG-FSA-92/28	-
4. *D. eleginoides*, Subarea 48.3: • length and age data in WG-FSA-90/34 and 91/24 should be submitted • changes to five-day reporting to include vessel days and number of hooks	Data were submitted to CCAMLR Data Centre (CDC), including haul-by-haul data from the commercial longline fishery (CCAMLR-X, paragraph 4.14)	-
5.		*D. eleginoides*, Subarea 48.3 (paragraph 6.176) • studies on hook selection factors required • studies on loss rates of fish
6.		*D. eleginoides*, Subarea 48.3 • age and maturity determination required for an expanded range of lengths from historical and current commercial and research catches (paragraph 6.123 to 6.126) • fish should be measured in 1 cm length classes and all data should be submitted to CCAMLR (paragraph 6.142)
7. Report *E. carlsbergi* catches from north of convergence	No information on areas north of the convergence	-
8. Biological data from historical catches of *E. carlsbergi* requested Fine-scale data requested	Some length composition data submitted to CDC, fine-scale data submitted	-
9. *E. carlsbergi*, Subarea 48.3: • description of operations (CCAMLR-IX, paragraph 4.27) • details of by-catch • full reporting of existing biological and survey data	• no information • WG-FSA-92/12 (research) • some length composition data	• description of operation (CCAMLR-IX, paragraph 4.2.7) • further information requested on by-catch in commercial *E. carlsbergi* fishery (paragraph 6.103) • new surveys required (paragraph 6.105)

I	II	III
10. Representative length frequency from the commercial catch of *C. gunnari* in Subarea 48.3 should be reported for recent years	No information	Representative length frequency from the commercial catch of *C. gunnari* in Subarea 48.3 should be reported for recent years
11. *C. gunnari* Subarea 48.3: • quantitative information on by-catch in midwater and demersal fisheries • reports from past surveys should be submitted in detail • research data should be submitted to Secretariat	• no information • some research data reported	Trawl fisheries in Subarea 48.3 • detailed data on the by-catch in pelagic (midwater) and demersal (bottom) trawl fisheries in Subarea 48.3 are urgently required to establish management advice (paragraphs 6.72 and 6.93) • research data should be submitted to the Secretariat
12. Biological information on incidental catch of *N. rossii* in Subarea 48.3	No information	*N. rossii*, Subarea 48.3 • biological information on incidental catch • haul-by-haul data from historical fishery requested (paragraph 6.34)
13. Length and age, *N. squamifrons*, Subarea 48.3 - commercial data for past years	No further information	Length and age, *N. squamifrons*, Subarea 48.3 - commercial data for past year's (paragraph 6.90)
14. Commercial age and length data for *N. gibberifrons*	No further information	Commercial age and length data for *N. gibberifrons*
15.		*P. guntheri*, Subarea 48.3 - clarification of position of past catches around South Georgia requested (paragraph 6.86)
16.		*E. carlsbergi* • clarification of position and time of catch of 1 518 tonnes reported for Subarea 48.2 in 1990/91 (paragraph 6.178) • clarification of position and time of catch of 50 tonnes in Subarea 48.1 in 1991/92 (paragraph 6.203)
17. *N. squamifrons*, Division 58.4.4 • STATLANT catches should be corrected to agree with those in WG-FSA-90/37 • catches should be reported for Ob and Lena Banks in fine-scale format • commercial age and length data should be submitted to Secretariat	All data submitted in WG-FSA-92/5 and will be used to update the CDC	-
18. Age/length data from catches of *C. gunnari* in Division 58.5.1 prior to 1980	No data	-
19. Commercial length and age data for the *D. eleginoides* trawl and longline fisheries in Division 58.5.1	Some data reported from France and WG-FSA-92/8 and 31	-
20. *N. squamifrons*, Division 58.5.1 • length and age/length key data • catch data separated for Division 58.5.1 • data consistency	Some data in WG-FSA-92/9; length composition from France; see Table 1	-

I	II	III
21. Reports requested from *Slavgorod*, *Borispol*, *Passat 2* fishing in October 1989 (SC-CAMLR-VIII, paragraph 3.7)	No information	-
22. Haul-by-haul information from research vessel surveys and experimental fisheries	No further information from Russia	-
23. Information on levels of discarding and conversion rates from fish products to nominal weight are required	No information	Information on levels of discarding and conversion rates from fish products to nominal weight are required
24.		Call for detailed charts to assist the Secretariat in the calculation of seabed areas (paragraph 8.11)
25.		Call for historic information from surveys to assist the Workshop on the Design of Bottom Trawl Surveys in investigating the interannual variability in the occurrence of fish aggregations (paragraphs 8.5 and 8.6)

APPENDIX E

SEABED AREA AT SELECTED DEPTH RANGES AROUND SOUTH GEORGIA AND SHAG ROCKS

Secretariat

The following seabed areas were calculated using the British Antarctic Survey bathymetric chart BAS (MISC) 4 Edition 1. Images were scanned into the Secretariat's Macintosh computers and relative areas calculated using the drawing package "Canvas". The distorting effects of latitude were assumed to be negligible at the scale of 0.5° latitude by 1° longitude (CCAMLR Fine-Scale Squares).

Latitude (northern boundary)	Longitude (eastern boundary)	Area of FS Square	Area (n miles^2) Within Depth Intervals				Total
			500-750 m	750-100 m	1000-1500 m	1500-2000 m	
53°	35°	1077.1	64.9	81.1	106.1	106.9	**359.0**
	36°	1077.1	0.0	62.3	143.1	98.9	**304.3**
	37°	1077.1	0.0	22.6	130.9	124.0	**277.6**
	38°	1077.1	0.0	0.0	0.0	14.3	**14.3**
	41°	1077.1	32.0	35.5	106.1	365.4	**539.0**
	42°	1077.1	59.2	51.7	126.2	373.4	**610.4**
	43°	1077.1	60.8	26.3	383.9	473.3	**944.3**
53.5°	35°	1064.4	34.9	49.7	141.6	40.0	**266.2**
	36°	1064.4	89.3	102.4	74.3	54.8	**320.8**
	37°	1064.4	54.1	83.4	87.7	0.0	**225.3**
	38°	1064.4	35.9	41.1	61.5	94.1	**232.6**
	39°	1064.4	70.2	29.3	48.2	227.2	**374.8**
	40°	1064.4	205.7	83.7	254.2	144.1	**687.7**
	41°	1064.4	39.7	42.0	62.7	40.0	**184.5**
	42°	1064.4	34.6	49.1	123.1	132.9	**339.8**
	43°	1064.4	0.0	0.0	5.6	69.3	**75.0**
54°	34°	1051.7	0.0	0.0	30.2	69.8	**100.0**
	35°	1051.7	39.2	47.4	126.6	39.0	**252.2**
	38°	1051.7	231.1	0.0	0.0	0.0	**231.1**
	39°	1051.7	76.2	42.2	147.9	157.9	**424.3**
54.5°	34°	1039.0	159.2	114.5	228.5	93.7	**595.9**
	35°	1039.0	4.9	5.4	18.9	0.0	**29.2**
55°	34°	1026.4	53.0	78.1	125.9	157.7	**414.8**
	35°	1026.4	14.6	6.2	7.1	0.0	**27.9**
	36°	1026.4	112.2	84.4	116.7	75.4	**388.9**
55.5°	34°	1013.0	3.7	50.1	124.6	222.8	**401.2**
	35°	1013.0	47.0	59.0	87.9	146.4	**340.3**
	36°	1013.0	0.0	2.3	14.5	22.2	**39.0**
Total		**29522.4**	**1522.5**	**1250.2**	**2884.2**	**3343.6**	**9000.3**

FORMATS FOR SUBMISSION OF DATA FROM THE CRAB FISHERY

FORMAT 1C

OBSERVER SUMMARY INFORMATION (CRAB FISHERY)

CRUISE NUMBER _____ CRAB FISHING DETAILS* SPACING OF POTS (m) _____

LENGTH OF LINE (m) _____ NUMBER OF POTS _____ SHAPE OF POTS _____

MESH SIZE OF POT COVER (mm)_____

Haul No. (HN)	Sample No. (SN)	Date	Coordinates	Surface Water t°C	State of Sea**	Target Species	Type of Bait	Bottom Depth (m)	Begin to Set Pots (GMT)	Finish Setting Pots (GMT)	Begin to Haul Pots (GMT)	Finish Hauling Pots (GMT)	Number of Empty Pots	Total Catch (kgs)	By-Catch (species/kg)

* If other than one type of pot string (different length of line, spacing and number of pots) had been used during the observed fishing cruise, separate forms should be used for each type

** State of the Sea Scale is given overleaf

FORMAT 6

SUBSAMPLE FOR MATURITY AND AGE DETERMINATION FOR CRABS

CRUISE NUMBER: _____ SPECIES: _____

HAUL NUMBER: _____ TOTAL NUMBER IN THE SUBSAMPLE _____

SAMPLE NUMBER: _____ TOTAL WEIGHT OF THE SUBSAMPLE _____

SUBSAMPLE NUMBER: _____

CARAPACE MEASUREMENT USED IN THE TABLE (Tick the appropriate box)*

CL	CW

Carapace Size (mm)	Males					Females									Number of parasites (see ***)
	Maturity**	Relative age (carapace condition)**				Maturity**					Relative age (carapace condition)**				
	Chela height (mm)	1 (soft)	2 (new hard)	3 (old)	4 (very old)	I (eggs uneyed)	II (eggs eyed)	III (eggs dead)	IV (empty egg cases)	V (non ovigerous)	1 (soft)	2 (new hard)	3 (old)	4 (very old)	

* For definitions of CL and CW see Appendix 2

** For definitions of maturity stages of female crabs and relative age see Appendices 7 and 10

*** Number of parasites of the genus Briarosaccus (Crustacea) and parasite scars found underneath the crab abdomen

SUMMARIES OF AVAILABLE INFORMATION AND ESTIMATES OF BIOLOGICAL PARAMETERS FOR *DISSOSTICHUS ELEGINOIDES*

Table G.1: Summary of available age/length keys for *D. eleginoides*.

Southern Chile:

Source: WG-FSA-92/30
Catches: 1991/92
Ages determined from: Scales
Lengths represent the minimum of 5 cm length classes

Sex	Age (yrs)		Length (cm)		Length (cm)	**n**
	Young	Old	Small	Large	Youngest/Oldest	
Males	5	19	45	170	45 / 140	1 305
Females	3	20	50	185	55 / 165	1 146

South Georgia:

Source: WG-FSA-92/30
Catches: February to March 1991
Ages determined from: Scales
Lengths represent the minimum of 5 cm length classes

Sex	Age (yrs)		Length (cm)		Length (cm)	**n**
	Young	Old	Small	Large	Youngest/Oldest	
Males	5	18	60	140	60 / 140	695
Females	5	21	55	180	55 / 180	537

Kerguelen Island Area:

Source: WG-FSA-92/8
Ages determined from: Scales
Lengths represent the minimum of 5 cm length classes

Location	Age (yrs)		Length (cm)		Length (cm)	**n**
	Young	Old	Small	Large	Youngest/Oldest	
West shelf (Oct-Nov 1984)	4	14	35	115	35 / 115	110
West shelf (Mar-Apr 1987)	2	14	20	115	20 / 115	184
North shelf (Jan 1992)	3	17	35	155	35 / 155	205

Table G.2: Summary of available length frequency data for *D. eleginoides* in Subarea 48.3.

Longline data:
- Sept/91 - Jun/92 - WG-FSA-92/23
- May-Jun - WG-FSA-92/14
- Jun-Jul - WG-FSA-92/15

Trawl data:
- Jan-Feb - WG-FSA-92/17

WG-FSA-92/17
Length frequency distribution from trawl survey

WG-FSA-92/13
Length frequency data for longlines in 1986

WG-FSA-92/14 and 15
(two longline vessels)

Data for South Georgia and Shag Rocks; May-July 1992
- Length frequency data
- Weight length data

Table G.3: Summary of available length-weight relationships for *D. eleginoides*. See Figure G.1 showing the differences between the relationships.

Weight = $a.L^b$, W (g), L(cm).

	a	***b***	Length Range (cm)	Source
South Georgia:				
Both sexes	0.00590	3.131	mostly <90	Kock *et al*. (1985)[1]
Both sexes	0.04570	2.653	??	Gasiukov *et al*. (1991)[2]
Male	0.07567	2.559	60-134	Aguayo and Cid (1991)[3]
Female	0.15997	2.407	20-164	Aguayo and Cid (1991)
Both sexes	0.07568	2.559	20-164	Aguayo and Cid (1991)
Male	0.00444	3.18	21-110	WG-FSA-92/17
Female	0.00334	3.25	26-94	WG-FSA-92/17
Southern Chile:				
Males	0.01104	2.970	??	WG-FSA-92/30
Females	0.00692	3.109		WG-FSA-92/30
Both sexes	0.00695	3.063		WG-FSA-92/30
Chilean Shelf:				
Both sexes	0.00382	3.221	51-127	Martinez (1975)*
Patagonian Shelf:				
Both sexes	0.00350	3.29	mostly <90	Zakharov and Frolkina (1976)[4]
Both sexes	0.0026	3.326	mostly <90	Messtorff and Kock (1978)[5]
Kerguelen, Crozet				
Both sexes	0.0015	3.58	8.9-95.7	Hureau and Ozouf-Costaz (1980)[6]
Kerguelen:				
Male	0.0033	3.260	20.3-129	Duhamel (1981)[7]
Female	0.0032	3.269	26.1-141	Duhamel (1981)

* Original estimates considered to be in mm by Kock *et al*. (1985). The estimate of ***a*** was transformed to make conversion from lengths in cm.

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1 KOCK, K.-H., G. DUHAMEL and J.C. HUREAU. 1985. Biology and status of exploited Antarctic fish stock: a review. *BIOMASS Scientific Series No. 6*: 143 pp. ISCU Press.

2 GASIUKOV, P.S., R.S. DOROVSKIKH and K.V. SHUST. 1991. Assessment of the *D. eleginoides* stock in Subarea 48.3 for the 1990/91 season and calculation of the TAC for the 1991/92 season. Document *WG-FSA-91/24*. CCAMLR, Hobart, Australia.

3 AGUAYO, M. and CID. 1991. Recopilación, proceso y análisis de los antecedentes biológico - pesqueros en la pesca exploratoria de bacalao de profundidad realizada por el BP *Rriosur V. Informe interno, Inst. Form. Pesq*. 63 pp.

4 ZAKHAROV, G.P. and ZH.A. FROLKINA. 1976. Some data on the distribution and biology of the Patagonian toothfish (*Dissostichus eleginoides* Smitt) occurring in the southwest Atlantic. *Trudy. Atlant. Nauchno-Issled. Ryb. Khoz. Oceanogr. 65*: 143-150.

5 MESSTORFF, J. and K.-H. KOCK. Deutsch-Argentinische Zusammenarbeit in der Fischereiforschung mit FFS *Walther Herwig* efrolgreich fortgesetzt. *Infn. Fischwirtsch. 25* (6): 175-180.

6 HUREAU, J.C. and C. OZOUF-COSTAZ. 1980. Age determination and growth in *Dissostichus eleginoides* Smitt 1898 from Kerguelen and Crozet Islands. *Cybium, 4*(1): 23-32.

7 DUHAMEL, G. 1981. Caractéristiques biologiques des principales espèces de poissons du plateau continental des Iles Kerguelen. *Cybium, 5*(1): 19-32.

Table G.4: Summary of available estimates for growth parameters. See Figure G.2 showing the differences between the growth curves.

Area	L_{∞}	K	t_0	Method	Source
Patagonian Shelf	204.3	0.0563	-0.545	??	Zakharov and Frolkina (1976)
South Georgia	174.8	0.0712	-0.005	??	Shust *et al*. (1990)[1]
	210.8	0.0644	0.783	Walford	Moreno (data from WG-FSA-92/30)
	170.8	0.0916	-0.031	Non-linear	Moreno (data from WG-FSA-92/30)
	164.8	0.097	0.430	Tomlinson & Toramson	Moreno (data from WG-FSA-92/30)
Southern Chile	216.1	0.062	-0.877	Walford	WG-FSA-92/30
Males	199.2	0.0714	-0.809	Walford	WG-FSA-92/30
Females	214.0	0.062	-1.265	Walford	WG-FSA-92/30

[1] SHUST, K.V., P.S. GASIUKOV, R.S. DOROVSKIKH and B.A. KENZHIN. 1990. The state of *D. eleginoides* stock and TAC for 1990/91 in Subarea 48.3 (South Georgia). WG-FSA-90/34.

Table G.5: Estimates of natural mortality for *D. eleginoides*.

Estimates of **M** pre 1992			
Area	**M**	Method	Source
Patagonian Shelf	0.06	Pauly (1980)	Kock *et al*. (1985)
	0.12	Rikhter and Efanov (1976)	Kock *et al*. (1985)
South Georgia	0.18	Alverson-Carnee	Shust *et al*. (1990)
	0.16	Rikhter-Efanov	Shust *et al*. (1990)

Estimates of **M** - Summary from WG-FSA-92/21

Natural mortality estimates based on length data for three fishing areas and three growth curves.

Area	Method	Growth Curve		
		1	2	3
Shag Rocks	B and H	0.09	0.12	0.15
	A-C	0.17	0.14	0.18
	Mean	0.13	0.13	0.17
South Georgia north	B and H	0.10	0.09	0.12
	A-C	0.15	0.13	0.16
	Mean	0.13	0.11	0.14
South Georgia south	B and H	0.08	0.07	0.09
	A-C	0.17	0.14	0.19
	Mean	0.13	0.11	0.14

Means: B and H = Beverton and Holt length based estimate
A-C = Alverson-Carnee estimate

Growth Curves:

1) $L_t = 204.3\ (1-e^{-0.0563[t+0.545]})$; Zakharov and Frolkina (1976)
2) $L_t = 174.8\ (1-e^{-0.0712[t+0.0049]})$; Shust *et al*. (1990)
3) $L_t = 210.8\ (1-e^{-0.0644[t+0.783]})$; Aguayo (1991)

Means: B and H = 0.10
A-C = 0.16
Grand Mean = 0.13

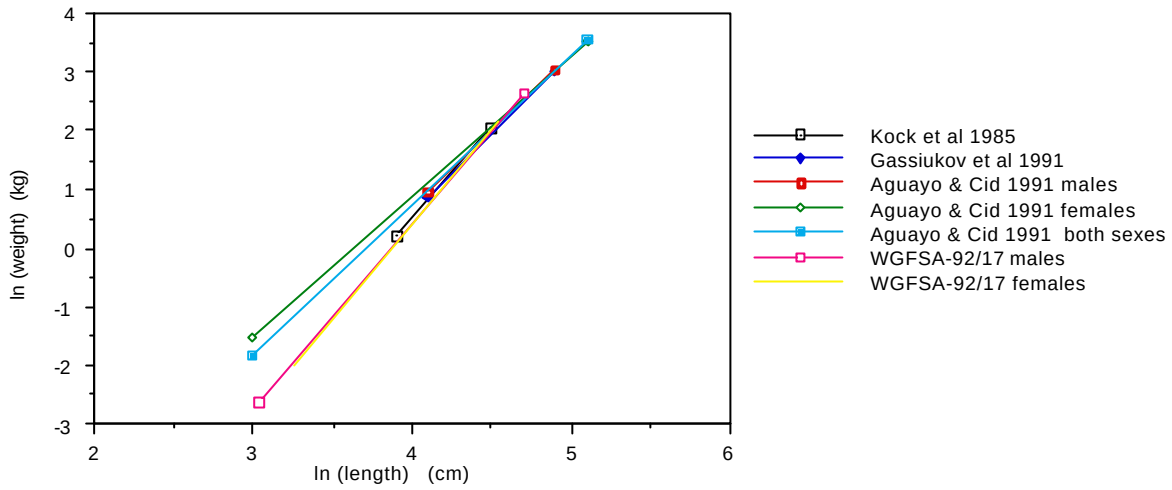

Figure G.1: *D. eleginoides*, Subarea 48.3. Length-weight relationship (parameters from Table 3).

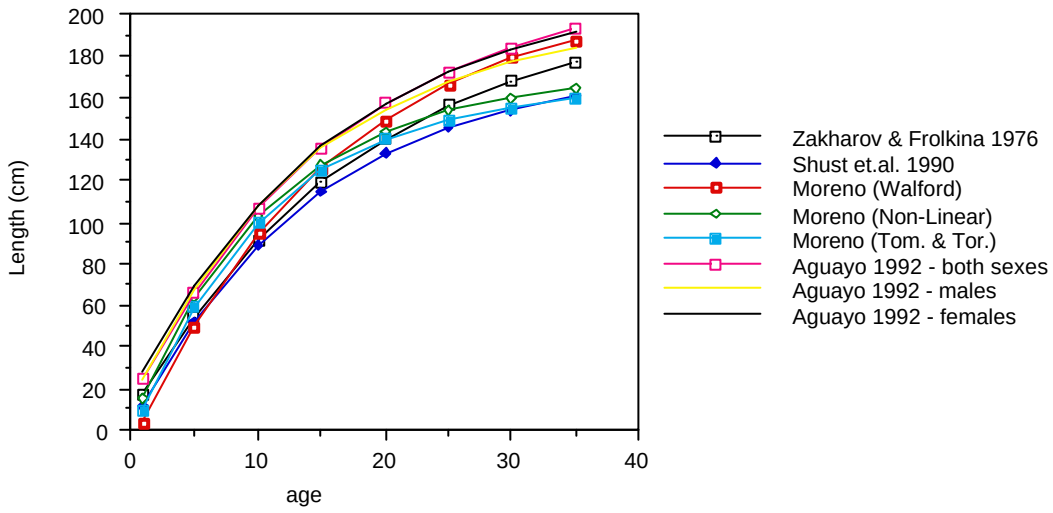

Figure G.2: *D. eleginoides*, Subarea 48.3 and Patagonian slope, growth in length (parameters from Table G.4)

APPENDIX H

CCAMLR WORKSHOP ON DESIGN OF BOTTOM TRAWL SURVEYS

(Hamburg, Germany, 16 to 19 September 1992)

CCAMLR WORKSHOP ON DESIGN OF BOTTOM TRAWL SURVEYS

(Hamburg, Germany, 16 to 19 September 1992)

OPENING OF THE MEETING

1.1 The workshop was held at the Bundesforschungsanstalt für Fischerei (Federal Research Centre for Fisheries), Hamburg, Germany, from 16 to 19 September 1992. The Convener Dr K.-H. Kock (Germany) chaired the workshop.

1.2 The participants of the workshop were welcomed by the Director of the Institut für Seefischerei (Sea Fisheries Research Institute), Dr. G. Hubold, on behalf of the Federal Research Centre for Fisheries.

ORGANISATION OF THE MEETING AND APPOINTMENT OF RAPPORTEURS

2. 1 The following were appointed rapporteurs:

Dr Kock (Agenda Items 1 to 4, appendices)
Dr I. Everson (UK) (Agenda Items 5 to 12).

A list of participants is given in Attachment A. A list of papers tabled and references is given in Attachment B.

ADOPTION OF THE AGENDA

3.1 A draft agenda had been prepared by the Convener. This agenda, with minor modifications and additions was adopted and is included as Attachment C.

BACKGROUND OF THE MEETING

4.1 Difficulties concerning bottom trawl survey design and the application of the 'swept area' method and associated t-statistics on species with a contagious distribution, such as the mackerel icefish (*Champsocephalus gunnari*), have been a considerable problem to the CCAMLR Working Group on Fish Stock Assessment (WG-FSA) in the past. The Working Group at its meetings in

1990 and 1991 drew attention to the need for investigation of this problem as a matter of priority (SC-CAMLR-IX, Annex 5, paragraph 91). Because of the specialised and detailed examination required, this work could not be done during a regular meeting of the Working Group. The Working Group therefore recommended that a workshop on survey design and analyses of research vessel surveys be held in the 1991/92 intersessional period (SC-CAMLR-X, paragraph 4.108). The terms of reference for this workshop are set out in SC-CAMLR-X, paragraph 4.109. They combine theoretical aspects, such as survey design for sampling different types of fish distribution, two-phase surveys and properties of estimators of biomass, with practical aspects, such as sources of errors in comparisons between surveys, into a synthesis on survey design and cost effective allocation of sampling resources.

4.2 The workshop was originally scheduled for May 1992 but was delayed until September when the report of an ICES workshop covering similar topics was to be distributed. The report of the ICES workshop was unfortunately not available in time for the meeting.

4.3 It was noted with great regret that despite the great interest of Members in the workshop expressed during SC-CAMLR-X, only four scientists from Member countries attended the workshop. No statistician was present at the workshop which limited the discussion on theoretical aspects to a large extent. Since no scientist familiar with bottom trawl surveys in the Indian Ocean sector was present at the workshop, deliberations were mainly based on experience from the Atlantic Ocean sector.

OBJECTIVES OF THE MEETING

5.1 It was agreed that the main aim of the meeting would be to begin the development of a manual describing the techniques to be used for bottom trawl surveys for fish stock assessment within the Convention Area.

5.2 Bottom trawl surveys could be undertaken for two major purposes. These were identified as:

(i) the estimation of Standing Stock; and
(ii) to provide information on Population Structure

5.3 Currently the main target species for bottom trawl surveys is *C. gunnari*. Other species of likely commercial interest, and for which bottom trawl suveys were appropriate, are: *Notothenia*

gibberifrons, *Notothenia rossii*, *Notothenia squamifrons*, *Chaenocephalus aceratus* and *Pseudochaenichthys georgianus*.

5.4 Other fish resources, such as *Dissostichus eleginoides* and the myctophid *Electrona carlsbergi*, which are of current interest to CCAMLR, were not considered in detail because they either occur deeper than the range of normal bottom trawls or are holopelagic.

FACTORS AFFECTING THE ACCURACY OF BOTTOM TRAWL SURVEYS

Trawl Geometry, Rigging and Performance

6.1 The ideal situation would be for all operators to use the same trawl design, rigged in a standard manner. In spite of this it is accepted that there will always be variations between operators.

6.2 The following characteristics of the gear should be included in the description of a trawl survey:

(i) full net plan; and
(ii) full description of ground tackle from trawl door to trawl door.

6.3 The geometry of trawl nets is known to vary due to a variety of causes. These include water depth, bottom type, warp length, wind and current direction relative to ship's heading (Carrothers, 1981; Engås, 1991). The high natural variation in fish distribution corresponds to a high intrinsic variance in the data which often masks variation due to these operational characteristics. Even so, the group recommended that these variables should be monitored whenever possible.

6.4 Electronic equipment is now available for monitoring many aspects of the trawl configuration during fishing, such as headline height, wing spread, door spread, effective fishing area, and water temperature and depth. Wherever possible it was recommended that these devices be used to monitor the behaviour of the net.

6.5 In the absence of electronic monitoring equipment other devices, such as a cable between the doors to control the door spread, might be helpful in standardising the operation of the gear (Engås, 1991).

6.6 The degree to which the target species are herded into the net by sweep wires and wings in the net is unknown. This affects the effective area of the net and hence the swept area, the parameter that is used for standing stock estimation. It was agreed that for standing stock estimation by the swept area method the width of the net should be defined as the estimated distance between the wings in a straight line when the net is in operation.

6.7 Current practice is to use a standard haul time of 30 minutes with the net on the bottom. Recent studies by Vølstad (1990) have indicated that shortening the haul time to 10 minutes or less allows more hauls to be made during the course of a survey without any loss of precision in standing stock estimates. Bearing in mind the distance between sampling sites and the problems of finding suitable trawling grounds it was felt that such gains would be unlikely to be made in Antarctic waters. It was also noted that a longer haul time would improve sampling for population structure studies. The group agreed that 30 minutes was probably the best standard haul time for surveys in Antarctic waters.

6.8 It is current practice to assume that the net is fishing correctly on the bottom from the time that the winch brakes are applied until hauling commences. This may not be the case, particularly for deep hauls. The group recommended that whenever possible the time on the bottom should be monitored precisely using a net sounder or similar device.

Fish Behaviour in Relation to Fishing Gear

6.9 The main clues that the fish have of the presence of a net are either visual, sight of the net or a 'sand cloud', or vibration, from strain in the rigging wires or noise from the fishing vessel.

6.10 Responses by fish to the presence of a net vary greatly even between closely related species. For example, in the North Sea, cod (*Gadus morhua*) swim down towards the seabed when a net approaches whereas haddock (*Gadus aeglefinus*) swim upwards (Main and Sangster, 1981, 1982; Ehrich, 1991). No information is available to indicate how Antarctic fish respond to the presence of trawls.

6.11 There is evidence that the pattern of reaction behaviour by fish to an approaching net is largely controlled by visual stimuli. Reaction ceases below a certain level of light and fish react to a trawl only when struck by the net (Glass and Wardle, 1989). This may lead to a different pattern of entrance to the net. It suggests that catchability may be dependent on the time of the day and fishing depth. The sensitivity of Antarctic fish to light is unknown but it must be assumed that, at least in

shallow water, the fish are likely to see the net or sweep wires before they reach them. No information is available to indicate the likely response of the fish to these visual cues.

6.12 Fast swimming fish, such as mackerel (*Scomber scombrus*) have been observed swimming for up to 15 minutes in the mouth of a trawl net (He and Wardle, 1988), behaviour that is likely to affect the catching efficiency of the net. Evidence from physiological studies on Antarctic fish indicates that they would be unlikely to sustain a high level of swimming activity for more than perhaps a minute (Johnston and co-authors, see Kock, 1992). This would indicate that fish that are located in front of the net will be unable to avoid it and are therefore likely to be caught.

6.13 The group was unable to discuss extensively all factors potentially or effectively influencing catchability (see Carrothers, 1981; Godø, 1990; Engås, 1991 for a review). Due to the absence of information, most estimates of standing stock biomass using the swept area method have assumed a catchability (**q**) of 100 %, i.e. q = 1. This is unlikely to be met in reality, but the assumption that q < 1 is somewhat balanced by the herding effect of the doors and bridles increasing the area effectively swept by the net. As fish behaviour is an important factor affecting catchability the group strongly recommends that studies be undertaken to investigate the responses of Antarctic fish to the presence of the gear using techniques, such as remotely controlled underwater cameras, acoustic equipment and split-panel nets.

Fish Distribution in the Area

6.14 The distribution of fish within the survey area was discussed from two perspectives, small-scale distribution with respect to the volume of water sampled by the net and larger scale distribution over the whole area surveyed.

Small-Scale Distribution

6.15 *C. gunnari* are known to occur close to the bottom during daytime and an unknown proportion migrate upwards at night to feed in the water column. They are rarely more than 15 m from the bottom by day with the bulk of the fish less than 5 to 7 m from the bottom (Duhamel, 1987; Frolkina and Shlibanov, 1991). There is some evidence for the larger, and therefore older, fish being present closest to the seabed during the day. Therefore, the group recommended that net sampling during trawl surveys targetted at *C. gunnari* should be undertaken during daylight.

6.16 *C. aceratus* and *N. gibberifrons* primarily feed on the bottom and are thought to occur predominantly within about 1 m of the seabed.

6.17 *N. rossii, N. squamifrons, P. georgianus* and *Chionodraco hamatus* are known to feed on fish, krill and salps and probably feed well above of the seabed. The extent and frequency of these feeding migrations is unknown, but it is assumed that they occur during darkness.

Large-Scale Distribution

6.18 The main aspects of large-scale distribution that were considered of relevance to survey design were the geographical limits of individual stocks and the degree of aggregation of the fish. Previous surveys have provided some information on these aspects. In addition, much useful data could be derived from an analysis of haul-by-haul data from the commercial fishery. These data are currently unavailable to CCAMLR. The group recommends that these data be made available so that they can be used in planning future surveys.

6.19 At South Georgia during the summer, *C. gunnari* are likely to be found over most of the shelf in water less than 300 m deep. When the standing stock is low, as for example during the 1990/91 season, the fish are thought not to form larger concentrations. When the standing stock is high, dense aggregations do form which often extend some way above the seabed even in daytime.

6.20 It is unknown how long these aggregations persist but, because they have formed the focus of large-scale commercial fishing, it is assumed that they are present for several days or perhaps weeks.

6.21 Information from bottom trawl surveys indicates that these aggregations are likely to be found in small localities almost anywhere on the shelf. So far, it is impossible to identify where these aggregations might be in a particular season.

6.22 The presence of these aggregations is thought to be associated with the distribution of krill (*Euphausia superba*), a major food of *C. gunnari*. The distribution of krill is known to be dependent on the water circulation pattern in the South Georgia area in particular and the Scotia Sea in general.

6.23 Unequivocal information on the location of concentrations was not available to the meeting but it was felt that analysis of haul-by-haul data from the krill and *C. gunnari* fisheries might provide some further insight into the subject.

6.24 Spawning concentrations of *C. gunnari* have been observed inside bays on the northeast side of South Georgia during March, April and May. No information is available to indicate what proportion of the spawning stock enters these bays to spawn or whether these fish represent a constant proportion of the total spawning stock.

6.25 At Kerguelen during September, *C. gunnari* spawn inshore in water depths of 100 to 150 m. After spawning the fish move along the shelf on a feeding migration. It is not clear whether the extent of this feeding migration is dependent on the abundance of the fish.

6.26 No information was available to the meeting on the distribution of spawning concentrations of *C. gunnari* in Subareas 48.1 and 48.2.

6.27 The group agreed that surveys for standing stock estimation should not be undertaken during the spawning season due to the uneven distribution of fish at this time.

6.28 The distribution of *N. gibberifrons*, *C. aceratus* and *P. georgianus* appears to be more uniform than that of *C. gunnari* over the shelf at South Georgia. Local concentrations may nonetheless occur.

6.29 The distribution of *N. rossii* is extremely patchy and appears to be concentrated in canyons, for example at the eastern end of South Georgia and also north of Cumberland Bay. The group felt that surveys targetting on this species should be concentrated in these specific areas and also make use of any haul-by-haul information from historical catches in determining sampling localities.

6.30 *N. squamifrons* has occasionally occurred in large concentrations in single hauls of surveys at South Georgia but these concentrations are unlikely to be representative since an unknown part of the population is found deeper than 500 m.

6.31 At Kerguelen the major concentrations of each species of commercial importance appear to be located in different areas of the shelf and shelf break (Duhamel, 1987). The group thought that surveys could be designed so that the effort could be concentrated in the area of greatest abundance of the primary target species.

DESIGN OF BOTTOM TRAWL SURVEYS

7.1 Using the information described in the preceeding paragraphs and from the tabled papers several options for bottom trawl surveys were considered.

Non-Random (Systematic) Surveys

7.2 Surveys based on a grid of regularly spaced sampling stations were considered to be useful when there was no *a priori* information available about the distribution of the resource. The approach has the distinct disadvantage that, due to the uneven nature of the seabed on many Antarctic fishing grounds, few stations on a regular grid would be suitable for fishing. No standing stock surveys have been reported to CCAMLR that have used regular pattern sampling grid. This approach was not recommended by the group.

Random Surveys

7.3 The normal practice in recent years has been to undertake surveys using series of randomly located sampling stations. Due to the widespread presence of bad trawling grounds the sampling stations have been determined as 'the nearest available trawlable location to the given position'. In some instances this may be several miles from the pre-selected position. Subsequent surveys have sampled at the same sites rather than in other randomly selected localities.

7.4 The optimum time to undertake such surveys is when the fish are as dispersed as possible; at South Georgia this is most likely to occur during the summer months when all the target fish species are actively feeding. Although spawning, and hence aggregation, of *C. gunnari* at Kerguelen occurs later than at South Georgia, the fish are likely to be most widely dispersed on the shelf during the same months.

Stratification

7.5 Stratification of the survey has distinct advantages because it allows the concentration of sampling effort into regions of highest abundance. At South Georgia the surveys have been divided into three strata based on water depth. These are: 50 to 150, 150 to 250 and 250 to 500 m. The number of stations allocated to each of these strata is based on the area of seabed within each depth stratum weighted by abundance observed on previous surveys within that depth stratum (Parkes *et al*., 1990). An alternative approach is to incorporate the variance of the standing stock estimate into the weighting factor (Sparre *et al*., 1989).

7.6 Surveys for *C. gunnari* at South Georgia have indicated that the highest concentrations are present in the depth range 150 to 250 m whereas at Shag Rocks the density is approximately the same in this and the 50 to 150 m depth stratum.

7.7 At Kerguelen *C. gunnari* tends to be concentrated in the depth range 100 to 200 m.

7.8 The group agreed that it would be advantageous to stratify the survey further by identifying areas where the abundance was likely to be high. Even though it is known that concentrations are likely to be encountered no information was available to provide a reasonable indication of where they might be. This form of stratification was considered important in survey design and it was agreed that some mechanism needed to be incorporated into the design to allow increased sampling of high density patches that might be located during the survey.

Approaches to Survey Design that Take Account of Local High Concentrations

7.9 Three options were considered, all of which are based on a series of randomly located sampling stations which would be augmented by additional sampling at areas of high concentration.

Two-Stage Survey - First Approach

7.10 The time available for the survey would be apportioned to two phases, the standard random sampling stations and intensive sampling on concentrations. The division between these two phases would be made based on the number and size of concentrations that are expected to be encountered. Stations would be sampled sequentially and the location of any concentration of fish that is detected would be noted. At the end of this first phase the remaining sampling period would be divided up to allow sampling on the concentrations. The sampling on the concentrations would include hauls to estimate density and small-scale surveys to map the concentrations. This 'encounter-response' approach is described in Leaman (1981).

7.11 This approach has the advantage that the effort allocated to the high density stratum can be apportioned to the concentrations in advance of that phase of the sampling program. A disadvantage of this approach is that the time allocation may not be sufficient to sample all the concentrations adequately. Therefore up two weeks may have elapsed between the concentration being first detected and the vessel returning to sample on it; there is a significant chance that after this amount of time the concentration might not be found again.

Two-Stage Survey - Second Approach

7.12 This approach is similar to the First Approach described in paragraph 7.10 except that the intensive sampling on the concentrations is undertaken when the concentrations are detected.

7.13 This approach has the advantage that the concentration can be relocated for sampling. It has the disadvantage that in the event that several concentrations are detected early in the survey this might constrain sampling activity later in the program.

7.14 Both of these approaches have the disadvantage that it is unlikely that all concentrations within the survey area will be detected and sampled. A scaling factor, determined by consideration of the sizes of concentrations detected in relation to the survey track, will need to be incorporated to take account of the underestimation of the standing stock in this stratum.

An Adaptive Approach

7.15 Using a simple model, Everson *et al*. (1992) had considered options for incorporating information on the presence of patches obtained during a survey into the design.

7.16 All of the randomly located sampling sites would be given a randomly selected ranking in addition to their 'sampling order'. Stations would be sampled in 'sampling order' and the total distance sailed between the stations measured. When a concentration is located it would be sampled and its chord length measured. As each patch is sampled the lowest ranked station is deleted from the list of remaining stations. Thus, as concentrations are detected sampling effort is increased in these high density locations at the expense of the predetermined sampling sites.

7.17 The ratio of the total intersected chord length of all concentrations detected to the total distance steamed during the survey provides an estimate of the proportion of the survey area that is occupied by concentrations. This factor, multiplied by the mean 'within concentration' density provides an estimate of the standing stock in the high density stratum.

7.18 As a practical aspect it was suggested that when the vessel is in transit, as for example from station 'A' to station 'B', if a concentration is detected the vessel should complete the track to station 'B' before breaking off and fishing at the concentration. This would ensure that the chord length of the concentration is properly determined. The net haul could be made at the mid-point of the concentration.

7.19 This approach has the advantage that all the time allocated to the survey can be used effectively irrespective of how many concentrations are present in the area. It has the disadvantage that it provides little information on the size or density of individual concentrations; such information could be provided by further sampling following completion of the survey.

Consideration of the Different Approaches

7.20 The group favoured the adaptive approach as it offered the most effective utilisation of sampling effort. Formulae for parameter estimation and combining data over strata are given in Attachment D.

7.21 The similarity of the approaches depends on their ability to take into account the limits of fish concentrations. Experience has shown that although fish concentrations often appear as more or less continuous layers close to the seabed (see Duhamel, 1987: Figure 98; Kock, 1992: Figure 63), in which case determination of the limits of the concentrations present little difficulty, they are frequently present only as separate but close aggregations (see Frolkina and Shlibanov, 1991: Figure 4).

7.22 The group recommended that further work be undertaken so as to better define the characteristics of echotraces of *C. gunnari* aggregations.

7.23 The group discussed the approaches to sampling within high concentration regions. The 'rules' of the two-stage and the adaptive approaches indicate that the net hauls within the concentrations should be randomly located because the aim is to provide estimates of density within this high density stratum. Where the distribution is discontinuous within the concentration the hauls should not be targetted at local high concentrations. It was agreed that this situation could only be resolved by examination of echocharts from actual hauls within concentrations. The group also agreed that statistical advice should be sought on sampling strategies when the target species is discontinuously distributed within a small area.

7.24 The group also considered the possibilities of repeat sampling within concentrations. Repeat sampling has the advantage that the sample size is increased. It also has the disadvantages that samples subsequent to the first are unlikely to be statistically independent and also there may be behavioural responses (dispersion or aggregation) resulting from the initial haul.

8.1 For many applications the Normal distribution is assumed to fit the distributions of the data. When the target species is widespread and not present in aggregations this is probably appropriate (Saville, 1977). The approach has the advantage that there is a wide range of statistical tests that can be applied to the data.

8.2 Bottom trawl survey data do contain many datasets where the distribution is markedly skewed and for which Normal statistics are not appropriate. Under these circumstances transformations are applied to the data. Of those that are commonly used are Poisson, negative binomial, log(x+1), gamma, delta and beta distributions (e.g., Steinarsson and Stefansson, 1986; Pennington, 1986; Conan, 1987; Gröger and Ehrich, 1992).

8.3 The group noted some situations when different transformations might be appropriate for different components of a survey. For example, on a survey at South Georgia the more or less uniform distribution of *N. gibberifrons* might be analysed using Normal statistics on untransformed data whereas data on *C. gunnari*, which are generally highly skewed might warrant an alternative treatment. It was also noted that for one species data from different strata might warrant different treatments.

8.4 The group was unclear on some applications of these techniques. Specifically these were:

- Conversion of transformed to untransformed data for the purposes of providing values of mean and variance that could be included in management advice.

- Combination of means and variances from stratified surveys where different functions had been applied to different strata.

8.5 In the absence of specialist statistical advice the group was unable to comment further.

8.6 The group was aware of developments in the use of geostatistics for analysing survey data (e.g., Conan, 1987; Petitgas, 1990), but nobody in the group had specialist knowledge of the technique.

MANUAL FOR BOTTOM TRAWL SURVEYS IN THE CONVENTION AREA

9.1 Based on information included in the reports of WG-FSA and also presented at this meeting, the group prepared a draft manual to describe standard procedures to be used in undertaking bottom trawl surveys. A copy of the draft manual is included as Attachment E for further consideration by the Working Group on Fish Stock Assessment.

ADOPTION OF THE REPORT

10.1 The Report of the Workshop on the Design of Bottom Trawl Surveys was adopted.

CLOSE OF THE MEETING

11.1 In closing the meeting, the Convener thanked the participants for their input and the good humour throughout the three days. Dr Everson, on behalf of the participants of the workshop, expressed his thanks to the Convener and his staff for their hospitality in hosting the meeting.

Table 1.A: Areas of seabed within selected depth ranges in Subarea 48.1 west (from Everson, 1987).

Sub-division	Coordinates				Percentage of Sea Area in Depth Range (m)					Area (km^2)	
	N	S	E	W	0-50	50-150	150-250	250-500	>500	Sea	Total
21	62°00’	62°20’	60°30’	61°10’	-	2.2	8.7	44.6	44.6	1284	1284
22	62°20’	62°40’	60°30’	61°10’	-	85.7	7.7	6.6	0	964	1266
23	62°40’	63°05’	60°30’	61°10’	-	24.7	27.4	44	3.9	1476	1565
24	62°40’	63°05’	60°00’	60°30’	-	7.3	5.5	9.6	77.6	1036	1174
25	62°20’	62°40’	60°00’	60°30’	-	95.2	2.1	2.8	0	564	947
26	62°00’	62°20’	60°00’	60°30’	-	54.1	17.8	19	9.1	961	961
27	60°00’	64°00’	64°00’	70°00’	0	0	0	3.4	96.6	371299	371299
28	60°00’	61°00’	60°00’	64°00’	0	0	0	0	100	24340	24340
29	64°00’	66°00’	68°00’	70°00’	-	0.4	-	49.2	50.4	20886	20886
30	66°00’	67°00’	68°00’	70°00’	-	3.9	3.1	67.9	25.1	9226	9850
31	67°00’	68°00’	68°00’	70°00’	-	51.8	12.7	25	10.5	6607	9456
32	68°00’	69°00’	68°00’	70°00’	-	19.2	6	61.4	13.5	9049	9054
33	66°00’	67°00’	66°00’	68°00’	-	22.1	23.4	49.7	4.8	8110	9850
34	67°00’	68°00’	66°00’	68°00’	-	36.6	17.2	37.6	8.6	2261	9456
35	68°00’	69°00’	66°00’	68°00’	-	53.4	23	23.6	0	3555	9054
36	61°00’	62°00’	61°10’	64°00’	0	0	0	0	100	16703	16703
37	62°00’	63°00’	61°10’	64°00’	-	15.9	5	6.8	72.3	15952	16159
38	63°00’	64°00’	61°10’	64°00’	-	19.2	12.9	36.2	31.7	14894	15617
39	61°00’	62°00’	60°00’	61°10’	-	0	0	3.2	96.8	6877	6877
40	63°05’	64°00’	60°00’	61°10’	-	22.3	5.2	9.2	63.3	5586	5874
41	65°00’	66°00’	66°00’	68°00’	-	13.9	23	50.9	12.2	10085	10245
42	64°00’	65°00’	66°00’	68°00’	0	0	2.4	67.1	30.5	10637	10637
43	64°00’	65°00’	64°00’	66°00’	-	15.3	7.2	43	34.5	10407	10637
44	65°00’	66°00’	64°00’	66°00’	-	42.2	42.2	11.2	4.4	8685	10245
45	66°00’	67°00’	64°00’	66°00’	-	5.6	5.6	1	0	1196	9850
46	64°00’	65°00’	62°00’	64°00’	-	35.9	35.9	16	12.1	6744	10637
47	64°00’	65°00’	61°00’	62°00’	-	33.7	33.7	18.4	14.2	2686	5319
	Total for Subarea 48.1 west				-	10.4	6.1	18.6	64.9	572070	609242

Table 1.B: Areas of seabed within selected depth ranges in Subarea 48.1 west (from Everson, 1987).

Sub-division	Coordinates				Percentage of Sea Area in Depth Range (m)							Total Sea Area (km^2)
	N	S	E	W	0-150	0-250	0-500	>50	>150	>250	>500	
21	62°00’	62°20’	60°30’	61°10’	2.2	10.8	55.4	100	97.8	89.2	44.6	1284
22	62°20’	62°40’	60°30’	61°10’	85.7	93.4	100	100	14.3	6.6	0	964
23	62°40’	63°05’	60°30’	61°10’	24.7	52.1	96.1	100	75.3	47.9	3.9	1476
24	62°40’	63°05’	60°00’	60°30’	7.3	12.9	22.4	100	92.4	87.1	77.6	1036
25	62°20’	62°40’	60°00’	60°30’	95.2	97.2	100	100	4.8	2.8	0	564
26	62°00’	62°20’	60°00’	60°30’	54.1	71.9	90.9	100	45.9	28.1	9.1	961
27	60°00’	64°00’	64°00’	70°00’	0	0	3.4	100	100	100	96.6	371299
28	60°00’	61°00’	60°00’	64°00’	0	0	0	100	100	100	100	24340
29	64°00’	66°00’	68°00’	70°00’	0.4	0.4	49.6	100	96.6	96.6	50.4	20886
30	66°00’	67°00’	80°00’	70°00’	3.9	7	74.9	100	96.1	93	25.1	9226
31	67°00’	68°00’	68°00’	70°00’	51.8	64.5	89.5	100	48.2	35.5	10.5	6607
32	68°00’	69°00’	68°00’	70°00’	19.2	25.2	86.5	100	80.8	74.8	13.5	9049
33	66°00’	67°00’	66°00’	68°00’	22.1	45.5	45.2	100	77.9	54.5	4.8	8110
34	67°00’	68°00’	66°00’	68°00’	36.6	53.8	91.4	100	63.4	46.2	8.6	2261
35	68°00’	69°00’	66°00’	68°00’	53.4	76.4	100	100	46.6	23.6	0	3555
36	61°00’	62°00’	61°10’	64°00’	0	0	0	100	100	100	100	16703
37	62°00’	63°00’	61°10’	64°00’	15.9	20.9	27.7	100	84.1	79.1	72.3	16159
38	63°00’	64°00’	61°10’	64°00’	19.2	32.1	68.3	100	80.8	67.9	31.7	15617
39	61°00’	62°00’	60°00’	61°10’	0	0	3.2	100	100	100	96.8	5877
40	63°05’	64°00’	60°00’	61°10’	22.3	27.5	36.7	100	77.7	72.5	63.3	5586
41	65°00’	66°00’	66°00’	68°00’	13.9	37	87.8	100	86.1	63	12.2	10085
42	64°00’	65°00’	66°00’	68°00’	0	2.4	69.5	100	100	97.6	30.5	10637
43	64°00’	65°00’	64°00’	68°00’	15.3	22.5	65.5	100	84.7	77.5	34.5	10407
44	65°00’	66°00’	64°00’	66°00’	42.2	84.4	95.6	100	57.8	15.6	4.4	8685
45	66°00’	67°00’	64°00’	66°00’	5.6	11.2	12.1	100	94.4	88.8	87.9	1196
46	64°00’	65°00’	62°00’	64°00’	35.9	71.9	87.9	100	64.1	28.1	12.1	6744
47	64°00’	65°00’	61°00’	62°00’	33.7	67.4	85.8	100	66.3	32.6	14.2	5319
	Total for Subarea 48.1 west				10.0	15.4	33.8	100	90	84.1	66.2	575633

Table 1.C: Areas of seabed within selected depth ranges in Subarea 48.1 east (from Everson, 1987).

Sub-division	Coordinates				Percentage of Sea Area in Depth Range (m)					Area (km^2)	
	N	S	E	W	0-50	50-150	150-250	250-500	>500	Sea	Total
1	62°00’	62°20’	59°30’	60°00’	-	2.2	8.7	44.6	44.6	956	957
2	62°00’	62°20’	58°30’	59°30’	-	91.6	2.9	3.7	1.8	1359	1934
3	62°00’	62°20’	57°30’	58°30’	-	27.6	6.4	12	54	1500	1934
4	62°20’	62°40’	57°30’	58°30’	-	0	0	0	100	1898	1898
5	62°20’	62°40’	58°30’	59°30’	-	9.5	2.7	3.2	84.5	1809	1898
6	62°20’	62°40’	59°30’	60°00’	-	63.3	8.7	9.7	18.4	772	949
7	62°40’	63°05’	59°00’	60°00’	-	0.3	0.3	2.6	96.7	2350	2352
8	62°40’	63°05’	58°00’	59°00’	-	4.6	3.4	22.7	69.3	2352	2352
9	62°40’	63°05’	57°30’	58°00’	-	95.3	2	2.7	0	1176	1176
10	60°00’	61°00’	50°00’	60°00’	-	0.6	1.2	2.6	95.6	60850	60850
11	61°00’	63°00’	50°00’	53°00’	0	0	0	0	100	34819	34819
12*	58°00’	60°00’	50°00’	58°00’	0	0	0	0	100	101837	101837
13	61°00’	62°00’	57°30’	60°00’	-	6.6	4.3	20.4	68.8	14417	14740
14	61°00’	62°00’	56°00’	57°30’	-	1.5	2.4	28.4	67.4	8843	8843
15	61°00’	62°00’	53°00’	56°00’	-	11.6	2.8	12.1	73.5	17110	17686
16	62°00’	63°00’	56°00’	57°30’	-	14.4	11.1	12.9	61.6	8539	8555
17	62°00’	63°00’	53°00’	56°00’	-	2	18	41.8	38.2	17109	17109
18	63°05’	64°00’	57°30’	60°00’	-	31.7	5.8	16.5	45.9	5136	12587
19	63°00’	64°00’	56°00’	57°30’	-	15.4	3.6	7.2	73.8	6279	8268
20	63°00’	64°00’	50°00’	56°00’	-	4.5	1.8	86.1	7.5	30827	33082
	Total for Subarea 48.1 east				-	5.6	3.2	11.6	79.6	218101	226989

* Subdivision 12 is outside Subarea 48.1

Table 1.D: Areas of seabed within selected depth ranges in Subarea 48.1 east (from Everson, 1987).

Sub-division	Coordinates				Percentage of Sea Area in Depth Range (m)							Total Sea Area (km^2)
	N	S	E	W	0-150	0-250	0-500	>50	>150	>250	>500	
1	62°00’	62°20’	59°30’	60°00’	2.2	10.8	55.4	100	97.8	89.2	44.6	956
2	62°00’	62°20’	58°30’	59°30’	91.6	94.5	98.2	100	8.4	5.5	1.8	1359
3	62°00’	62°20’	57°30’	58°30’	27.6	34	46	100	72.4	66	54	1500
4	62°20’	62°40’	57°30’	58°30’	0	0	0	100	100	100	100	1898
5	62°20’	62°40’	58°30’	59°30’	9.5	12.2	15.5	100	90.5	87.8	84.5	1809
6	62°20’	62°40’	59°30’	60°00’	63.3	71.9	81.6	100	36.7	28.1	18.4	772
7	62°40’	63°05’	59°00’	60°00’	0.3	0.7	3.3	100	99.7	99.3	96.7	2350
8	62°40’	63°05’	58°00’	59°00’	4.6	8	30.7	100	95.4	92	69.3	2352
9	62°40’	63°05’	57°30’	58°00’	95.3	97.3	100	100	4.7	2.7	0	1176
10	60°00’	61°00’	50°00’	60°00’	0.6	1.8	4.4	100	99.4	98.2	95.6	60850
11	61°00’	64°00’	50°00’	53°00’	0	0	0	100	100	100	100	34819
12*	58°00’	60°00’	50°00’	58°00’	0	0	0	100	100	100	100	101837
13	61°00’	62°00’	57°30’	60°00’	6.6	10.8	31.2	100	93.4	89.2	68.8	14417
14	61°00’	62°00’	56°00’	57°30’	1.5	3.8	32.2	100	98.5	96.2	67.8	8843
15	61°00’	62°00’	53°00’	56°00’	11.6	14.4	26.5	100	88.4	85.6	73.5	17110
16	62°00’	63°00’	56°00’	57°30’	14.4	25.5	38.4	100	85.6	74.5	61.6	8539
17	62°00’	63°00’	53°00’	56°00’	2	20	61.8	100	98	80	78.2	17109
18	63°05’	64°00’	57°30’	60°00’	31.7	37.6	54.1	100	68.3	62.4	45.9	12587
19	63°00’	64°00’	56°00’	57°30’	15.4	19	26.2	100	84.6	81	73.8	6279
20	63°00’	64°00’	50°00’	56°00’	4.6	6.4	92.5	100	95.4	93.6	7.5	30827
	Total for Subarea 48.1 east				5.6	8.8	20.4	100	94.6	91.5	80.3	218101

* Subdivision 12 is outside Subarea 48.1

Table 1.E: Areas of seabed within selected depth ranges around Elephant Island (Subarea 48.1) (from Kock, 1986).

Depth (m)	Area of Seabed (nm^2)
0 - 100	458.8
101 - 200	461.5
201 - 300	500.0
301 - 400	736.5
401 - 500	1012.1

Table 1.F: Areas of seabed within selected depth ranges in Subarea 48.2 (from Everson, 1987).

Sub-division	Coordinates				Percentage of Sea Area in Depth Range (m)					Area (km^2)	
	N	S	E	W	0-50	50-150	150-250	250-500	>500	Sea	Total
73	60°21’	60°40’	44°10’	45°00’	-	10.8	7.8	15.9	65.5	1601	1603
74	60°40’	61°00’	44°10’	45°00’	-	27.6	61.4	11	0	1930	2008
75	60°40’	61°00’	45°00’	46°00’	-	19	29	52	0	1927	2008
76	60°40’	61°00’	46°00’	47°00’	-	11.2	70.8	18	0	2008	2008
77	60°00’	64°00’	30°00’	50°00’	0	0	0	4.5	95.5	452647	452647*
78	57°00’	60°00’	30°00’	50°00’	0	0	0	0	100	387430	387430
79	60°21’	60°40’	46°00’	47°00’	-	65	10.7	5	19.3	1919	1926
80	60°21’	60°40’	45°00’	46°00’	-	29.2	16	18.1	36.6	1535	1926
	Total for subarea				0	0.4	0.5	2	97.1	850997	851556

* Excludes areas 73 to 76, 79 and 80.

Table 1.G: Areas of seabed within selected depth ranges in Subarea 48.2 (from Everson, 1987).

Sub-division	Coordinates				Percentage of Sea Area in Depth Range (m)							Total Sea Area (km^2)
	N	S	E	W	0-150	0-250	0-500	>50	>150	>250	>500	
73	60°21’	60°40’	44°10’	45°00’	10.8	18.6	34.5	100	89.2	81.4	65.5	1601
74	60°40’	61°00’	44°10’	45°00’	27.6	89	100	100	72.4	11	0	1930
75	60°40’	61°00’	45°00’	46°00’	19	48	100	100	81	52	0	1927
76	60°40’	61°00’	46°00’	47°00’	11.2	82	100	100	88.8	18	0	2008
77	60°00’	64°00’	30°00’	50°00’	0	0	4.5	100	100	100	95.5	452647*
78	57°00’	60°00’	30°00’	50°00’	0	0	0	100	100	100	100	387430
79	60°21’	60°40’	46°00’	47°00’	65	75.7	80.7	100	35	24.3	19.3	1919
80	60°21’	60°40’	45°00’	46°00’	29.2	45.2	63.4	100	70.8	54.8	36.6	1535
	Total for Subarea 48.2.3				0.4	0.8	2.9	100	99.6	99.2	97.1	850997

* Excludes areas 73 to 76, 79 and 80.

Table 1.H: Areas of seabed within selected depth ranges in Subarea 48.3 between 53° and 54°30'S (from Everson and Campbell, 1990).

Areas of seabed (km^2) around South Georgia between 53° and 54°30'S.

NE Corner			0-50	50-100	100-150	150-200	200-250	250-500	>500
S Deg	S Min	W							
53	0	43	0.0	0.0	0.0	0.0	0.0	12.0	3673.9
53	0	42	0.0	0.0	0.0	129.8	158.3	445.2	2952.6
53	0	41	0.0	0.0	88.9	116.9	41.4	26.8	3411.9
53	0	40	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	0	39	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	0	38	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	0	37	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	0	36	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	0	35	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	0	34	0.0	0.0	0.0	0.0	0.0	0.0	3685.9
53	30	43	0.0	0.0	0.0	0.0	0.0	0.0	3642.8
53	30	42	0.0	0.0	93.3	174.9	115.0	178.6	3081.0
53	30	41	0.0	0.0	1209.8	500.2	495.1	410.5	1027.2
53	30	40	0.0	3.8	77.7	101.3	37.6	536.9	2885.5
53	30	39	0.0	0.0	0.0	39.5	138.1	689.2	2776.0
53	30	38	51.2	105.8	363.9	819.4	340.7	640.9	1320.9
53	30	37	107.6	232.7	1025.4	585.5	246.5	732.9	690.8
53	30	36	0.0	0.0	131.0	808.2	728.6	723.1	1251.9
53	30	35	0.0	0.0	6.0	57.7	81.6	270.5	3227.0
53	30	34	0.0	0.0	0.0	0.0	0.0	0.0	3642.8
54	0	43	0.0	0.0	0.0	0.0	0.0	0.0	3599.2
54	0	42	0.0	0.0	0.0	0.0	0.0	0.0	3599.2
54	0	41	0.0	0.0	0.0	0.0	0.0	0.0	3599.2
54	0	40	0.0	0.0	0.0	0.0	0.0	0.0	3599.2
54	0	39	0.0	0.0	15.8	260.6	457.5	482.7	2382.6
54	0	38	54.0	106.7	113.1	782.7	2466.2	66.5	0.0
54	0	37	124.4	46.6	41.6	14.3	5.5	4.6	0.0
54	0	37(S)	447.6	313.6	703.4	605.3	510.9	251.3	0.0
54	0	36	138.4	313.4	447.4	309.2	414.7	176.6	0.0
54	0	36(S)	175.0	76.7	26.2	24.9	23.8	0.0	0.0
54	0	35	0.0	38.8	100.5	451.4	1261.8	528.7	1218.0
54	0	34	0.0	0.0	0.0	0.0	0.0	0.0	3599.2

Table 1.I: Areas of seabed within selected depth ranges in Subarea 48.3 between 54°30 and 56°S (from Everson and Campbell, 1990).

Areas of seabed (km^2) around South Georgia between 54°30' and 56°S.

NE Corner			0-50	50-100	100-150	150-200	200-250	250-500	>500
S Deg	S Min	W							
54	30	43	0.0	0.0	0.0	0.0	0.0	0.0	3555.5
54	30	42	0.0	0.0	0.0	0.0	0.0	0.0	3555.5
54	30	41	0.0	0.0	0.0	0.0	0.0	0.0	3555.5
54	30	40	0.0	0.0	0.0	0.0	0.0	0.0	3555.5
54	30	39	0.0	0.0	0.0	14.1	113.1	106.0	3322.3
54	30	38	0.0	0.0	0.0	542.9	715.0	273.8	2023.8
54	30	37	0.0	0.0	422.0	649.6	1034.7	455.5	993.7
54	30	36	17.9	2.6	10.3	0.0	0.0	0.0	0.0
54	30	36(S)	234.8	263.5	565.0	492.2	597.5	903.7	0.0
54	30	35	180.8	371.8	922.0	792.9	443.1	554.0	84.9
54	30	34	0.0	8.9	142.4	145.0	199.4	317.7	2742.1
55	0	43	0.0	0.0	0.0	0.0	0.0	0.0	3511.5
55	0	42	0.0	0.0	0.0	0.0	0.0	0.0	3511.5
55	0	41	0.0	0.0	0.0	0.0	0.0	0.0	3511.5
55	0	40	0.0	0.0	0.0	0.0	0.0	0.0	3511.5
55	0	39	0.0	0.0	0.0	0.0	0.0	0.0	3511.5
55	0	38	0.0	0.0	0.0	0.0	0.0	0.0	3511.5
55	0	37	0.0	0.0	0.0	0.0	0.0	6.9	3504.6
55	0	36	0.0	4.6	22.8	262.8	94.8	178.2	2948.3
55	0	35	0.0	52.8	1321.2	810.1	586.4	457.9	283.1
55	0	34	0.0	18.1	523.9	221.0	55.5	153.4	2539.6
55	30	43	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	42	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	41	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	41	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	39	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	38	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	37	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	36	0.0	0.0	0.0	0.0	0.0	0.0	3467.1
55	30	35	0.0	0.0	0.0	0.0	0.0	18.3	3448.8
55	30	34	0.0	0.0	0.0	0.0	0.0	209.5	3257.7

Table 1.J: Areas of seabed within selected depth ranges in Subarea 48.3 between 53° and 54°30'S (from Everson and Campbell, 1990).

Areas of seabed (km^2) around South Georgia between 53° and 54°30'S.

NE Corner			50-150	150-250	250-500	>500
S Deg	S Min	W				
53	0	43	0.0	0.0	12.0	3673.9
53	0	42	0.0	2887.1	445.2	2952.6
53	0	41	88.9	158.3	26.8	3411.9
53	0	40	0.0	0.0	0.0	3685.9
53	0	39	0.0	0.0	0.0	3685.9
53	0	38	0.0	0.0	0.0	3685.9
53	0	37	0.0	0.0	0.0	3685.9
53	0	36	0.0	0.0	0.0	3685.9
53	0	35	0.0	0.0	0.0	3685.9
53	0	34	0.0	0.0	0.0	3685.9
53	30	43	0.0	0.0	0.0	3642.8
53	30	42	93.3	289.9	178.6	3081.0
53	30	41	1209.8	995.3	410.5	1027.2
53	30	40	81.5	138.9	536.9	2885.5
53	30	39	0.0	177.6	689.2	2776.0
53	30	38	469.7	1160.1	640.9	1320.9
53	30	37	1258.1	832.0	732.9	690.8
53	30	36	131.0	1536.8	723.1	1251.9
53	30	35	6.0	139.3	270.5	3227.0
53	30	34	0.0	0.0	0.0	3642.8
54	0	43	0.0	0.0	0.0	3599.2
54	0	42	0.0	0.0	0.0	3599.2
54	0	41	0.0	0.0	0.0	3599.2
54	0	40	0.0	0.0	0.0	3599.2
54	0	39	15.8	718.1	482.7	2382.6
54	0	38	219.8	3248.9	66.5	0.0
54	0	37	88.2	19.8	4.6	0.0
54	0	37(S)	1017.0	1116.2	251.3	0.0
54	0	36	760.8	723.9	176.6	0.0
54	0	36(S)	102.9	48.7	0.0	0.0
54	0	35	139.3	1713.2	528.7	1218.0
54	0	34	0.0	0.0	0.0	3599.2

Table 1.K: Areas of seabed within selected depth ranges in Subarea 48.3 between 54°30' and 56°S (from Everson and Campbell, 1990).

Areas of seabed (km^2) around South Georgia between 54°30' and 56°S.

NE Corner			50-150	150-250	250-500	>500
S Deg	S Min	W				
54	30	43	0.0	0.0	0.0	3555.5
54	30	42	0.0	0.0	0.0	3555.5
54	30	41	0.0	0.0	0.0	3555.5
54	30	40	0.0	0.0	0.0	3555.5
54	30	39	0.0	127.2	106.0	3322.3
54	30	38	0.0	1257.9	273.8	2023.8
54	30	37	422.0	1684.3	455.5	993.7
54	30	36	12.9	0.0	0.0	0.0
54	30	36(S)	828.5	1089.7	903.7	0.0
54	30	35	1293.8	1236.0	554.0	84.9
54	30	34	151.3	344.4	317.7	2742.1
55	0	43	0.0	0.0	0.0	3511.5
55	0	42	0.0	0.0	0.0	3511.5
55	0	41	0.0	0.0	0.0	3511.5
55	0	40	0.0	0.0	0.0	3511.5
55	0	39	0.0	0.0	0.0	3511.5
55	0	38	0.0	0.0	0.0	3511.5
55	0	37	0.0	0.0	6.9	3504.6
55	0	36	27.4	357.6	178.2	2948.3
55	0	35	1374.0	1396.5	457.9	283.1
55	0	34	542.0	276.5	153.4	2539.6
55	30	43	0.0	0.0	0.0	3467.1
55	30	42	0.0	0.0	0.0	3467.1
55	30	41	0.0	0.0	0.0	3467.1
55	30	40	0.0	0.0	0.0	3467.1
55	30	39	0.0	0.0	0.0	3467.1
55	30	38	0.0	0.0	0.0	3467.1
55	30	37	0.0	0.0	0.0	3467.1
55	30	36	0.0	0.0	0.0	3467.1
55	30	35	0.0	0.0	18.3	3448.8
55	30	34	0.0	0.0	209.5	3257.7

Table 1.L: Summary of areas of seabed within selected depth ranges in Subarea 48.3 (from Everson and Campbell, 1990).

Summary of areas of seabed for Shag Rocks, South Georgia and the whole of Subarea 48.3. An asterisk (*) indicates that there are no reported soundings for this depth range.

Depth Range (m)	Area of Seabed (km^2)		
	Shag Rocks	South Georgia	Subarea 48.3
0 - 50	*	1 531.7	1 531.7
50 - 100	3.8	1 956.6	1 960.4
100 - 150	1 469.7	6 903.8	8 373.6
150 - 200	1 023.1	8 689.3	9 712.4
200 - 250	847.5	10 515.0	11 362.8
250 - 500	1 610.0	8 201.9	9 811.9
> 500	24 360.0	144 798.0	169 158.9
Total	29 314.1	182 597.6	211 911.7

Table 1.M: Areas of seabed within selected depth ranges in Subarea 48.4 (from Everson, 1987).

Sub-Division	Coordinates				% Sea Area in Depth Range (m)		Area (km^2)	
	N	S	E	W	0-500	>500	Sea	Total
66	56°00’	60°00’	24°00’	29°30’	0.9	99.1	143782	144073
67	50°00’	53°00’	26°00’	30°00’	0	100	92322	92322
68	53°00’	56°00’	26°00’	30°00’	0	100	86121	86121
69	60°00’	64°00’	24°00’	30°00’	0	100	139235	139235
70	56°00’	60°00’	29°30’	30°00’	0	100	13097	13097
71	50°00’	56°00’	20°00’	26°00’	0	100	267758	267758
72	56°00’	60°00’	20°00’	24°00’	0	100	104782	104782
	Total for subarea				0.1	99.9	847097	847388

Table 1.N: Areas of seabed within selected depth ranges in Subarea 48.4 (from Everson, 1987).

Sub-Division	Coordinates				% Sea Area in Depth Range (m)		Area (km^2)	
	N	S	E	W	0-500	>500	Sea	Total
81	65°00’	70°00’	50°00’	66°00’	50	50	313029	378286
82	64°00’	65°00’	50°00’	60°00’	51.6	48.4	49890	53196
83	64°00’	65°00’	30°00’	50°00’	0	100	106396	106396
84	65°00’	70°00’	30°00’	50°00’	0	100	472858	472858
85	64°00’	78°00’	20°00’	30°00’	9.9	90.1	507572	561341
86	70°00’	78°00’	30°00’	62°00’	15.8	84.2	733571	871718
	Total for subarea				9.6	90.4	2183316	2445595

Table 1.O: Areas of seabed within selected depth ranges in Statistical Area 88 (from Everson, 1987).

Sub-division	Coordinates				Percentage Sea Area in Depth Range (m)							Total Sea Area (km^2)
	N	S	E	W	0-150	0-250	0-500	>50	>150	>250	>500	
87	60°00’	66°00’	70°00’	92°00’	0	0	0	100	100	100	100	740541
88	66°00’	70°00’	70°00’	92°00’	4.6	5.5	15.6	100	95.4	94.5	84.4	393266
	Total for Area 88				1.7	2.0	5.6	100	98.3	96.3	94.4	1133807

Table 2: Maturity scale for nototheniids and channichthyids based on ovarian and testis cycles in *Notothenia coriiceps*, *Champsocephalus gunnari*, *Chaenocephalus aceratus* and *Pseudochaenichthys georgianus* (from Kock and Kellermann, 1991).

Maturity Stage	Description
Females:	
1. Immature	Ovary small, firm, no eggs visible to the naked eye
2. Maturing virgin or resting	Ovary more extended, firm, small oocytes visible, giving ovary a grainy appearance
3. Developing	Ovary large, starting to swell the body cavity, colour varies according to species, contains oocytes of two sizes
4. Gravid	Ovary large, filling or swelling the body cavity, when opened large ova spill out
5. Spent	Ovary shrunk, flaccid, contains a few residual eggs and many small ova
Males:	
1. Immature	Testis small, translucent, whitish, long, thin strips lying close to the vertebral column
2. Developing or resting	Testis white, flat, convoluted, easily visible to the naked eye, about $^1/_4$ length of the body cavity
3. Developed	Testis large, white and convoluted, no milt produced when pressed or cut
4. Ripe	Testis large, opalescent white, drops of milt produced under pressure or when cut
5. Spent	Testis shrunk, flabby, dirty white in colour

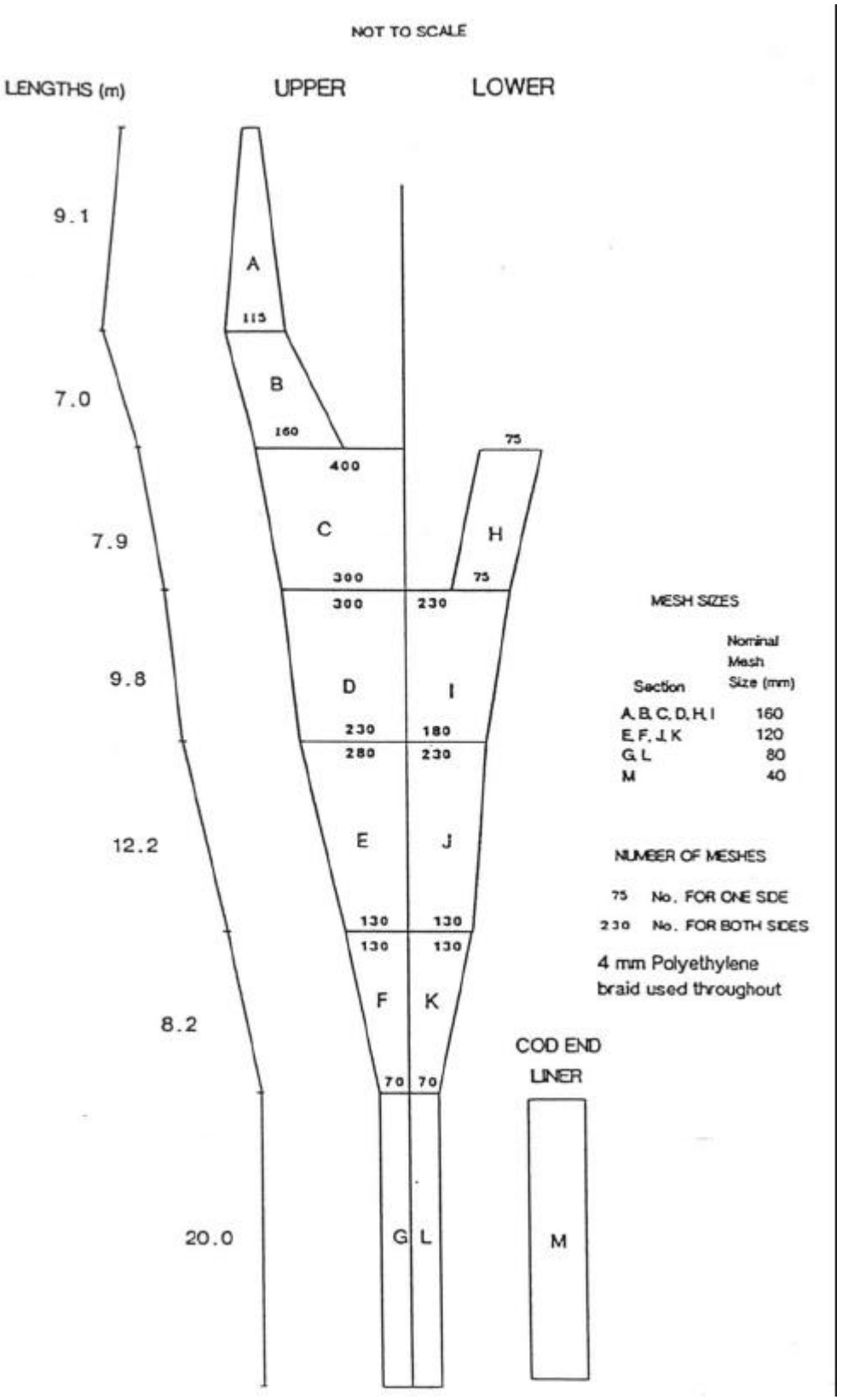

Figure 1: Construction of the FP-120 net (from Parkes, 1991).

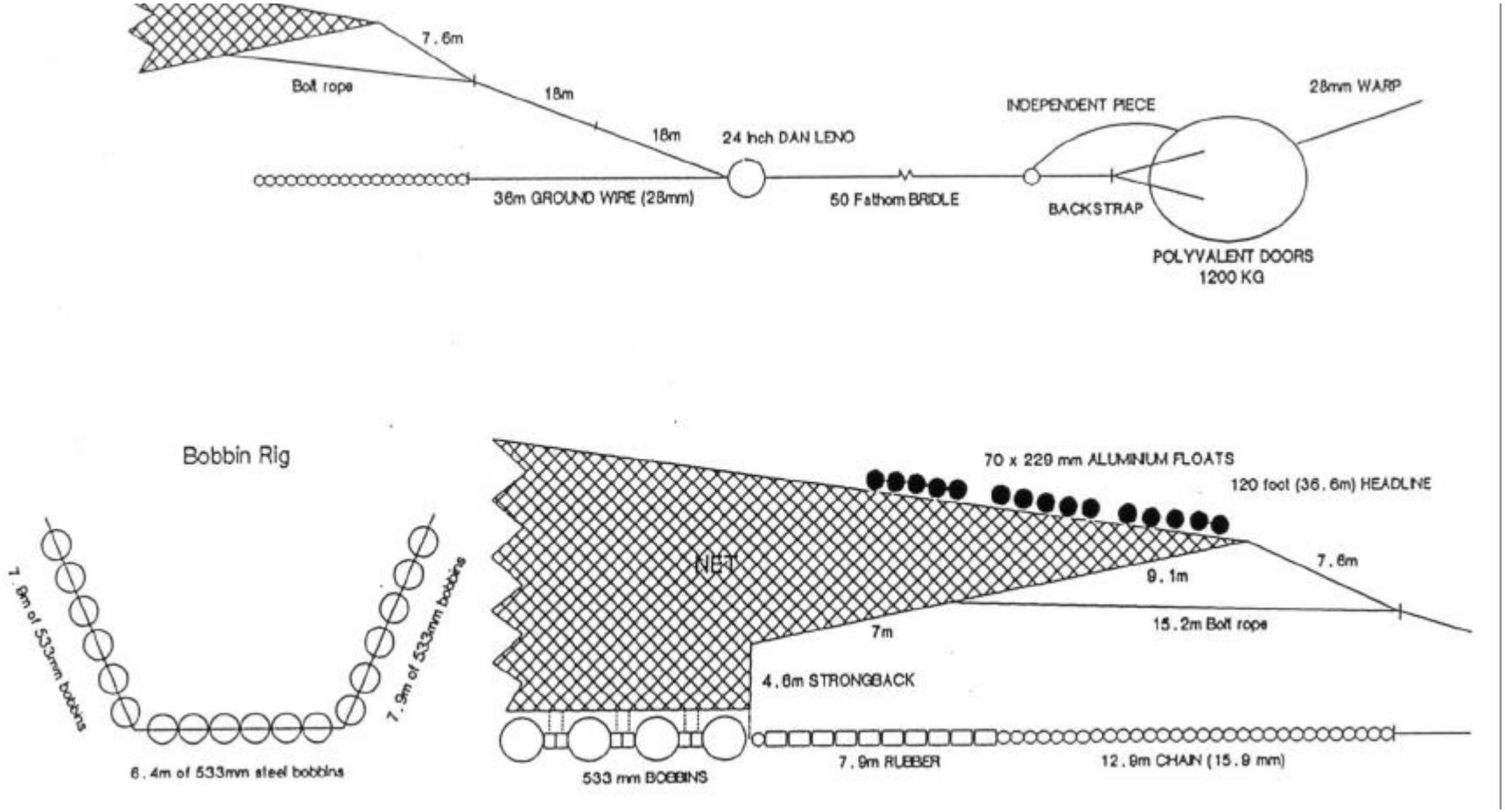

Figure 2: Rigging of the FP-120 trawl (from Parkes, 1991).

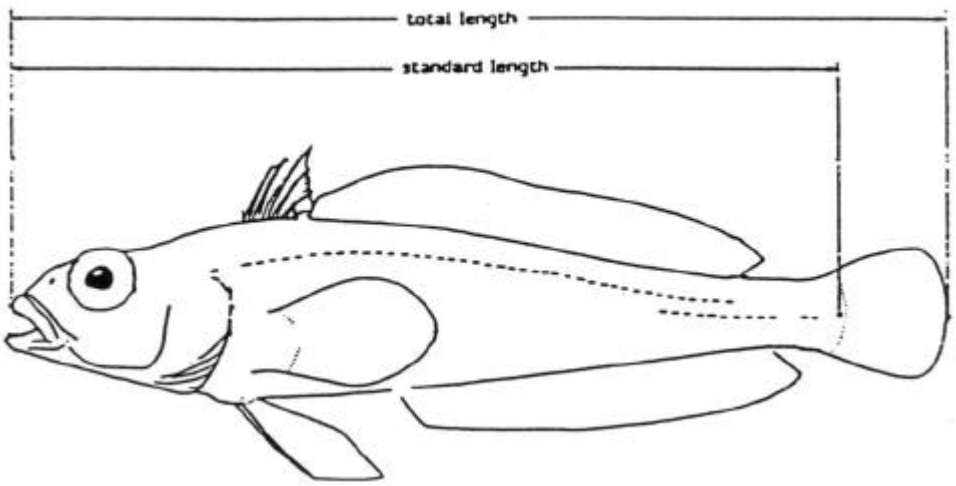

Figure 3: Standard body length measurements of fish.

TL - Total Length is from the most anterior part of the snout to the most posterior part of the caudal fin when this fin is extended along the length of the body.

SL - Standard length is from the most anterior part of the snout to the end of the vertebral column (usually marked by a vertical groove in the caudal peduncle when it is flexed).

ATTACHMENT A

LIST OF PARTICIPANTS

Workshop on Design of Bottom Trawl Surveys
(Hamburg, Germany, 16 to 19 September 1992)

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(Hamburg, Germany, 16 to 19 September 1992)

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ATTACHMENT C

AGENDA

CCAMLR Workshop on Bottom Trawl Survey Design
(Hamburg, 16 to 19 September 1992)

1. Opening of the Meeting

2. Organisation of the Meeting and Appointment of Rapporteur(s)

3. Adoption of the Agenda

4. The Objectives of Bottom Trawl Surveys in the Convention Area

5. Factors Affecting the Accuracy of Bottom Trawl Surveys

   (i) Trawl Geometry, Rigging and Performance
   (ii) Fish Behaviour in the Catching Process
   (iii) Fish Distribution in the Area
   (iv) Stock Characteristics

6. Design of Bottom Trawl Surveys

   (i) Non-Random (Systematic) Surveys
   (ii) Random Surveys
   (iii) Stratification

7. Analysis of Bottom Trawl Surveys

   (i) Distributions Fitted to the Data
   (ii) Models Used to Analyse the Data
   (iii) Geostatistical Methods

8. Manual for Bottom Trawl Surveys in the Convention Area

9. Adoption of the Report

10. Close of the Meeting.

FORMULAE FOR PARAMETER ESTIMATION AND COMBINING DATA OVER STRATA FOR THE 'ADAPTIVE APPROACH'

1. Proportion '**p**' of area occupied by concentrations

If a total of **k** patches is encountered in a track of total length **L**, and the length of the track within the **i**th is l_i, then the estimator of $\hat{p}$ is:

$$\hat{p} = \frac{\sum l_i}{L}$$

2. Stratified Mean Biomass $\hat{B}$

To provide a combined mean biomass from two strata, the within stratum mean densities $\hat{B}$ and $\hat{D}_b$ are weighted by the area of the strata. Assuming that $\hat{p}$ is the proportion of the survey area occupied by concentrations whose mean density is $\hat{D}_a$ and mean density of the remaining area is $\hat{D}_b$, and the total area is **A**, the formula for the weighted mean is:

$$\hat{B} = [\hat{D}_a \cdot \hat{p} + \hat{D}_b \cdot (1-\hat{p})]A$$

3. Combined Variance $\mathbf{V[\hat{B}]}$

The combined variance must incorporate terms for the variance of $\hat{D}_a$, $\hat{D}_b$ and $\hat{p}$.

The formula for combining these variances is:

$$V[\hat{B}] = A^2\{V_a \cdot \hat{p}^2 + V_b \cdot (1-\hat{p})^2 + V_p[V_a + \hat{D}_a^2) + (V_b + \hat{D}_b^2) - 2\hat{D}_a \cdot \hat{D}_b]\}$$

ATTACHMENT E

DRAFT MANUAL FOR BOTTOM TRAWL SURVEYS IN THE CONVENTION AREA

1. INTRODUCTION

Research vessel surveys should ideally provide the following information:

- standing stock biomass for all species (exploited and unexploited);
- length and age structure from the exploited stocks;
- length/age-weight relationships;
- maturity ogives;
- year class strengths of pre-recruits.

To date, bottom trawl surveys in the Convention Area have been national surveys with varying degrees of comparability among surveys and nations. The objective of this Manual is to increase comparability between these surveys by standardising fishing methods, survey methods, sampling of catches, and recording and analysis of data. This Manual incorporates results of earlier deliberations of the Working Group, such as in SC-CAMLR IX, Annex 5, p. 249 to 254, and the CCAMLR Workshop on Bottom Trawl Survey Design.

2. THE SURVEY TRAWL

Survey results are critically dependent on the size, construction and rigging of the trawl. The trawl should preferably be a commercial sized trawl with a codend lining of max mesh size of 40 mm. As it is unlikely that a standard trawl will used by all nations, a full description of the net, and ground tackle including doors, should be provided as indicated in Figures 1 and 2.

It is crucial to achieve a good bottom contact of the whole groundrope, and this should be checked regularly. A proper contact could be indicated by inspecting for wear on bobbins and chains.

3. SURVEY DESIGN AND FISHING POSITIONS

The survey should cover the main geographical and bathymetric range of the target species within a given statistical subarea. It should follow a random survey design stratified by depth and, if known, fish density. The areas of seabed within selected depth ranges in the Atlantic Ocean sector are set out in Tables 1.A to 1.O. Fishing positions have to be chosen randomly in the first survey, but may be used as known clear tow stations during subsequent surveys. To reduce or avoid covariance between fishing stations in adjacent strata, fishing stations should be separated by at least 5 miles. Fishing must not be directed towards fish shoals located by sonar or echosounder. The survey design and the method of stratification needs to be carefully described.

If an adaptive ('encounter-response') survey design is used, in which acoustic equipment is utilised to identify high density and low density regions, the acoustic equipment should be described in detail.

4. STANDARD FISHING METHOD

Standard fishing speed measured as trawl speed over the ground should be used. The actual ground speed and distance towed should be monitored and reported.

Each haul should last 30 minutes. Start time is defined as the moment when the net settles on the bottom or in case of a continuous recording of net parameters, when vertical net-opening and wing spread indicate that the net is in its stable fishing configuration. Stop time is defined as the start of hauling. Hauls of less than 15 minutes duration should not be included for subsequent estimate of standing stock of the data.

Vertical net-opening, wing spread and door spread should be monitored at 30 second intervals.

Trawling should be carried out only during daylight hours, i.e. between sunrise and sundown.

Any incidental mortality of marine mammals or birds must be recorded.

All fishing gear lost during the course of the survey must be logged and reported.

5. ANALYSIS OF THE CATCH

Fish in the catch should be sorted into species and the total weight and total number of each species recorded. In case of large catches, a representative subsample should be sorted. Attention must then be given to a possible uneven distribution of species and/or size classes in the hold.

In order to assess the impact of bottom trawling on benthic communities the catch of benthos should be weighed.

6. BIOLOGICAL SAMPLING

Representative length distributions should be recorded for all exploited species (high priority) and all other species (if time permits). The size of a representative sample is difficult to define but usually contains a minimum of 100 fish measured. Length is defined as total length (Figure 3) measured to the nearest centimetre below.

Concurrently with length measurements sex and maturity data should be collected. Maturity stages should be classified according to the maturity scale given in Table 2. Otoliths (and scales for nototheniids) should be collected on a survey area basis, or in the case of the presence of two or more stocks according to their stock boundaries. For the commercially exploited species a minimum sampling level of 10 otoliths per sex and 1 cm length class should be maintained. For the smaller size groups, that presumably contain only one age class, the number of otoliths per sex and length class may be reduced.

7. INFORMATION TO BE REPORTED TO CCAMLR

7.1 Survey Design and Data Collection

- Survey area
- Geographical boundaries: latitude and longitude
- Map of area surveyed including location of fishing stations (and preferably bathymetry)
- Scientist in charge

7.2 Description of Vessel

- Name of vessel
- Vessel size (length, GRT, HP)
- Vessel type
- Included in CCAMLR register of commercial or research vessels.

7.3 Description of Fishing and Other Gear

- Description of gear used, e.g. bottom or semi-pelagic trawl, including construction drawing and rigging diagram (see Figures 1 and 2)
- Auxiliary gear (dan leno assembly, etc.)
- Type of mesh (diamond, square, other)
- Mesh size in cod end (mm) (measurements according to standards set out in the CCAMLR Inspection Manual).

7.4 Description of Acoustic Equipment

- Operating frequency
- Calibration method
- Calibration details, e.g.
    - Source level
    - Pulse length
    - Directivity index
    - Receiving sensitivity
    - Calibration constant (source level plus receiving sensitivity)
    - TVG correction details

7.5 Survey Design

- Survey design (random, systematic, etc.)
- Target species
- Stratification (according to depth zones, fish density, etc.)
- Details of sources of stratification
- Haul duration
- Number of stations planned and carried out
- Locations and map of fishing stations

7.6 Methods of Survey Data Analyses

for example:

- Swept area method
- Statistical properties of the estimator

7.7 Data to be Reported to CCAMLR

Haul-by-haul data including

Date and time
Designated stratum for the haul
Start and end position of trawl
Method of position fixing (e.g., GPS)
Duration of haul
Mean trawling depth
Wire out
Distance trawled over ground
Net mouth opening (vertical-horizontal)
Catch by species in weight and numbers
Length frequency distributions of exploited species
Benthos weight
Maturity stage information
Feeding information
Other (e.g., parasitic infestation, lesions, etc.)

Combined for rectangle subarea:

Length/weight-age information of exploited species
Incidental mortality of mammals and birds
Fishing gear lost

Data should be reported to CCAMLR using Formats C1, C4, B2, B3 and B4.

1992 ASSESSMENT SUMMARIES

Assessment Summary: *Notothenia rossii*, Subarea 48.3

Source of Information: This Report

Year:	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC				0				
Agreed TAC				300	300	0		
Landings	216	197	152	2	1	1	24897	1
Survey Biomass	11471[a]	1699	2439	1481[a]	4295[c]	7309[c]		
	1634[b]			3915[b]	10022[d]			
				3900[b]				
Surveyed by	Spain[a]	USA/POL	UK/POL	UK/POL[a]	UK[c]	UK[c]		
	USA/POL[b]			USSR[b]	USSR[d]			
Sp. Stock Biomass[3]	No information available since 1985/86							
Recruitment (age...)								
Mean **F** (.....)[1]								

Weights in tonnes, recruits in .....

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

2 Over period 1982 to 1992

3 From VPA using (.....)

Conservation Measures in Force: 2/III and 3/IV

Catches: UK 1 tonne (research).

Data and Assessment: No new data for an assessment.

Fishing Mortality:

Recruitment:

State of Stock: Stock remains at a low level.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	SSB	Catch	**F**	SSB	Catch	

Weights in tonnes

Assessment Summary: *Champsocephalus gunnari*, Subarea 48.3

Source of Information: This Report

Year:	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC		31500	10200	12000		8400-61900		
Agreed TAC		35000	-[4]	8000	26000	0		
Landings	71151	34619	21359	8027	92	5	128194[6]	25
Survey Biomass	159283	15716	22328[5]	149598[a]	26204[a]	40246[a]		
				442168[b]	192144[b]			
Surveyed by	Spain	USA/POL	UK/POL	UK/POL[a]	UK[a]	UK[a]		
				USSR[b]	USSR[b]			
Sp. Stock Biomass[3]								
Recruitment (age...)								
Mean **F** (.....)[1]						0		

Weights in tonnes

1 ... weighted mean over ages (...)
2 Over period 1982 to 1992
3 From VPA using (.....)
4 Prohibition from 4 November 1988
5 Standard estimate from WG-FSA-91, Appendix D
6 Maximum catch in 1983

Conservation Measures in Force: 19/IX and 33/X

Catches: UK 5 tonnes (research).

Data and Assessment: VPA assessment tuned to survey abundance and CPUE indices in WG-FSA-92/27 and at the meeting gave poor results for most recent years, current abundance estimate provided by 1992 trawl survey.

Fishing Mortality: Zero **F** in 1991/92 due to closure of the fishery.

Recruitment: Recent levels of recruitment uncertain, poor reproductive performance reported from 1991 survey (WG-FSA-91/14) may result in poor recruitment of one year olds in 1992/93.

State of Stock: Stock abundance increased since 1990/91 in line with expectations. Condition of fish and feeding intensity improved since 1990/91.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	Stock	Catch	**F**	Stock	Catch	
$\mathbf{F_{0.1}}$	Zero	38000[1]	5	0.39	52000[2]	15200[2]	Lower 95% confidence limit of stock in 1993/94 49400[3]
Closure	Zero	38000	5	Zero	52000[2]	Zero	Lower 95% confidence limit of stock in 1993/94 62700[3]

Weights in '000 tonnes

1 Age 2+
2 Age 2+, assumes recruitment in 1991/92 at lower 95% confidence limit
3 Age 2+, assumes recruitment in 1992/93 at lower 95% confidence limit

Assessment Summary: *Patagonotothen guntheri*, Subarea 48.3

Source of Information: This Report

Year:	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC			-	-	20-36000	0		
Agreed TAC			13000	12000	0	0		
Landings	8810	13424	13016	145	0	0	36788[4]	5029
Survey Biomass	81000				584[a]	12746		
Surveyed by	Spain				16365[b]			
					UK[a]	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: 34/X

Catches: Research catch only (<1 tonne).

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock: Unknown.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	SSB	Catch	**F**	SSB	Catch	

Weights in tonnes

Assessment Summary: *Dissostichus eleginoides*, Subarea 48.3

Source of Information: This Report

Year:	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC				-				
Agreed TAC				-	2500[5]	3500		
Landings	1199	1809	4138	8311	3843	3703	8311	109
Survey Biomass	1208	674	326	9631*[a] 335+[a]	19315*	3353*		
				1693*[b] 3020+[b]	885+	2460+		
Surveyed by	USA/ POL[4]	USA/ POL[4]	UK/ POL[4]	POL/UK[a] USSR[b]	UK	UK		
Stock Biomass[3]				20745 - 435817			8000 - 160000[6]	
Recruitment (age...)				na				
Mean **F** (.....)[1]				na			na	

Weights in tonnes

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

Conservation Measures in Force: 35/X, 36/X, 37/X

Catches: TAC of 3 500 tonnes reached 10 March (started 4 November). Bulgaria fished 11 tonnes after the closure. Russia 132 tonnes during a research cruise until 30 June 1992. After 30 June, 59 tonnes. UK bottom trawl survey, 1 tonne.

Data and Assessment: One assessment (De Lury) presented in WG-FSA-92/24. Problem with possible need to standardise effort for effects such as hook size/type, depth of fishing, area. Haul-by-haul data provided; this allowed investigation of effect of different factors on CPUE. At meeting: used De Lury method on subsets of data where one/two vessels fished in a 'local' area and CPUE showed a decline, to estmate 'local' density. Seabed area between 500 to 2 000 m was calculated to extrapolate from density to overall biomass.

Fishing Mortality: Not calculated.

Recruitment: Survey results (WG-FSA-92/17) suggest future recruitment at an average level.

State of Stock: Between 8 000 to 160 000 tonnes; thought unlikely to be above 45 000 tonnes.

Forecast for 1992/93: Suggested catch levels 750 to 5 370 tonnes.

Option Basis	1992			1993			Implications/ Consequences
	F	SSB	Catch	**F**	SSB	Catch	

Weights in tonnes

Assessment Summary: *Notothenia gibberifrons*, Subarea 48.3

Source of Information: This Report

Year:	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC						500-1500		
Agreed TAC						0		
Landings	2844	5222	838	11	3	4	11758	0
Survey Biomass	1400	7800	8500	17000	25000	29600		
Surveyed by	USA	USA	UK	UK USSR	UK USSR	UK		
Sp. Stock Biomass[3]	4700	4300	3300	4300	6200		18800	3300
Recruitment (age 2)	24000	24000	21000	27000	25000		27000	13000
Mean **F** (.....)[1]	0.36	0.86	0.54	0.014	0.0002		0.95	0

Weights in tonnes

1 Weighted mean over ages 2 to 16

2 Over period 1975/76 to 1991/92

3 From VPA using survey q = 1 model

Conservation Measures in Force: 34/X

Catches: Research catch only in 1990/91 and 1991/92.

Data and Assessment: No new information on past by-catch in the *C. gunnari* fishery. No new analytical assessment performed, due to no catch-at-age data for last four seasons.

Fishing Mortality: Zero in 1991/92.

Recruitment:

State of Stock: Steady increase in survey biomass estimates in recent years, now estimated to be 73 to 78% of the initial level.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	Stock	Catch	F	Stock	Catch	
Survey q = 1 by-catch in *C. gunnari* fishery limited to MSY level	0	29600	4			1470	

Weights in tonnes

Assessment Summary: *Chaenocephalus aceratus*, Subarea 48.3

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC			1100	0	300	300-500		
Agreed TAC			0	300	300	0		
Landings	339	313	1	2	2	2	1272	1
Survey Biomass	8621	6209	5770	14226[a] 14424[b] 17800[b]	13474[c] 18022[d]	12500		
Surveyed by	USA/POL	USA/POL	UK/POL	UK/POL[a] USSR[b]	UK[c] USSR[d]	UK		
Sp. Stock Biomass[3]	4179	4156	4404	5098[4]				
Recruitment (age 2)	5375	8648	6717	4047[4]				
Mean **F** (.....)[1]	0.17	0.13	0.002					

Weights in tonnes, recruits in '000s

1 ... weighted mean over ages 3 to 11

2 Over period 1982 to 1992

3 From VPA using revised VPA from WG-FSA-90/6

4 Predicted

Conservation Measures in Force: 34/X

Catches: Research catch only in 1990/91 and 1991/92.

Data and Assessment: No new information on past by-catch in *C. gunnari* fishery. No new analytical assessment performed, due to no catch-at-age data for last four seasons.

Fishing Mortality: Zero in 1991/92.

Recruitment:

State of Stock: Survey biomass relatively consistent over recent year, now estimated to be 66 to 67% of initial level.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	Biomass	Catch	**F**	SSB	Catch	
Survey q = 1, catch limited to by-catch in *C. gunnari* fishery	0	12500	2				

Weights in tonnes

Assessment Summary: *Pseudochaenichthys georgianus*, Subarea 48.3

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]
Recommended TAC			1800	0	300	300-500		
Agreed TAC				300	300	0		
Landings	120	401	1	1	2	2	1661	1
Survey Biomass	5520	9461	8278	5761[a] 12200[b] 10500[b]	13948[c] 9959[d]	13469		
Surveyed by	USA/POL	USA/POL	UK/POL	UK/POL[a] USSR[b]	UK[c] USSR[d]	UK		
Sp. Stock Biomass[3]	5498	8090	8889[4]					
Recruitment (age 1)	4337	1372						
Mean **F** (.....)[1]	0.09	0.15						

Weights in tonnes, recruits in '000s

1 ... weighted mean over ages 3 to 6

2 Over period 1982 to 1992

3 From VPA described in WG-FSA-90/6

4 Predicted

Conservation Measures in Force: 34/X

Catches: Research catches only in 1990/92 and 1991/92.

Data and Assessment: No new information on past by-catch in *C. gunnari* fishery. No new analytical assessment performed, due to no catch-at-age data for last four seasons.

Fishing Mortality: Zero in 1991/92.

Recruitment:

State of Stock: Survey biomass relatively consistent over recent years, now estimated to be 30 to 37% of initial level. Recovery appears to be slower than for *N. gibberifrons* and *C. aceratus*.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	Biomass	Catch	**F**	SSB	Catch	
Survey q = 1 catch limited to by-catch in *C. gunnari* fishery	0	13500	2				

Weights in tonnes

Assessment Summary: *Notothenia squamifrons*, Subarea 48.3

Source of Information:

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[2]
Recommended TAC				0	300	300			
Agreed TAC				300	300	0			
Landings	190	1553	927	0	0	0	1553	0	563
Survey Biomass	13950	409	131	1359[a] 534[b]	1374	1232			
Surveyed by	USA/POL	USA/POL	UK/POL	UK/POL[a] USSR[b]	UK	UK			
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean **F** (.....)[1]									

Weights in tonnes, recruits in .....

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

2 Over period 1982 to 1992

3 From VPA using (.....)

Conservation Measures in Force: 34/X

Catches: Research catches only in 1991/92.

Data and Assessment: Now new data, no assessment performed.

Fishing Mortality: Zero in 1991/92.

Recruitment:

State of Stock: Unknown.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	SSB	Catch	**F**	SSB	Catch	

Weights in tonnes

Assessment Summary: *Electrona carlsbergi*, Subarea 48.3

Source of Information:

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[2]
Recommended TAC	-	-	-	-	-	-	-	-	-
Agreed TAC	-	-	-	-	-	245000	-	-	-
Landings	1102	14868	29673	23623	78488	46960			
Survey Biomass		1200 kt	USSR[4]						
Surveyed by		160 kt	USSR[5]						
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean **F** (.....)[1]									

Weights in tonnes, recruits in .....

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

2 Over period 1982 to 1992

3 From VPA using (.....)

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

5 WG-FSA-90/21 Shag Rocks region

Conservation Measures in Force: 38/X; TAC 245 000 tonnes. 39/X, 40/X.

Catches: 46 960 tonnes - fine-scale data incomplete.

Data and Assessment: Length composition data August to October 1991 from commercial catches. By-catch data from research trawl 1987 to 1989. No new biomass surveys or estimates of biological parameters such as age stucture of the stock were available.

Fishing Mortality:

Recruitment:

State of Stock: With no estimates of biomass or age structure of the current stock (most of the stock originally surveyed over 1988/89 are likely to have disappeared) no assessments of stock size were possible.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	Exploitable Biomass	Catch	**F**	Exploitable Biomass	Catch	

Weights in '000 tonnes

Assessment Summary: *Notothenia rossii*, Division 58.5.1

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings	482	21	245	155	287	0	9812	0	1462
Survey Biomass Surveyed by									
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean **F** (.....)[1]									

Weights in tonnes, recruits in .....

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

2 Over period 1982 to 1992

3 From VPA using (.....)

Conservation Measures in Force: Conservation Measure 2/III. Resolution 3/IV. Limitation of trawlers allowed on fishing grounds each year. Arrêté Nº: 18, 20, 32 (for details see SC-CAMLR-VIII, Annex 6, Appendix 10, page 290).

Catches: Nil

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	SSB	Catch	**F**	SSB	Catch	

Weights in tonnes

Assessment Summary: *Notothenia squamifrons*, Division 58.5.1

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC	5000	2000	2000[4]						
Landings	1635	39	1553	1262	98	1	7394	1	2191
Survey Biomass Surveyed by									
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean **F** (.....)[1]									

Weights in tonnes, recruits in .....

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

2 Over period 1982 to 1992

3 From VPA using (.....)

Conservation Measures in Force: Catch limits set since 1987 (French/Soviet agreement). Conservation Measure 2/III; Arrêté 20 and 32.

Catches: 1 tonne only - possibly as by-catch from *C. gunnari* fishery.

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1992/93:

Option Basis	1991			1992			Implications/ Consequences
	F	SSB	Catch	**F**	SSB	Catch	

Weights in tonnes

Assessment Summary: *Champsocephalus gunnari*, Division 58.5.1

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[2]
Recommended TAC Agreed TAC Landings (Kerguelen) Landings (Combined)	0	157	23628		12644	44	25852	44	10402
Survey Biomass Surveyed by									
Sp. Stock Biomass[3] Recruitment (age...) Mean **F** (.....)[1]									

Weights in tonnes, recruits in .....

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

2 Over period 1982 to 1992

3 From VPA using (.....)

Conservation Measures in Force: Conservation Measure 2/III; Arrêté 20; Conservation Measure as for *N. rossii* TACs set under French/Soviet Agreement.

Catches: Low catch of 44 tonnes despite expected high abundance of fish due to presence of strong 3+ cohort.

Data and Assessment:

Fishing Mortality:

Recruitment: Probably low this season.

State of Stock: If the pattern of recent years continues, there will be a strong 1+ cohort in the population in 1992/93. This will not be recruited to the fishery until 1993/94 season.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	SSB	Catch	**F**	SSB	Catch	

Weights in tonnes

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.1

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings	3144	554	1630	1062	1848	7492	7492	121	2123
Survey Biomass			27200						
Surveyed by									
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean **F** (.....)[1]									

Weights in tonnes, recruits in .....

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

2 Over period 1982 to 1992

3 From VPA using (.....)

Conservation Measures in Force: None.

Catches: Highest annual catch on record comprising:

1 589 tonnes by French trawlers in the northern grounds;
5 903 tonnes by Ukraine trawlers in the northern grounds; and
705 tonnes by Ukraine longliners in the western grounds.

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock: New grounds in the northern part of the area have been heavily exploited by trawlers in 1991/92. CPUE at 1.0 to 2.0 tonnes/hour has declined to similar levels to those experienced on the western grounds after several fishing seasons.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	SSB	Catch	**F**	SSB	Catch	

Weights in tonnes

Catches should be limited to not more than 1 100 tonnes from each ground until scientific data indicate otherwise.

Assessment Summary: *Notothenia squamifrons*, Division 58.4.4

Source of Information: This Report

Year	1987	1988	1989	1990	1991	1992	Max[2]	Min[2]	Mean[3]
Recommended TAC (Lena Bank)									
Agreed TAC									
Landings (Ob Bank[a])	1457	2989	850	867	?	0	4999	0	1151
Landings (Lena Bank[a])	506	2013	3166	596	?	0	6284	0	1335
Landings (Combined[b])	1963	5002	4016	1463	575	0	11283	027	2487
Survey Biomass (Ob Bank)			12700						
Survey Biomass (Lena Bank)									
Surveyed by			USSR						
Sp. Stock Biomass[4]				na					
Recruitment (age...)				na					
Mean **F** (.....)[1]									

Weights in tonnes, recruits in .....

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

2 Over period 1982 to 1992

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

4 From VPA using (.....)

a From WG-FSA-92/5

b From SC-CAMLR-IX/BG/2 Part 2 (Statistical Bulletin)

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

Catches: A further set of catch histories (WG-FSA-92/5) was provided, which were inconsistent with the three previous reports.

Data and Assessment: There is much confusion over catch data, which must be considered as unreliable. A VPA was re-run using the new catch history and **M** of 0.15, which gave a stock of 6 000 tonnes for Lena Bank and 3 500 tonnes for Ob Bank.

Fishing Mortality: High prior to 1989, but moderate to low since then.

Recruitment: Unknown.

State of Stock: Severely depleted in the past, but now probably slowly recovering.

Forecast for 1992/93:

Option Basis	1992			1993			Implications/ Consequences
	F	SSB	Catch	**F**	Biomass	Catch	

Weights in tonnes