REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 10 to 18 October 1995)

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REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 10 to 18 October 1995)

INTRODUCTION

1.1 The meeting of the Working Group on Fish Stock Assessment (WG-FSA) was held at CCAMLR Headquarters, Hobart, Australia from 10 to 18 October 1995. The Convener, Dr W. de La Mare (Australia), chaired the meeting.

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

2.1 The Convener welcomed participants to the meeting and introduced the Provisional Agenda which had been circulated prior to the meeting. The following additions were made:

- Sub-item 7.3 'Notification of Intended Research Activity';
- Sub-item 10.2 'UN Convention on Straddling Stocks';
- Sub-item 11.3 'Work of Scientific Observers - Observer Data Handling and Future Work'; and
- Item 12 'Advice to the Scientific Committee'.

With these additions the Agenda was adopted.

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

2.3 The report was prepared by Drs D. Agnew (Secretariat), A. Constable (Australia), J. Croxall and I. Everson (UK), S. Hanchet (New Zealand), R. Holt (USA), G. Kirkwood (UK), Lic. E. Marschoff (Argentina), Dr D. Miller (South Africa), Prof. C. Moreno (Chile), Drs G. Parkes (UK), G. Watters (USA) and Mr R. Williams (Australia).

REVIEW OF AVAILABLE INFORMATION

Data Requirements Endorsed by the Commission in 1994

3.1 At its last meeting, WG-FSA identified specific data that were required for its future work (SC-CAMLR-XIII, Annex 4, Appendix D). The Data Manager reported that a number of requests for information on *Dissostichus eleginoides* had been fulfilled through submissions of scientific observer data and reports to the present meeting, the completion of new data reporting formats and the acquisition of catch data from *D. eleginoides* fisheries in areas adjacent to CCAMLR (see Appendix D).

3.2 On the other hand, little of the information from other fisheries requested in Appendix D, Annex 4 of SC-CAMLR-XIII had been forthcoming. The Working Group recalled that there had often been poor responses to similar forms of data request in the past, and concluded that repeated requests for data through the format given in Appendix D did not seem to be particularly effective. Further discussion of this problem is reported in section 11.

Fisheries Information

New Catch, Effort, Length and Age Data

3.3 The Data Manager reported that revised historical catch data from fishing directed at *Lepidonotothen squamifrons*[1] on the Ob and Lena Banks (Division 58.4.4) had been submitted by Ukraine, and were now incorporated in the CCAMLR databases. Data on pre-1970 catches of *Notothenia rossii* in Subarea 48.3, obtained from the FAO, have also been incorporated in the CCAMLR databases (WG-FSA-95/17). Revisions of Ukrainian historical catches of *Pleuragramma antarcticum* and *Chaenodraco wilsoni* in Divisions 58.4.1 and 58.4.2 are currently being validated by the Secretariat.

3.4 Dr K.-H. Kock (Chairman of the Scientific Committee) reported that cooperative research between Germany and Russia aimed at acquiring and analysing historical USSR scout vessel information was likely to yield data which could be submitted to CCAMLR in the near future. The Working Group encouraged further initiatives towards the revision of historical catch data records since these data are often important in determining critical parameters of stocks prior to exploitation. However, it acknowledged that this work was usually only possible with the provision of adequate funds.

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[1] Formerly known as *Notothenia squamifrons*

3.5 The Data Manager reported that the Secretariat had experienced some difficulties in processing haul-by-haul data from the *D. eleginoides* fishery this year. These difficulties were primarily the result of the submission of data in unconventional formats, and the large volume of very detailed data submitted by scientific observers. The suggestions of the Working Group towards a standardisation of the formats for submitting scientific observer reports and observer data (see paragraphs 11.10) should alleviate these problems, although the Secretariat anticipates a continued heavy workload should the quantity of submitted data continue to increase.

3.6 Further problems were caused by submission on computer spreadsheets, which are difficult to convert to the data structures expected by a relational database. Members are urged to submit data in the agreed CCAMLR reporting formats.

3.7 As requested by WG-FSA-94 (SC-CAMLR-XIII, Annex 4, paragraph 4.22), the CCAMLR database of haul-by-haul data from the *D. eleginoides* fishery has been modified so that most vessels are now individually identified, enabling analyses of standardised catch per unit effort (CPUE) to be performed across fleets and years (Appendix E, paragraphs 3.5 to 3.8). Efforts towards the correct identification of vessels should continue, especially when vessels re-flag or re-register, and the Working Group recommended that the Scientific Committee consider mechanisms to achieve this.

3.8 A study of discrepancies between various data sources (WG-FSA-95/25 Rev. 2) found that sometimes processed rather than live weight was reported, zero catches were unreported, or series of lines were amalgamated. However, it concluded that these errors were probably the result of misunderstandings of what data were required by CCAMLR and of the purpose and importance of the data. The Working Group recommended that attempts be made to clarify misunderstandings that national reporting agencies might have, to explain that accurate and complete data were extremely important for the work of WG-FSA and that errors could significantly bias the Working Group's analyses.

3.9 Information contained in the reports of scientific observers and the haul-by-haul data reported to CCAMLR for the same vessels revealed a number of discrepancies:

- catches from the two report types differed by ±1-2%. The differences were probably the result of the application of slightly different conversion factors by the fishing vessel masters and scientific observers. Four conversion factors were described in the scientific observer reports;

- there were two cases where the two reports were identical, which suggested that the vessel reports had been compiled by the scientific observer. In general, this should not be recommended since it reduces the capacity to evaluate the accuracy of the reports provided by vessel masters. This ability would be particularly important in fisheries where there was less than 100% scientific observer coverage;

- three hauls out of the 208 had been reported by the scientific observers as having zero catch of *D. eleginoides*, but did not appear in the vessel reports;

- for one vessel, the observer had reported 90 hauls and the vessel 74. The total catch was the same from both sources, however, implying that this was the result of the amalgamation of hauls in the vessel report; and

- although there were scientific observer reports on six vessels, only five vessels are represented in the haul-by-haul data received to date by CCAMLR.

3.10 With the exception of the last point, these differences were relatively small. However, a refinement of conversion factors could reduce some of the discrepancies (paragraphs 3.8 and 3.9). It is also important that all hauls are reported separately, irrespective of catch quantity, so that CPUE is unbiased.

3.11 Other analyses from scientific observer reports are discussed in paragraphs 3.13, 5.13 and 8.54.

Scientific Observer Information

3.12 Eighteen scientific observer reports were available to the Working Group this year (WG-FSA-95/4 Rev. 1, 95/5 Rev.1, 95/16 Rev. 1, 95/46, 49, 50, 51, 52, 53, 54, 55, 56, 57, SC-CAMLR-XIV/BG/23, 24, 25, 26 and 27), most of which reported on observations of the longline fishery for *D. eleginoides* in Subarea 48.3 (scientific observers were obligatory on every vessel engaged in this fishery in the 1995 season). In addition, a number of scientific observers submitted their raw data directly to the Secretariat, generally using the data collection formats given in the *Scientific Observers Manual*. The Working Group expressed its deep appreciation to all scientific observers active in the 1994/95 season, and emphasised that it placed great importance on scientific observer information. These reports, as well as the raw scientific observer data, were used extensively by the Working Group for a number of different analyses.

3.13 A number of important points were noted from these reports:

- there appear to have been some difficulties in recognising maturity stage (Appendix E, paragraph 2.23);
- paper WG-FSA-95/4 reports that some vessels use a number of short longline sets while searching for good fishing areas;
- considerable information on by-catch was reported by all scientific observers (Table 1);
- paper WG-FSA-95/4 indicates that some gear loss is associated with the fishery. The Working Group had no information to quantify this loss, but Mr D. Japp (invited expert) reported that information from the South African fishery (WG-FSA-95/20) suggests that gear loss may be significant in longline fisheries;
- data on the proportion of fish with a jellymeat condition, which are discarded and may not always be reported, are available from some reports. If retained, these fish may provide important biological information;
- some reports include details of catch losses to marine mammal predation (Table 2);
- some reports include information on the numbers of other longline vessels in the scientific observer's vicinity, which may assist quantification of total effort in the fishery; and
- most reports contain detailed environmental information which is not, currently, recorded in the CCAMLR databases. A study of a trawl fishery at Macquarie Island (WG-FSA-95/6) indicated that such information may be important in interpreting catch and effort data from the fishery.

Table 1: By-catch in the *D. eleginoides* longline fishery in Subarea 48.3 during the 1995 season. All data in kilograms.

Vessel	*Paralomis* spp.	Raji -dae	Lamni -dae	Macrouri -dae	Mori -dae	Other Fish[1]	Other Invertebra -tae	Total Catch[2] (kg)	% By-catch
RK-1	92	1153		756	11	13		254985	0.79
Ihn Sung 66		31879		797				340705	9.59
Isla Camila	266	5565		125	158			494241	1.24
Itkul		236		2450				12225	21.97
Arbumasa XXII	91	12715		1122	177		18	140053	10.08
Estela	7	307		1321				134413	1.22
Marunaka	43	1548	120	5942	371	1	1	226329	3.55
Mar del Sur II	14	2293		2373				83390	5.61
Arbumasa XX	35	1557		7295	830			91917	10.57
Arbumasa XXIII	34	11325		1389	665		1	212637	6.31
Total	582	68577	120	23570	2210	14	20	1990895	4.78
% By-catch	0.02921	3.44453	0.00603	1.18389	0.11103	0.00070	0.00100		
								Mean =	7.09
								Std =	6.43
								Max =	21.97
								Min =	0.79

1 Includes Muraenolepidae, Nototheniidae and Channichthyidae
2 Includes by-catch and *D. eleginoides*

Table 2: Records obtained from scientific observer reports of fish lost directly from the line as it is being hauled, and from the line attributed to killer whale predation.

Reference/Vessel	Lost		Loss Attributed to Killer Whales		
	Lost Fish	Total Catch Number	Number of Haul	Estimated Lost Weight[1] (kg)	% of Total Catch of the Vessel
WG-FSA-95/49 *Arbumasa XXIII*	142	13992	1	3252	3
WG-FSA-95/50 and 52 *Estela*			No interactions observed		
WG-FSA-95/51 *Marunaka*			3	8314	4
WG-FSA-95/53 *Mar del Sur II*			3	8673	11
WG-FSA-95/54 *Arbumasa XX*			2	4837	6
WG-FSA-95/55 *Arbumasa XXIII*			4	14860	7

1 Estimated using the mean catch per haul of each vessel

3.14 The Working Group experienced some difficulty in assimilating the information contained in the scientific observer reports, since the reports were usually very detailed and often extended to considerable analysis of the scientific observer data. The Working Group considered that there is a need for standardisation of scientific observer report formats, and a mechanism for archiving the information contained in them, which would both reduce the amount of work required of scientific observers and enable observer data to be analysed in a constructive way by the Working Group; this is taken up further in paragraphs 11.9 to 11.11.

Research Surveys

3.15 Four research or exploratory surveys were described in documents submitted to the meeting. Papers dealing with the results of the Argentinian survey of Subarea 48.3 are discussed further under Agenda Item 5, the other surveys being discussed here.

3.16 Paper WG-FSA-95/10 described the results of French exploratory trawling in Subarea 58.6 (Crozet archipelago). These expeditions, by a single vessel, took place in six separate seasons between 1983 and 1995 and found *D. eleginoides* to be dominant in all catches. Although it was highly variable, CPUE averaged about 0.6 tonnes per hour, some six times lower than at Kerguelen. Trawling took place in progressively deeper water over the six seasons (hauls were made at maximum depths of 300 m in 1983 and 750 m in 1995). Data on length composition indicate that larger fish were caught in deeper water, supporting evidence for the distribution of sizes by depth in this species discussed by the Workshop on Methods for the Assessment of *Dissostichus eleginoides* (WS-MAD) (Appendix E, paragraph 2.38). The paper concluded that there were limited resources in the subarea to support a continuous commercial fishery.

3.17 The Working Group welcomed this detailed report of exploration in an area for which it has never performed a stock assessment. Although catch rates were low, it was noted that they were somewhat similar to those obtained in a developing fishery around Macquarie Island (WG-FSA-95/6), and that there may therefore be some interest in a limited fishery in the area in the future. However, it was difficult to draw conclusions about trends in CPUE since the number of hauls made in some years was quite low. Submission of all haul-by-haul catch, effort and biological data from these exploratory cruises was strongly encouraged so that the Working Group might attempt detailed analyses at a future meeting.

3.18 Prof. G. Duhamel (France) informed the Working Group that France was considering a comprehensive research survey in Subarea 58.6 for 1997, which should contribute to such an assessment. The Working Group especially welcomed this news. He also informed the meeting that

France had carried out a myctophid survey around Kerguelen (Division 58.5.1) in 1995. This survey was conducted simultaneously with a study of king penguin foraging and diet. The results will be presented at the next meeting of WG-FSA. The attention of the Working Group on Ecosystem Monitoring and Management (WG-EMM) was drawn to this study.

3.19 Paper WG-FSA-95/11 described ichthyoplankton samples obtained during the Italian oceanographic cruise in the western Ross Sea (Subarea 88.1) in November/December 1994 (see also paragraph 3.30). *P. antarcticum* was the most abundant post larvae and juvenile fish followed by *Chionodraco* spp. A high number of larvae of *Trematomus lepidorhinus* were found in a single station in Terra Nova Bay, but were absent from all other stations. Both abundance and diversity of fish larvae were greater inshore than offshore.

3.20 The Working Group welcomed this study, from an area where there is little information on larval fish distribution, and noted that although there has never been a fishery in the area, *P. antarcticum* has been taken in the past by commercial vessels in Area 58.

3.21 Paper WG-FSA-95/6 described the results of exploratory fishing for *D. eleginoides* to the immediate west of Macquarie Island. Although this island is not within the Convention Area, this fishery has some similarities with CCAMLR fisheries for *D. eleginoides*. Despite repeated trawling in the same location for six weeks, CPUE was highly variable, showed no evidence of systematic depletion, and appeared to increase following storms. These changes were interpreted as evidence of fish movement, possibly following oceanographically induced changes in prey distribution. The Working Group agreed that the paper provided further argument for the collection of environmental variables in other *D. eleginoides* fisheries.

Selectivity Studies

3.22 Dr Everson drew the attention of the Working Group to a recent report of the ICES Working Group on Fishing Technology and Fish Behaviour (ICES CM 1995/B:2) which included reports of the Study Group on Unaccounted Mortality (ICES CM 1995/B:1 Ref. Assess) and the Sub-group on Selectivity Methods.

3.23 The Study Group had considered the following components of fishing mortality: landed catch, illegal and misreported landings, discard mortality, escape mortality, ghost fishing mortality, avoidance mortality, predation mortality and habitat degradation mortality. It was recognised that the relative magnitudes of each of these would vary according to target species, locality and gear. A key factor in determining mortality arising from the stress associated with either escape or avoidance of gear was the size and condition of the fish and it was noted that in a recent study, contrary to expectation, mortality is higher in small fish when compared to larger fish escaping from trawls.

3.24 The Sub-group on Selectivity Methods has prepared a draft 'Manual on Recommended Methodology of Selectivity Experiments' which would be finalised later in the year for presentation to the 1995 ICES Annual Science Conference.

3.25 The Working Group welcomed these developments and asked the Secretariat to request copies of future reports from the ICES Secretariat.

Fish and Crab Biology/Demography/Ecology

Taxonomy

3.26 Papers WG-FSA-95/8 and 9, available as abstracts, review the genus *Channichthys* and describe four new species. The subject had been discussed during a recent meeting of the Antarctic Fish Network of the European Science Foundation in Liege, Belgium, at which doubts had been raised regarding the validity of the proposed species. The Working Group was unable to comment at this stage.

Reproduction

3.27 Ovarian maturation rates in three Channichthyids from South Georgia are discussed in WG-FSA-95/32. It is concluded that the transition from immature to spawning in female fish takes about one year for *Champsocephalus gunnari* and *Pseudochaenichthys georgianus*. For *Chaenocephalus aceratus* this transition is thought to take about four years. It is concluded that, as a general rule, the spawning stock biomass should be based on fish of maturity stage III-V and not stage II-V.

3.28 Information on sex ratios and maturity stages for *D. eleginoides* was presented in the reports of two CCAMLR scientific observers. Catches from *Itkul* (WG-FSA-95/12) tended to contain more male than female fish. The sex ratio of fish from *Ihn Sung 66* (WG-FSA-95/16) was approximately 50:50, but varied greatly from haul to haul, probably indicating a high degree of mobility of the fish. In both studies many of the larger fish were coming into maturity stage III, confirming that the spawning season was likely to be near to the middle of winter.

3.29 The need for closer standardisation of technique when determining maturity stages for *D. eleginoides* had been identified as a priority task for action following WS-MAD (Appendix E, paragraph 2.24).

Larval Fish Distribution

3.30 Paper WG-FSA-95/11, based on a recent survey, describes the distribution of larval fish in the Ross Sea (see also paragraph 3.19). Although there was one haul containing large numbers of *T. lepidorhinus* (larvae), the dominant species in the catches was *P. antarcticum* (post larvae and juveniles). The largest catches of early life history stages of *P. antarcticum* were made to the southern end of the survey area.

3.31 Paper WG-FSA-95/7 describes the distribution of larvae and assumed spawning areas of *Electrona carlsbergi* in the southwest Atlantic. Survey results indicate that the main spawning areas are in the sub-Antarctic and sub-Tropical Frontal Zones and that the fish migrate into the Antarctic Polar Frontal Zone to feed. These observations therefore corroborated information previously supplied to the Working Group.

Feeding and Diet

3.32 Information from *D. eleginoides* taken on longlines presented in WG-FSA-95/12 and 16 indicates that, of the less than 10% of fish with food in their stomachs, over half had fish in their stomachs. Other major components were crabs and squid. It was felt that such results would be biased for two reasons. Firstly, because hook-caught fish were actively searching for food and therefore likely to have empty stomachs and secondly, because when hooked they are likely to regurgitate their stomach contents. In view of these biases, the Working Group considered whether it was worth continuing to recommend that such data be collected by scientific observers. It was agreed that, although the data would be of limited quantitative value, they did provide qualitative estimates of value in an ecosystem analysis.

3.33 Information from *C. gunnari* in Subarea 48.3 during February 1995 in WG-FSA-95/36 indicates that around South Georgia the fish were feeding predominantly on crustacea, taking approximately equal proportions of *Euphausia superba* and the Hyperiid amphipod *Themisto*. In the vicinity of Shag Rocks a much larger proportion of *Themisto* was present in the stomachs. Fish represented only a very small proportion of the diet at both sites. These results suggest that the availability of krill around South Georgia was about average.

3.34 At Kerguelen there was a seasonal change in the diet of *C. gunnari*, which during November were feeding almost totally on the euphausiid *E. frigida*, to January, February and March 1995 when the dominant component in the diet was hyperiid amphipods (WG-FSA-95/13). *C. gunnari* at Kerguelen are thought to be major food for the larger icefish *Channichthys rhinoceratus*.

3.35 Studies on feeding, particularly involving krill, had been highlighted at WG-EMM. The Working Group emphasised the need for such studies to be based on large sample sizes and also that the sampling design should take account of the aggregated distribution of *C. gunnari*.

Parasites

3.36 The metazoan endoparasitic fauna found in *D. eleginoides* is described in WG-FSA-95/28. The frequency of occurrence and abundance of eleven parasites had been recorded from fish from Chile, Patagonia and South Georgia. These had been compared with published information from the sub-Antarctic islands in the Indian Ocean. The infestation ratios and parasite species indicate that there is a slightly closer relationship between fish from Subarea 48.3 and the Indian Ocean sector than between fish from Subarea 48.3 and South America. The Working Group considered that this similarity was due to similar host parasite cycles being present at South Georgia and the Indian Ocean sites rather than a real closeness of breeding populations and therefore urged caution in drawing conclusions on the distribution of stocks from parasite information alone.

Age Determination and Growth

3.37 Papers dealing with age determination of *D. eleginoides* were considered during WS-MAD and the conclusions summarised in the Workshop report (Appendix E).

3.38 During recent seasons, collections of otoliths and scales from *D. eleginoides* had been made as a result of the CCAMLR Scheme of International Scientific Observation. It was accepted that extensive analysis of these samples should await further study on otolith and scale reading but in the meantime summary information on samples should be forwarded to CCAMLR.

Developments in Assessment Methods

3.39 Developments and evaluations of assessment methods were presented in WG-FSA-95/33 and 41.

3.40 Paper WG-FSA-95/33 reviewed the use of stock depletion models based on longline catch data for the assessment of *D. eleginoides* in Subarea 48.3 and in Chilean waters. This was an extension of analyses conducted for the Working Group last year (WG-FSA-94/24[2]; see SC-CAMLR-XIII, Annex 4, paragraphs 4.8 to 4.12 for discussion) but extended the analysis to include appropriate commercial and experimental data from the four following sources:

(i) commercial fisheries data in the CCAMLR database from Chilean longline vessels operating in Subarea 48.3 and adjacent areas during 1991/92 (22 data sets) and 1992/93 (60 data sets);

(ii) data from the commercial fishery for *D. eleginoides* toothfish off Valdivia, Chile in mid-1992 (four data sets);

(iii) data from experimental fishing in southern Chile in 1991 and 1992 (15 data sets); and

(iv) depletion experiments undertaken in Subarea 48.3 during the 1993/94 fishing season (six data sets).

3.41 The paper presented the results from applying the Leslie depletion method (Leslie and Davis, 1939[3]) to the suitable series of data. One hundred and seven data series were found to fulfil the required criteria of single vessels operating in a localised area for a period of several days. Of these, 18 (17%) showed significant negative slopes (one tailed *t*-test to detect significant negative slope, $p < 0.05$). The paper concluded that applying this model to longline catch data for assessing the abundance of *D. eleginoides* is not generally appropriate on the scale of single longline vessels operating in localised areas. Two factors were identified as being potentially important: (i) *D. eleginoides* is probably a highly mobile predator; and (ii) the relationship between catch per hook and abundance may not be able to be described by the simple linear model applied in this analysis.

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[2] Parkes, G. and G. Pilling. 1994. Comments on the use of stock depletion models for the assessment of local abundance of toothfish in Subarea 48.3 and adjacent waters. Document *WG-FSA-94/24*. CCAMLR, Hobart, Australia.

[3] Leslie, P.H. and D.H.S. Davis. 1939. An attempt to determine the absolute number of rats on a given area. *J. Anim. Ecol.*, 8: 94-113.

3.42 Paper WG-FSA-95/26 provided an assessment of the Falkland/Malvinas longline fishery for *D. eleginoides*, examining trends in CPUE data between 1994 and mid-1995. Some data were also able to be analysed using the Leslie depletion method. A trend of declining CPUE in 1994 was followed by an increase in 1995. The paper concluded that the assumption that no fish move into or out of the area being analysed was violated; the declines and increases in CPUE may have arisen from either short-term or seasonal migrations of fish through the area.

3.43 The Working Group agreed that the mobility of these fish is likely to influence CPUE. Understanding the migratory patterns of these fish (over large geographic areas, with depth and timing within seasons) will be an important factor in understanding how applicable these models are to assessments of this stock. Despite this, many of the data series showed strong temporal trends in CPUE even though the overall trends were highly variable and the regressions not significantly negative. Analyses presented elsewhere (WG-FSA-95/6; paragraphs 5.17 to 5.21) showed that trends in CPUE can be influenced greatly by vessel, season and weather conditions. These factors may have confounded these analyses and should be incorporated into future analyses of this type.

3.44 Paper WG-FSA-95/41 presents the development of a general yield model, extending the application of the krill yield model to assessments of fish stocks generally as discussed in 1994 (SC-CAMLR-XIII, Annex 4, paragraph 7.4). The new version incorporates a standard application of differential equations to solving fishery problems. It provides flexibility in assessing the influence of different patterns of growth, natural mortality, spawning and fishing on the estimates of yield per recruit. In a similar manner to the krill model, it can evaluate the performance of a stock under different catch regimes, nominated either as a proportion of the pre-exploitation biomass (γ) or as a specified catch. The model uses an adaptive Runge-Kutta procedure to calculate catches over each year by integrating a set of differential equations which incorporate functions that specify the rate of change or magnitude of parameters, such as growth, mortality, age-dependent selectivity and seasonal patterns in fishing mortality, at specified time intervals during the year. This model also includes an option for a stock to experience a known catch history before the constant catch regime is introduced.

3.45 The method for the projections and the way in which the spawning stock is modelled under specified catch regimes during simulations is presented in Appendix F. The model will be further refined over the intersessional period.

3.46 The results from the program were checked by running the input parameters of two models from Butterworth et al. (1994)[4] and by using the program to conduct a yield-per-recruit analysis to

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

compare with the CCAMLR software for a Thompson and Bell yield-per-recruit analysis. The outputs from the new program were comparable with these two programs which had been previously verified by the CCAMLR Data Manager.

3.47 On the basis of these results, the Working Group accepted the model for use in assessment work at this meeting and requested that the CCAMLR Data Manager validate the program in the intersessional period. The Working Group noted that a general model of this kind is now required for routine stock assessments and thanked the authors for producing the new program for use at this meeting.

REPORT OF THE WORKSHOP ON METHODS FOR THE ASSESSMENT OF *DISSOSTICHUS ELEGINOIDES*

4.1 The Workshop on Methods for the Assessment of *Dissostichus eleginoides* (WS-MAD) was held at CCAMLR Headquarters, Hobart, Australia from 5 to 9 October 1995. The main aim of the Workshop was to develop methods for assessing the biomass and status of *D. eleginoides* stocks. The full terms of reference of the Workshop are given in SC-CAMLR-XIII, paragraph 2.17.

4.2 In addition to participants from Member States, two invited experts, Mr D. Japp from the Sea Fisheries Research Institute, South Africa and Dr A. Zuleta from the Instituto de Fomento Pesquero, Chile, also participated in the Workshop.

4.3 The Workshop first reviewed the approaches taken in previous CCAMLR assessments of *D. eleginoides*, and the approaches used in the assessments of the longline fishery for *D. eleginoides* in Chile and the trawl and longline fishery for hake in South Africa. Key problem areas in CCAMLR assessments were identified and potential solutions were discussed.

4.4 A brief summary of key sections of the Workshop report (Appendix E) is given below.

Biology and Demography

4.5 Shortcomings have been noticed in ageing *D. eleginoides* using both otoliths and scales. These would affect the accuracy of age/length keys derived from the estimated ages. Further efforts are needed to improve age determination using both methods. Also, experiments need to be designed and undertaken to determine the magnitude of biases in estimated age/length keys caused by the use of different hook types and sizes, and different bait sizes and species.

4.6 Existing age and length data were reviewed, and a table of estimates of size-at-age was prepared using data from trawl catches, trawl surveys and longline catches. In addition, revised estimates of von Bertalanffy growth parameters were calculated using a non-linear estimation procedure.

4.7 There is no precise information on the spawning location of *D. eleginoides*. The maturity scale developed for nototheniids has been used by observers examining catches from the *D. eleginoides* fishery. However, results from scientific observer reports indicated that there had been difficulties in recognising specific maturity stages. The Workshop recommended a number of detailed investigations designed to refine estimates of age-at-maturity.

4.8 *D. eleginoides* has a widespread distribution in the sub-Antarctic zone, being found off the east and west coasts of South America, South Georgia and Shag Rocks, South Sandwich Islands, Kerguelen Plateau, Crozet Island, Ob and Lena Banks, and Macquarie Ridge. There are, however, some areas of uncertainty, including the southern limit of distribution in the South Orkney/Antarctic Peninsula and southern Kerguelen Plateau areas, where the distribution may be confused with that of *Dissostichus mawsoni*. Recent findings of *D. eleginoides* on the South African shelf and the Campbell Plateau south of New Zealand, as well as a much larger population than previously thought on the Macquarie Ridge, demonstrate that our knowledge of the distribution of this species is still imperfect. It is likely that fish occur in other areas which have not yet been investigated.

4.9 Information on the extent and timing of movements was reviewed. Some information exists for possible movements on a time-scale of a few days from depletion experiments, and there is weak evidence relating to seasonal movements. The presence of larger fish in deeper water seems well established, and data from the Chilean fishery indicate that *D. eleginoides* apparently can move in depths to around 3 000 m. However, there is no information on the extent to which *D. eleginoides* is capable of movement over long distances in midwater. There is no direct information on movements between geographic areas but there is some indirect information from parasite loadings that the Chilean population is split at 47°S. Parasite loadings also suggest that fish from southern Chile to the southern Patagonian shelf have similar origins. There are greater differences between fish from the southern Patagonian shelf and South Georgia, which may reflect different host-parasite cycles (see paragraph 3.36).

4.10 The Workshop agreed that the most promising method for obtaining direct observations on movements on all temporal and spatial scales was from tagging experiments in commercial fishing areas, and it recommended that high priority be given to such studies in the future.

4.11 There do not appear to be any known spawning or feeding aggregations, but many fisheries exploit areas of consistently higher than average abundance. Acoustic methods using deep-towed bodies may provide some information on this. There is also no information at present on the number of stocks of *D. eleginoides*. Direct investigation by analysis of mitochondrial DNA has encountered technical problems.

Abundance

4.12 The Workshop reviewed a variety of methods for estimating the abundance of *D. eleginoides*. A number of attempts have been made to estimate local abundance using CPUE data from depletion experiments, but no consistent depletion has been detected. Longer term depletion-type analyses using CPUE data have also been attempted by WG-FSA at previous meetings, but these too have not revealed any consistent patterns.

4.13 Since this lack of consistency might be the result of a large number of variables influencing the CPUE and its relationship with abundance, standardisation of the CPUE series was considered to be a high priority. An analysis of the CPUE data using Generalised Linear Models (GLMs) was initiated during the Workshop.

4.14 A large number of bottom trawl surveys have been undertaken on the shelf in Subarea 48.3 during the last 20 years. These surveys were not targetted specifically at *D. eleginoides*, covering only the shallower part of their range, however, catches of young fish were occasionally taken. The Workshop initiated an analysis of fish density-at-length in order to develop an index of recruitment to the size classes fished by longlines.

Estimates of Total Catches

4.15 Circumstantial evidence and confidential records indicate clearly that the reported catches of *D. eleginoides* by longliners in Subarea 48.3 and adjacent banks do not represent the true level of removals. Since many of the methods of estimating the abundance of *D. eleginoides* rely on estimates of total removals, the Workshop agreed that every effort should be made to estimate these as accurately as possible.

4.16 The Workshop agreed on a procedure for estimating total removals that required the use of confidential records which are not officially available. The resulting estimates of real catches are shown in Table 3 of Appendix E.

4.17 The estimated total removal in Table 3 for each year is an approximation and it is likely to be slightly underestimated. However, it is apparent that over the last four years the reported catch is only about 40% of the total catch from Subarea 48.3 and adjacent areas.

Yield

4.18 Estimates of sustainable yields in previous CCAMLR assessments of *D. eleginoides* have been calculated from yield-per-recruit analyses. An alternative method for estimating precautionary yields has been used for the myctophid *E. carlsbergi* (WG-FSA-94/21[5]), similar to the method originally developed for estimating precautionary total allowable catches (TACs) for krill. A generalised version of this fish yield model was presented to the Workshop (WG-FSA-95/41). This model takes account of both demographic uncertainty and stochastic variability in recruitment.

4.19 The Workshop also discussed other assessment methodologies that might overcome some of the difficulties previously encountered in CCAMLR stock assessments for *D. eleginoides*. These are listed in paragraph 2.72 of the Workshop report (Appendix E).

Recommendations to WG-FSA

4.20 As a result of its discussions, the Workshop developed recommendations under four main areas:

A. An experimental approach to assessing stock abundance must be initiated.
B. Data consistency and quality from the commercial fishery must be improved.
C. Estimates of biological and demographic parameters must be improved.
D. Specific recommendations for assessments at WG-FSA-95 should be made.

The detailed recommendations are listed in paragraph 4.1 of the Workshop report (Appendix E).

4.21 The Working Group observed that the key recommendations of the Workshop related to the accuracy of estimates of total catches, the need for the development of new assessment methods,

[5] Constable, A.J. and W.K. de la Mare. 1994. Revised estimates of yield for *Electrona carlsbergi* based on a generalised version of the CCAMLR krill yield model. Document *WG-FSA-94/21*. CCAMLR, Hobart, Australia.

and the need for a directed research program. In relation to the need for a directed research program, it was emphasised that it is no longer possible to rely on fishery-dependent data alone.

4.22 The Working Group endorsed all the recommendations of the Workshop.

ASSESSMENTS AND MANAGEMENT ADVICE

New Fisheries

5.1 CCAMLR received one proposal for a new fishery in 1995, from Australia (CCAMLR-XIV/8). The proposal was for a single trawler to undertake an exploratory cruise in Division 58.5.2 (Heard Island) to explore deeper water than has hitherto been investigated by Australian research cruises (>800 m), and Division 58.4.3 (Elan and Banzare Banks) for which there are no records of fishing or research except one paper submitted to the present meeting (WG-FSA-95/47).

5.2 A wide range of data will be collected by an on-board observer (detailed in CCAMLR-XIV/8). This information will be analysed by Australian scientists and presented at the next meeting of WG-FSA.

5.3 The Working Group congratulated Australia on the detail contained within the proposal. Of particular note was the assurance that the vessel would carry a transponder on board and that the vessel's position would be monitored using a vessel monitoring system by Australia.

5.4 The Working Group agreed that considering the paucity of existing information on the resources in Division 58.4.3, and the experience of the exploratory fishery in the South Sandwich Islands in 1993, for which similarly little was known (CCAMLR-XI/7[6]), the TACs suggested in the proposal would be unlikely to adversely affect the stocks in Division 58.4.3. It also agreed that bearing in mind that TACs already applied to *D. eleginoides* and *C. gunnari* in Division 58.5.2 (Conservation Measure 78/XIII), the suggested TACs for other species caught in the new exploratory cruise in that area were unlikely to cause problems. The full set of TAC proposals is listed in Table 3.

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[6] Delegation of Chile. 1992. Application for permit to carry out exploration around the South Sandwich Islands in order to determine the feasibility of a new fishery. Document *CCAMLR-XI/7*. CCAMLR, Hobart, Australia.

Table 3: Recommended TACs for the new fisheries proposed by Australia in Divisions 58.5.2 and 58.4.3.

Area	Species	TAC
Division 58.5.2 (new exploratory deep-water fishery)	*D. eleginoides*	No additional TAC: catches to be part of the 297 tonnes currently set by Conservation Measure 78/XIII
	C. gunnari	No additional TAC: catches to be part of the 311 tonnes currently set by Conservation Measure 78/XIII
	L. squamifrons, N. rossii, *C. rhinoceratus* and *Bathyraja* spp.	By-catch limitation of 5% of the catch in any haul
	Other species	50 tonnes each species
Division 58.4.3 Elan and Banzare Banks	*D. eleginoides* and *D. mawsoni*	200 tonnes combined catch
	Other species	50 tonnes each species

5.5 Bearing in mind that previous research surveys in Division 58.5.2 found a low biomass of *L. squamifrons, N. rossii, C. rhinoceratus* and *Bathyraja* spp., and that there is no TAC or prohibition on directed fishing for these species in this division, the Working Group suggested that a by-catch limitation should be considered, along the lines of that in Conservation Measure 84/XIII, paragraph 7. The relevant part of Conservation Measure 84/XIII, paragraph 7 with suggested insertions, reads:

> 'If, in the course of the directed fishery [for *D. eleginoides* or *D. mawsoni*], the by-catch of any one haul of any of the species [*Lepidonotothen squamifrons, Notothenia rossii, Channichthys rhinoceratus* and *Bathyraja* spp] exceeds 5%, the fishing vessel shall move to another fishing ground ...'

5.6 The Working Group also recommended that in order to maximise the use to which information from the exploratory cruises could be put, fishing should take place over as large a geographical and bathymetric range as possible. In particular, areas where concentrations of fish are found should not be the only areas that are fished.

5.7 It was noted that both the new fishery for *D. eleginoides* in Subarea 48.4 which took place in 1993 (CCAMLR-XI/7) and this proposal in Divisions 58.5.2 and 58.4.3, were limited to a single vessel. The Working Group considered that this effort limitation was entirely appropriate for a new fishery.

South Georgia (Subarea 48.3)

Dissostichus eleginoides (Subarea 48.3)

Brief Review of 1994/95 Season and History of the Fishery

Catch and Effort Data

5.8 The total reported catch of *D. eleginoides* in Subarea 48.3 during the 1994/95 split-year was 3 241 tonnes. The catch was taken entirely by longline vessels, including six from Chile, five from Argentina, one from Bulgaria, one from the Republic of Korea and one from Russia. The catches by month are shown in Table 4.

Table 4: Catches by month from Subarea 48.3 reported to CCAMLR during the 1994/95 split-year. The catch in the 1994/95 season, from 1 March to 16 May 1995, was 3 062 tonnes.

Month	Total Catch of *D. eleginoides* (tonnes)
July	72.8
August	71.7
September	34.9
March	1278.4
April	1333.9
May	449.8
Total	3241.5

5.9 Longline fishing effort was again concentrated in patches on the 1 000 m contour around both South Georgia and Shag Rocks (Figure 1). No information was available to the Working Group on locations of catches on banks adjacent to Subarea 48.3 (North and Rhine Banks).

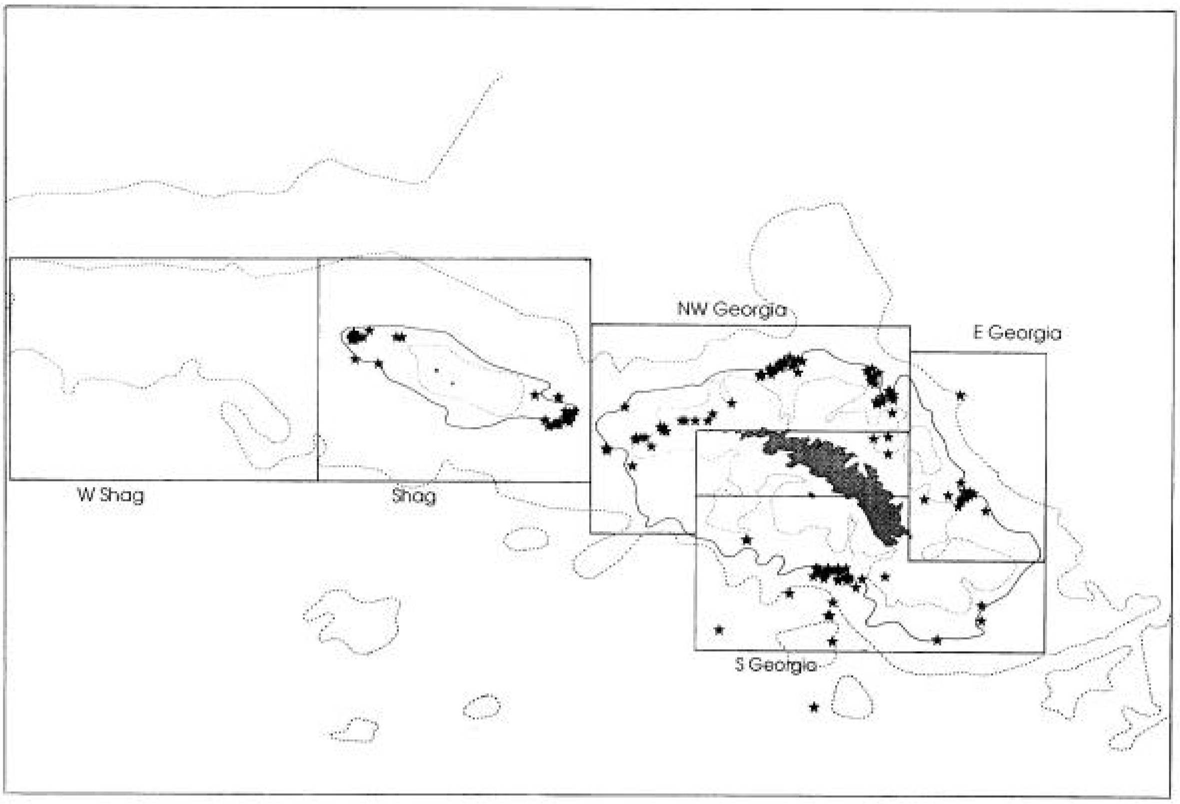

Figure 1: Locations of longline catches in Subarea 48.3 during 1994/95. Boxes indicate boundaries of areas used for GLM analysis (paragraphs 5.22 to 5.48).

5.10 At last year's meeting the Working Group requested that data on catches of *D. eleginoides* taken in areas of the southwest Atlantic, which are outside the Convention Area, be sought and compiled by the Secretariat. These data have been provided and are shown in Table 5.

Table 5: Catches by year from Statistical Areas 41 (southwest Atlantic), 87 (southeast Pacific), 48 (Atlantic Ocean sector) and 58 (Indian Ocean sector) for the period 1977 to 1994. Note that catches for CCAMLR Areas (48 and 58) are shown by split-year, but catches for Areas 41 and 87 are shown for calendar years from FAO and national statistics.

Year	Area 41	Area 87(1)	Total Adjacent Areas	Area 48	Area 58	Total CCAMLR Areas
1977	1096		1096	441	16	457
1978	2257		2257	2020	638	2658
1979	338		338	331	28	359
1980	843		843	261	208	469
1981	787		787	322	59	381
1982	612		612	354	287	641
1983	417	2	419	116	153	269
1984	325		325	109	153	262
1985	7174	375	7549	294	6685	6979
1986	1188	877	2065	564	494	1058
1987	5711	953	6664	1199	3186	4385
1988	3791	504	4295	1809	1053	2862
1989	7374	2002	9376	4138	1722	5860
1990	11757	3771	15528	8156	1075	9231
1991	7818	6523	14341	3640	1973	5613
1992	15461	10384	25845	3842	8750	12592
1993	9604	5972	15576	3089	2700	5789
1994	4814	5928	8004	460	5139	5599
Total	81367	37291	115920	31145	34319	65464

5.11 WS-MAD had reviewed the catch data for *D. eleginoides*. The importance of having as complete information as possible on removals of fish for the purposes of stock assessment was stressed by the Workshop. Circumstantial evidence and information from confidential sources indicated that the reported catches from the longline fishery in Subarea 48.3 did not represent the true level of removals (Appendix E, paragraph 3.2). The Workshop attempted to estimate the total removals from Subarea 48.3 and adjacent banks (North and Rhine Banks) using all available sources of data (Appendix E, paragraph 3.3). The results of this work are shown in Table 6.

Table 6: Estimated catches of *D. eleginoides* in Subarea 48.3 and adjacent Rhine and North Banks and TACs agreed by the Commission for Subarea 48.3.

Split-year	TAC (tonnes)	CCAMLR Catch (tonnes)	Estimate of Additional Catch	Best Estimate of Real Catches[1]
1990	-	8156.0	345	8501.0
1991	2500	3639.0	565	4206.0
1992	3500	3841.6	3470	6309.6
1993	3350	3088.5[4]	2500	5588.5
1994	1300	459.5[3]	6145	6604.5
1995	2800	3301.1[2]	2870	6171.1

1 Includes the adjacent banks.

2 Includes 180 tonnes taken by Bulgaria in August 1994, and 59 tonnes taken outside Subarea 48.3 on Rhine and North Banks but reported to CCAMLR. The total catch reported from Subarea 48.3 for the 1994/95 season (1 March to 16 May) was therefore 3 062 tonnes.

3 180 tonnes of this TAC was taken after 1 July and appears below, under 1995.

4 Fishery closed early due to non-reporting of zero catches. Closure date was projected from previous non-zero catch rates. In all other cases, the difference between TAC and actual catch is due to differences between 5-day reports and final reports from the fishery.

5.12 Paper WG-FSA-95/25 Rev. 2 reported on a comparison of catch data reported to CCAMLR and information acquired by the UK from some longline vessels fishing in Subarea 48.3. This paper was reviewed under section 3 of the Agenda (paragraph 3.8).

Scientific Observer Reports

5.13 For the second year running, all longline vessels operating in Subarea 48.3 were required to have on board scientific observers appointed under the CCAMLR Scheme of Scientific Observation. The Working Group received a number of reports from observers, which were reviewed under section 3 of the Agenda (paragraphs 3.12 to 3.14).

5.14 In relation to the stock assessment of *D. eleginoides*, the Working Group was particularly interested in factors reported by scientific observers which affected the recording of total catch and CPUE. These included the following:

Factors affecting the recording of total catch:

- methods used to estimate the total weight and numbers of fish caught from the processed catch, including conversion factors. In some cases conversion factors recorded by scientific observers differed from those reported with the commercial data (paragraph 3.9);

- numbers and weight of fish discarded, which may not be included in the calculation of total catch, including the occurrence of the jellymeat condition; and

- loss rates from hooks, both due to fish falling from hooks before they reach the vessel and predation by marine mammals.

Factors affecting the recording of CPUE:

- gear loss: significant differences between the numbers of hooks deployed and the number of hooks recovered would affect the recording of CPUE; and

- baiting efficiency: this was particularly important for vessels using the autoliner system. If baiting efficiency changes over time due to changes in the set up of the automatic baiting system, this could significantly affect CPUE.

5.15 In relation to the second category (factors affecting CPUE), the Working Group also noted the apparent non-reporting of zero catches reported in WG-FSA-95/25 Rev. 2.

5.16 A more systematic approach to the reporting of such information from observations made by scientific observers to CCAMLR would help the Working Group to refine estimates of total removals of fish from the population for use in the assessments. This is discussed further under Agenda Item 11.

Assessment Work Presented to the Working Group

5.17 Paper WG-FSA-95/33 presented a review of the use of stock depletion models for the assessment of local abundance of *D. eleginoides*. This paper was also considered by the Working Group under item 3 of the Agenda (paragraphs 3.40 and 3.41). In general, the results of this analysis indicated that the depletion model was not appropriate for estimating local abundance in Subarea 48.3 and in the *D. eleginoides* fishery in Chilean waters. However, out of the 107 data sets examined 18 showed a significant negative trend in catch per hook. The Working Group considered that this was an indication that some areas might be more susceptible to local depletion than others and this possibility could be investigated further.

5.18 The Working Group endorsed the conclusion of WS-MAD that work on other approaches to stock assessment should take precedence. No further work on local depletion was undertaken by the Working Group at this meeting.

5.19 Paper WG-FSA-95/14 proposed VPA as a possible technique for the assessment of *D. eleginoides*. The Working Group acknowledged that this was likely to be a useful method for the future, however, there was presently insufficient information available, and problems with age determination needed to be overcome. The paper suggested that the FAO VPA program ANACO could be used. The Working Group considered that various VPA packages, including those used previously to assess other stocks in the CCAMLR Convention Area, should be evaluated as part of the future work. However, this work has a low priority at this stage.

Work Undertaken at WG-FSA-95

5.20 WS-MAD made a number of recommendations for future work on the assessment of *D. eleginoides*. A number of these were identified as specific recommendations for assessments at WG-FSA-95 (Appendix E, paragraph 4.1 section D):

(i) the length-density analyses described in Appendix E, paragraphs 3.11 to 3.13 should be completed by WG-FSA during its 1995 meeting;

(ii) WG-FSA should determine which of the estimates of von Bertalanffy growth parameters are appropriate for yield calculations in the light of size selectivity of different fishing methods;

(iii) WG-FSA should perform stock projections and yield analysis using the information derived above; and

(iv) the CPUE standardisation described in Appendix E, paragraph 2.51 should be completed by WG-FSA during its 1995 meeting.

5.21 The Working Group endorsed the recommendations of WS-MAD and agreed that work on the assessment of *D. eleginoides* at this year's meeting would follow these recommendations.

Standardisation of CPUE Indices from the *D. eleginoides* Fishery in Subarea 48.3

5.22 WS-MAD determined that there are probably many factors contributing to variability in CPUE data from the *D. eleginoides* fishery in Subarea 48.3. Since it is important to account for variability in catch rates when conducting assessments, the Workshop considered standardisation of CPUE data from this fishery to be a high priority (Appendix E, paragraphs 2.49 and 2.50).

5.23 GLMs provide a method for working with non-linear responses and non-normal error structures. These characteristics make GLMs well suited for use in the standardisation of CPUE data. Standardisation allows one to study variability in CPUE data by changing one predictor variable while simultaneously controlling for the effects of changes in other predictors.

5.24 The analysis of CPUE data using GLMs was continued by the Working Group. Details of the methodology are provided in Appendix G. The method was applied to time series of *D. eleginoides*

CPUE both in Subarea 48.3 (South Georgia) and Subarea 58.5 (Kerguelen) (paragraphs 5.156 et seq.).

5.25 GLMs were fitted to haul-by-haul data from Subarea 48.3 over the period 1992 to 1995. Data from years prior to 1992 were not available in haul-by-haul format, so they could not be used in the analyses. The data were screened according to the rules outlined in Appendix G.

5.26 The predictor variables (see Appendix G) were used to model four CPUE indices: kilograms per hook, numbers per hook, kilograms per hook-hour, and numbers per hook-hour.

5.27 In general, all four GLMs provided good fits to the CPUE data. Residual deviances (variations in CPUE not explained by the addition of factors and covariates to the model) were between 51% and 63% of the null deviances (variations in CPUE not explained solely by the mean catch rate) (Table 7).

5.28 Results from the GLM analyses indicated that vessel differences were always the most significant component of variability in catch rates (Table 7). Standardised kilogram-per-hook indices varied by an order of magnitude when plotted by vessel (Figure 2). There was a large amount of variability in catch rates between vessels from the Chilean fleet but these vessels generally had higher catch rates than vessels from other fleets.

5.29 The year factor was the second most important component of variability in catch rates (Table 7). Figure 3 plots a time series of each standardised CPUE index from 1992 to 1995. Kilograms per hook and kilogram per hook-hour were more variable in time than numbers per hook and numbers per hook-hour. The time series show no trends in kilogram per hook and kilogram per hook-hour, but numbers per hook and numbers per hook-hour do show trends in time. Numbers per hook increased between 1992 and 1993 and was steady between 1993 and 1995. Numbers per hook-hour generally appear to increase over the time series.

Table 7: Cumulative reductions of residual deviance from GLMs fit to catch rate data. Factors/covariates were entered into the models in order from top to bottom.

Factor/Covariate	Kg/hook	Numbers/hook	Kg/hook-hour	Numbers/hook-hour
Null	1145.7	891.9	2003.6	1532.8
Vessel	757.8	620.1	1208.0	1008.7
Year	695.5	586.4	1091.4	930.6
Month	679.0	578.4	1056.8	908.5
Area	666.6	565.2	1026.5	897.7
Depth	658.4	563.6	1023.9	897.5
Resid Dev/Null Dev	0.57	0.63	0.51	0.59

5.30 Differences between time series of kilograms per hook and numbers per hook suggest that the mean weight of captured *D. eleginoides* has decreased over the course of the fishery (Figure 3). This observation can also be made from the hook-hour time series.

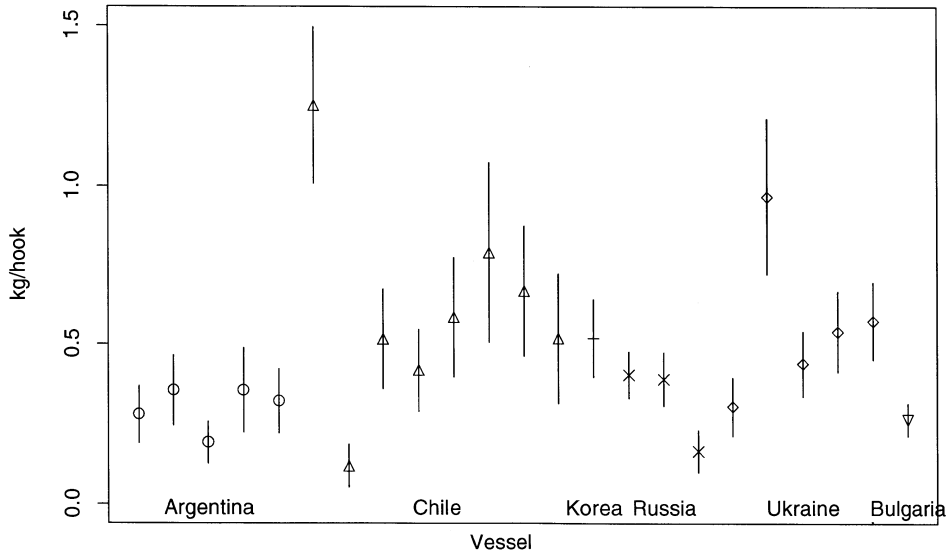

Figure 2: Estimated vessel effects from GLMs fit to CPUE data from the *D. eleginoides* fishery in Subarea 48.3. Hollow points are predicted mean responses and lines represent approximate 95% confidence intervals for the predictions.

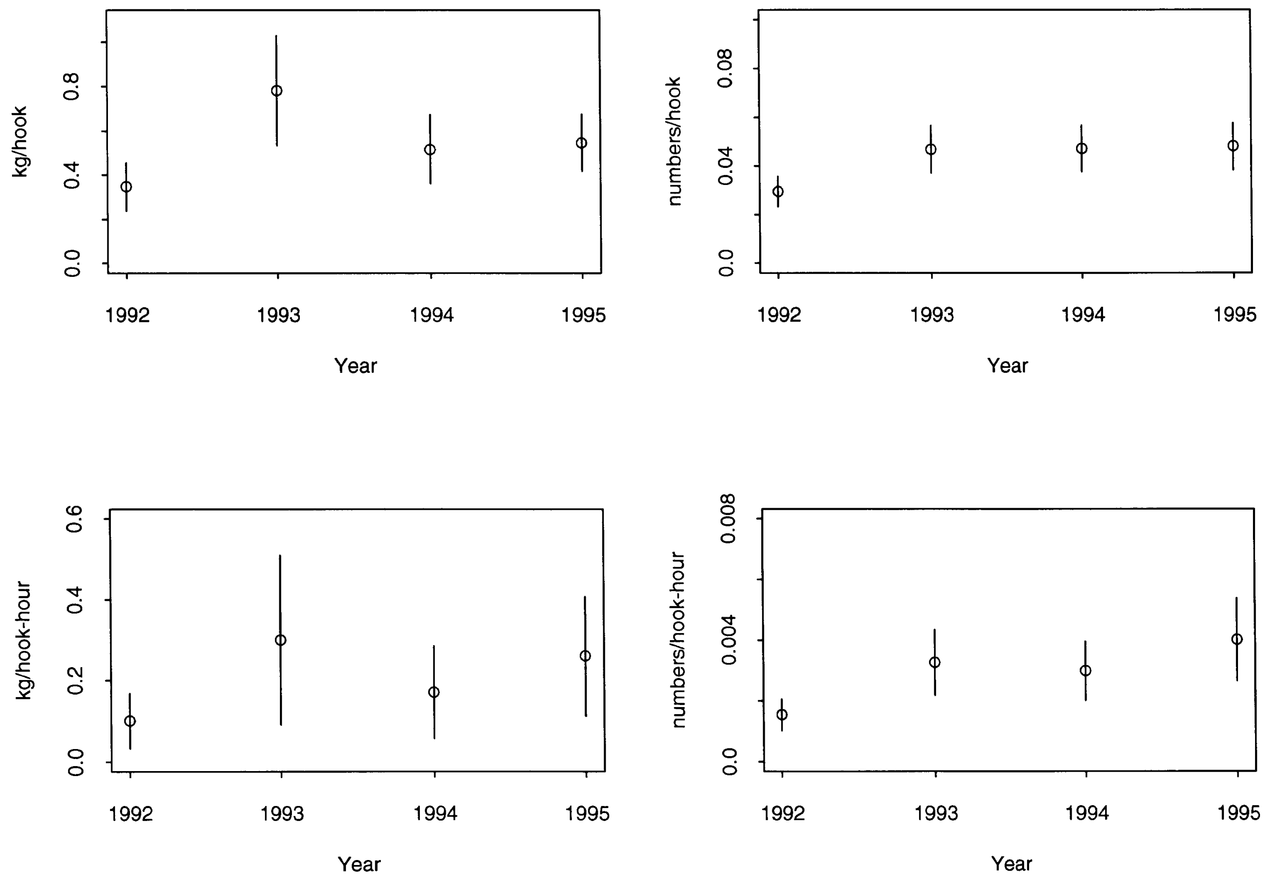

Figure 3: Estimated year effects for four different measures of effort from GLMs fit to CPUE data from the *D. eleginoides* fishery in Subarea 48.3. Hollow points are predicted mean responses and lines represent approximate 95% confidence intervals for the predictions.

5.31 The remaining predictors (month, area, and depth as a covariate) always explained a significant amount of variability in CPUE, but the significance level of these two factors and the single covariate depended on the order in which they were entered into the models.

5.32 All four CPUE indices showed a consistent decrease during July and August, although this was based principally on data from only one vessel fishing during this period in 1994. It was therefore not possible to draw any inference from this result regarding seasonal trends in catch rates. No data were available to estimate month effects for October and November.

5.33 Standardised catch rates from west Shag Rocks (Figure 2) were about half the size of catch rates from the other geographic areas.

5.34 All four CPUE indices were positively correlated with depth, but the rate of change in kilograms per hook with depth was greater than that for numbers per hook (a difference in slopes was also evident when kilograms per hook-hour and numbers per hook-hour were compared). This seemed to support the observation that, on average, larger fish are found in deeper water.

5.35 Since there were differences between catch rates calculated in units of hooks and hook-hours, the Working Group completed a separate GLM analysis using soak time as a continuous covariate rather than as an element of the dependent variable. Results from this analysis suggested that soak time is an important component of the variability in catch rates, but soak time and depth are highly correlated. It was generally felt that calculating soak time as the difference between time at start of setting and time at start of hauling may not be appropriate for this fishery.

Comments on Data Requirements for Standardising CPUE Data

5.36 The Working Group recognised the utility of standardising CPUE data (paragraphs 5.40 to 5.43) and noted that haul-by-haul data are essential for such analyses. The Working Group further noted that, in the future, all of the haul-by-haul data submitted to the Commission should be of the highest possible quality, and that every effort should be made to ensure that all data types are reported.

5.37 The Working Group discussed the possibility of obtaining haul-by-haul data for fishing operations conducted prior to 1992 and concluded that such data would be very useful for future analyses. Members were urged to submit complete data sets as soon as possible.

5.38 The Working Group recognised that there are differences between CPUE indices (Figure 3) and determined that, as a minimum, kilograms per hook, numbers per hook, kilograms per hook-hour, and numbers per hook-hour should be used in future standardised analyses.

5.39 The Working Group determined that additional work should be done on defining an appropriate measure of soak time.

Comments on the Use of Standardised CPUE Indices

5.40 The Working Group considered standardised CPUE indices to be useful in both the short and long term. In the short-term, the standardised CPUE series can be used as an indicator of whether the stock of *D. eleginoides* is overexploited. Standardised catch rates should be more sensitive to declining abundance than non-standardised catch rates, so declines in standardised CPUE between years might indicate that the stock is in danger of being overexploited.

5.41 On a longer term basis, the Working Group considered that standardised CPUE data will be useful for validating predictions from stochastic projections. The current assessment relies on survey data about young fish (paragraphs 5.44 to 5.49) to make predictions about the fate of animals that are just recruiting to the exploited stock. The standardised CPUE data will provide information about older, fully recruited fish and help determine whether the stock is behaving as predicted.

5.42 The Working Group noted that the successful integration of CPUE data into future assessments will be critically dependent on submission of haul-by-haul data from the fishery. The Working Group further emphasised the importance of scientific observers for collecting data to help validate and interpret information submitted by the fishing companies.

5.43 After some years, when more data of sufficient resolution are available, standardised catch rates can be used to tune VPAs and may facilitate the use of long-term depletion studies/production models for assessing *D. eleginoides* in Subarea 48.3. The Working Group noted that for VPAs to be used in future assessments scientific observers would be necessary for collecting information about the age distribution of the catch.

Length-Density Analysis

5.44 The Working Group continued with the analysis of trawl survey data using the length-density method started by WS-MAD.

5.45 The abundance of fish can be estimated from trawl survey data by the swept-area method, in which fish density (the number of fish caught in a known amount of trawling, for example in numbers per square kilometre) is scaled to the total area sampled by the survey. The swept-area method can be extended to estimate the number of fish in each age class if the trawl survey data can be expressed in terms of the density of fish at each age in the survey. This could be achieved by direct estimation of the ages of fish in the survey, or, as in this assessment, by an analysis of the length composition of the catches. Analysis of the length composition of the catches can be quite effective for separating age classes in smaller, younger fish because the high growth rates in young fish lead to clear groupings in the length data.

5.46 Paper WG-FSA-95/23 listed 12 trawl surveys in Subarea 48.3 in which *D. eleginoides* have been recorded, the data from which are stored in the CCAMLR database. The length-density analysis requires that length compositions of the catch from each haul be expressed in terms of density (e.g., numbers of fish per seabed area swept by the trawl). Technical problems were encountered in linking sample length distributions from survey hauls in the CCAMLR database to the total numbers of fish caught in those hauls. It was therefore not possible during the Working Group meeting to use the survey data stored in the CCAMLR database.

5.47 Data were made available to the Working Group from seven of the bottom trawl surveys carried out in Subarea 48.3 over the period 1989 to 1995. These were the UK surveys in 1989, 1990, 1991, 1992 and 1994, and the Argentine surveys in 1994 and 1995. In the event, data from the UK survey in 1989 and the Argentine survey in 1994 were not used. The UK survey in 1989 did not sample at Shag Rocks and was therefore not comparable with the other surveys. There was a problem in the analysis of the data from the 1994 Argentine survey which could not be resolved during the meeting.

5.48 The densities of fish in age classes 3, 4 and 5 for each survey were estimated by fitting a mixture of normal distributions directly to the length data expressed as fish densities in a series of length classes for each haul (Figure 4). The area under each fitted distribution component is assumed to estimate the density of the corresponding age class. Multiplying the age-class densities by the area surveyed leads to an absolute abundance estimate for each age class in the survey year. The mixture distribution has been fitted by maximum likelihood using the method and computer program developed by de la Mare (1994a)[7]. The mixture distributions could not be fitted for two surveys (UK 1990 and UK 1991) because, although there were substantial quantities of fish in some hauls, the number of hauls with fish in them were too few to give a reliable fit. In these cases the fish were allocated to age classes based on the means and standard deviations (SDs) of the mixture components found from fitting to the remainder of the surveys. This could be done with little error because the length distributions of 3-, 4- and 5-year-old fish have very little overlap. Once allocated to age classes, the densities were estimated using the maximum likelihood trawl survey program described in de la Mare (1994b)[8].

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7 de la Mare, W.K. 1994a. Estimating krill recruitment and its variability. *CCAMLR Science*, Vol. 1: 55-69.

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

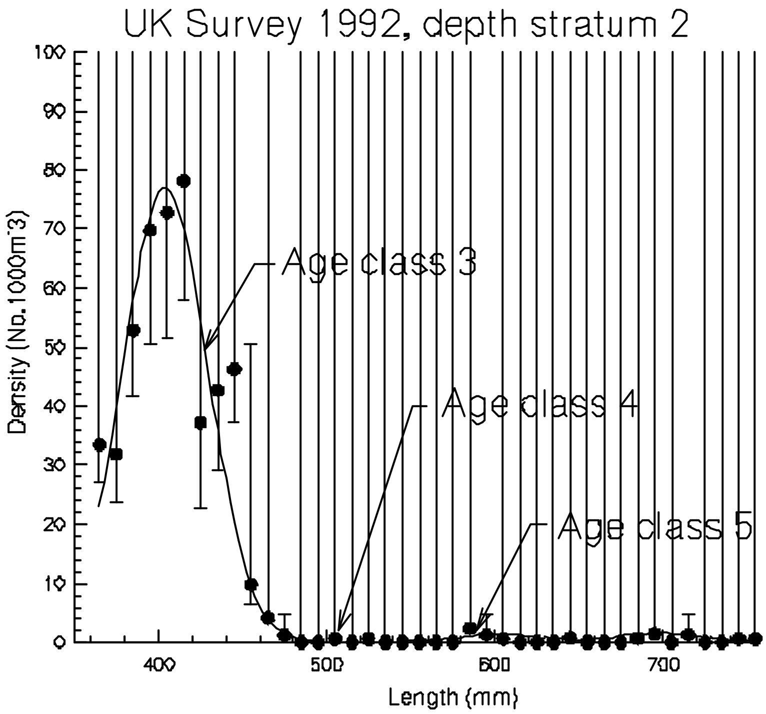

Figure 4: An example of a mixture of normal distributions fitted to a length-density distribution.

5.49 The absolute abundance estimates for each year class in the surveys analysed are shown in Table 8. The number of recruits was standardised to age 4 by correcting the 3- and 5-year-old numbers for the effects of natural mortality. In some cases, the same cohort is represented as a different year class in different surveys. In these cases the number of recruits was estimated from the weighted average of the log recruit numbers from the different surveys. The resultant estimates of recruits at age 4 in each year are given in Table 9. The recruitment estimates were used to estimate a lognormal recruitment function for use in stock projections. The Working Group noted that this procedure assumed that there was no trend in recruitment over the time period of the estimated recruitments. The parameters for this function are given in Table 10.

Table 8: Estimates of abundance by age for *D. eleginoides* Subarea 48.3 (WG-FSA-95) from UK surveys 1990, 1991, 1992 and 1994, and from Argentina 1995, obtained from length-density analyses assuming a catchability coefficient of 1.0 using the seabed areas in Everson and Campbell (1990)*.

Survey	Estimated Abundance-at-Age (millions of fish)					
	N3	SE(N3)	N4	SE(N4)	N5	SE(N5)
ARG 95 S.G.	-	-	1.212	0.599	2.118	0.627
ARG 95 S.R	2.384	1.644	3.360	1.163	1.092	0.726
Total	2.384	1.644	4.572	1.308	3.210	0.959
UK 94 depth 1	0.269	0.172	0.186	0.097	0.208	0.159
UK 94 depth 2	1.306	0.919	1.160	0.262	-	-
UK 94 depth 3	0.456	0.240	0.611	0.231	0.691	0.300
Total	2.031	0.965	1.957	0.363	0.899	0.340
UK 92 depth 1	2.410	0.791	-	-	-	-
UK 92 depth 2	10.236	3.651	0.171	0.949	0.213	0.239
UK 92 depth 3	4.449	1.101	0.879	0.756	0.633	0.443
Total	17.095	3.895	1.050	1.213	0.846	0.503
UK 91 depth 1	0.263	0.118	0.049	0.038	0.107	0.064
UK 91 depth 2	0.109	0.068	0.048	0.024	0.105	0.054
UK 91 depth 3	0.053	-	0.245	0.134	1.294	0.961
Total	0.425	0.136	0.342	0.141	1.506	0.965
UK 90 depth 1	2.680	2.662	12.262	11.239	7.813	7.000
UK 90 depth 2	0.107	0.064	0.150	0.116	0.306	0.191
UK 90 depth 3	0.020	-	0.017	-	0.075	0.056
Total	2.807	2.663	12.429	11.240	8.194	7.003

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

Table 9: Estimates of recruitment at age 4 by year class for *D. eleginoides* in Subarea 48.3. Variance-weighted means of estimated abundances-at-age from Table 8 were adjusted to correspond to age 4 by accounting for natural mortality (M = 0.16).

Year Class	Weighted Mean Recruitment Age 4 (millions)	Biomass (thousand tonnes)
1989	9.616	14.81
1990	3.392	5.22
1991	0.461	0.71
1992	0.391	0.60
1993	7.241	11.15
1994	2.348	3.62
1995	3.531	5.44
1996	2.032	3.13

Table 10: Estimates of parameters of log-normal distribution of annual recruitment at age 4: *D. eleginoides* Subarea 48.3 (WG-FSA-95). Estimates obtained from results in Table 9; estimated mean numbers of recruits calculated by back transformation from logs using variance correction.

Mean log-transformed recruitment	14.637
SD log-transformed recruitment	1.161
Mean numbers of recruits (millions)	4.463
CV numbers of recruits	1.161

Thompson and Bell Yield-Per-Recruit Program

5.50 The CCAMLR Thompson and Bell deterministic yield-per-recruit program was used to estimate the yield per recruit at $F_{0.1}$, as has been done for single species fisheries in the past. The biological parameters used in these calculations are summarised in Table 11.

Table 11: Data inputs into the yield-per-recruit program.

Data Input/parameter	Data
M	0.16
Selectivity (by age)	Selectivity changes from 0 to age 1 between ages 5 and 7 as follows: age 5 = 0.0, age 6 = 0.3, and 7 = 1.0 (age < 5 = 0, age > 7 = 1.0)
Maturity ogive	Maturity at age as follows (starting with age 1): 0.0001, 0.0005, 0.0014, 0.0055, 0.013, 0.036, 0.078, 0.2, 0.33, 0.54, 0.74, 0.84, 0.91, 0.96, 0.98, 0.99, 1.0 (full maturity at age 17)
Growth curve	$K = 0.088$, $L_8 = 170.8$, $t_0 = 0$
Number of age classes	34 with a plus class

5.51 Values of M were re-calculated during the Working Group meeting on the basis of new von Bertalanffy growth parameters, estimated by non-linear methods during WS-MAD (Appendix E, paragraph 2.16). The growth parameters used in estimating M were $L_8 = 170.8$ cm, $t_0 = 0$ and three values of K: 0.08, 0.085 and 0.09. M was estimated using the Beverton and Holt method, as described in WG-FSA-92/21[9]. The length distribution of the unexploited population was taken from exploratory longline catches in 1986. Three values of M were obtained, corresponding to the three values of K: M = 0.152 (K = 0.08), M = 0.161 (K = 0.085), and M = 0.171 (K = 0.09). The value of M in the yield-per-recruit analysis was fixed at 0.16.

5.52 There were problems estimating selectivity of longline gear directly from commercial length frequency data, due to the change in size distribution with depth. Analyses undertaken during WS-MAD indicated major differences between the selectivity of trawl and longline gear, with trawl gear taking smaller fish (Appendix E, Figure 4). Some data were available for areas where trawl and longline gear had been deployed at similar depths. These indicated that small fish may not be taken by longline gear, even if present in the area. Data from Argentina made available to the Working Group during the meeting showed differences in the size distribution of catches taken by trawlers and longliners operating in similar areas on the Patagonian Shelf (Figure 5). These indicated that fish of between 50 cm and 185 cm were present in the area, but longlines only caught fish of about 75 cm and larger. There was no depth overlap between the trawl survey and longline catches taken in Subarea 48.3 (Figure 6). However, length distributions of the catch from the 1994/95 season

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9 Moreno, C.A. and P.S. Rubilar. 1992. Remarks on natural mortality of *Dissostichus eleginoides* in Subarea 48.3. Document *WG-FSA-92/21*. CCAMLR, Hobart, Australia.

indicated that fish recruited to the longline fishery at smaller lengths than on the Patagonian shelf. For the yield per recruit, selectivity by age was assumed to be quasi knife-edged, changing from 0 to 1 between ages 5 and 7 (Table 11).

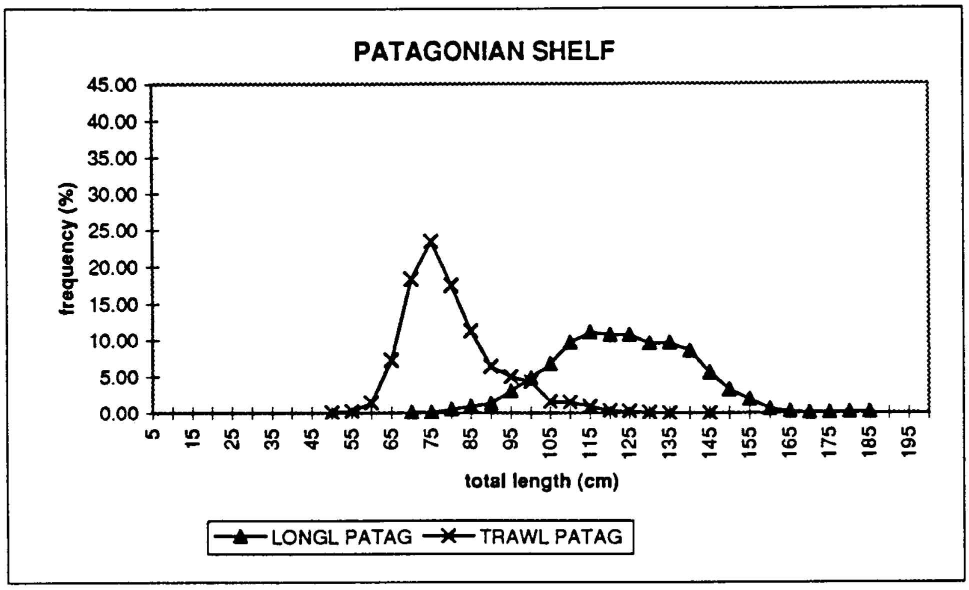

Figure 5: Length composition of catches from Argentinian trawl and longline fishing on the Patagonia shelf.

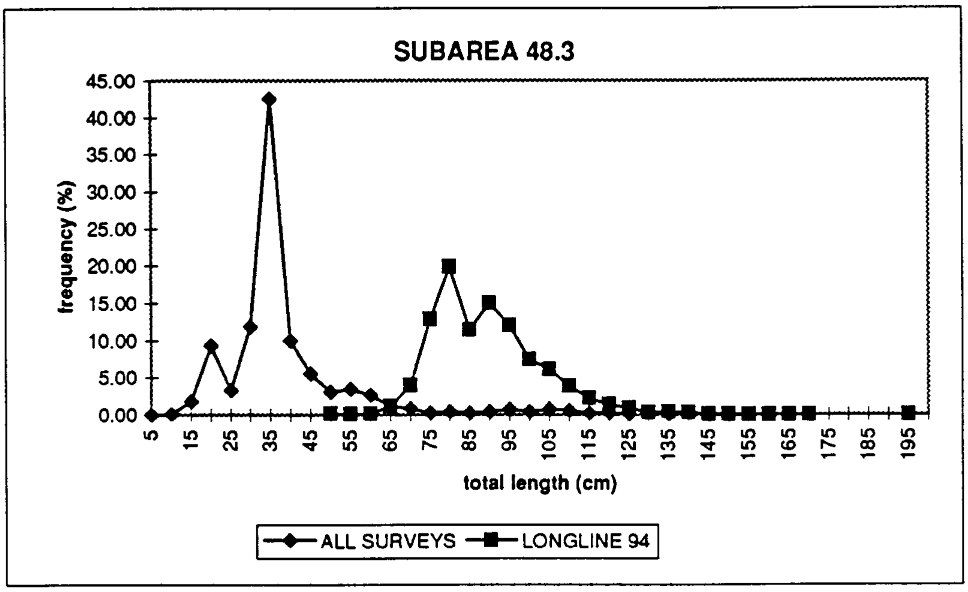

Figure 6: Length composition from trawl surveys and longline fishing in 1994 at South Georgia.

5.53 Percentage maturity-at-age was derived from the length-maturity data analysed by WS-MAD (Appendix E, Figure 2) and estimates of size-at-age from a number of sources (Appendix E, Figure 1).

5.54 The value of $F_{0.1}$ from yield-per-recruit analysis was 0.137, with a yield per recruit (age 1) of 1.72 kg. The estimate of yield at $F_{0.1}$ was 12 400 tonnes, calculated by multiplying the value of yield per recruit (age 1) by an estimate of the mean recruitment at age 1 from the length-density analysis (mean recruitment at age 4 (Table 10) x e^{-3M}).

5.55 The Working Group noted that the yield-per-recruit analysis might be sensitive to variation in some of the input data. It was suggested that sensitivity to the von Bertalanffy growth parameters, the age at which the plus group was fixed and the maturity ogive, should be investigated at a future meeting.

Assessment of Yield Under Conditions of Uncertainty

5.56 The generalised yield model (WG-FSA-95/41), described in paragraphs 3.44 to 3.47, was used to examine the effects of various harvesting strategies under conditions of uncertainty.

5.57 The structure of the new generalised yield model provides for evaluation of the effects of nominated catches on the size of the spawning stock over a specified period. The program takes into account uncertainties in estimates of recruitment and mortality as well as interannual variability in recruitment.

5.58 The yield model was configured to mimic the CCAMLR deterministic yield-per-recruit program in order to test its performance. The results of the two analyses were virtually identical.

5.59 Some of the calculations involved in the assessment needed to be revised due to a misunderstanding about the calculation of some model parameters. This highlights the requirement for sufficient validation and documentation of assessment programs.

Data Inputs

5.60 The data inputs into the yield model are shown in Table 12.

Table 12: Data inputs into the yield model for *D. eleginoides* in Subarea 48.3.

Data input	Data
Recruitment Function	Log transformed recruitment: Mean = 14.637; SD = 1.161
M	Option 1: M fixed at 0.16 Option 2: M randomly selected between 0.1 and 0.2 (uniform distribution)
Selectivity (by length)	L_{50} = 60cm, assumed to change linearly from 0 to 1 over the range 55 cm to 65 cm (this is equivalent to the selectivity by age used in the yield-per-recruit analysis)
Maturity ogive	As per Table 11 (yield per recruit)
Growth curve	As per Table 11 (yield per recruit)
Duration of the projection	35 years
Number of evaluations per run	1 000

5.61 The recruitment function derived from the length-density analysis was used as the basis for the projections using the yield model. The deterministic yield-per-recruit analysis (paragraphs 5.50 to 5.55) indicated that a suitable time period for the projection of the *D. eleginoides* stock was 35 years. After this time the year class born at the start of the projection period would not be contributing significantly to the increase in biomass of the stock. Each projection using the generalised yield model was started in 1989, run to 1995 using known catches, and then run for a further 35 years assuming some specified harvesting strategy.

5.62 The estimates made by WS-MAD of real catches taken in Subarea 48.3 and adjacent areas (Table 6) were used in the yield model. All commercial catches were assumed to have been taken by longline vessels. The by-catch of small fish taken by the trawl fishery over the period 1977 to 1988 was not included in the calculations.

5.63 The Working Group considered the results of the projections using the yield model in relation to the decision rule for γ_1 adopted for krill and for *D. eleginoides* in Division 58.5.2 (Heard Island) at last year's meeting of the Scientific Committee. This decision rule criterion is that the probability during the projection period of the spawning stock biomass falling below 20% of its initial level should not exceed 10% (SC-CAMLR-XIII, paragraphs 5.18 to 5.26 and 2.70). Twenty per cent of the initial level of the spawning stock biomass has become a standard biological reference point used in fisheries management, based on Beddington and Cooke (1983)[10], in which the probability of stock depletion influencing recruitment was found to increase once the spawning stock reached 20% of its equilibrium level.

[10] Beddington, J.R. and J.G. Cooke. 1983. The potential yield of fish stocks. *FAO Fisheries Technical Paper*, 242: 47 pp.

5.64 Two criteria were used to indicate the performance of *D. eleginoides* in Subarea 48.3 during each projection run:

(i) the probability of depletion of the spawning stock biomass to 0.2 (20%) of the pre-exploitation level (Depletion Probability); and

(ii) the level of median spawning stock biomass expected at the end of the projection period relative to the median pre-exploitation spawning stock biomass (SB_e / SB_0).

5.65 A detailed explanation of the manner in which the projections are undertaken and the way in which the spawning stock is monitored under specified catch regimes during the runs is presented in Appendix F.

5.66 Two initial runs of the yield model were made. The harvesting strategies for these runs were based on the results of the deterministic yield-per-recruit analysis. The first run was a strategy of applying $F_{0.1}$ (0.137) over the whole period of the projection. The second run was a constant catch strategy, with the catch limit fixed at 12 400 tonnes per annum, equal to the catch value at $F_{0.1}$, calculated from the Thompson and Bell yield-per-recruit analysis (paragraph 5.54). Both projections were run with mean recruitment assuming no uncertainty (Table 12) and M = 0.16. The results are presented in Table 13.

Table 13: Evaluation of the performance of *D. eleginoides* in Subarea 48.3 during the 35 year projection under a fixed catch of 12 400 tonnes/year and constant F ($F_{0.1}$). Projections used a fixed mean recruitment with variability in annual recruitment (Table 12), and M = 0.16.

Exploitation Strategy	Depletion Probability	Median SB_e / Median SB_0
12 400 t/year	0.59	0.28
$F_{0.1}$ = 0.1369	0.80	0.23

5.67 The strategy of applying $F_{0.1}$, or a constant catch equivalent to $F_{0.1}$ at mean recruitment, results in approximately a 60 to 80% chance of the spawning stock biomass falling below 20% of its initial level over the 35-year period. This violates the γ_1 decision rule by a considerable margin. In addition, at the end of the projection period, the spawning stock biomass was reduced to only 20 to 30% of the pre-exploitation level.

5.68 Following these two initial runs, four projections were carried out to identify the catch level at which γ_1 was satisfied. These four projections included uncertainty surrounding the estimate of mean recruitment, interannual variability in recruitment and the fixed estimate of natural mortality (Option 1 in Table 12). The results of these projections are presented in Table 14.

Table 14: Evaluation of the performance of *D. eleginoides* in Subarea 48.3 during the 35-year projection under a series of fixed catches. Projections incorporated uncertainty in mean recruitment and variability in annual recruitment (Table 12) and M = 0.16.

Exploitation Strategy	Depletion Probability	Median SB_e / Median SB_0
3 000 t/year	0.07	0.82
3 500 t/year	0.07	0.79
4 000 t/year	0.10	0.74
4 500 t/year	0.12	0.77
5 000 t/year	0.14	0.70

5.69 The results in Table 14 indicate that an annual yield of 4 000 tonnes would satisfy the γ_1 criterion. At this level of catch the median spawning stock at the end of the projection period is likely to be approximately 74% of the pre-exploitation level.

Sensitivity Analyses

Sensitivity to Uncertainty in Estimated Mean Recruitment

5.70 The Working Group investigated the effects of improving the precision of the estimate of mean recruitment on the estimated yield that would meet the criterion of γ_1. The results in Table 15 can be compared directly with those in Table 14 at the same level of fixed annual catch. These results show that reducing uncertainty in mean recruitment could lead to an increase in the estimate of potential yield consistent with γ_1 (7 500 tonnes/year in Table 15), provided that the estimate of mean recruitment remained at or above the current level. Uncertainty in mean recruitment would be expected to be reduced as more data become available from which to estimate mean recruitment. These data may be obtained from trawl surveys not yet analysed using the length-density analysis, or future trawl surveys in Subarea 48.3. The Working Group noted, however, that care should be taken to watch for trends in recruitment as the time series of data from which recruitment is estimated increases. Any trends could introduce bias into the recruitment function.

Table 15: Evaluation of the performance of *D. eleginoides* in Subarea 48.3 during the 35-year projection under a series of fixed catches. Projections used a fixed mean recruitment combined with variation in annual recruitment (Table 12) and M = 0.16.

Exploitation Strategy	Depletion Probability	Median SB_e / Median SB_0
4 000 t/year	0.004	0.74
5 000 t/year	0.009	0.70
6 000 t/year	0.03	0.65
7 000 t/year	0.08	0.58
7 500 t/year	0.10	0.53
8 000 t/year	0.12	0.55

Sensitivity to Uncertainty in M

5.71 Assessments of yield per recruit are affected by the level of natural mortality used in the analysis. While the estimates of M used in this assessment are the best currently available, they may be refined in the future as more information becomes available. The sensitivity of the estimated yield to uncertainty in M was investigated for two catch regimes (4 000 and 5 000 tonnes) with both fixed mean recruitment and uncertain mean recruitment, as discussed above. In both cases, M was integrated over a range of values between 0.1 and 0.2. The results of these four projections are shown in Table 16. These results can be compared directly with the projection results with the same exploitation strategy (Tables 14 and 15). The results showed no appreciable change in the outcome with uncertainty in mean recruitment, and only slight differences when mean recruitment was fixed.

Table 16: Evaluation of the performance of *D. eleginoides* in Subarea 48.3 during the 35-year projection under a series of fixed catches but integrating over a range of M (0.1 to 0.2). These projections investigated the effects of both fixed and uncertain mean recruitment.

Exploitation Strategy	Mean Recruitment	Depletion Probability	Median SB_e / Median SB_0
4 000 t/year	Uncertain	0.15	0.76
4 000 t/year	Fixed	0.08	0.75
5 000 t/year	Uncertain	0.20	0.72
5 000 t/year	Fixed	0.13	0.69

5.72 The Working Group considered that further analysis of the sensitivity of the model to variability in M could be undertaken, for instance, variable M with age. This was identified as a topic for future work on the yield model.

Comparison of Model Projections with CPUE Data

5.73 Figure 7 presents a comparison of the standardised CPUE series from the GLM analysis (kilogram/hook and number/hook), and estimated abundance from the yield model projections, over the period 1992 to 1995. It was not possible to interpret the relationship between CPUE and abundance based on the information currently available.

5.74 The Working Group considered a number of assumptions made in this assessment of *D. eleginoides* using the generalised yield model, and the potential effect of variations in these assumptions on the results (Table 17).

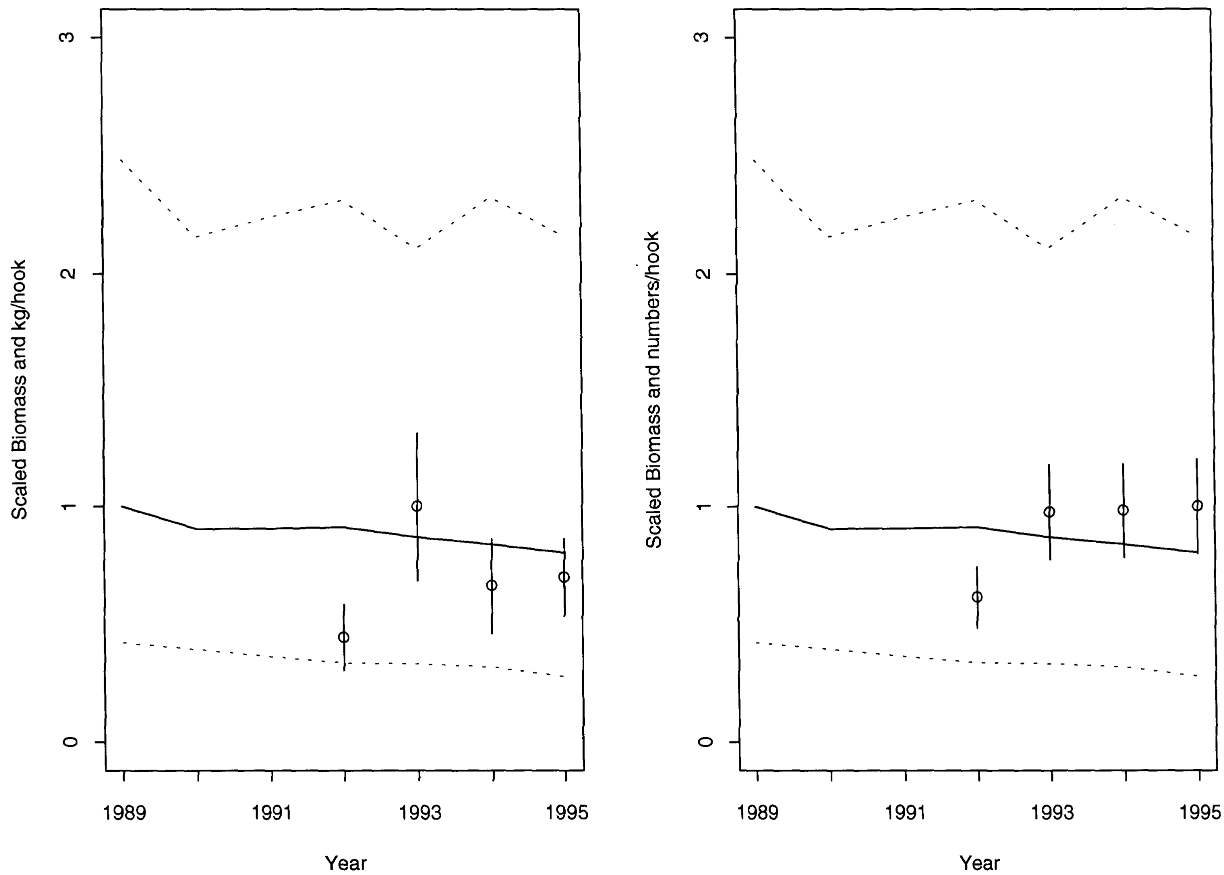

Figure 7: Standardised CPUE (kilogram/hook and numbers/hook scaled to 1) and estimated spawning stock biomass (scaled to 1) over the period 1989 to 1995. The solid line shows the trend in median spawning stock biomass projected with the yield model. Dashed lines indicate the 5 and 95% quantities for the spawning stock biomass. Open circles are the CPUE from the GLM analysis, vertical lines are ±2 SD.

Table 17: Assumptions made in the assessment of *D. eleginoides* in Subarea 48.3.

Assumption	Potential Effect on the Result
q for the survey is unknown, but is assumed to be 1.	If q were less than 1, estimates of abundance, and therefore recruitment, based on the survey results would increase. The level of catch consistent with the γ_1 decision rule would increase.
Recruitment is a log-normally distributed random variable with variance equal to that estimated from the bottom trawl surveys and mean with a normally distributed sampling error.	Conduct and analysis of additional surveys will reduce the uncertainty in recruitment. This will have the effect of increasing the level of catch which can be taken without violating the γ_1 decision rule (see paragraph 5.67).
The mean recruitment estimated from the surveys applies to the *D. eleginoides* population around Shag Rocks and South Georgia (Subarea 48.3).	If the recruitment was made to a larger area, then the catch limit should be applied to that larger area and not just to Subarea 48.3.
The estimated total catches shown in Table 6 apply only to Subarea 48.3.	If the catch applies to a larger area (i.e., the catches taken from Subarea 48.3 are lower) the level of catch in the assessment consistent with the γ_1 decision rule would increase.
The allowable catches will be the only removals from the population by fishing (i.e. there is no significant illegal fishing) and that only longline fishing will occur.	If significant illegal fishing occurred over and above the catch limit consistent with γ_1, the stock could become depleted.
Estimated total catches (paragraph 5.11) accurately reflect total removals from the stock over the period.	If the total removals from the stock were higher than those used in the projections, the level of catch consistent with γ_1 would decrease.

Future Work

5.75 The Working Group recommended that future work be undertaken in an attempt to refine information on which the assumptions in Table 17 were based. Several specific recommendations were made for additional sensitivity analyses (paragraph 5.72).

5.76 The Working Group considered a number of other areas of future work on stock assessment of *D. eleginoides*, following on from the work undertaken at this year's meeting:

(i) work on refining the standardised time series of CPUE should continue. This process will develop as more haul-by-haul data are supplied from the commercial fishery in due course;

(ii) the development of length and/or age specific standardised indices of CPUE might provide more information on trends in abundance;

(iii) further work to investigate the relationship between CPUE and abundance and the sensitivity of CPUE to declines in abundance;

(iv) more trawl survey data should be made available for analysis using the length-density approach. This would increase the amount of information on which to base estimates of recruitment which are fed into the projections using the yield model. The technical problems encountered when accessing the trawl survey data stored in the CCAMLR database should be addressed during the intersessional period;

(v) several areas for future work on methodologies which will improve the level of information on which the assessment of *D. eleginoides* is based were identified by WS-MAD (Appendix E, paragraph 2.72). The Working Group endorsed these recommendations, drawing particular attention to the need for tagging studies to study movement and migration;

(vi) the computer programs used for the assessment of *D. eleginoides* at this year's meeting (length-density analysis (de la Mare, 1994a[11]) and the generalised yield model (WG-FSA-95/41)) should be formally validated by the Secretariat during the intersessional period; and

(vii) the Working Group also considered some practical measures to enhance the Secretariat's capability to undertake assessment work (e.g., improved computing power). These are taken up under Agenda Item 11 (paragraph 11.5).

5.77 The Working Group agreed that the assessment of *D. eleginoides* in Subarea 48.3 carried out at this meeting is far superior to any it has conducted previously for this species. In particular, it noted that:

(i) previous assessments have relied on applying deterministic yield-per-recruit analyses to abundance estimates calculated by extrapolation of estimates of local densities. The local density estimates were based on analysis of short- to medium-term trends in CPUE. At best, this technique produces indirect estimates of density, and in practice the failure to observe consistent depletion (paragraphs 5.17 and 5.18) has often meant that no such estimates can be calculated;

(ii) in contrast, in this assessment, direct estimates of absolute recruitment have been obtained from fishery independent scientific survey results. These are not only likely to

[11] de la Mare, W.K. 1994a, op. cit. p. 289.

be much more reliable than those based on CPUE analyses, but also it has been possible to quantify both estimation uncertainty and interannual variability in recruitment; and

(iii) use of the generalised yield model has allowed specific account to be taken of these sources of uncertainty and variability. Furthermore, this model also provides a future means for quantitatively evaluating the possible effects of failure in assumptions listed in Table 17.

5.78 The Working Group noted that the use of the generalised yield model to make stochastic projections to test the effect of different harvesting strategies had revealed that an $F_{0.1}$ harvesting strategy was not appropriate for this fishery, due to the uncertainty and variability in recruitment. Harvesting at $F_{0.1}$ over the period of the projection had in fact resulted in considerable depletion of the spawning stock (Table 13).

5.79 The Working Group recognised the potential value of this new assessment method for *D. eleginoides* in the analysis of similar fisheries in other areas.

5.80 The Working Group considered that the results of the projections using the yield model with the γ_1 decision rule was a reasonable basis for setting guidelines for the limits on total removals of *D. eleginoides* in Subarea 48.3 during the 1995/96 season. The projection run which fulfilled the γ_1 decision rule criteria and included uncertainty in recruitment gave a constant catch of 4 000 tonnes.

Management Advice

5.81 The Working Group welcomed the significant progress which had been made at this meeting in developing a new approach to the assessment of the *D. eleginoides* fishery in Subarea 48.3. A program of future work was identified to refine this approach.

5.82 The Working Group noted with concern the apparent high level of unreported fishing for *D. eleginoides* in Subarea 48.3. At this year's meeting an attempt had been made to estimate total removals and to take these into account in the assessment. However, the Working Group noted that future illegal catches would continue to hinder severely attempts to make reliable stock assessments and requested that the problem be addressed as a high priority.

5.83 The Working Group also noted that since catches of *D. eleginoides* are also taken outside the Convention Area in waters adjacent to Subarea 48.3, it constituted a straddling stock. Issues relating to conservation and management of straddling stocks are addressed in paragraphs 10.10 to 10.14.

5.84 The Working Group noted that the assessment of yield was based on the expectation that future catches will be taken only by longline vessels. Use of other types of fishing gear, such as trawls, would change the age structure of the catch. The Working Group made no assessment of the effects of such catches at this meeting. The Working Group therefore recommended that the directed fishery for *D. eleginoides* in Subarea 48.3 should be restricted to longliners during the 1995/96 season. (See other advice on trawling in Subarea 48.3 in paragraphs 5.113 and 6.27 to 6.29.)

5.85 The results of the projections using the generalised yield model indicated that an annual catch of 4 000 tonnes applied over a period of 35 years resulted in a probability of stock depletion (the spawning stock biomass falling to below 20% of its unexploited level) of about 10%. At this level of catch the ratio of median spawning stock biomass at the end of the projection period to the pre-exploitation level was about 74%. These criteria have been used in the past as a basis for setting catch limits. However, the Working Group noted that this assumed that the actual removals of fish would be no greater than the catch limit. Total annual removals exceeding 4 000 tonnes would increase the probability of stock depletion (Table 14).

5.86 The analysis of CPUE data highlighted the importance of collecting catch and effort information on as fine a scale as possible. The Working Group recommended the continuation of the current procedures for reporting haul-by-haul and biological information from the fishery, and strongly encouraged the reporting of existing haul-by-haul data from the longline fishery prior to 1992.

5.87 The Working Group also recognised the importance for the assessment work of the biological data and information collected by scientific observers. The Working Group recommended that the 100% observer coverage applied to this fishery over the past two seasons be maintained.

5.88 The technical problems encountered when accessing the trawl survey data stored in the CCAMLR database will require some attention during the intersessional period. The Working Group recommended that Members with relevant data be requested to assist the Secretariat by submitting those data in the required format at the earliest opportunity.

Champsocephalus gunnari (Subarea 48.3)

Commercial Catch

5.89 The fishery for *C. gunnari* was closed for the 1994/95 fishing season in accordance with Conservation Measure 86/XIII. There has now been no substantial reported commercial catch of *C. gunnari* in Subarea 48.3 since March 1990. A total of 8 027 tonnes was reported in that season.

Research Surveys

5.90 A research survey was conducted in Subarea 48.3 in February 1995 by the *Dr Eduardo L. Holmberg*. The methods and results of this survey are reported in WG-FSA-95/34 and 35.

5.91 The main aim of the survey was to investigate the variability in the spatial distribution of *C. gunnari* in Subarea 48.3. The methodology was similar to that used for the 1994 survey and involved sampling clusters of stations (i.e., stations which were spatially correlated). This enabled a measure of the relative importance of within and between-cluster variability to be determined. Thirty-one stations (27 from the South Georgia shelf and 4 from Shag Rocks) were in the same position, to within 1 n mile, as sites sampled during the 1994 survey. An additional 17 new stations were surveyed.

5.92 Because of differences in survey design, sampling equipment and estimation methods the data could not be used in the time series of relative abundance indices obtained from previous surveys of this area (see SC-CAMLR-XIII, Annex 4, paragraphs 3.17 to 3.20). It was felt, however, that a comparison of the difference in catch rates between the replicate stations might yield some qualitative information on the status of the stock compared to the previous year.

5.93 Analysis of the data from the replicated stations on the South Georgia shelf (n = 27 stations) using parametric and non-parametric tests indicated that there had been a significant increase in fish density since the 1994 survey ($P < 0.01$).

5.94 The length and age composition data collected during the 1994 and 1995 Argentinian surveys from South Georgia were compared. The 1995 survey was dominated by small fish mainly less than 30 cm, and contained two modes, one at 14 cm (1-year-old fish) and one at 27 cm (2- and 3-year-old fish) (WG-FSA-95/37). In contrast, the 1994 survey had a much greater proportion of fish larger than 30 cm, and a dominant mode at about 24 cm (2-year-old fish). The change in the size of the dominant mode from 24 to 27 cm could be explained by growth of the fish in the intervening year. The relative paucity of larger fish could not be explained.

5.95 There were too few data to draw conclusions on fish density differences in the Shag Rocks area. A single mode was present in the size distribution in both surveys. The mode increased from about 25/26 cm in 1994 to 29 cm in 1995, probably representing one year's growth.

5.96 Lic. Marschoff stated the analysis of the between site variability as proposed in WG-FSA-95/34 has the potential to be used in studies of patchiness in the spatial distribution of *C. gunnari,* but fuller application of the model will require verification of the assumptions of the statistical model.

5.97 Other members felt that the sampling design offered no advantages and was less efficient than that recommended by WG-FSA in 1992.

Population Status and Mechanism for Providing Advice on Catch Limits

5.98 Problems with determining the population status and establishing a TAC for *C. gunnari* were discussed in WG-FSA-95/24. The paper put forward four recommendations; two with respect to future research and two with respect to management advice.

5.99 The first two recommendations concerned methods for the use of acoustics, and bottom and midwater trawling, to determine the distribution of the fish in the water column. Research surveys in recent years were conducted during only daylight hours, when most fish are likely to be close to the bottom. The Working Group agreed that it would be very useful to use acoustics and midwater trawls in addition to bottom trawls in order to obtain a better understanding of the vertical distribution of the fish both during the day and at night.

5.100 The third recommendation was to allocate a TAC for the fishery, even when the biomass was low, so that the population could be observed and VPAs conducted. The fourth recommendation was that a scientific observer be put on board commercial vessels conducting trawling to collect samples and data from the commercial catch. Both of these recommendations have been incorporated into option (ii) of the management advice.

Alternative Assessment Methods

5.101 An alternative way of formulating ADAPT to analyse the catch-at-age and trawl survey data has been proposed by Dr P. Gasiukov (Russia). In earlier assessments using ADAPT the estimated F on the terminal age in each year was assumed to equal the mean of the F on the previous three ages for that year. The alternative approach involves a model which treats the Fs on the terminal age as unknown parameters. When this approach was used a plot of the log catchability coefficients by age show a dome shaped pattern, rather than the flat-topped pattern shown in earlier assessments. This difference has quite a large impact on the estimated numbers of fish surviving at the terminal age and hence on stock abundance.

5.102 The Working Group considers that it would be useful to explore alternative assumptions concerning some of the parameters such as selectivity-at-age when analysing data using ADAPT.

5.103 To do this most effectively, data from as many surveys as possible will be required. The Working Group felt it would be useful to review historical research and commercial trawl data on *C. gunnari* with a view both to the above, and also to help define the optimum timing of trawl surveys in this area and to standardise the research surveys. The Working Group recommended that these data be submitted to the Secretariat in the appropriate format and reviewed by an intersessional group convened by Dr Holt.

5.104 There are no new estimates of abundance for this stock. The most recent reliable estimate of abundance is from the 1994 UK survey. The stock abundance appears to have increased since then but the magnitude of this increase is unknown. The stock is currently dominated by 1- to 3-year-old fish.

Development of a Long-term Management Approach

5.105 The Working Group reiterated the need for a long-term management plan for the fishery which accounts for the high interannual recruitment variability, the uncertainty in biomass estimates and potential variability in M with age and between years. Any estimates of yield should be carried out using stochastic projections and will need to incorporate the possibility of major mortality events occurring every few years.

Management Advice

5.106 Given the difficulties associated with using estimates of relative abundance from the two Argentinian surveys in 1994 and 1995 (see paragraph 5.92), the Working Group felt that the most reliable estimate of abundance for *C. gunnari* around South Georgia and Shag Rocks was that from the 1994 UK survey (see SC-CAMLR-XIII, Annex 4, Table 3). Given the uncertainty associated with the state of this stock, the Working Group recommended that the lower confidence interval of that estimate be used if TACs are considered. The lower 95% confidence interval estimate equalled 13 295 tonnes.

5.107 For setting a TAC for *C. gunnari*, the Working Group considered two options:

(i) no TAC should be set until a new research survey to assess the status of the stock has been conducted. This new estimate would then be considered by WG-FSA as a basis for providing new management advice; and

(ii) a TAC be set (at some proportion of the lower confidence interval of the 1994 UK survey estimate), but this TAC being dependent on two things; a research survey being carried out before the commercial operation, and an international scientific observer being on board each vessel fishing commercially.

5.108 The Working Group recommended option (i). If the Commission were to consider re-opening the fishery then the Working Group recommended that a TAC be set at a level which is considerably below the lower 95% confidence limit of the 1994 UK survey estimate (13 295 tonnes), a research survey should be carried out in accordance with the design recommended by WG-FSA in 1992, and an international scientific observer be on board all commercial fishing vessels.

5.109 The Working Group reiterated its advice from last year that a long-term management plan be developed for this fishery and noted that this remains a high priority.

Chaenocephalus aceratus, Gobionotothen gibberifrons[12], *Notothenia rossii, Pseudochaenichthys georgianus, Lepidonotothen squamifrons* and *Patagonotothen guntheri* (Subarea 48.3)

5.110 Estimates of fish density and size composition were available from the Argentinian bottom trawl survey around South Georgia (WG-FSA-95/34 and 35).

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[12] Formerly known as *Notothenia gibberifrons*

5.111 Because of differences in survey design, sampling equipment and estimation methods the data could not be used in the time series of relative abundance obtained from previous surveys of this area. However, it was felt that a comparison of the difference in catch rates between the replicate stations might yield some qualitative information on the status of the stocks compared to the previous year.

5.112 Analysis of the South Georgia data (n = 27 stations) showed that there were no significant differences in the density of all six species between 1994 and 1995 ($P > 0.05$). The size composition data were not analysed because the sample sizes and numbers of fish measured in the 1994 survey were too small to compare with earlier surveys.

Management Advice

5.113 The Working Group reiterated its advice from previous years concerning these species (SC-CAMLR-XIII, Annex 4, paragraphs 4.98, 4.102 and 4.103). In the absence of any new information on these species the Working Group recommended that a directed fishery of these species should remain prohibited (Conservation Measures 2/III, 3/IV, 76/XIII and 85/XIII).

Electrona carlsbergi (Subarea 48.3)

5.114 The only new information on *E. carlsbergi* was on the abundance of larvae and juvenile fish in the South Atlantic submitted in WG-FSA-95/7. These data could not be used to revise the precautionary TACs proposed by the Working Group last year (SC-CAMLR-XIII, Annex 4, paragraphs 4.91 to 4.93) because there was no clear relationship between this survey and the stocks observed in Subarea 48.3.

5.115 The Working Group agreed that the precautionary yields based on the revised krill yield model are appropriate estimates of yield for this species pending a revision of the biological parameters. The Working Group noted that the calculations of long-term yield using this method do not require updated estimates of stock biomass because the estimate of yield obtained from the projections is based on estimates of pre-exploitation biomass and the biological parameters. The estimate of yield (as a proportion of the estimated pre-exploitation biomass) is dependent on the uncertainties in the estimates, with a smaller yield arising from greater uncertainty in the estimates (SC-CAMLR-XIII, paragraphs 5.18 to 5.26).

Management Advice

5.116 Consequently, the Working Group recommends that a TAC for *E. carlsbergi* should be 14 500 tonnes for the region around Shag Rocks and 109 000 tonnes for all of Subarea 48.3 (see SC-CAMLR-XIII, Annex 4, paragraphs 4.91 to 4.93). A consequence of this recommendation is that any potential by-catch of other pelagic species taken by the *E. carlsbergi* fishery is likely to be reduced proportionately to the reduction of the precautionary limit from the 200 000 tonnes set by Conservation Measure 84/XIII.

5.117 In addition, the Working Group agreed that the conservation measure pertaining to the collection of biological information on *E. carlsbergi* from the commercial fishery (Conservation Measure 54/XI) should contain requirements equivalent to those regarding the reporting of this information from other fisheries, including monthly reporting of by-catch and biological information on all species found in the catch. In addition, the Working Group noted that this fishery may take other pelagic species. The Working Group recommended that if Conservation Measure 84/XIII is continued, then it should reference Conservation Measure 52/XI instead of Conservation Measure 54/XI, with the following provisions for setting a TAC and reporting conditions on this fishery:

- the target species is designated as *E. carlsbergi*;
- by-catch species are all other species caught during the fishing operations;
- the relative densities of each species of fish within catches from each fishing ground should be reported; and
- length composition data of 500 specimens of each species taken randomly from catches in this fishery from each fishing ground should be reported.

Historical Commercial Catch Data for *Notothenia rossii* in Subarea 48.3

5.118 Early landings data for *N. rossii* in Subarea 48.3 were reviewed in WG-FSA-95/17. It was concluded that a proportion of the *N. rossii* landings reported in 1969 and 1970 may have been other species including *C. gunnari* (see also paragraphs 3.3. to 3.11).

Crabs (*Paralomis spinosissima* and *P. formosa*) (Subarea 48.3)

5.119 On 1 September 1995, the US fishing vessel *American Champion* began fishing for Antarctic crabs in Subarea 48.3. The vessel is targetting *Paralomis spinosissima* with *P. formosa* being returned to the sea. Fishing operations were conducted in accordance with requirements of Phase I of Conservation Measure 75/XII. Provisions of Phase I require a vessel entering the fishery for the first time to expend its first 200 000 pot hours of effort within a series of 0.5° latitude by 1° longitude blocks. The vessel is limited to expending a maximum of 30 000 pot hours in any single block. To date, fishing effort of the *American Champion* has been mostly conducted to satisfy Phase I requirements. After finishing Phase 1 operations, the vessel began standard commercial operations.

5.120 Conservation Measure 79/XIII requires the reporting to CCAMLR of catch and biological data for all catches taken prior to 31 August 1995; however, no fishing occurred prior to this date. Data for 1 September to 10 October have been submitted in accordance with the 10-day Catch and Effort Reporting System set out in Conservation Measure 61/XII (Table 18). By-catch of *D. eleginoides* during these periods is given in Table 19. *N. rossii* and *G. gibberifrons* were also caught as by-catch, but the total amount of by-catch for these species was low (237 kg for *N. rossii* and 84 kg for *G. gibberifrons*).

Table 18: Catch of *P. spinosissima* (KCS) in crab fishery.

Start of 10-day Period	Catch KCS (numbers)	Catch KCS (kg)	Pots Fished	Hours Fished	CPUE numbers/pot
1 September	3198	2677	847	84	3.8
11 September	2827	2541	960	125	2.9
21 September	36398	32125	2220	240	16.4
1 October	50114	41985	2040	240	24.6
Totals	92537	79328	6067	689	15.3

Table 19: By-catch of *D. eleginoides* (TOP) in crab fishery.

Start of 10-day Period	Catch TOP (numbers)	Catch TOP (kg)	Numbers of TOP/pot	Catch TOP/pot (kg)	kg TOP/ kg KCS
1 September	77	196	0.09	0.23	0.07
11 September	133	418	0.14	0.44	0.16
21 September	1039	4291	0.47	1.93	0.13
1 October	460	2090	0.23	1.02	0.05
TOTALS	1709	6995	0.28	1.15	0.09

5.121 Although the 10-day Catch and Effort Reporting System of Conservation Measure 61/XII does not include position data, Dr Watters (the US scientist aboard the vessel at the beginning of the fishing season) noted that data for the first 10-day period was for effort off the southeast coast of

South Georgia. Dr Watters also noted that effort for remaining 10-day periods was expended as the vessel worked its way northwest along the eastern side of the island.

5.122 The Working Group noted that catch rates (crabs/pot) increased with time as the vessel moved along the eastern side of South Georgia. Dr Watters noted that the increased catch rates may have been realised, as it participated in Phase I, because the vessel appeared to change and improve its fishing strategy and methods as the season progressed, but he also thought it likely that crab density is higher in the northwest area.

5.123 The Working Group was concerned that the crabs seemed to be concentrated off the northwest coast of South Georgia and that few crabs were available in other areas. Future assessments may need to consider that the area containing fishable concentrations of crab may not include all of the areas around South Georgia.

5.124 The Working Group recognised that additional information regarding geographical differences in crab density would be very valuable. It noted that during the 1995/96 season, the vessel will be required to conduct Phases 2 and 3 of Conservation Measure 75/XII. Fishing effort during these phases must be expended in three small squares, each measuring approximately 26 n miles^2 in area, until there is a decline in catch rates. The vessel operator has the option of choosing which squares to fish. The Working Group thought that it would be better for all of the squares occupied during Phases 2 and 3 to be in an area of high density. The area with high densities would also have the greatest variation in catch rates and would be a good area to test whether depletion experiments are likely to work for these species.

5.125 The Working Group noted the presence of finfish by-catch associated with the fishery. The amount appeared to be larger than had previously been observed in the 1991/92 crab fishery. Dr Watters noted that the current fishery uses pots with different opening configurations than those used in 1991/92, and fish may be more susceptible to the current pots. However, insufficient data were available to complete an appropriate analysis of this topic. Members were informed that the presence of scientific observers on the crab vessel would ensure that data on finfish by-catch would be available at the next meeting of the Working Group.

5.126 The Working Group was concerned about the high by-catch rates of *D. eleginoides* from the pots used in the current fishery and recommended that the variability in by-catch rates between different types of pots be investigated further. It also noted that this might be a useful source of live *D. eleginoides* for tagging studies. The study of methods to control by-catch should be undertaken independently of the experimental fishing regime described under Conservation Measure 75/XII.

5.127 Dr Watters reminded the Working Group that Conservation Measure 79/XIII set minimum carapace widths of 102 mm and 90 mm for male *P. spinosissima* and *P. formosa* respectively. The minimum width for *P. spinosissima* was determined using the limited data collected during the 1991/92 fishery; however, because catches of *P. formosa* were not retained during the initial season, the minimum size limit for this species was chosen arbitrarily. Data collected aboard the *American Champion* indicated that a minimum carapace width of 102 mm was appropriate for male *P. spinosissima*; however, observations of *P. formosa* indicate that approximately 75% of the male crabs retained in pots were below the minimum carapace width of 90 mm. It would be unlikely that this large percentage of harvestable male crabs would be sexually immature. The Working Group agreed that the minimum size limit for *P. formosa* should be based upon better data and encouraged the collection of additional measurements for this purpose during the course of the current fishery.

Management Advice

5.128 Since data were not available to make a re-assessment of the crab stock, the Working Group recognised that a conservative management scheme is still appropriate for this fishery. In particular, the Working Group noted that the fishery should be controlled by direct limitations on catch and effort, as well as by limitations on the size and sex of individual crabs which may be retained in the catch. The Working Group agreed that Conservation Measure 79/XIII contains such limitations, and that it should continue to be applied in the management of the crab fishery.

5.129 The Working Group again recalled the Commission's view that an exploratory fishery should not be allowed to expand faster than the acquisition of information necessary to ensure that the fishery can and will be conducted in accordance with the principles in Article II of the Convention. Given this view, the Working Group agreed that Conservation Measure 75/XII could provide valuable information about the crab stock and should continue to be applied in the management of the fishery.

5.130 The Working Group also noted that Conservation Measure 75/XII was in force during the 1993/94, 1994/95 and 1995/96 fishing seasons. However, no fishing had occurred during the 1993/94 season and only limited effort occurred during the 1994/95 season. The Working Group agreed that management of the fishery would benefit from additional data as required by Conservation Measure 75/XII and recommended that this measure remain in force for at least the 1995/96, 1996/97 and 1997/98 fishing seasons.

Other Subareas in Area 48

Antarctic Peninsula (Subarea 48.1) and
South Orkney Islands (Subarea 48.2)

5.131 In the absence of new information on stocks in these areas, the Working Group reiterated its advice of last year that fisheries in Subareas 48.1 and 48.2 should remain closed until a survey is conducted to provide more accurate estimates of the status of these stocks (SC-CAMLR-XIII, Annex 4, paragraph 4.116).

South Sandwich Islands (Subarea 48.4)

5.132 Although a small fishery for *D. eleginoides* was open in this area, no catches were reported. In the absence of further information, the Working Group could not update its advice from 1993 when a TAC of 28 tonnes was recommended (SC-CAMLR-XII, Annex 5, paragraph 6.4).

Statistical Area 58

5.133 Catches in the 1995 season are shown in Table 20. Catches of *D. eleginoides* in Division 58.5.1 were taken in the French trawl fishery and the Ukrainian longline fishery. A fishery for *C. gunnari* was conducted for the first time since the 1991 season, most of the catch being taken by Ukrainian trawlers in Division 58.5.1.

5.134 Catches in Subarea 58.6 (Crozet Island) were taken during French exploratory fishing reported in WG-FSA-95/10, the most recent part of a series extending back to 1983. The results are discussed in paragraphs 3.16 to 3.18.

Kerguelen Islands (Division 58.5.1)

Notothenia rossii (Division 58.5.1)

5.135 At its 1994 meeting the Working Group considered that although there was some evidence for a recovery of this stock, no recent and relevant data were available on the biomass of this species, and so advised that the fishery remain closed until a biomass survey demonstrates that the stock has recovered to a level that will support a fishery (SC-CAMLR-XIII, Annex 4, paragraphs 4.120 to 4.123). No new data are available this year.

Management Advice

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

Lepidonotothen squamifrons (Division 58.5.1)

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

5.138 Prof. Duhamel advised that in the 1996 season, the two French vessels trawling for *D. eleginoides* will be required to conduct an exploratory fishery for *L. squamifrons* on the traditional grounds for this species southeast of the Kerguelen shelf. These surveys will take place between 15 October and 31 December 1995, and each of the two trawlers will survey for up to 10 days to obtain data on CPUE and length frequency. This fishery will attempt to cover all of the new fishing grounds, but for operational reasons will not be a systematic survey. Scientific observers will be aboard the vessels. These data will be presented at next year's meeting.

Table 20: 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 (*Lepidonotothen squamifrons*), ANS (*Pleuragramma antarcticum*), MZZ (Unknown), SRX (*Rajiformes spp.*), WIC (*Chaenodraco wilsoni*).

Split-	ANI		LIC	WIC	TOP				NOR			NOS			ANS		MZZ			SRX
Year	58	58.5	58.5	58.4	58	58.4	58.5	58.6	58	58.4	58.5	58	58.4	58.5	58	58.4	58	58.4	58.5	58.5.1
1971	10231				XX				63636			24545					679			
1972	53857				XX				104588			52912					8195			
1973	6512				XX				20361			2368					3444			
1974	7392				XX				20906			19977					1759			
1975	47784				XX				10248			10198					575			
1976	10424				XX			6	6061			12200					548			
1977	10450				XX			-	97			308					11			
1978	72643	250	82		196	-	2	370	46155			31582	6023	98	234		261			
1979				101	3	-	-	-				1307	2096				1218			
1980		1631	8	14		56	138	-			1742		3035	11308				239		
1981		1122	2			16	40	-		217	7924		4865	6239				375	21	
1982		16083				83	121	-		237	9812		1594	4038		50		364	7	
1983		25852				4	128	14			1829		733	1832		229		4	17	1
1984		7127				1	145	-		50	744		1175	3794					611[1]	17
1985		8253		279		8	6677	-		34	1707		570	7394		966		11	7	4
1986		17137		757		8	459	-		-	801		11283	2464		692				3
1987		2625		1099		34	3144	-		2	482		1963	1641		28		22		
1988		159		1816		4	554	491		-	21		5002	41		66				

Split-	ANI		WIC	TOP			NOR	NOS		ANS	
Year	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	4016	1553	30	17
1990	226	-	339	5	1062	-	155	1463	-	-	-
1991	13283[2]	-	-	-	1944	-	287	1000	-	-	-
1992	44	3	-	-	7492[3]	13	-	-	1	-	-
1993	-	-	-	-	2722	-	-	-	-	-	-
1994	12	3	-	-	5083	56	-	-	-	-	-
1995	3936	-			5534	114					

[1] Mainly *Rajiformes spp.*

[2] There are some discrepancies between the French statistics for the Soviet fishery under licence in Division 58.5.1 (12 644 tonnes) 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.

Management Advice

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

Champsocephalus gunnari (Division 58.5.1)

Catch History Before 1979

5.140 New information provided by Dr V. Gherasimchook in WG-FSA-95/15 Rev. 1 on the Soviet fishery for *C. gunnari* in Subarea 58.5 between 1970 and 1978, before the establishment of the French and Australian Exclusive Economic Zones (EEZs), provides an opportunity to re-assess the early history of this fishery.

5.141 There are large differences between catches reported in WG-FSA-95/15 Rev. 1 and the CCAMLR catch statistics published in the 1990 edition of the *Statistical Bulletin*[13] (Table 21). Dr Gherasimchook's data from Ukrainian records only account for 65% of the total catches in the *Statistical Bulletin*. In addition, only 69% of the catches reported by Dr Gherasimchook were taken in Division 58.5.1 (Kerguelen Plateau, Skif Bank and Zapadnaya (west) Bank), whereas it had previously been assumed that all reported catches were from this division. The remaining 31% was from Pike Bank (Shchuchya Bank), which is now astride the boundary between the Australian and French EEZs, being mostly within Division 58.5.2.

Table 21: Catches of *C. gunnari* from various locations in Subarea 58.5 reported from the Soviet fishery between 1970 and 1978 in WG-FSA-95/15 Rev. 1, compared to the equivalent data in the *Statistical Bulletin*.

Year	Division 58.5.1				Division 58.5.2	
	Kerguelen Shelf	Skif Bank	Zapadnaya (west) Bank	Total	Shchuchya Bank (Pike Bank)	Total
1969/70	5			5		
1970/71	380			380		
1971/72	33578	1990		35568	5860	5860
1972/73	45			45		
1973/74	25			25		
1974/75	1737			1737	14572	14572
1975/76	11324		253	11577	2663	2663
1976/77	32766		346	33112	4201	4201
1977/78	11220	3520	1841	16581	16166	16166
Total	91080	5510	2440	99030	43462	43462

[13] CCAMLR. 1990. *Statistical Bulletin*, Vol. 1 (1970-1979). CCAMLR, Hobart, Australia: 61 pp.

Year	Total in WG-FSA-95/15	Total from Area 58 in *Statistical Bulletin*
1969/70	5	0
1970/71	380	10231
1971/72	41428	53857
1972/73	45	
1973/74	25	7392
1974/75	16309	47784
1975/76	14240	10424
1976/77	37313	10714
1977/78	32747	72939
Total	142492	219853

5.142 In view of these differences, it is recommended that the Data Manager verify the accuracy and completeness of the data reported in WG-FSA-95/15 Rev. 1, and if appropriate check with Russian authorities to see if additional catch data from this fishery are stored there. If he is satisfied that the new data are correct, the *Statistical Bulletin* should be updated.

5.143 Analysis of length frequency distributions given in WG-FSA-95/15 Rev. 1 shows that:

- the three-year cycle of cohort strength was already in place at the beginning of the fishery in 1970 for the Kerguelen shelf stock;

- the first large catches in the 1971/72 season (35 578 tonnes) were taken mainly from the 1+ age group of the 1970 cohort;

- catches on the Kerguelen shelf between 1974/75 and 1977/78 seasons are mainly from the 1973 cohort, exploited from age 1+ to 4+. More than 50 000 tonnes were taken from this cohort during these seasons;

- the 1976 cohort was also heavily exploited at age 1+. In the 1977/78 season 11 220 tonnes were taken from the 1973 cohort at age 4+ and the 1976 cohort at age 1+, and about 75% of fish by number were age 1+; and

- catches on Skif, Pike and other banks outside the Kerguelen shelf were of adult fish, ages 2+ and greater.

5.144 A map of the various banks in the subarea with their English and Russian language names is given in Figure 8.

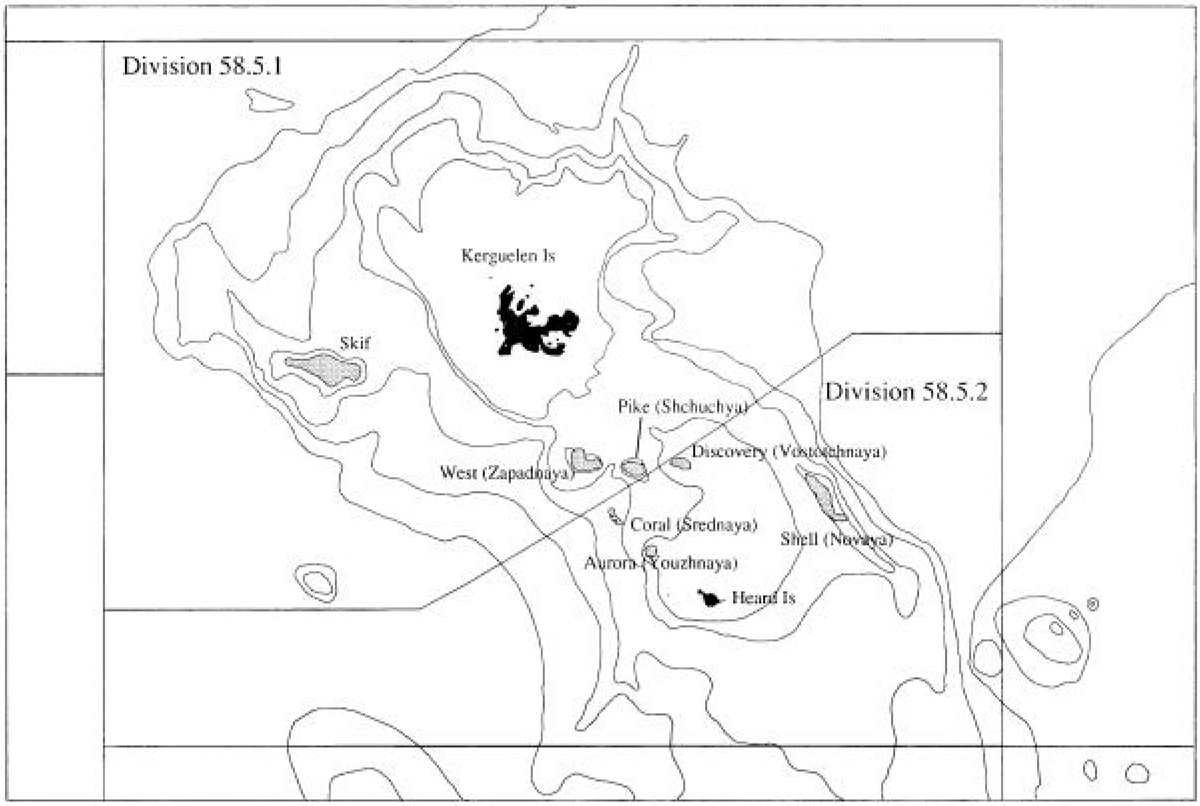

Figure 8: A map of the various banks in the subarea with their English and Russian language names.

5.145 Since this phase of the Soviet fishery ended with the creation of the EEZs, French, Soviet and Australian surveys or exploratory fishing have failed to find concentrations of *C. gunnari* on Pike or the other banks on the Heard shelf. This may be the result of heavy exploitation before 1978, especially of young age classes.

The Current Fishery

5.146 *C. gunnari* was fished for the first time since the 1991 season. Three Ukrainian trawlers took 3 852 tonnes from the traditional grounds on the northeastern Kerguelen plateau, and a French trawler took 84 tonnes. The 1991 cohort, now at age 3+, was exploited, with a mean total length in February 1995 of 31.1 cm (WG-FSA-95/13 Rev. 1). This catch was low compared to other seasons when a strong year class has been fished (Table 20).

5.147 This was in accord with the management advice in the 1994 report (SC-CAMLR-XIII, Annex 4, paragraphs 4.129 and 4.130). This stated that although a strong year class was expected to be present in the 1995 season, only restricted fishing should be allowed on it in order to enable sufficient escapement of fish to spawn a second time. This was because a declining trend in strength of previous strong cohorts had been detected, and it was hoped this strategy would contribute to establishing a population with more than one strong cohort and reduce variability in biomass.

5.148 The Working Group calculated an abundance index based on CPUE for this cohort, as used for previous cohorts in WG-FSA-90/17[14], which gave a value of 0.68 x 10^4 fish per fishing hour, much lower than for the three previous cohorts at the same age (Figure 9).

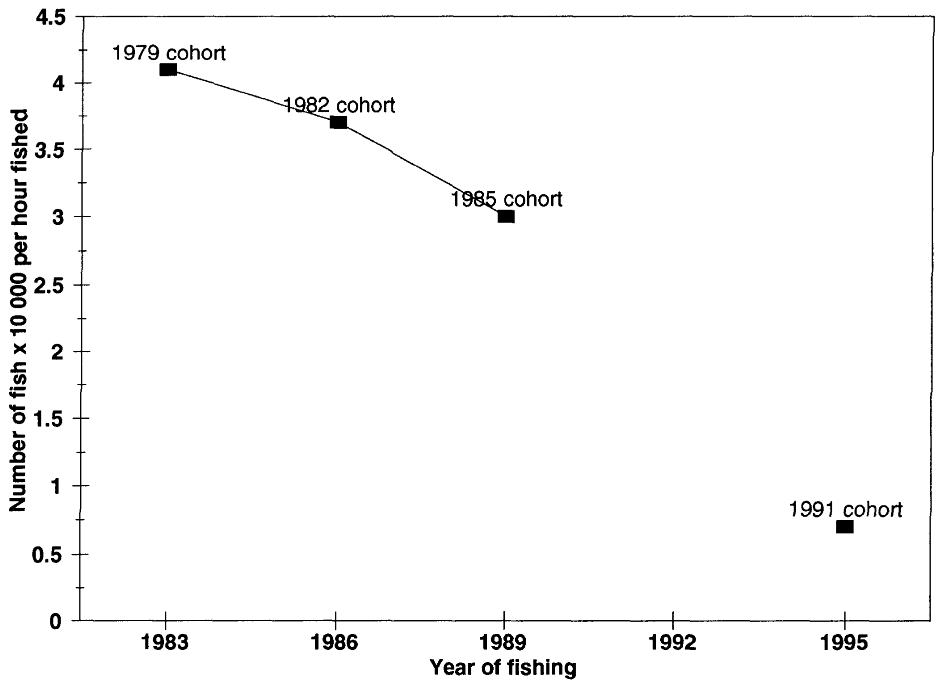

Figure 9: Abundance index of successive cohorts of *C. gunnari* at age 3+ in Division 58.5.1.

5.149 CPUE for all three trawlers in the fishery also declined markedly through the season, from about 2 tonnes/hour in November 1994 to less than 0.3 tonnes/hour in March (Figure 10), which indicates that stock abundance was affected even by this relatively low level of fishing. This phenomenon has not been observed over one season in fisheries targetting previous cohorts.

[14] Duhamel, G. and D.J. Agnew. 1990. A re-analysis of the Kerguelen shelf stock and Skif Bank stocks of *Champsocephalus gunnari*. Document *WG-FSA-90/17*. CCAMLR, Hobart, Australia.

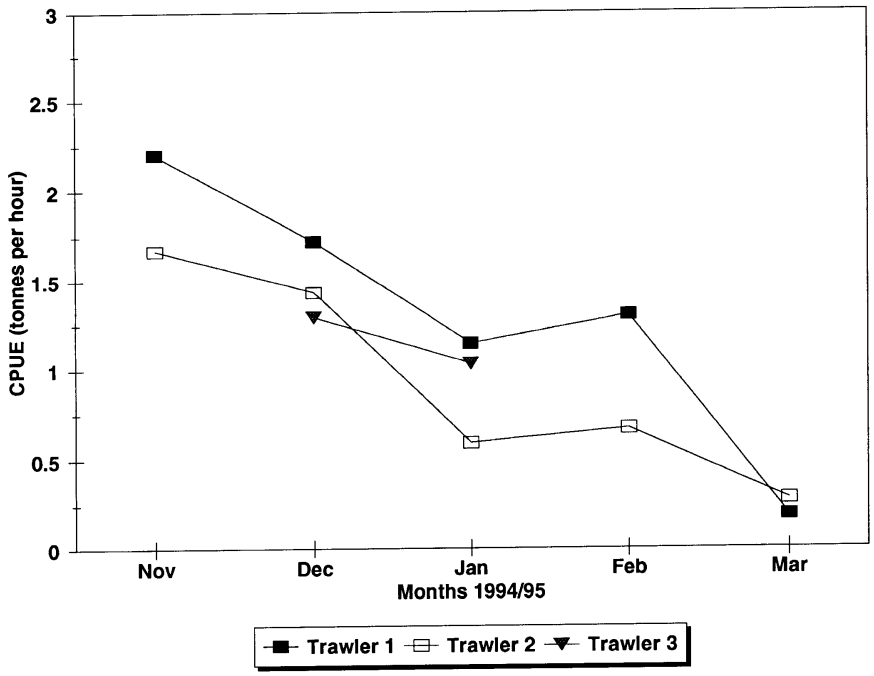

Figure 10: Trends in CPUE of trawlers fishing for *C. gunnari* in Division 58.5.1 during the 1995 season.

5.150 This continues the trend of decline in cohort strength even though no fishing had taken place since the present cohort was born in 1991. The previous 1988 cohort, however, had been heavily fished (13 283 tonnes were taken in the 1990/91 season when these fish were 2+ years old) and before most of them had spawned. This may explain the low abundance of its daughter cohort. More encouraging is that Dr L. Pshenichnov (Ukraine) in WG-FSA-95/13 Rev. 1 notes that many 0+ age fingerlings of *C. gunnari*, 25 mm to 60 mm long, were observed in the by-catch during the fishery last season. This suggests that the first spawning of the 1991 cohort in July 1994 was successful, even though the cohort abundance was low.

Management Advice

5.151 The Working Group advised in its 1993 and 1994 reports that because of the consistent decline in abundance of the strong cohorts appearing every three years, fishing of them should be delayed until they have had at least one opportunity to spawn and, thereafter, fishing should be kept to a low level to allow sufficient escapement of fish to spawn a second time.

5.152 Given the continuation of this decline, the Working Group recommended that this policy be continued. It therefore recommended that the fishery for *C. gunnari* in Division 58.5.1 be closed until at least the 1997/98 season, when the cohort born in 1994 will have had an opportunity to spawn. Before this cohort is fished, it is recommended that a pre-recruit biomass survey be conducted in the 1996/97 season to evaluate the strength of the cohort at age 2+. These data should be evaluated at the 1997 meeting of WG-FSA, and an appropriate level of catch recommended.

Dissostichus eleginoides (Division 58.5.1)

5.153 Fishing for this species continued in the 1994/95 season in the two traditional areas, a longline fishery on the western slope and a trawl fishery on the northern shelf. The most recently discovered ground on the eastern part of the shelf (WG-FSA-93/15[15]) was also exploited by one trawler for one cruise.

5.154 On the western slope of the plateau, 1 432 tonnes were caught by three Ukrainian longliners. The catches were in accordance with the 1 400 tonnes recommended in the 1993 report (SC-CAMLR-XII, Annex 5, paragraph 6.129).

5.155 There was a substantial decrease in catches in the northern area, from 4 141 tonnes during the 1994 season (SC-CAMLR-XIII, Annex 4, paragraph 4.132) to 3164 tonnes caught by two French trawlers in the 1995 season. This slightly exceeded the 3 000 tonne limit set for this zone by French authorities. One of the two trawlers also took 810 tonnes from the new fishing zone on the eastern edge of the plateau, and 128 tonnes were taken as a by-catch of the *C. gunnari* bottom trawl fishery on the northeastern shallow shelf.

Standardisation of CPUE Indices from *D. eleginoides* Fisheries in Division 58.5.1 (Kerguelen)

5.156 Since the results of standardising CPUE data from the *D. eleginoides* fishery in Subarea 48.3 were useful, the Working Group decided that it would be valuable to conduct similar analyses for the fisheries in Division 58.5.1.

5.157 Two separate GLM analyses were conducted on CPUE data from the fisheries for *D. eleginoides* around Kerguelen. The first was an analysis of CPUE data from the French trawl fishery operating off the northern and eastern coasts of Kerguelen. The second analysis was

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[15] Duhamel, G. 1993. The *Dissostichus eleginoides* fishery in Division 58.5.1 (Kerguelen Islands). Document *WG-FSA-93/15*. CCAMLR, Hobart, Australia.

conducted on CPUE data from the Ukrainian longline fishery operating off the western coast of the island. The French trawl data and the Ukrainian longline data could not be simultaneously analysed in a single GLM because there is no spatial overlap between these two fisheries.

Analysis of French Trawl Data

5.158 Five variables were selected as predictors for standardisation of the trawl CPUE data: vessel, year, month, area and depth. These predictors were used to model one CPUE index: kilograms per trawl hour.

5.159 The GLMs were fit to haul-by-haul data from 1994 and 1995, and the Working Group thanked Prof. Duhamel for providing these data.

5.160 The predictor effects were considered to be multiplicative, and the modelling strategy followed the methods previously outlined for the *D. eleginoides* fishery in Subarea 48.3. (paragraphs 5.22 to 5.43).

5.161 Year, vessel and depth were significant components of the variance in CPUE from the French trawl fishery (Table 22). There were not enough data to estimate month or area effects. The trawl GLM did not fit as well as those estimated for the longline fishery in Subarea 48.3; the reduction in deviance was only 4%.

5.162 Depth was the most significant component of the variance in trawl CPUE (Table 22). Kilograms per trawl-hour declined with increasing depth (Figure 11).

Table 22: Analysis of deviance table from GLM fit to French trawl data (1994-1995, northern and western sectors).

Factor/Covariate	Residual df*	Residual Deviance	p
NULL	957	602.4	
Year	956	596.1	0.0117
Vessel	955	590.5	0.0180
Depth	954	577.5	0.0003

* degrees of freedom

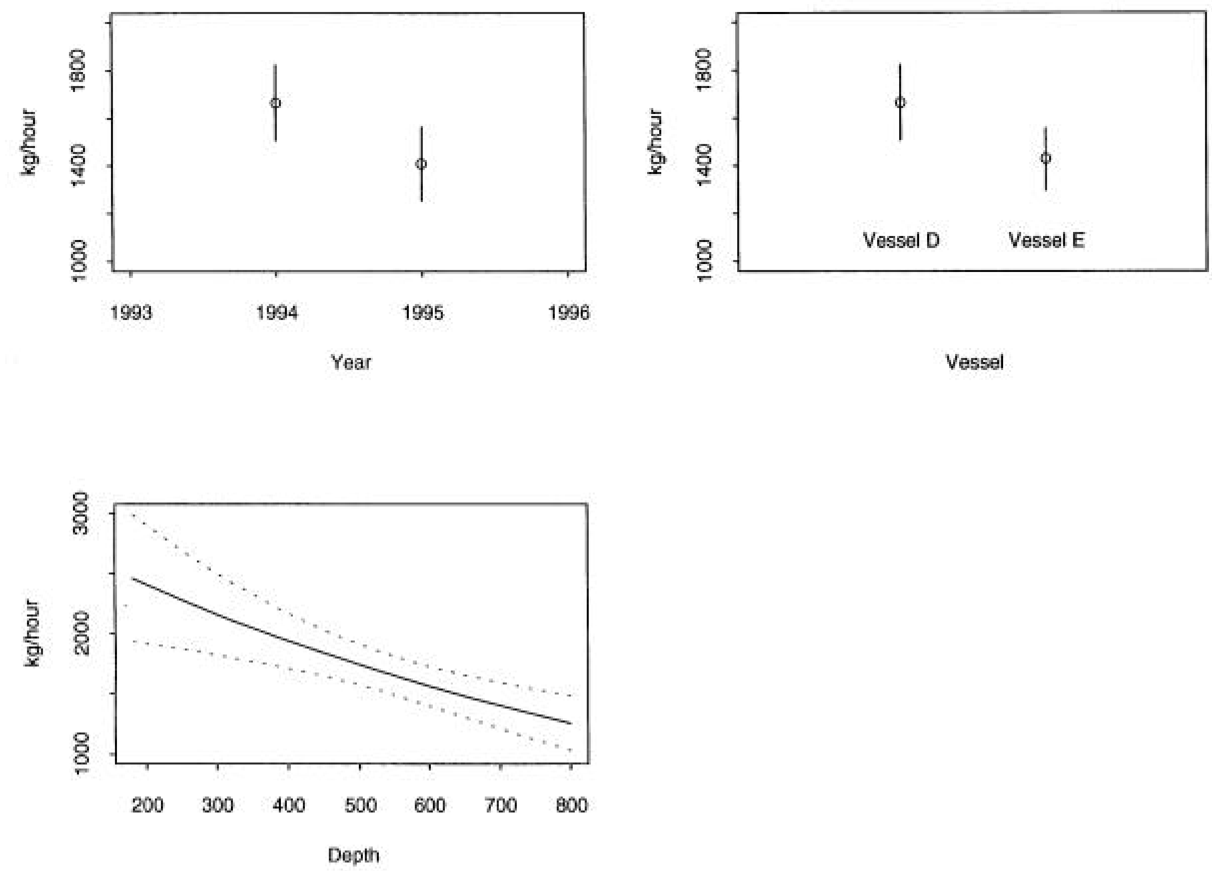

Figure 11: Estimated year, vessel and depth effects from a GLM fit to CPUE data from the *D. eleginoides* trawl fishery in the northern and eastern sectors of Division 58.5.1 (French fishing fleet). Circles are predicted area responses in the year and vessel plots and lines in these plots represent approximate 95% confidence limits. In the depth plot, the solid line is the estimated area response, and the dotted lines are the approximate 95% confidence limits on the predicted area response.

5.163 The year and vessel factors were about equally significant components of the variance in trawl CPUE. Kilograms per hour decreased between 1994 and 1995, and vessel 'D' had higher catch rates than vessel 'E' (Figure 11). Prof. Duhamel noted that the difference in catch rates between the two vessels was a result of differences in the type of factory production on each vessel. Vessel 'E' targets larger fish for the fillet market, while vessel 'D' targets smaller fish to produce headed and gutted product.

5.164 The Working Group noted that since the residual deviance from the trawl GLM was relatively large when compared to the null deviance, there are probably variables contributing to variation in CPUE that were not considered in the GLM. For this reason, the Working Group recommended that during the intersessional period the haul-by-haul data from the trawl fishery be explored to identify additional predictor variables.

Analysis of Ukrainian Longline Data

5.165 Five variables were selected as predictors for standardisation of the Ukrainian CPUE data: vessel, year, month, soak time and depth. These predictors were used to model one CPUE index: kilograms per hook.

5.166 Unfortunately, haul-by-haul data from the Ukrainian fishery were not available to the Working Group, but Prof. Duhamel provided vessel-specific catch and effort data that was averaged over 5-day intervals.

5.167 Year was the only significant component in the variance of the Ukrainian CPUE data; none of the other predictors contributed to a significant reduction in residual deviance (Table 23). The predicted year effects for kilograms per hook (averaged over 5-day intervals) are plotted in Figure 12. The standardised CPUEs differ between years, but there is no apparent trend over time.

Table 23: Analysis of deviance table from GLM fit to Ukrainian longline data (1991 to 1995, eastern sector).

Factor/Covariate	Residual df	Residual Deviance	p
NULL	172	44.5	
Year	168	35.4	0.0573

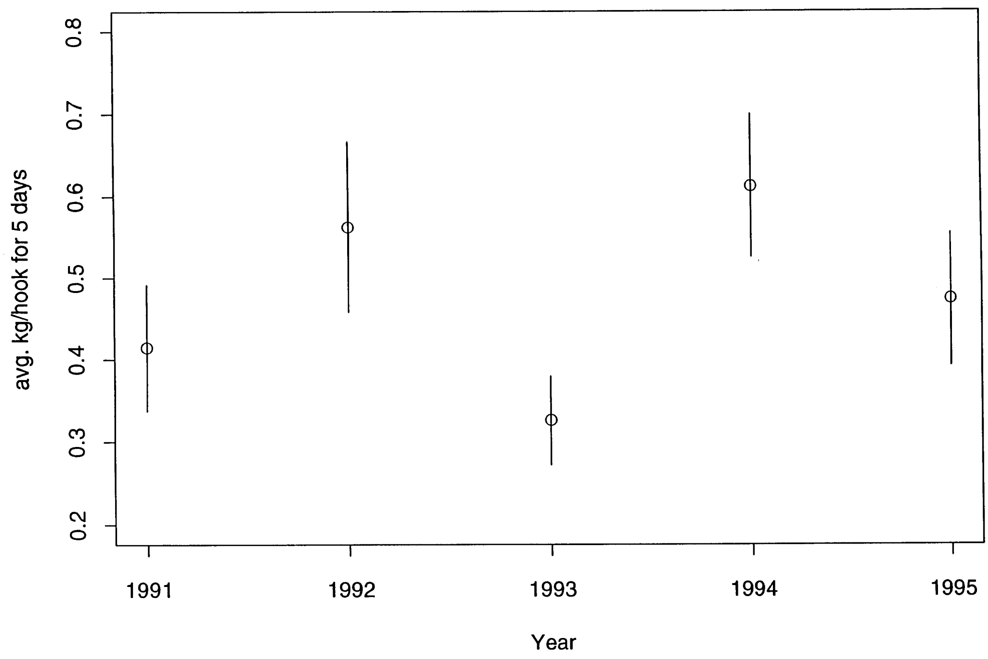

Figure 12: Estimated year effects from a GLM fit to CPUE data from the *D. eleginoides* longline fishery in the western sector of Division 58.5.1 (Ukraine fishing fleet). Circles are predicted area responses and lines represent approximate 95% confidence intervals for the predictions.

5.168 The Working Group was concerned about the lack of significance of factors in the GLM that are known to be significant for the fishery in Subarea 48.3 (i.e., month, soak time and depth). The Working Group noted that haul-by-haul data are critical for proper standardisation of CPUE data and recommended that every effort should be given to providing these data to future meetings of the Working Group.

Management Advice

5.169 French authorities have already set TACs for the three sectors fished for the 1995/96 season. These are 2 800 tonnes for the trawl fishery in the northern sector, 1 000 tonnes for the trawl fishery in the eastern sector, and 500 tonnes until the end of 1995 for the longline fishery in the western sector.

5.170 For the western sector longline fishery, there has been no decline in the trend of CPUE in recent years (WG-FSA-93/15 and subsequent data), so the Working Group recommended that the value of the longterm sustainable yield estimated at the 1994 meeting (SC-CAMLR-XIII, Annex 4, paragraph 4.134) of 1 400 tonnes per split-year be continued. As a 500 tonne catch has already been authorised for the first half of the split year, this would imply a catch limit for the January to

June 1996 period of 900 tonnes. The Working Group recommended, however, that further analysis of the *D. eleginoides* stocks exploited by the longline and trawl fisheries should be undertaken at the next meeting using the improved techniques recently established at WS-MAD.

5.171 At its 1993 meeting, the Working Group recorded that CPUE in the trawl fishery in the northern sector had fallen from 3.4 tonnes/hour in 1990/91, the first season of exploitation, to about 1 tonne/hour in the 1991/92 season (SC-CAMLR-XIII, Annex 5, paragraph 6.211). Since then the CPUE has stabilised at about 1.5 tonnes/hour. The Working Group therefore recommended that the TAC set by French authorities, which is a slight decrease from the 3 000 tonnes set in the previous year, be endorsed.

5.172 The eastern sector has only been fished in the 1995 season, when 810 tonnes were caught. The limit of 1 000 tonnes set by French authorities is considered appropriate as a precautionary approach.

5.173 The Working Group felt that the GLM analysis of factors affecting CPUE in longline and trawl fisheries is a potentially useful technique to improve its assessments. However, the analyses described in paragraphs 5.157 to 5.169 were limited by the lack of data on a haul-by-haul basis for the longline fishery, and by lack of data prior to 1994 for the trawl fisheries. The Working Group recommended therefore, that in future, catch and effort data be collected and reported to CCAMLR on a haul-by-haul basis for the longline fishery. In addition, efforts should be made to acquire haul-by-haul data from Ukrainian authorities for the fisheries in previous years. Prof. Duhamel will bring to next year's meeting the haul-by-haul data for the French trawl fishery prior to 1994. This will enable a more thorough GLM analysis to be performed in subsequent years.

Ob and Lena Banks (Division 58.4.4)

5.174 At CCAMLR-XIII, a conservation measure to allow a commercial catch of 1 150 tonnes of *L. squamifrons* to be taken over a two-year period (Conservation Measure 87/XIII) was approved at the request of Ukraine, provided a biomass survey was undertaken. Despite this, no fishing took place during the 1994/95 season, and so no new data are available.

5.175 Revised catch figures for both banks submitted to last year's meeting too late to be used in assessments (SC-CAMLR-XIII/BG/13[16]) were verified intersessionally by the Data Manager. These differ little from the previously accepted data set (Table 24), and it was felt that the differences did

[16] Ukraine. 1994. Ob and Lena Banks: Report of Observer. Document *SC-CAMLR-XIII/BG/13*. CCAMLR, Hobart, Australia.

not warrant a re-assessment of the stocks. As these data now describe catches for Ob and Lena Banks separately, it is recommended that separate statistical subdivisions be made for each bank and that in future catch and effort data be continued to be reported separately for each bank.

Management Advice

5.176 The Working Group reiterated its opinion held for the past few years that a biomass survey is necessary to provide a valid assessment of the fish stocks on the two banks.

5.177 As Conservation Measure 87/XIII, allowing a catch of 1 150 tonnes of *L. squamifrons* on the two banks provided an approved biomass survey is undertaken, is still valid until the end of the 1995/96 season, the Working Group encouraged this option to be taken up. This should provide data on which a new assessment can be based.

Heard and McDonald Islands (Division 58.5.2)

5.178 Dr Gherasimchook's re-analysis of fisheries statistics held by Ukraine (WG-FSA-95/15 Rev. 1) reveals for the first time that catches of *C. gunnari* had been taken from the Heard Island shelf and associated banks between 1970 and 1978 (Table 21 and paragraphs 5.141 to 5.145).

5.179 No fishery has been reported in recent times, but Conservation Measure 78/XIII set precautionary TACs of 311 tonnes and 297 tonnes for *C. gunnari* and *D. eleginoides* respectively on the basis of results from Australian biomass surveys (Williams and de la Mare, 1995[17]).

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[17] Williams, R. and W.K. de la Mare. 1995. Fish distribution and biomass in the Heard Island zone (Division 58.5.2). *CCAMLR Science*, Vol. 2: 1-20.

Table 24: Reported catches of *L. 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	1990 /91	Total 1977/78 to 1990/91	Reference
Ob	4952	1511	2831	1645	114	307	341	513	4999	1683	2989	850	867	-	22735	New data reported to CCAMLR
Ob	4952	1511	2830	1586	70	313	341	513	4999	1457	2989	850	867	-	22411	WG-FSA-92/5
Ob	4821	234	4167	41	56	588	40	1023	9531	1601	1971	913	-	-	24986	WG-FSA- 90/37
Lena	1071	585	204	3220	1480	426	834	57	6284	280	2013	3166	596	1000	19620	New data reported to CCAMLR
Lena	1071	585	201	3073	514	426	822	57	6284	506	2013	3166	596	-	18718	WG-FSA-92/5
Lena	1592	267	2616	1934	59	840	397	87	1977	441	2399	3003	-	-	15612	WG-FSA- 90/37
Ob and Lena	6023	2096	3035	4865	1594	733	1175	570	11283	1963	5002	4016	1463	1000	42355	New data reported to CCAMLR
Ob and Lena	6023	2096	3031	4659	584	739	1163	570	11283	1963	5002	4016	1463	-	41129	WG-FSA-92/5
Ob and Lena	6413	501	6783	1975	115	1428	437	1107	11508	2045	4370	3916	-	-	40598	WG-FSA- 90/37

5.180 At the 1994 meeting, TACs for *D. eleginoides* and *C. gunnari* were estimated using the revised form of the krill yield model (SC-CAMLR-XIII, Annex 4, paragraphs 4.153 to 4.159). The Scientific Committee agreed that the TAC should be revised when better estimates of the biological parameters became available.

5.181 The estimates of biological parameters for *D. eleginoides* established at WS-MAD this year were used as the basis for a revised assessment. However, the estimates of M are still uncertain, and a range of values of M between 0.1 and 0.2 were used in the model. Table 25 shows the γs estimated using the generalised yield model (paragraphs 3.44 to 3.47) and γ_2 calculated using 50% escapement from the fishery. The program was run for each of the CVs derived from the two valid biomass surveys, as in WG-FSA-94 (SC-CAMLR-XIII, Annex 4, paragraph 4.150). Estimates of yield for these runs are shown in Table 25. γ_2 remains the most conservative approach and its value is identical with that obtained last year (0.025). The TAC does not change.

Table 25: Values of γ calculated from the general yield model for each of the CVs derived from the two biomass surveys reported in Williams and de la Mare, 1995.

Survey	CV%	Biomass Estimate	γ_1	γ_2	TAC (using γ_2)
Autumn 1990	25.2	17714	0.028	0.025	443
Spring 1993	18.6	11880	0.0295	0.025	297

5.182 No other new data were available, but an Australian vessel plans to fish both *C. gunnari* and *D. eleginoides* in the division in the 1996 season. There is also an application to attempt a new fishery on *D. eleginoides* in Division 58.4.3 which adjoins Division 58.5.1 (paragraphs 5.1 to 5.7).

Management Advice

5.183 Conservation Measure 78/XIII established a TAC of 311 tonnes for *C. gunnari* in Division 58.5.2. In the light of experience with the fishery for this species in Division 58.5.1 (paragraphs 5.146 to 5.152), it is recommended that the fishery for *C. gunnari* in Division 58.5.2 also avoid the taking of fish smaller than the size at first spawning (about 28 cm total length).

5.184 The revised assessments given in paragraph 5.181 did not suggest that any revision of the TAC of 297 tonnes was necessary. Information from the fishery in the coming season may enable new assessments to be made at next year's meeting. Improved techniques developed in WS-MAD should be used with biological parameters derived from data on fish from this area.

Pacific Ocean Sector (Area 88)

5.185 No information was available to make any assessment of this area.

CONSIDERATIONS OF ECOSYSTEM MANAGEMENT

Interactions with WG-EMM

6.1 At its first meeting, WG-EMM had developed a plan for providing an ecosystem assessment and had concluded that such an assessment should consist of:

> Part 1: an analysis of the status of key biotic components of the ecosystem; and
>
> Part 2: a prediction of the likely consequences of alternative management actions for the future status of these components.

6.2 WG-EMM concluded that 'status' should include not only the points necessary for a single-species assessment, which are:

> current abundance and productivity of the harvested species, with abundance related to some level prior to the onset of exploitation; and
>
> if possible, the relationships between these quantities and the state of the environment;

but also points related to dependent species which may be summarised as:

> current abundance of dependent species (usually expressed as breeding population size or an index thereof) in relation to previous values, where possible in conjunction with data on current and recent adult survival and recruitment rates.

6.3 Historical developments have been towards assessments of the status of krill, as the key harvested species, and selected krill-dependent bird and mammal species. It was, however, recognised that other animals, such as fish and squid, are also dependent on krill and also that there are other food chains containing harvested species that do not directly include krill.

6.4 The icefish *C. gunnari* is a good example of a harvested species that is, in part, dependent on krill and is also predated by fur seals and some species of birds. Myctophids are an example of a group which had been harvested previously and which are a primary source of food of birds and seals.

6.5 The common interests of WG-FSA and WG-EMM concerning various aspects of the interactions, clearly indicate that there is a need for the two working groups to work together. In developing this work it is important that the focus of attention of each working group is aimed at avoiding duplication and also ensuring that the work of one group supports and extends the work of the other, thus improving the quality of advice being brought forward to the Scientific Committee.

6.6 The Working Group agreed that WG-EMM might provide information on harvested finfish species present in the diet of predators to be used in determining functional relationships between harvested fish and their predators. The types of information which WG-FSA could utilise would include: species taken, amount eaten, size and age composition of the prey, distribution and density of foraging activity.

6.7 WG-FSA felt that WG-EMM might benefit from information on the status of harvested species and specifically on the subjects of distribution, abundance and production.

6.8 It was noted that there are some fields where the same approaches are used by both working groups. One example is the use of acoustics for estimating the abundance and distribution of pelagic resources; this is a topic that receives much attention at WG-EMM from experts in the field. Clearly WG-EMM is the best forum for this topic to be developed for the time being. Another area of interest is statistical analyses, where both working groups have specific requirements; where the statistical problems were similar for the two groups there would be advantages in combining some of this work.

6.9 The Working Group discussed how best to achieve close liaison between the working groups and provide the best advice to the Scientific Committee. The advice from WG-FSA to the Scientific Committee is generally targetted towards developing a management plan on a season-by-season basis whereas WG-EMM is looking to drawing together information for ecosystem assessment over a longer time-scale. It was felt that because some Members participate in both working group meetings, requests from one group could be more easily understood by the other. The other approach was to formulate specific questions, examples of which are set out below.

6.10 The Working Group considered specific interactions for which advice might be sought from WG-EMM.

6.11 The recent history of the *C. gunnari* fishery in Subarea 48.3 has included periods when the stock has declined in the absence of commercial harvesting. This topic has been discussed at WG-FSA and raised at WG-EMM. It is thought that the decline is in some way related to the availability of krill, either directly as food for icefish, or else as a result of predators feeding more intensively on fish when krill are scarce. The Working Group therefore proposed the following questions for consideration by WG-EMM:

(i) How much *C. gunnari* is eaten by major predators in Area 48 and particularly in Subarea 48.3?

(ii) How does this impact vary within and between seasons?

(iii) Under what circumstances does the diet of individual predator species feeding on *C. gunnari* vary?

6.12 It was noted that the overlap between the distributions of krill and myctophids is being considered by WG-EMM. Studies in this field may provide information of value to WG-FSA in providing advice on the status of myctophids. In the event that a fishery recommences on Myctophidae, WG-FSA will be required to reconsider previous assessments. An abundance survey of myctophids in Subarea 48.3 was requested by WG-FSA at its 1992 meeting (SC-CAMLR-XI, paragraph 6.107). Estimates of annual production of myctophids would be enhanced by taking note of consumption rates by predators as had been done in the early krill assessments. WG-FSA therefore puts the following question to WG-EMM:

What is the estimated consumption by predators of Myctophidae in the Convention Area and adjacent waters?

6.13 The Working Group considered that this question should have a lower priority than those related to *C. gunnari* in paragraph 6.11 above.

6.14 WG-CEMP initially, and also WG-EMM, have considered *P. antarcticum* as a species for study within the Ecosystem Monitoring Program. No proposals for monitoring studies have been received and, accordingly, research activities on this species were given a low priority. It was noted that the biology and ecology of *P. antarcticum* were discussed at some length during a meeting of the Antarctic Fish Network of the European Science Foundation and that Dr G. Hubold (Germany) is preparing a review paper on the subject. The Working Group looked forward to receiving this review.

6.15 WG-FSA considered a proposal which had been put to WG-EMM on the use of blue-eyed shags (*Phalacorcorax atriceps*) as indicators of the status of some coastal fish species. The proposal had been brought forward for consideration in WG-EMM-95/84. The Working Group felt that the study might provide useful indices for *N. rossii* and *G. gibberifrons*, particularly since it had not been possible to provide resources for direct estimation of the status of these species.

By-catch of Fish in the Krill Fishery

6.16 Two papers reporting on the by-catch of fish in the krill fishery had been tabled at WG-EMM. One (WG-EMM-95/56) assessed the by-catch in the Japanese krill fishery off the South Shetland Islands (Subarea 48.1) from 30 January to 18 February 1995, the other (SC-CAMLR-XIV/BG/10) the occurrence of fish in commercial krill catches taken by a Japanese trawler off Wilkes Land (Division 58.4.1) from 19 January to 2 March 1995.

6.17 A detailed examination of these papers was prepared by WG-EMM for submission to WG-FSA and is included below.

6.18 The study conducted in the South Shetland Island region used the subsample size of 50 kg recommended in the *Scientific Observers Manual* as suggested by WG-Krill and WG-FSA last year (SC-CAMLR-XIII, Annex 5, paragraph 3.15; SC-CAMLR-XIII, Annex 4, paragraph 5.6). However, the by-catch (in numbers and weight of fish) was only extrapolated to 100 kg of krill and not standardised to numbers per tonne krill caught and numbers per tonne/hour as recommended in the *Scientific Observers Manual*. As a consequence, the findings are not directly comparable to previous studies. The study off Wilkes Land was the first study carried out by an international scientific observer. Most (88.8%) of the 169 hauls were made in a narrow band between 63 to 64°S latitude and 103 to 104°E longitude. Twenty-one hauls (12.4%) were sampled for finfish by-catch. With a few exceptions, the crew of the trawler surveyed the entire catch as the fish passed on a conveyor belt through the processing deck and as fish were gathered. Subsamples from hauls only partially surveyed were extrapolated to the entire catch. Subsamples of 25 to 50 kg krill from a number of hauls in the second part of the cruise (from station 70 onwards) were investigated more thoroughly for the presence of larval fish.

6.19 Twenty (25.6%) out of 78 hauls investigated in WG-EMM-95/56 contained fish. The area of operation is clearly reflected in the species composition of the fish incidentally caught. They were all mesopelagic species with the myctophid *Electrona antarctica* being the most abundant both in terms of numbers (85.6%) and weight (64.7%). However, no larval fish were observed. The author concluded that there is evidence that the by-catch of fish is greater when catch rates of krill are lower.

6.20 The Working Group noted that based on information provided by Japanese scientists during the meeting, it became obvious that the study in the South Shetland Islands was only representative, if at all, for the first part of the fishing season when Japanese trawlers were operating offshore over the deeper slope and in oceanic waters. The amount of by-catch extrapolated to 1 tonne of krill varied between 10 and 500 fish and is comparable to the level of by-catch of young notothenioids reported for Japanese trawlers operating in the shelf and upper slope waters of the South Shetland Islands in the previous season by the same author (WG-Krill-94/25[18]). The author's conclusion that the by-catch of fish tended to be greater at lower catch rates of krill agreed with earlier conclusions by the Scientific Committee. However, the Working Group noted that plots of the krill/fish catch ratio (as shown in Figure 1 of WG-EMM-95/56) can be misleading because they impose an implicit negative correlation (krill catch at the y-axis and fish/krill catch at the x-axis). The appropriate manner in which to investigate the hypothesis is to consider plots of fish catch rates versus krill catch rates. Given the limited amount of data available from one cruise this may best be achieved by pooling data from several cruises in the same region and period.

6.21 The observations off Wilkes Land represented the first study of that kind in this region. Twenty out of the 21 hauls surveyed contained fish. No larval fish were observed. The by-catch composition was different to the one observed off the South Shetland Islands. The most abundant species were the mesopelagic *Notolepis coatsi* and *Xenocyttus nemotoi* and juveniles of the giant nototheniid *D. mawsoni*. On five occasions, squid (*Psychroteuthis glacialis* and unidentified species) were found. The Working Group noted that, given the different way the data had been obtained and presented, it was impossible to compare by-catch levels with those provided in WG-EMM-95/56.

6.22 Subsequent to WG-EMM, a further analysis of the data in SC-CAMLR-XIV/BG/10 had been undertaken by Dr Watters and presented as WG-FSA-95/40. The author concluded that there was a great deal of uncertainty in the estimates of mean and total by-catch. It was suggested that one way of improving this situation would be by increasing the sampling effort, however, since this topic had been assigned a low priority in the list of sampling procedures in the *Scientific Observers Manual*, it was felt that this situation was unlikely to improve in the near future.

6.23 The Working Group was concerned that in spite of requests for this work to be undertaken it was still unable to provide a clear indication of the likely impact of krill harvesting on juvenile fish.

[18] Iwami, T. 1994. Fishes caught along with the Antarctic krill in the vicinity of the South Shetland Islands during the austral summer months of 1994. Document *WG-Krill-94/25*. CCAMLR, Hobart, Australia.

Two approaches were considered, a thorough examination of current data leading to a revision of the sampling requirements and an increase in sampling effort.

6.24 It was noted that work is in progress on reviewing current information through a group which includes T. Iwami (Japan), Z. Cielniaszek (Poland) and E. Pakhomov (Ukraine). It was recommended that this group be augmented by inclusion of Dr Watters for statistical advice and Dr M. White (UK) for information on larval distribution. In the first instance the group would operate by correspondence and be coordinated by Dr E. Sabourenkov (Secretariat).

6.25 The Working Group agreed that the topic should have a higher priority and be discussed under a single agenda item at its next meeting. The Secretariat was requested to develop a format for reporting of historical data and thereby encourage Members to submit further data.

6.26 One additional scientific observer's report was received too late to be considered by the Working Group (SC-CAMLR-XIV/BG/20). The Working Group recommended that WG-EMM consider this paper in more detail at its 1996 meeting.

Ecological Interactions

6.27 When considering trawl fisheries, the Working Group had previously advised that, due to the likely slow regeneration times for benthos, and the lack of any firm information on the effects of trawling on benthic communities, bottom trawling should be banned. The topic of ecological interactions is currently being investigated in other fisheries, for example, by the ICES Study Group on Unaccounted Mortality (ICES CM 1995/B:1 Ref. Assess) under the heading 'habitat degradation mortality', and further information is likely to accrue from that source. In the meantime, the Working Group agreed that bottom trawling should continue to be prohibited in Area 48. Midwater trawling could be permitted because the gear is likely to have minimal impact on benthos even when conducted close to the bottom.

6.28 The Working Group considered conservation measures which apply to finfish. In general, conservation measures specify target species but not the fishing method. For example, Conservation Measure 80/XIII is drafted on the assumption that the only method of fishing will be longlining even though it is clear that, based on historical catches and survey information, the target species *D. eleginoides* can be caught in trawls. The Working Group noted that the trawl fishery in Patagonia for *D. eleginoides* had been closed and that there were concerns that trawlers might move to parts of the CCAMLR Convention Area where this species is found. Providing part of a TAC was still available and the season was still open, such trawlers could legitimately target *D. eleginoides*. The

Working Group emphasised that its advice in paragraph 5.86 was based on the assumption that longlining would be the only fishing method employed in Subarea 48.3.

Experimental Fishing

6.29 The crab fishery in Subarea 48.3 was an example of a predetermined sampling design being incorporated into a conservation measure (Conservation Measure 75/XII). The first results of this study were available to the Working Group and are reported in paragraphs 5.119 to 5.122. The Working Group noted with pleasure that much useful information from this fishery was becoming available from the outset and as the fishery develops. This in turn would aid the Working Group in providing good advice for management of the resource. The Working Group considered that this approach might be applied to other fisheries within the Convention Area.

RESEARCH SURVEYS

Simulation Studies

7.1 The Working Group endorsed the use of simulation studies in tackling specific survey design questions. It also recognised that simulation studies need to be developed in conjunction with experimental surveys in an iterative manner. For example, the survey design simulation described in Everson et al. (1992)[19] addressed the specific problem of assessing the abundance of aggregating fish such as *C. gunnari*. Although the 1994 UK cruise tried to implement this approach, aggregations of *C. gunnari* were not found (WG-FSA-94/18[20]).

7.2 The Working Group identified a number of other fields in which simulation studies could be applied:

- surveys aimed at obtaining simultaneous estimates of the abundances of *C. gunnari* and *D. eleginoides*;

- the design of experiments in the *D. eleginoides* fishery; and

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[19] Everson, I., M. Bravington and C. Goss. 1992. Trawl survey design: results from a simulation study of the mackerel icefish, *Champsocephalus gunnari* at South Georgia. Document for the CCAMLR Workshop on Bottom Trawl Survey Design, Hamburg, Germany, 16-19 September, 1992.

[20] Everson, I., G. Parkes, K.-H. Kock, C. Goss, D. Cielniaszek, J. Szlakowski, H. Daly, L. Allcock and G. Pilling. 1994. Fish stock assessment survey in Subarea 48.3. Document *WG-FSA-94/18*. CCAMLR, Hobart, Australia.

- determination of sample sizes for the calculation of representative length distributions from survey data.

Notification of Intended Surveys

7.3 Last year, some concern was raised that the six-month lead-in time, required by Conservation Measure 64/XII (paragraph 3a) for the notification of research surveys in cases where the catch in surveys is expected to be greater than 50 tonnes, was too long (SC-CAMLR-XIII, paragraph 11.4). After considerable discussion, the Working Group confirmed that this provision is appropriate, since it ensures that there are sufficient opportunities for review of proposals by working groups and the Scientific Committee before those research plans can proceed.

INCIDENTAL MORTALITY ARISING FROM LONGLINE FISHING

Intersessional Work on Seabird Incidental Mortality in Longline Fisheries

8.1 In 1993 the Scientific Committee established an ad hoc working group to consider Incidental Mortality Arising from Longline Fishing (WG-IMALF). This met in Hobart in 1994 (SC-CAMLR-XIII, Annex 8). Although there was no meeting of the ad hoc working group in 1995, a coordinating group convened by Prof. Moreno and the Secretariat worked during the intersessional period in accordance with the plan of work outlined in last year's paper 'Intersessional work on longline incidental mortality, 1994/95' (CCAMLR-XIII/BG/30).

8.2 A summary of work undertaken by the Secretariat during the 1994/95 intersessional period is given below. Items are listed in the same order as in the program of work recommended in CCAMLR-XIII/BG/30.

8.3 As required, all members of the coordinating group were provided with a set of working documents at the beginning of the intersessional period.

8.4 The following additional documents were distributed to the coordinating group during the intersessional period:

- two reports of observations of seabirds conducted on board a Korean longliner in 1995 and a Bulgarian/Ukrainian longliner in 1994 by Russian scientific observers designated in accordance with the Scheme of International Scientific Observation; and

- a paper by Dr M. Hall of the Inter-American Tropical Tuna Commission (IATTC), received via Dr Croxall, entitled 'Strategies to reduce the incidental capture of marine mammals and other species in fisheries'.

8.5 The Secretariat has informed the following international organisations of CCAMLR initiatives on the prevention of incidental mortality of seabirds in longline fisheries:

- International Commission for the Conservation of Atlantic Tunas (ICCAT);
- Indian Ocean Fisheries Commission (IOFC);
- South Pacific Commission (SPC);
- South Pacific Fisheries Forum Agency (FFA);
- Commission for the Conservation of the Southern Bluefin Tuna (CCSBT);
- UN Food and Agriculture Organisation (FAO); and
- UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks.

8.6 This information was also provided to all CCAMLR scientific observers nominated by the Commission to meetings of the international organisations listed above and the XIX Antarctic Treaty Consultative Meeting (ATCM) (CCAMLR-XIII, paragraph 12.16). FAO and IWC were also consulted on possible means of reducing interactions between cetaceans and longline fishing in the Convention Area (SC-CAMLR-XIII, paragraph 9.60).

8.7 The Secretariat had received reports from CCAMLR scientific observers at meetings of the ATCP, FAO and ICCAT, which contain references to information presented on behalf of CCAMLR. Other reports are expected to be available during CCAMLR-XIV.

8.8 The Secretariat had also received letters from IATTC, ICCAT, FFA and IWC acknowledging the receipt of information and indicating steps being taken or planned by these organisations to deal with the problem of incidental mortality of seabirds in longline fisheries. Copies of this correspondence were passed to the convener of the coordinating group, Prof. Moreno.

8.9 The Secretariat was asked to arrange for two documents, originally produced by Mr N. Brothers (Australia), on the prevention of incidental mortality of seabirds during longline fishing and on the principles of bird-line construction, to be suitably revised to apply to CCAMLR fisheries, published and widely circulated in all languages of the Commission, as well as other languages of Members currently fishing in the Convention Area. Australia contributed A$20 000 to a special fund to assist in the drafting of text, design, translation and printing of these documents (SC-CAMLR-XIII, paragraphs 9.30 and 9.39; CCAMLR-XIII, paragraphs 4.28 to 4.32).

8.10 Both documents have been carefully studied by the Secretariat in order to determine the extent of revision required to ensure their applicability to longline fisheries in the Convention Area and adjacent waters. It was found that the first document requires extensive revision because, in its present form, it deals mainly with pelagic longline fisheries and, as such, most of its conclusions and recommendations may not necessarily be valid for bottom longline fisheries. The recommendations contained in the second document were, however, found to be in agreement with the current CCAMLR strategies on the reduction of incidental mortality of seabirds.

8.11 In order to ensure completeness and a high level of applicability of both documents, the Secretariat asked Mr Brothers to assist with the revision of the documents. Mr Brothers suggested that it would be useful if both documents were combined into a longline fishery/seabird handbook for vessels fishing in the CCAMLR Convention Area. He also suggested that the required completeness and applicability of this handbook would best be achieved if the author were able to have first-hand experience in studying incidental mortality of seabirds on board longline vessels fishing for *D. eleginoides* in the Southern Ocean. Mr Brothers therefore strongly recommended that CCAMLR delay proceeding with the preparation of the book until the information that will be obtained during the current 1995 fishing season is incorporated.

8.12 The coordinating group was consulted and the responses received showed agreement with the recommendations of the Secretariat and Mr Brothers.

8.13 Mr Brothers consequently continued his research program and conducted observations in May and June 1995 on board a longliner fishing for *D. eleginoides* in the waters around the Falkland/Malvinas Islands. In accordance with a tentative agreement with Mr Brothers, the Secretariat plans to prepare a draft handbook and distribute it to the coordinating group for comments by early March next year.

8.14 The Secretariat drafted data sheets for reporting scientific observations of incidental mortality of seabirds aboard longline vessels and sent them to the coordinating group for comments. The comments received were incorporated into the revised versions of the data sheets. With the assistance of Mr Brothers and Dr R. Gales (Australia), the Secretariat has also prepared guidelines for observations of incidental mortality of seabirds and marine mammals on board longline fishing vessels. The data sheets and guidelines are submitted to WG-FSA for consideration in the document SC-CAMLR-XIV/BG/13.

8.15 The Secretariat suggested that in addition to publishing data sheets and guidelines in a book format for distribution to scientific observers, as recommended by the Scientific Committee (SC-

CAMLR-XIII, paragraph 9.28), both documents should also be appended to the revised edition of the *Scientific Observers Manual*. A draft of the revised manual was prepared by the Secretariat (SC-CAMLR-XIV/6).

8.16 In order to ensure that data and samples collected by scientific observers are analysed and reported to CCAMLR in a timely fashion, Members were reminded that, at the initiation of observer arrangements, agreement should be reached on the fate of such data and samples, and on their analyses (COMM CIRC 95/5 of 20 February 1995) (see paragraph 8.76 and Appendix H).

8.17 The Secretariat consulted with Dr S. Bartle (New Zealand) regarding New Zealand plans to produce a seabird identification manual for scientific observers on fishing vessels. Some work on the identification manual was started this year. It is expected that the delegation of New Zealand will submit an official proposal to the Scientific Committee regarding the preparation of the manual and funding of its publication.

8.18 A presentation on 'CCAMLR Initiatives on the Prevention of Incidental Mortality of Seabirds in Longline Fisheries' was given to the First International Conference on the Biology and Conservation of Albatrosses (28 to 30 August 1995, Hobart, Tasmania, Australia) by the CCAMLR Executive Secretary. The Secretariat's Data Manager and Science Officer participated in the conference workshop on albatross-fisheries interactions.

Matters Arising from Intersessional Work

8.19 The Secretariat was thanked for its efficient conduct of the considerable volume of intersessional business.

8.20 The responses from organisations listed in paragraphs 8.5 to 8.7, in respect of the request for information on the steps they have taken and are planning to address the topic of incidental mortality of seabirds associated with fisheries, especially longline fisheries, and details of current and forthcoming meetings at which input from CCAMLR might be particularly relevant, were not available at the meeting. They were expected to be available for the meeting of the Scientific Committee and would need evaluation at that time.

8.21 It was agreed that it would be very useful to request similar information from Members with respect to fisheries under their control in waters adjacent to the Convention Area and in other regions where seabirds from the Convention Area might be affected.

8.22 It was agreed that the proposed handbook on 'Catching fish not birds: a guide to improving longline fishing efficiency' (including the details of the principles of streamer line construction) should be produced as soon as possible on the basis of the best information currently available on both Spanish and autoliner methods. A draft version should be available for circulation by March 1996.

8.23 The need for a seabird identification manual for scientific observers on fishing vessels was re-emphasised (see also paragraph 8.42(i)). New Zealand was encouraged to continue its work on this and the Scientific Committee was requested to support proposals that would assist in its publication.

8.24 The Working Group commended CCAMLR staff for their role in the recent International Albatross Conference, particularly in publicising the activities of CCAMLR in addressing the topic of incidental mortality of seabirds. The conference, which attracted 120 people from 11 nations, was presented with some 20 papers and 13 posters on topics of direct relevance to incidental mortality of albatrosses (see WG-FSA-95/19), and most of the conference workshop was devoted to consideration of this topic.

8.25 As WG-FSA-95/59 notes, much of the success of the conference was due to the diversity of participants. Especially important for making progress on key issues was the participation of fishery managers, fishing industry representatives (from Australia, Japan and New Zealand) and scientists active in seabird by-catch research from Argentina, Brazil and Uruguay.

8.26 The Working Group noted some of the workshop interim conclusions, that:

'• there was unanimity in the concern for albatross conservation due to longline fishing;

• the recognition that probably all albatross species are currently affected by longline fishing for tuna, broadbill, hake and toothfish;

• the extent and severity of albatross by-catch is poorly documented in most areas;

• except for black-browed, grey-headed and wandering albatrosses there are few studies of albatross demography adequate to understand the effect of incidental mortality at the population level; and

• the need to implement mitigating measures to reduce seabird by-catch in most current longline fisheries.'

8.27 In respect of these conclusions, the Working Group noted that CCAMLR could take considerable credit for its prompt action in requiring mitigating measures to be used on all vessels and in developing a comprehensive scientific observer program.

8.28 CCAMLR was fortunate that several of the major current long-term population studies of albatrosses are at sites within the Convention Area. Nevertheless, the Working Group also noted the workshop conclusions that:

(i) similar studies on additional populations are needed. Members (particularly Chile, South Africa and New Zealand) were encouraged to initiate and maintain such research; and

(ii) albatross banding programs should be initiated, particularly in order to help determine the provenance of birds caught in longlines at sea. Members were encouraged to undertake this work. It was recognised that there was potential scope for collaboration with SCAR, particularly as the SCAR Bird Biology Subcommittee had organised large-scale banding studies (of giant petrels and penguins) in the past.

8.29 The Working Group noted that CCAMLR would be very interested in the full report of the workshop (and in due course the conference proceedings) and looked forward to receiving it. It congratulated the organisers on holding such a timely and productive conference.

8.30 The Working Group noted that the IMALF coordinating group had received no reports from Members on existing or projected monitoring studies on albatrosses, giant petrels and white-chinned petrels (as requested in CCAMLR-XIII/BG/30). One report was tabled at the meeting.

8.31 The UK reported that:

- monitoring of population size and breeding success, together with adult survival and juvenile recruitment rates of black-browed, grey-headed and wandering albatrosses at Bird Island, South Georgia had been carried out annually since 1976 (see Croxall et al., 1990[21]; Prince et al., 1994[22]; black-browed albatross data are submitted annually to CEMP);

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[21] Croxall, J.P., P. Rothery, S.P. Pickering and P.A. Prince. 1990. Reproductive performance, recruitment and survival of wandering albatrosses *Diomedea exulans* at Bird Island, South Georgia. *Journal of Animal Ecology*, 59: 775-796.

[22] Prince, P.A., P. Rothery, J.P. Croxall and A.G. Wood. 1994. Population dynamics of black-browed and grey-headed albatrosses *Diomedea melanophris* and *D. chrysostoma* at Bird Island, South Georgia. *Ibis*, 136: 50-71.

- a census of breeding population size of northern and southern giant petrels at Bird Island, South Georgia is being undertaken in 1996 and 1997 for comparison with similar data collected there from 1979 to 1981; and

- a census of the breeding population of white-chinned petrels at Bird Island, South Georgia is to be undertaken in 1997 and 1998 for comparison with similar data collected there in 1980 and 1981.

8.32 Other Members of CCAMLR and the IMALF coordinating group were requested to make reports as soon as possible. Such information is important in assessing the likelihood and/or time-scale of detecting population changes of the species known to be the ones most affected by longline fishing.

8.33 Chile stated it had not submitted a report because it was unable to carry out any work on the only available site (Diego Ramirez - a globally important breeding site for black-browed and grey-headed albatrosses). Other Members known to be carrying out appropriate work or having the potential to do so include Argentina, Australia, France, New Zealand and South Africa.

8.34 The Working Group looked forward to advice from SCAR (and Members) on establishing a research program on albatross population genetics to identify the origin of birds caught in longline vessels (CCAMLR-XIII/BG/30).

Reports on Incidental Mortality of Seabirds During Longline Fishing

Data from the Convention Area

Observations for 1994

8.35 The remaining report for the 1994 season (WG-FSA-95/4) (see SC-CAMLR-XIII, paragraph 9.9) was circulated intersessionally.

8.36 This report, which provided detailed information on fish, fishing operations and fish by-catch, indicated that three to eight short longlines (1 250 to 2 500 hooks, 60 to 70% baited, setting time 20 to 30 minutes) per day were set using a Mustad autoliner. Spaced weights were used on the line, thawed bait was used and a streamer line modified from the CCAMLR design deployed. Sixteen seabirds were recovered dead, but because the report does not specify what proportion of hooks were monitored, an overall catch rate of seabirds cannot be calculated. The 16 specimens were examined in Stanley by Dr Croxall; all black-browed albatrosses were adult and the unidentified petrel turned out to be a white-chinned petrel.

Observations for 1995

8.37 Observation programs carried out in the 1995 season are summarised in Table 26 (SC-CAMLR-XIV/BG/16 Rev. 1). All except the vessels of Argentina observed by Chile had one scientific observer on board. The ability to use two scientific observers on each Argentinian vessel (one local (from Argentina) and one international (from Chile)) reflected significant assistance from the fishing industry, which is acknowledged.

8.38 The Working Group noted that the quality of information provided clearly relates closely to the degree of observer coverage. Thus, for some Chilean-observed vessels, 100% of every haul was monitored. The reports from most other vessels state, or suggest, incomplete coverage and do not specify the proportion of hooks observed. It is essential to have this information in order to make an estimate of overall by-catch.

8.39 The report on the *Ihn Sung* (WG-FSA-95/5 Rev. 1) contains considerable valuable information on seabird by-catch and the scientific observer was commended for the detail on this topic. Important points from the report are:

- only 72% of sets were made at night;
- offal was discharged on the same side as, and only 2 m away from, hauling operations;
- a CCAMLR-designed streamer line was not very effective (WG-FSA-95/58 suggests it was probably incorrectly rigged) and was replaced by a streamer line with bags attached;
- one of the two albatrosses recovered dead was caught during a daylight set;
- the other albatross and one of the two white-chinned petrels were caught on a longline deployed without a streamer line;
- although observations of sperm whales were frequent, only one potential interaction involving the removal of fish from the line occurred; and
- lack of data on the proportion of hooks observed precludes any estimate of overall seabird mortality.

8.40 The report of the *Itkul* (WG-FSA-95/56) is very brief. Important points include: a Mustad autoliner with squid bait was used; and 12.5% of the 24 sets took place during daylight. There was no reported incidental mortality but without any information on scientific observer effort or viewing position it would seem prudent to treat the report with caution.

Table 26: Summary of observation programs on longline fisheries conducted in the 1994/95 season, in accordance with Conservation Measure 80/XIII, by scientific observers designated under the CCAMLR Scheme of International Scientific Observation.

Flag State	Vessel	Observer	Report	Subarea/ Fishery	Period of Observation	Data Reported
Republic of Korea	*Ihn Sung 66*	Russia	WG-FSA-95/16 Rev. 1	48.3 *D. eleginoides*	3/3 - 8/4/95	Fish catch and biological data; seabird incidental mortality and marine mammal interaction data
Chile	*Magallanes III* *Isla Sofia* *Cisne Verde* *Puerto Ballena* *Isla Isabel* *Isla Camila*	Argentina Spain	WG-FSA-95/49 - 55 WG-FSA-95/46	48.3 *D. eleginoides*	5/3 - 29/5/95	Fish catch and biological data; seabird incidental mortality and marine mammal interaction data
Argentina	*Arbumasa XX* *Arbumasa XXII* *Arbumasa XXIII* *Marunaka* *Estela*	Chile	SC-CAMLR-XIV/BG/23 - 27	48.3 *D. eleginoides*	1/3 - 12/5/95	Fish catch and biological data; seabird incidental mortality and marine mammal interaction data
Russia	*Itkul*	Ukraine	WG-FSA-95/56	48.3 *D. eleginoides*	4/5 - 20/5/95	Fish catch and biological data; seabird incidental mortality and marine mammal interaction data

8.41 Many aspects of the results of the remaining observations are summarised in WG-FSA-95/42. In this paper, of 537 birds reported caught and released alive, 61% were white-chinned petrels (though mainly identified as sooty albatrosses - see below), 18% giant petrels and 17% black-browed albatrosses. Of 956 birds reported captured dead, the overall catch rate (hereafter referred to as birds-per-unit-effort (BPUE)) was 0.175 birds per thousand hooks, being 0.115 and 0.215 for the Argentinian and Chilean vessels respectively. Of this total, 82% were white-chinned petrels, 9% giant petrels, 4% black-browed albatrosses, 3% wandering albatrosses and 1% grey-headed albatrosses. Interactions with killer and sperm whales were reported as being common.

8.42 The authors of WG-FSA-95/42 drew attention to certain problems noted by the scientific observers:

(i) difficulties that some scientific observers (particularly those inexperienced with seabird work) had in species identification. In particular, most identifications of sooty albatrosses almost certainly refer to white-chinned petrels; records of royal albatrosses probably all relate to wandering albatrosses; gulls were likely to be black-browed albatrosses;

(ii) although on leaving port all vessels were provided with streamer lines constructed to CCAMLR specifications, these were not used by the *Estela*, *Marunaka*, *Mar del Sur II*, *Puerto Ballena*, *Isla Camila* (first leg) (i.e., at least 36% of the vessels involved in the fishery); and

(iii) offal was usually being discharged during hauling. This sometimes resulted in a substantial number of birds (e.g., 325 white-chinned petrels, 86 black-browed albatrosses and 72 giant petrels by *Isla Camila* (first leg)) being caught while hauling, necessitating considerable work in releasing them alive.

8.43 The data on incidental mortality of seabirds reported by the scientific observers were analysed in WG-FSA-95/42 in relation to distance from South Georgia (the nearest breeding colonies of the seabirds involved), the lunar cycle, hook size and the presence/absence of streamer lines.

8.44 There was a statistically significant trend ($P < 0.001$) for more birds to be caught by vessels fishing closer to South Georgia.

8.45 The Working Group noted that there was the potential in this analysis for a confounding effect of the presence/absence of streamer lines, although it did note that the authors of WG-FSA-95/42 stated that one vessel which fished at three different distances from South Georgia also showed a trend of more birds being caught closer to the island. The Working Group suggested that it might be useful to look for temporal effects, particularly in relation to the timing of fledging of white-chinned petrels, whose abundance in the area would be expected to decline substantially after their chicks fledge (mean date 21 April, SD 6.4 days, range 9 April to 9 May; Hall, 1987[23]).

8.46 Paper WG-FSA-95/42 indicated a significantly ($P < 0.001$) higher catch rate for white-chinned petrels at the time of full moon.

8.47 Smaller hooks were significantly ($P < 0.001$) associated with higher capture rates of birds, though this requires further work because the smallest hooks were used only by one vessel although these were, however, of similar shape to the other hooks used.

8.48 After restricting the data set in terms of the phase of moon and distance from South Georgia, the catch rates of birds by vessels without streamer lines were significantly greater (by a factor of at least two) than for vessels using streamer lines.

8.49 The Working Group congratulated the authors on their work, which provided CCAMLR with by far the most detailed examination so far of the nature of interactions between seabirds and longline vessels in the Convention Area.

8.50 The Working Group particularly noted:

(i) the indication of lower overall catch rates (BPUE of around 0.15 to 0.20) of seabirds than in previous data for Subarea 48.3 (0.47 BPUE), which it inferred was probably due to a combination of night-time setting, fishing later in the breeding season of the most potentially vulnerable seabird species and more extensive use of streamer lines;

(ii) the dramatic reduction in seabird by-catch of albatrosses - 9% of the total catch as opposed to 50% in previous years. This was attributed almost exclusively to the use of night-time setting. Indeed the Working Group noted that of the 23 albatrosses caught by Argentinian vessels, 18 (78%) were in fact caught on sets in the daylight or extending into dusk/dawn (when albatrosses are particularly active); and

(iii) the increase in the number and proportion of white-chinned petrels caught, forming over 80% of the seabird by-catch. This had been recognised as a likely consequence of night-time setting. The Working Group noted that to reduce this catch level it was essential to use streamer lines at all times; further investigation of other ways of reducing the by-catch of this species was also requested (see paragraph 8.64 below).

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[23] Hall, A.J. 1987. The breeding biology of the white-chinned petrel, *Procellaria aequinoctialis*, at South Georgia. *J. Zool., Lond.*, 212: 605-617.

8.51 The Working Group noted that despite the value and importance of the analyses in WG-FSA-95/42, it provided insufficient information for a comprehensive assessment of the data on incidental mortality from individual vessels. This was of particular importance given the great variation between vessels in reported seabird by-catch, which in some cases did not appear to relate to the presence/absence of streamer lines.

8.52 The Working Group welcomed the provision of more detailed reports from scientific observers on individual vessels, many of which provided most of the data needed for a comprehensive assessment. The main data required for even a general assessment are, for each set/haul:

- timing and duration of set and haul;
- number of hooks deployed and, if possible, the proportion of hooks baited;
- number of hooks observed for seabird by-catch during set and/or haul;
- number and specific identity (with age and sex if known) of birds caught;
- whether streamer lines were used (and the type of line, particularly whether conforming to CCAMLR specification or not); and
- whether or not offal was discharged during set/haul and location of discharge (e.g., side of vessel, distance from haul point).

8.53 The Working Group used such data as were available in scientific observers' reports to undertake a preliminary assessment (Tables 27 and 28). This analysis should be repeated intersessionally, once certain aspects of the data have been validated (see below).

Table 27: Summarised data on incidental mortality of seabirds in longline fisheries for *D. eleginoides* in Subarea 48.3 (South Georgia) and adjacent areas in 1995.

Vessel	Dates of Fishing	Method[1]	Sets[2]			No. of Hooks (thousands)		Proportion (%) of Hooks Observed	No. of Birds Killed		Catch Rates		Streamer Line in Use	Offal Discharge at Haul[3]	Reference
			N	D	Total	Obs	Total		Obs	Total	Obs	Total			
Subarea 48.3															
Itkul	4/5 - 20/5	Auto	21	3	24	94?	94		0				Y	?	WG-FSA-95/6
Ihn Sung 66	4/3 - 17/7	Sp	31	33	64	679?	679		1				N/Y	YS	WG-FSA-95/5
									3		0.006		N/Y	YS	Rev. 1
									4				N/Y	YS	“
Estela	13/3 - 29/3	Sp	14	1	15	200?	200		1		0.005	-	N	YO	WG-FSA-95/52
Estela	14/4 - 17/5	Sp	31	0	31	c 310?	c 310?		3		0.010	-	N	YO	WG-FSA-95/50
Marunaka	7/3 - 20/4	Sp	31			411	411	100	84	84	0.204	0.204	N	YO	WG-FSA-95/51
				10		125	125	100	29	29	0.232	0.232	N	YO	“
					41	536	536	100	113	113	0.21	0.211	N	YO	“
Arbumasa XXII	29/3 - 5/5	Sp			39	326?	326		44		0.135		Y	Y?	WG-FSA-95/49
			35			2905	2905		11		0.038		Y	Y?	“
				4		355?	355		23		0.648		Y	Y?	“
Arbumasa XXIII	1/4 - 16/5	Sp			42	424?	424		70		0.165		Y	YO	WG-FSA-95/55
				2			11		0		0.0		Y	YO	“
			40			403?	403		70		0.174		Y	YO	“
Mar del Sur II	27/4 - 16/5	Sp	16			246?	246		0		0.0		N	Y?	WG-FSA-95/53
				3		36?	36		19		0.528		N	Y?	“
					19	282?	282		19		0.067		N	Y?	“
Arbumasa XX	13/4 - 17/5	Auto	31	5	36	?	c 360		0		0		Y	YS	WG-FSA-95/54
Puerto Ballena	6/3 - 25/4	Sp	56		56	757?	757	100	346	346	0.457	0.457	N	YS	
Cisne Verde	4/3 - 14/4	Sp	30		20	593?	593		134		0.226		Y	Y?	
Isla Camila[4]	3/3 - 2/5	Sp	90		90	827?	827		210		0.254		N	Y?	WG-FSA-95/57
Isla Sofia	26/3 - 15/5	Sp	39	4	43	421?	421		14	14?	0.033		Y?	Y?	Database
Isla Isabel	8/3 - 18/4	Sp	21	14	35	306?	306		0		0		Y?	Y?	Database
Magellanes III	1/3 - 2/4	Sp	30	0	30	288?	288		0		0		Y?	Y?	Database
Falklands/Malvinas															
Mar del Sur I	?	Sp			?		c 740		319		0.431		N	?	WG-FSA-95/58
Mar del Sur I	?	Sp			?		c 320		90		0.281		N	?	“
Isla Guafo	6/5 - 7/6	Sp			?	c 380	c 380	100	43	43	0.113	0.113	Y	YO	“

1 Sp = Spanish method; Auto = Mustad autoliner
2 N = night-time; D = daytime (including dawn and dusk)
3 O = opposite side to hauling; S = same side as hauling; ? unknown
4 See comments in paragraph 8.55

Table 28: Summary of the species composition of birds killed in longline fisheries in Subarea 48.3 and adjacent areas in 1994 and 1995.

Vessel	Method	Dates of Fishing	Area	No. of Killed Birds Identified[1]	Composition by Species[2] (%)							Reference
					DIX	DIM	DIC	MA	PRO	DAP	Other	
1994:												
RK-1	Auto	1/6 - 9/9	48.3	16		44			6	5		WG-FSA-95/4
1995:												
Itkul	Auto	4/5 - 20/5	48.3	0								WG-FSA-95/56
Ihn Sung 66	Sp	3/3 - 30/4	48.3	4	25	25			50			WG-FSA-95/5 Rev. 1
Estela	Sp	13/3 - 29/3	48.3	1		100						WG-FSA-95/52
Estela	Sp	14/4 - 17/5	48.3	3				100				WG-FSA-95/50
Marunaka	Sp	7/3 - 20/4	48.3	113	1	5	1	92				WG-FSA-95/51
Arbumasa XXII	Sp	29/3 - 5/5	48.3	44		2		2	95			WG-FSA-95/49
Arbumasa XXIII	Sp	1/4 - 16/5	48.3	70	3			9	89			WG-FSA-95/55
Mar del Sur II	Sp	27/4 - 16/5	48.3	19	11		47	42				WG-FSA-95/53
Arbumasa XX	Auto	13/4 - 17/5	48.3	0								WG-FSA-95/54
Puerto Ballena	Sp	6/3 - 25/4	48.3	346	7				93			WG-FSA-95/42
Cisne Verde	Sp	4/3 - 14/4	48.3	133		2			98			WG-FSA-95/42
Isla Camila	Sp	3/3 - 2/5	48.3	213		28		13	58		1[3]	WG-FSA-95/42
Isla Sofia	Sp	c 2/4 - c 12/5	48.3	14		36		36			29[3]	WG-FSA-95/42
Isla Isabel	Sp		48.3	0								
Magellanes III	Sp		48.3	0								
Mar del Sur I	Sp	?	Falk/Malv	319		93			6	<1		WG-FSA-95/58
Mar del Sur I	Sp	?	Falk/Malv	90		100						WG-FSA-95/58
Isla Guafo	Sp	6/5 - 7/6	Falk/Malv	43		12	77	5		7		WG-FSA-95/58

1 Identification corrected, where appropriate, as indicated in paragraph 8.42(i)
2 DIX = wandering albatross; DIM = black-browed albatross; DIC = grey-headed albatross; MA = giant petrel; PRO = white-chinned petrel; DAP = cape petrel
3 Albatross nei

8.54 The results provided in Tables 27 and 28 indicate that data in scientific observers' reports for Argentinian vessels, adequate for assessments of seabird by-catch, were available only from *Estela*, *Arbumasa XXII*, *Arbumasa XXIII*, *Marunaka* and *Mar del Sur II*. The report on *Arbumasa XX* clearly indicates that only partial observation was achieved.

8.55 Some data from Chilean vessels are more difficult to interpret.

(i) Except for the *Isla Camila*, the scientific observer reports contain no data on incidental mortality nor any indication of observer effort. Reports of zero incidental mortality from *Isla Isabel* and *Magallanes III* should, therefore, be regarded with caution.

(ii) The data submitted to CCAMLR for *Cisne Verde* are entirely plausible, though the complete absence of daytime hauls is perhaps unexpected.

(iii) The extensive data submitted to CCAMLR from *Puerto Ballena* suggest particularly comprehensive scientific observer coverage. The data revealed plausible, if somewhat high catch rates (the vessel did not use streamer lines). However, all hauls are reported to be restricted to night-time yet 24 wandering albatrosses were caught on five hauls, a most surprising result in these circumstances.

(iv) Data submitted to CCAMLR from the master of the *Isla Camila* give a total of 117 black-browed albatrosses, 2 macaroni penguins, 132 giant petrels and 450 white-chinned petrels caught. The timing of all sets is reported as restricted to night-time. Paper WG-FSA-95/42, based on these data, reports identical totals of giant petrels (72 released alive, 60 dead), macaroni penguins (two released alive), and white-chinned petrels (325 released alive, 125 dead) but slightly different numbers of black-browed albatrosses (86 released alive, 27 dead). However, the scientific observer's report (WG-FSA-95/57), which was not available to the authors of WG-FSA-95/42, tabulates 2 macaroni penguins, 1 gentoo penguin and 2 giant petrels released alive and 133 giant petrels, 100 black-browed albatrosses and 452 white-chinned petrels recovered dead. The similarity of the overall totals from the two sources suggests errors in classification in data originally reported to CCAMLR. In addition, WG-FSA-95/57 reports that 98 giant petrels (73%), 84 black-browed albatrosses (84%) and 31 white-chinned petrels (6%) were captured in daytime. This is a much more realistic situation. Further clarification of the data submitted to CCAMLR will be required during the intersessional period.

The difficulties with some of these data illustrate the importance of the detailed reports from independent scientific observers. Without WG-FSA-95/57, substantially erroneous conclusions might have been drawn from the data submitted to CCAMLR.

8.56 Further analyses of data on seabird by-catch at this meeting were not possible; there was also insufficient time for any review of the data on interactions with cetaceans beyond that reported in Table 2 and paragraph 3.13. Further assessment of these interactions might be desirable intersessionally. From the vessels with apparently unambiguous detailed information, however, it was confirmed that a disproportionate amount of seabird mortality occurred:

(i) on the daytime sets (which formed 5 to 24% of sets), especially in the case of albatrosses; and

(ii) on one or two specific sets. Thus 52% of the bird by-catch on the *Arbumasa XXII* occurred on set 6 (BPUE 2.875), the remaining sets having a low rate (BPUE 0.066). Similarly, three sets (17, 21 and 41) on the *Marunaka* contributed 42% of the mortality (BPUE 1.205), the rest having a low rate (BPUE 0.133).

8.57 The Working Group reiterated the importance of detailed reports, even where these included data on apparently high catch rates of birds. Only with such complete records could problems be recognised and solutions devised and it commended the vessels and scientific observers who had collaborated in producing such good reports. By contrast, reports of zero by-catch with inadequate supporting details were inherently suspect, given the known difficulties, even in ideal conditions, of avoiding any by-catch of seabirds. Furthermore, it was recognised (e.g., in WG-FSA-95/58) that scientific observers unable to watch the line from a close vantage point were liable significantly to underestimate the seabird by-catch; this may be exacerbated if only partial coverage can be achieved.

8.58 Paper SC-CAMLR-XIV/BG/12 reported on mortality of seabirds associated with the longline fishery around Kerguelen (Division 58.5.1) in November/December 1994. A scientific observer was present on one of the three vessels in the area and observation of hauls was believed to be comprehensive. The overall observed mortality rate of 26 birds on 437 lines was 0.059 birds per line (or 0.025 birds per thousand hooks). However, for 42 lines observed in detail the catch rate was 0.28 birds per line (0.117 per thousand hooks). White-chinned petrels (65%) were the main species killed, followed by black-browed albatrosses (19%), grey-headed albatrosses (12%) and wandering albatrosses (4%). This mortality rate is lower than observed in the previous year (0.50 birds per line in February), which may reflect the difference between mortality during incubation and chick-rearing periods. Streamer lines are not used in this fishery, nor is setting restricted to night-time. However, the use of offal to distract birds from the set results in significantly lower capture rates (0.02 birds per line compared to 1.19 per line without offal discharge), suggesting that this method may be useful in this fishery, for which setting times are very short.

Information from Outside the Convention Area

8.59 Paper WG-FSA-95/45 provides a preliminary assessment of the fishing effort in longline fisheries for *D. eleginoides* in Patagonian waters (i.e., adjacent to the Convention Area), based on a survey of 74 fishing trips from December 1993 to July 1995 involving 12 of the 19 vessels presently operating in Patagonian waters. Of the ships studied, 10 used manual and 2 used autoline systems.

8.60 Most of the fishing takes place in two areas, the Patagonian shelf north of the Falklands/Malvinas and around Islas de los Estados and Cape Horn, although some setting takes place around seamounts between the latter area and Subarea 48.3. During 1994, effort was fairly constant, but increased throughout 1995. The total effort in 1994 and 1995 was 20.164 million hooks.

8.61 The Working Group noted the report with interest. At current by-catch rates for seabirds in Subarea 48.3 (say 0.2 BPUE) this represents a mortality of 4 000 birds. However, noting that the fishery is not restricted to night-time setting, nor are mitigating measures in use, the mortality of seabirds could easily reach 1.0 BPUE (and, not impossibly, rates like 5.0 BPUE as reported last year from Uruguay), giving a potential mortality of 20 000 birds over two years, possibly 30 to 50% of which could be albatrosses. This is a situation of great concern, indicating the importance of using appropriate mitigating measures in regions outside the Convention Area.

8.62 Paper WG-FSA-95/21 provides data on seabird mortality in an experimental longline fishery for hake off South Africa. Seabird mortality rates observed during the set of the two vessels observed were 0.435 and 0.534 BPUE, extrapolating to a total of 1 505 and 1 170 birds killed per vessel. Over the total fleet of 61 vessels, this would sum to an estimated mortality of 58 800 birds. All birds observed killed were white-chinned petrels. The fishery currently uses no mitigating measures and the report recommends that these should be adopted as a matter of urgency.

8.63 Mortality of white-chinned petrels on this scale is of great concern to CCAMLR because South African waters are probably an important wintering ground for birds from two of the main world population centres of this species - South Georgia in the South Atlantic Ocean and Kerguelen and Crozet in the Southern Indian Ocean. The Working Group wished to see South Africa encouraged to use appropriate mitigating measures in this longline fishery.

8.64 Paper WG-FSA-95/21 also indicates that the capture of white-chinned petrels was strongly related to the time of the set and the diel activity patterns of the birds. Thus, white-chinned petrels showed much increased activity from 0300 to dawn (c. 0600) and were much more susceptible to capture between these times. This activity pattern should be investigated in the CCAMLR area but, even as an interim measure, it would seem sensible to suggest that longline setting in the Convention Area should try to start soon after complete darkness and end at least three hours before dawn.

8.65 Paper WG-FSA-95/58 presents a comprehensive evaluation of the causes of and potential solutions to mortality of seabirds associated with the use of the Spanish system of longlining, as practiced in the Falklands/Malvinas fishery in the 1995 season. This clearly has substantial implications for the use of similar fishing methods in the Convention Area.

8.66 Attention was drawn primarily to the detailed recommendations in the report in order to evaluate their applicability to fishing in the Convention Area.

8.67 Rec. 1 - single fishing line. Longline fishing using the Spanish method in the Convention Area only uses a single line and thereby already conforms to this recommendation.

Rec. 2 - line setting confined to night-time. Conservation Measure 29/XIII already requires this.

Rec. 3 - the release of weights before line tension occurs. The reduction in availability of baited hooks to birds would clearly also be true for the Convention Area. Consideration should be given to highlighting this, perhaps even in advisory text to Conservation Measure 29/XIII.

Rec. 4 - construction of line-setting boxes. Improved construction to reduce loss of boxes and hook-ups will reduce bird catch and increase fishing efficiency. This would apply equally to the fishery in the Convention Area and should be highlighted as appropriate.

Rec. 5 - discharge of offal. Conservation Measure 29/XIII prohibits discharge of offal on the same side as hauling and thereby already conforms to this recommendation. (However, there is a clear need for greater compliance with this element of Conservation Measure 29/XIII.)

Rec. 6 - discharge of homogenised offal. This is likely to be a useful technological development but probably not feasible for the fishery to implement at this stage. Its desirability should certainly be indicated in the forthcoming handbook.

Rec. 7 - hook recovery. Better hook recovery would reduce opportunities for birds to swallow hooks and reduce costs to the fishery. This is equally applicable in the Convention Area and the suggestions for future work on snood breaking strain should be followed up.

Rec. 8 - bird scaring lines. These devices are mandatory under Conservation Measure 29/XIII. (However, scientific observer reports suggest that fishing masters would benefit from help and advice in rigging these lines to achieve maximum benefit.)

Recs 9/10 - stone weight and spacing. The recommendation of 6 kg mass stones (compared to current mean of 3.9 kg) and 20 m spacing (against current 30 m) may need further investigation (given the considerable mass of stones this would represent). The attention of investigators (and the fisheries generally) should be drawn to the study in WG-FSA-95/58 of sinking rates for different combinations of stone weight and spacing.

8.68 Additional recommendations (B1 to B9 in WG-FSA-95/58):

B1 - scientific observers
The existing CCAMLR recommendations are designed to try to obtain accurate estimates of seabird mortality but, as noted previously, there are some clear improvements (e.g., in documenting numbers of hooks observed) that need implementing. The new logbook design and instructions are intended to help address these and related issues. The Working Group noted particularly the advice in B(ii)c that scientific observers be aware of the importance of a vantage point allowing them to observe birds on the line as it is hauled on board to ensure that birds are not knocked off at this time. A modification to the reporting code may be necessary to accommodate such records.

B2 - policy with respect to vessel track record
The Working Group endorsed the importance of working with vessels to assist them in overcoming problems of high by-catch of seabirds, rather than discriminating against such vessels. Indeed the Working Group, as noted earlier, would wish to encourage vessels providing comprehensive and accurate scientific observer reports.

B3 to B9
The Working Group noted these general recommendations, mainly concerning the investigation and promotion of desirable technological developments. A particularly

important development is that of longline systems which release the baited line under water. This has great potential for reducing, if not eliminating, most seabird by-catch; the Working Group encouraged the rapid development and deployment of such systems.

8.69 The author of the report, Mr Brothers, the manager of Consolidated Fisheries Limited (Martin Cox) and the Australian Government were thanked for their contributions to this most valuable study and report.

Information Relevant to Fishery Management

8.70 Paper WG-FSA-95/43 used data on distribution at sea (derived from satellite tracking studies) of wandering albatrosses breeding at South Georgia to investigate the potential risk from the longline fishery to *D. eleginoides* in the waters around South Georgia. The report concluded that for most of the breeding cycle, wandering albatrosses are at limited risk from fisheries at South Georgia (though at substantial risk from fisheries around the Patagonian shelf). However, during the chick-brooding period (March through mid-May) adults of both sexes forage mainly over waters of the South Georgia shelf (including Shag Rocks), thereby being almost exactly coextensive with the distribution of the local longline fishery. The paper suggested prohibiting longline fishing in Subarea 48.3 during March and April.

8.71 The Working Group welcomed the fact that data on seabird behaviour and distribution is now used to assess risks of interactions with fisheries. It was noted, however, that delaying the start of the fishery for *D. eleginoides* in Subarea 48.3 until May might risk causing the fishery to operate during the *D. eleginoides* spawning season (July/August). There was some feeling that the current use of night-time setting and streamer lines gives albatrosses (including wandering albatross) adequate protection. On the other hand, an absolute minimum of 29 wandering albatrosses were killed in Subarea 48.3 in 1995, so some restriction on the timing of the fishery, at least until more vessels are complying in full with Conservation Measure 29/XIII, might still be appropriate.

8.72 Dr Croxall was asked whether the at-sea distribution of black-browed and grey-headed albatrosses indicated any opportunity for managing the longline fishery in such a way as to avoid critical periods of high risk of albatross mortality. He replied that from September through April black-browed albatrosses foraged widely over the whole South Georgia shelf and were therefore at relatively high risk at all times, at least until most of the adult population moved towards South African waters in winter. Grey-headed albatrosses feed less extensively over the shelf and are more concentrated around the Antarctic Polar Frontal Zone to the north and west of South Georgia. This and their more localised breeding distribution at South Georgia might offer some prospect of reducing potential interactions by restricting the location of longline fishing in the area; this is being investigated currently.

Conservation Measure 29/XIII

8.73 Appendix 2 of WG-FSA-95/58 is an appraisal of Conservation Measure 29/XIII based on Mr Brothers' experience aboard a longline fishing vessel using the Spanish system around the Falklands/Malvinas in 1995. The numbered items below refer to the numbered sub-items in the conservation measure.

1. It was agreed that it would be desirable to specify minimum mass of weights and distance between these on the line; however, it was clear that further research was needed before advice suitable for a mandatory measure could be framed. Similarly, further work on the condition (thawed or not) of bait might be required but it would be inappropriate to change the measure now.

2. Contrary to the statement in WG-FSA-95/58, night setting in the Convention Area does cause an increase in catch rates of white-chinned petrels. Therefore, while night setting is very effective at avoiding albatross mortality, the problem it continues to pose for white-chinned petrels needs urgent investigation.

3. The incorporation of two options for the disposal of offal reflects the inability of some fishing operations to avoid discharge of offal during processing. Ways of avoiding offal discharge or discharging homogeneous offal under water need to be explored with the fishing industry.

4. Conservation Measure 29/XIII is not an appropriate way to deal with hooks being retained in discarded by-catch fish and heads of processed fish; further research is needed on snood breaking strain.

5. The Working Group noted the emphasis on correct operation of the CCAMLR-prescribed line; existing difficulties may indicate a need for expert practical assistance.

8.74 In all other respects Conservation Measure 29/XIII was deemed still to be appropriate, though earlier comments (paragraphs 8.64 and 8.67) might need reflecting upon, at least in footnotes to the measure, until the handbook is available.

Data Collection and Reporting

8.75 The Working Group welcomed the draft data sheets and accompanying guidelines for reporting scientific observations of seabird incidental mortality aboard longline vessels (SC-CAMLR-XIV/BG/13). It recommended that the Scientific Committee endorse the production and circulation of these and their attachment to the revised edition of the *Scientific Observers Manual*.

8.76 Two suggestions were made for further modifications to the forms. First, to allocate space to indicate where specimens and samples were lodged; second, to add extra pages to the G5 fish form (see also the comment in paragraph 8.68).

8.77 The Working Group noted that the work outlined in SC-CAMLR-XIV/BG/13 represents an ideal program for an experienced scientific observer dedicated to recording seabird and marine mammal incidental mortality and interactions.

8.78 The main problem, indicated in many of the scientific observers reports, was the difficulty that a single observer faced in apportioning time to the different tasks. This required some advice on priorities.

8.79 The highest priorities for a single scientific observer with regard to seabird data are as follows:

(i) observation of the whole of any set (or part thereof) carried out in daylight, dusk or dawn, together with the appropriate complete records of the number and species of seabirds caught;

(ii) observation of at least 50% of the haul, ideally divided into periods covering the early, middle and late stages, with a record of the times and numbers of hooks observed and the appropriate complete record of the species of seabirds caught;

(iii) the retention and labelling of specimens from the by-catch (albatrosses, giant petrels, white-chinned petrels in priority order for retention as whole specimens);

(iv) documentation of the streamer line used; and

(v) documentation of the location and timing of offal discharge.

8.80 In attempting to assign priorities within the collection and processing of fish data and specimens, and between fish and seabird work, it was recognised that it was necessary to have more detailed information on the time taken to perform the various tasks.

8.81 It was agreed to ask scientific observers to estimate the time taken to undertake each of their currently specified tasks, and to provide additional appropriate information on their overall daily time-budget.

8.82 The idea of incorporating the data forms into a scientific observer logbook was commended. It was also suggested that space be allocated in this logbook for recording the daily work schedule of the observer.

8.83 The Working Group encouraged work to ensure the easy conversion of logbook data into electronic formats appropriate for data analysis.

8.84 It was noted that there were potential complications as regards access to data provided under bilateral agreements between Members, especially when not all data were formally requested by CCAMLR.

Advice to the Scientific Committee

8.85 The Scheme of International Scientific Observation has developed in a most successful way. Despite some problems of meeting appropriate reporting standards (hopefully to be rectified with new data sheets and logbooks) and the need to reconcile and validate some data (to be tackled intersessionally), many reports are comprehensive and of a high standard (see also paragraph 8.27).

8.86 The reports enable the first systematic analyses of incidental mortality of seabirds in the Convention Area to be undertaken (see especially WG-FSA-95/42).

8.87 The results of this and the assessments performed at the Working Group meeting indicate that:

(i) the specification in Conservation Measure 29/XIII of restricting setting to night-time has reduced by-catch of albatrosses by four-fifths (and would nearly have eliminated it if all vessels had complied with all parts of the conservation measure); and

(ii) streamer lines are highly effective in reducing (by at least half) seabird by-catch. The conservation measure is therefore having a very significant effect in reducing seabird by-catch in general and that of albatrosses in particular. However, especially when streamer lines are not used, captures of white-chinned petrels are increasing and further work on appropriate mitigating measures for this species is needed.

8.88 The reports and assessments do, however, indicate widespread lack of compliance with some elements of Conservation Measure 29/XIII. In particular:

(i) many of the vessels are not using streamer lines, even though lines of appropriate specification were given to them;

(ii) most vessels continue to discharge offal during the haul and some do so on the same side of the vessel as hauling activities, thereby greatly increasing by-catch of seabirds and decreasing fishing efficiency; and

(iii) many vessels are carrying out some setting during hours of daylight, dawn or dusk.

The Scientific Committee should ask the Commission to request Members to ensure compliance with all aspects of the conservation measure, thereby achieving further reduction in seabird by-catch and also considerably more cost-effective fishing.

8.89 Data from outside the Convention Area indicate that many more birds of species breeding in the Convention Area are probably killed by longline fisheries in adjacent waters and, for some species, also in their more distant wintering grounds. This re-emphasises the high priority of developing and maintaining close liaison with international organisations in order to tackle the whole problem worldwide. The Scientific Committee should ask the Commission to encourage Members to be especially active in drawing CCAMLR's concerns to the attention of appropriate national authorities and organisations and in implementing the type of measures developed by CCAMLR in waters under their control (see also paragraphs 8.21, 8.61 and 8.63).

8.90 There are a number of additional points which should be drawn to the attention of the Scientific Committee, i.e.:

(i) the need to evaluate responses from international organisations to the questions posed by CCAMLR relating to work on longline fishing and incidental mortality of seabirds (paragraph 8.20) and the need to direct similar requests to Members (paragraph 8.21);

(ii) production of educational materials (paragraphs 8.22 and 8.23);

(iii) population studies of vulnerable species:

- long-term population studies of albatrosses (paragraph 8.28(i));
- banding programs for albatrosses (paragraph 8.28(ii));
- information on monitoring/demographic studies of albatrosses, giant petrels and white-chinned petrels (paragraphs 8.32 and 8.33);

(iv) improvements in reporting (paragraphs 8.51, 8.52 and 8.75);

(v) intersessional work on submitted data (paragraphs 8.53 to 8.56);

(vi) utility of Conservation Measure 29/XIII and potential modifications to it (paragraphs 8.64, 8.67, 8.68, 8.73 and 8.74);

(vii) potential modifications to the management of the *D. eleginoides* fishery in Subarea 48.3 (paragraphs 8.70 and 8.71);

(viii) acquisition of information on observer time-budgets in order to help prioritise observer tasks (paragraph 8.81);

(ix) production of logbooks (paragraphs 8.75 and 8.82); and

(x) suggested revised arrangements for the consideration of IMALF items intersessionally and at next year's meeting of WG-FSA (paragraphs 8.92 and 8.93).

Future Work

8.91 The Convener noted the difficulty in devoting adequate time to IMALF in a single day towards the end of the main WG-FSA meeting. He also noted that this timing had apparently not assisted attendance of members of the IMALF coordinating group.

8.92 Therefore, the Convener proposed that IMALF issues be treated in a similar fashion to other elements of the WG-FSA agenda. Thus, appropriate assessments of data and reports would commence at the start of the WG-FSA meeting. It was agreed to recommend this to the Scientific Committee.

8.93 It was recommended that the ad hoc WG-IMALF coordinating group should continue during the intersessional period. Its work would be coordinated by the Secretariat. Prof. Moreno was thanked for his work as coordinator during 1995.

OTHER INCIDENTAL MORTALITY

9.1 Paper SC-CAMLR-XIV/BG/12 noted some mortality of seabirds associated with the *C. gunnari* trawl fishery in the Kerguelen area (Division 58.5.1). This mortality was of two kinds. First, mortality of white-chinned petrels (10 individuals reported) killed by warps and/or in attempting to take fish from the net. Second, mortality of three white-chinned petrels, three black-browed and one grey-headed albatross killed by collision with the net-sonde cable of Ukrainian fishing vessels. The *D. eleginoides* trawl fishery appears to have minimum mortality impact on seabirds.

9.2 The paper noted that French trawlers (which do not use net-sonde cables) operate outside the breeding season of white-chinned petrels, which may reduce impact. The mortality associated with the net-sonde cable would be eliminated by banning the use of such equipment, as provided for in Conservation Measure 30/X.

9.3 The Working Group encouraged the French authorities to extend the provisions of Conservation Measure 30/X to the Crozet and Kerguelen area.

9.4 The capture of a southern elephant seal in a trawl was reported in SC-CAMLR-XIV/BG/12. This was an exceptional event. (Another elephant seal was reported as killed by a longline vessel in Subarea 48.3 in WG-FSA-95/57.)

9.5 Paper SC-CAMLR-XIV/BG/6 reported on detailed observations of seabird interactions with trawling operations near Macquarie Island. Although numerous seabirds were attracted to the vessel (which did not use net-sonde cables), no incidental mortality was reported. This was probably due to the location and configuration of the vessels gear, in particular that of the trawl warps. This is an encouraging report because the gear configuration used is common amongst factory vessels.

9.6 The Working Group noted that Conservation Measure 63/XII, prohibiting the use of plastic packaging bands to secure bait boxes, comes into force after the 1995/96 season.

Advice to the Scientific Committee

9.7 The Scientific Committee should request the Commission to encourage the French authorities to extend the provisions of Conservation Measure 30/X to the Crozet and Kerguelen area.

INTERNATIONAL DEVELOPMENTS IN FISHERIES MANAGEMENT

Precautionary Approach to Fisheries Management

10.1 The Government of Sweden in conjunction with FAO held a technical consultation on the precautionary approach to fisheries management at Lysekil in Sweden in June 1995. The consultation highlighted the nature of precaution in fisheries management, clarified the concept of 'burden of proof' and provided specific guidelines for management, research, technology development and transfer, and species introduction.

10.2 The consultation, working within the framework outlined in Article 15 of the Rio Declaration, considered that the precautionary approach involves the application of prudent foresight, taking into account the uncertainties in fisheries systems and the need to take action with incomplete knowledge. The precautionary approach requires, *inter alia:*

(i) consideration of the needs of future generations and the avoidance of changes which are not potentially reversible;

(ii) prior identification of undesirable outcomes and of measures which will avoid them or correct them promptly;

(iii) that any necessary corrective measures are initiated without delay and that they achieve their purpose promptly, on a time-scale not exceeding two or three decades;

(iv) that where the likely impact of resource use is uncertain, priority should be given to conserving the productive capacity of the resource;

(v) that harvesting and processing capacity should be commensurate with estimated sustainable levels of resource, and that increase in capacity should be further constrained when resource productivity is highly uncertain;

(vi) all fishing activities must have prior management authorisation and be subject to periodic review;

(vii) an established legal and institutional framework for fisheries management, within which management plans that implement the above points are instituted for each fishery; and

(viii) appropriate placement of the burden of proof by adhering to the requirements above.

10.3 On the question of the burden of proof, the consultation recognised that:

(i) all fishing activities have environmental impacts, and it is not appropriate to assume that these are negligible until proved otherwise;

(ii) although the precautionary approach may require cessation of fishing activities that have potentially serious adverse impacts, it does not imply that no fishing can take place until all potential impacts have been assessed and found negligible;

(iii) the precautionary approach to fisheries requires that all fishing activities be subject to prior review and authorisation; that a management plan be in place which clearly specifies management objectives and how impacts of fishing are to be assessed, monitored and addressed; and that specified interim management measures should apply to all fishing activities until such time as a management plan is in place; and

(iv) the standard of proof to be used in decisions regarding authorisation of fishing activities should be commensurate with the potential risk to the resource, while also taking into account the expected benefits of the activities.

10.4 The consultation considered that a precautionary approach to managing a fishery involves, within management strategies and plans, explicit consideration of precautionary actions that will be taken to avoid undesirable outcomes. As over-development of harvesting capacity is a common cause of undesirable outcomes, a management plan should include mechanisms to monitor and control that capacity. Consideration needs to be given to how uncertainty and ignorance are to be taken into account in developing and varying management measures. For all fisheries, plans should be developed or revised to incorporate precautionary elements. The plans, even where no additional precautionary elements are considered necessary, should be re-evaluated in accordance with a specified approach to management planning. This approach requires several key elements:

(i) specification of management objectives;

(ii) specification of operational targets and constraints;

(iii) specification of the procedure to apply and modification of management measures so as to meet operational targets and constraints;

(iv) evaluation of the procedure to determine its reliability in meeting targets and constraints; and

(v) revision of procedures until they are deemed to have adequate performance.

10.5 The consultation suggested a series of precautionary measures which should be considered for application in various types of fisheries at various stages of exploitation. For new and developing fisheries the consultation suggested a system of measures already instituted in CCAMLR as conservation measures for new and exploratory fisheries (Conservation Measures 31/X and 65/XII). For over-exploited fisheries, measures should include the development of a recovery plan for the fisheries, which would include the establishment of biological reference points to define stock recovery. Short-term action should be considered even on the basis of circumstantial evidence about the effectiveness of particular management measures. For fully utilised fisheries, regulatory agencies need to ensure that there are means to effectively keep fishing mortality rate and fishing capacity at the existing level and to implement interim management actions and undertake investigative action in response to early warning signs that the stocks are beginning to become over-utilised.

10.6 The consultation gave further advice on the role of fisheries research in:

(i) the establishment of management objectives;
(ii) the specification of the observations and information base needed for management; and
(iii) precautionary assessment methods and analyses.

10.7 The consultation set out the following guidelines for the implementation of a precautionary approach to fisheries management:

(i) take into account the best scientific evidence available when designing and adopting conservation measures;

(ii) require a minimum level of information to be made available for any fishery to start or continue;

(iii) ensure that the *'lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures°'*;

(iv) reduce critical uncertainties in the management plan;

(v) take measures aimed at eliminating or reducing non-reporting and mis-reporting of fisheries data;

(vi) systematically analyse various possible management options;

(vii) promote multidisciplinary research, including (a) social, economic and environmental sciences, and (b) research on management institutions and decision-making processes;

(viii) develop scientific information on multi-species and ecosystem processes as a foundation for identifying acceptable degrees of disturbance;

(ix) identify biological limit and target reference points for affected species and stocks, habitats and the ecosystem at large;

(x) identify bioeconomic reference points to address the objectives of the fishery management plan;

(xi) improve methods for quantification of direct and indirect impacts of fishing;

(xii) improve understanding of the performance of different management structures in relation to precaution;

(xiii) develop methods for optimising the monitoring system; and

(xiv) set up research and development programs aimed at improving the performance of fishery technology in relation to environmental impacts and precautionary management.

10.8 The consultation also outlined guidelines for the precautionary approach to the development and introduction of fishing technologies, and guidelines to follow to reduce the likelihood of inadvertent species introductions.

Management Advice

10.9 The Working Group acknowledged that CCAMLR had acted as a pioneer for many of the approaches outlined in the Lysekil meeting. CCAMLR has already implemented, or was in the process of developing, many of the recommendations of the Lysekil meeting. These recommendations represent the latest thinking on what a precautionary approach entails. It considered, however, that some progress could still be made within CCAMLR in the evaluation of management procedures and their likely outcomes under conditions of uncertainty (10.4(iv) above). There was much still to be done in this area, and the Working Group considered it to be important that CCAMLR continue to work at the forefront of world development of precautionary approaches.

Conservation and Management of Straddling Stocks

10.10 WG-FSA reviewed the recent UNCLOS agreement on highly migratory fish stocks and straddling fish stocks[24]. *D. eleginoides* is found within the Convention Area as well as in adjacent regions (see paragraph 5.83).

10.11 WG-FSA emphasised that the current *D. eleginoides* fishery operates both within the Convention Area and in neighbouring regions. The absence of information from the fishery across the Convention's boundaries makes it extremely difficult to assess the location and overall impact of the *D. eleginoides* fishery in Subarea 48.3 and adjacent areas.

10.12 WG-FSA therefore recommended that the Scientific Committee and Commission should seek to translate the intent of Resolution 10/XII into practical effect in order to ensure that approaches to managing the *D. eleginoides* fishery in Subarea 48.3 are more in keeping with the principles of the UNCLOS Agreement. Consequently, the 'Standard Provisions for Collection and Sharing of Data' contained in Annex 1 of the UNCLOS Agreement (especially Articles 3 to 6) offer a useful model for the development of a system to ensure the timely collection, compilation, verification and analysis of data essential for the management of *D. eleginoides* fisheries both within and outside the Convention Area. The types of data required include catch information and the location of catches (see paragraph 5.11).

10.13 WG-FSA also requested that the Scientific Committee consider establishing a system to ensure that data from the *D. eleginoides* fishery are freely exchanged between CCAMLR and operators fishing in regions adjacent to the Convention Area. In these terms, it would be

[24] Draft agreement for the implementation of the provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the conservation and management of straddling fish stocks and highly migratory fish stocks.

advantageous to extend the high level of scientific observer coverage aboard fishing vessels within the Convention Area to adjacent regions. Both the establishment of effective scientific observer schemes and vessel monitoring systems have been identified by the UNCLOS Agreement (Article 6 of the Standard Provisions) as important ways to verify fishery data for straddling stocks and highly migratory species.

10.14 Finally, WG-FSA agreed that although the UNCLOS Agreement applied to fish stocks only, many of its principles are relevant to other species which cross the Convention's boundaries and about which there is concern as to their conservation status (e.g., wandering albatross - see paragraph 8.70). As such, the need for information on these species when they are outside the Convention Area is crucial to the development of a comprehensive approach to their management.

FUTURE WORK

Data Requirements

11.1 As reported in paragraph 3.2, experience has shown that general requests for data do not always result in submission of information to the Working Group. Consequently, the Working Group attempted this year to identify data which could be acquired, and requested the Secretariat to pursue these requests with appropriate scientists or other authorities.

11.2 The following data were requested:

- *D. eleginoides*, Subarea 48.3: all data listed in Appendix D. Historical haul-by-haul data should be acquired to enable extended calculations of standardised CPUE (paragraph 5.43).

- *C. gunnari*, Subarea 48.3: all research and commercial data, previously the subject of working papers submitted to the Working Group, should be submitted in haul-by-haul format (paragraph 5.103).

- *P. formosa*, Subarea 48.3: data on size at sexual maturity should be collected from the current fishery (paragraph 5.127).

- *D. eleginoides*, Division 58.5.1: future and historical haul-by-haul data from longline fisheries should be reported (paragraph 5.173).

- Subarea 58.6: haul-by-haul data from French exploratory cruises should be submitted (paragraph 3.17).

- Area 58: the accuracy of data reported in WG-FSA-95/15 Rev. 1 should be verified (paragraph 5.142).

- Fish by-catch: historical data on fish by-catch in krill trawls should be acquired (paragraph 6.25).

- Research surveys: data should be resubmitted in a form to be circulated by the Secretariat for use in a new suite of research survey databases to be developed at the Secretariat (paragraph 5.88).

Future Work Required by WG-FSA

11.3 Stock assessment methodology has undergone considerable development over the last four years. The advent of computers with very high processing capacity, the availability of complex statistical and modelling software, and the demand for stochastic modelling particularly in response to uncertainty, has meant that much of the traditional analysis is no longer applicable. New methodologies rely on a stock-specific approach to specific assessment problems rather than creating standard assessments such as VPA.

11.4 An added problem of these analyses is the time required to perform them. Preparation of data and technical analysis by the Secretariat prior to the meeting of the Working Group would assist it in completing its work within the time-frame of its meeting.

11.5 The Secretariat is currently under-equipped to fully support or prepare for these new types of assessment. Considerable upgrading of hardware and software is required. As a first step, it is recommended that the Secretariat purchase a fast work station and analysis software in 1996.

11.6 The Working Group has identified a number of requirements in respect of the observer data and reports (paragraphs 11.9 to 11.11). The Working Group sets great importance by these data. It was recognised, however, that considerable processing and analysis of these data by the

Secretariat is required prior to the meeting of the Working Group if the group is to extract the full information from the observer program, to give them the justice they deserve.

11.7 The Secretariat is currently not equipped to process the volume (at least 20 000 records per year) of data arising from an observer program that demands 100% coverage (paragraph 3.5) and requires extra funding to deal with the problem. The Working Group recommended that this funding be specifically directed at:

- the employment of an extra person to deal with data arising from the observer program, covering all aspects of data acquisition, coding, and summary analysis;

- participation of this person in observation cruises to ensure a clear understanding of observer problems; and

- ensuring that this work is integrated with the existing data management structure in the Secretariat.

11.8 A number of other items of intersessional work were identified:

- the Data Manager should validate the new general yield model as a high priority (paragraph 3.47) and the trawl survey analysis program (de la Mare, 1994a[25]);

- a correspondence group, coordinated by Dr Sabourenkov, should re-analyse data on fish by-catch in krill trawls (paragraph 6.24);

- stochastic projections with the general yield model should be applied to *C. gunnari* in Subarea 48.3 (paragraph 5.105);

- a review of historic research and commercial data on *C. gunnari* in Subarea 48.3 should be performed by a correspondence group (Drs Gasiukov, Holt, Agnew and Everson) coordinated by Dr Holt (paragraph 5.103);

- further work is required to define longline soak time for use in the standardisation of CPUE (paragraph 5.39);

- the handbook 'Catching fish not birds: a guide to improving longline fishing efficiency' should be drafted for circulation to WG-IMALF and WG-FSA by March. This work will be coordinated by Dr Sabourenkov (paragraph 8.22);

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[25] de la Mare, W.K. 1994a, op. cit., p. 289.

- albatross population and banding studies should be initiated by Members not already performing them (paragraph 8.28);

- although intersessional work for IMALF will continue to be coordinated by the Secretariat, ad hoc WG-IMALF need not meet in 1996. Assessment of IMALF should be considered a part of the assessment work performed at WG-FSA (paragraphs 8.92 and 8.93);

- some changes to the formulation of the CCAMLR ADAPT program may be required at next year's meeting (paragraphs 5.101 and 5.102);

- incidental mortality data in scientific observer reports should be analysed intersessionally (paragraphs 8.53, 8.55 and 8.56) by the Secretariat;

- information on albatross monitoring and petrel demographic studies should be submitted (paragraphs 8.32 and 8.33);

- scientific observers should gather information on their overall daily time-budget (paragraph 8.81); and

- logbooks should be developed for other non-longline fisheries (paragraphs 8.75 and 8.82).

Work of Scientific Observers - Observer Data Handling and Future Work

Scientific Observer Reports to WG-FSA

11.9 Eighteen reports by scientific observers on fishing vessels were presented to WG-FSA. Most of these reports were from longliners operating in Subarea 48.3 with information coming from Russian (2), Ukrainian (3), Chilean (7) Argentinian and Spanish (1) scientific observers.

11.10 In reviewing scientific observers' reports, WG-FSA commended the observers concerned and noted the considerable range and detail of information presented in these reports. Given the volume of information, its extraction could be facilitated by presentation of the report in conformity with a standard format. WG-FSA therefore urged scientific observers to provide summaries of their work along the lines set out in Appendix H.

11.11 Scientific observer report summaries submitted in accordance with Appendix H are aimed at highlighting the scope of information available. WG-FSA endorsed the principle that submission of more data to CCAMLR should continue following the prescribed detailed formats.

Scientific Observers Manual

11.12 A number of scientific observer reports indicate that the various tasks outlined in the *Scientific Observers Manual* may on occasion be difficult to carry out. The Working Group agreed that in the interest of efficiency, scientific observers' tasks should be as simple as possible. There are two considerations in this context.

11.13 In the first instance, WG-FSA agreed that there would be merit in developing scientific observer logbooks for various types of fisheries which can be submitted to CCAMLR. The logbook would comprise a consolidated record of all the information required from scientific observers of the commercial finfish fishery as prescribed in the *Scientific Observers Manual*. It was agreed that the logbooks for longline fisheries should be a priority and should be developed for use in the 1996 season. It was also agreed that a small task group coordinated by the Secretariat and in consultation with potential users should develop draft scientific observer logbooks for use in other fisheries and would report to WG-FSA-96. The reports submitted in the form described in Appendix H should be submitted by every scientific observer and should accompany the logbook containing the raw data forms.

11.14 In the second instance, the actual tasks carried out by scientific observers can be simplified. WG-FSA agreed that techniques to facilitate scientific observer work should be investigated further during the forthcoming interesessional period. Due consideration should also be given to ways in which scientific observers' tasks can be automated (e.g., by using length measuring boards linked directly to laptop computers).

ADVICE TO THE SCIENTIFIC COMMITTEE

Management Advice

12.1 Advice on the management of species and areas, including advice on catch limits, should be read in its entirety under the relevant sections of Agenda Item 5. Summaries of the status assessments are given in Appendix I.

Advice with Budgetary Implications

- A scientific observer logbook for longline fisheries should be printed and translated in 1996 (paragraph 11.13). This logbook should include data forms, instructions, space for comments and the report forms given in Appendix H (paragraph 8.80). Logbooks for other CCAMLR fisheries will be developed during the intersessional period.

- The IMALF brochure should be developed in draft (paragraph 8.13).

- An extra edition of the *Statistical Bulletin* containing revised historical data should be produced (paragraph 5.142).

- Funds should be provided to enable the Secretariat to employ staff with responsibility for scientific observer data (paragraph 11.7).

- Funds should be provided to enable the Secretariat to purchase new hardware and software for assessment purposes (paragraph 11.5).

Action Towards Improving Data Quality

- The Scientific Committee should consider mechanisms for identifying individual vessels within the CCAMLR database should they re-register (paragraph 3.7).

- Misunderstandings about data reporting requirements should be clarified (paragraph 3.8), particularly the reporting of live weight, reporting of zero catch hauls and not amalgamating hauls in reports (paragraph 3.10).

- Mechanisms for data exchange with management agencies and with operators fishing in areas adjacent to the Convention Area should be developed (paragraph 10.13) along the guidelines provided by the UNCLOS Agreement.

- Division 58.4.4 should be subdivided at 43°E longitude into subdivisions for Ob and Lena Banks (paragraph 5.175).

Scientific Observer System

- Summaries of scientific observer reports should be submitted in the draft standard format given in Appendix H and comments on the draft are solicited (paragraph 11.10).

- Scientific observer programs of a similar quality to CCAMLR's should be encouraged in areas adjacent to the Convention Area, in particular Subarea 48.3 (paragraph 10.13).

- Adjusted priorities for observers in the longline fishery are given in paragraph 8.79.

- Appropriately amended formats and instructions for scientific observers of the longline fishery should be appended to the *Scientific Observers Manual* (paragraphs 8.75 and 8.76).

- Time budget information requested from scientific observers (paragraph 8.81).

Interaction with WG-EMM

- What is the quantity, seasonal and other variability of *C. gunnari* in the diet of predators in Subarea 48.3 (paragraph 6.11)?

- What is the estimated consumption of myctophids in Subarea 48.3 (paragraph 6.12)?

OTHER BUSINESS

13.1 There was no other business.

ADOPTION OF THE REPORT

14.1 The report of the meeting was adopted.

CLOSE OF THE MEETING

15.1 In his closing comments, the Convener expressed his gratitude to the Secretariat, rapporteurs, conveners of subgroups and to all participants for their hard work during the meeting. A great deal of assessment work had been performed during the meeting with major progress being made in the assessment of *D. eleginoides*.

15.2 Dr Kock congratulated the Convener for conducting such a successful meeting, and extended his thanks to the Convener and participants on behalf of the Scientific Committee.

15.3 The Convener then closed the meeting.

APPENDIX A

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 10 to 18 October 1995)

1. Opening of the Meeting

2. Organisation of the Meeting and Adoption of the Agenda

3. Review of Available Information
   - 3.1 Data Requirements Endorsed by the Commission in 1994
   - 3.2 Fisheries Information
     - (a) Catch, Effort, Length and Age Data
     - (b) Scientific Observer Information
     - (c) Research Surveys
     - (d) Mesh/Hook Selectivity and Related Experiments Affecting Catchability
   - 3.3 Fish and Crab Biology/Demography/Ecology
   - 3.4 Developments in Assessment Methods

4. Report of the Workshop on Methods for the Assessment of *Dissostichus eleginoides*

5. Assessments and Management Advice
   - 5.1 New Fisheries
   - 5.2 Antarctic Peninsula (Subarea 48.1)
   - 5.3 South Orkney Islands (Subarea 48.2)
   - 5.4 South Georgia (Subarea 48.3) - Finfish
   - 5.5 South Georgia (Subarea 48.3) - Crabs
   - 5.6 South Sandwich Islands (Subarea 48.4)
   - 5.7 Antarctic Coastal Areas (Subareas 58.4.1 and 58.4.2)
   - 5.8 Ob and Lena Banks (Subarea 58.4.4)
   - 5.9 Kerguelen Islands (Subarea 58.5.1)
   - 5.10 Heard Island (Subarea 58.5.2)
   - 5.11 Pacific Ocean Sector (Area 88)

6. Considerations of Ecosystem Management
   - 6.1 Interactions with WG-EMM
   - 6.2 Ecological Interactions (e.g., multi-species, benthos, etc.)

7. Research Surveys
   - 7.1 Simulation Studies
   - 7.2 Recent and Proposed Surveys
   - 7.3 Notification of Intended Research Activity

8. Incidental Mortality Arising from Longline Fishing

9. Other Incidental Mortality

10. International Developments in Fisheries Management
    - 10.1 Report from the FAO Technical Consultation on the Precautionary Approach to the Management of Capture Fisheries (including draft code)
    - 10.2 UN Convention on Straddling Stocks

11. Future Work
    - 11.1 Data Requirements
    - 11.2 Software and Analyses to be Prepared or Developed Prior to the Next Meeting
    - 11.3 Work of Scientific Observers - Observer Data Handling and Future Work

12. Advice to the Scientific Committee

13. Other Business

14. Adoption of the Report

15. Close of the Meeting.

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(Hobart, Australia, 10 to 18 October 1995)

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LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 10 to 18 October 1995)

WG-FSA-95/1	PROVISIONAL AGENDA AND ANNOTATION TO THE PROVISIONAL AGENDA FOR THE 1995 MEETING OF THE WORKING GROUP ON FISH STOCK ASSESSMENT (WG-FSA)
WG-FSA-95/2	LIST OF PARTICIPANTS
WG-FSA-95/3	LIST OF DOCUMENTS
WG-FSA-95/4 Rev. 1	REPORT OF THE THIRD CRUISE OF THE SRTM *RK-1* IN THE ATLANTIC SECTOR OF THE SOUTHERN OCEAN (MAY TO OCTOBER 1994) (SEABIRD OBSERVATIONS) V.A. Khvichiya (Russia)
WG-FSA-95/5 Rev. 1	REPORT OF THE FISHING CRUISE OF THE KOREAN VESSEL *IHN SUNG 66* IN STATISTICAL SUBAREA 48.3 (SOUTH GEORGIA) (SEABIRD OBSERVATIONS MARCH TO MAY 1995) A.N. Kozlov (Russia)
WG-FSA-95/6	A NEW FISHERY FOR *D. ELEGINOIDES* AT MACQUARIE ISLAND R. Williams (Australia)
WG-FSA-95/7	ABUNDANCE OF LARVAE AND ASSESSMENT OF RECRUITMENT SIZE OF CARLSBERG LANTERN FISH (*ELECTRONA CARLSBERGI* TÅNING, 1932) - (FAMILY MYCTOPHIDAE) IN SOUTHWEST ATLANTIC IN 1989 M.M. Nevinsky (Russia)
WG-FSA-95/8	SPECIES COMPOSITION OF ICEFISHES OF THE GENUS *CHANNICHTHYS* (CHANNICHTHYIDAE, NOTOTHEIOIDEI) IN THE KERGUELEN ISLANDS AREA WITH A DESCRIPTION OF THREE NEW SPECIES G.A. Shandikov (Ukraine)
WG-FSA-95/9	A NEW SPECIES OF ICEFISH *CHANNICHTHYS PANTICAPAEI* SP. N. (CHANNICHTHYIDAE, NOTOTHENIOIDEI) FROM KERGUELEN ISLAND, ANTARCTICA G.A. Shandikov (Ukraine)

WG-FSA-95/10 PECHES EXPLORATOIRES DANS LA SOUS-ZONE 58.6, RESULTATS DES CAMPAGNES 1983 A 1995
G. Duhamel (France)

WG-FSA-95/11 LARVAL FISH DISTRIBUTION AND ABUNDANCE OF THE WESTERN ROSS SEA
M. Vacchi, M. La Mesa and S. Greco (Italy)

WG-FSA-95/12 BRIEF BIOLOGICAL CHARACTERISTICS OF PATAGONIAN TOOTHFISH (*DISSOSTICHUS ELEGINOIDES*) IN SUBAREA 48.3 ACCORDING TO THE RESULTS OF THE SRTMK *ITKUL* FISHING TRIP IN MAY 1995
A.K. Zaitsev (Ukraine)

WG-FSA-95/13 Rev. 1 SOME BIOLOGICAL ASPECTS OF FISHING *CHAMPSOCEPHALUS GUNNARI* IN THE KERGUELEN AREA IN THE SEASON OF 1994/95
L.K. Pshenichnov (Ukraine)

WG-FSA-95/14 VPA AS ONE OF THE APPROACHES FOR SETTLING A PROBLEM OF PATAGONIAN TOOTHFISH, *DISSOSTICHUS ELEGINOIDES*, POPULATION QUANTITY (SUBAREA 48.3, SOUTH GEORGIA)
V.A. Shlyakhov (Ukraine)

WG-FSA-95/15 Rev. 1 FISHING OF ICEFISHES (CHANNICHTHYIDAE FAMILY) IN THE KERGUELEN RIDGE WATERS (SUBAREA 58.5) IN 1970-1978 SPLIT YEARS
V.V. Gherasimchook (Ukraine)

WG-FSA-95/16 Rev. 1 REPORT OF THE FISHING CRUISE OF THE KOREAN VESSEL, *IHN SUNG 66*, IN STATISTICAL SUBAREA 48.3 (SOUTH GEORGIA) (FISH OBSERVATIONS - MARCH TO MAY 1995)
A.N. Kozlov (Scientific Observer)

WG-FSA-95/17 *ROSSII* REVISITED: NEW INFORMATION ON THE EARLY HISTORY OF THE FISHERY FOR *NOTOTHENIA ROSSII* IN SUBAREA 48.3
D.J. Agnew (Secretariat)

WG-FSA-95/18 ANALYSIS OF FISHING FOR PATAGONIAN TOOTHFISH, *DISSOSTICHUS ELEGINOIDES*, CONDUCTED DURING THE 28TH FISHERY VOYAGE BY SRT *PRIMORETS*
V.N. Chikov (Ukraine)

WG-FSA-95/19 EXTRACT FROM THE FIRST INTERNATIONAL WORKSHOP ON ALBATROSS-FISHERIES INTERACTIONS
Delegation of United Kingdom

WG-FSA-95/20 REPORT SUBMITTED TO THE LONGLINE MANAGEMENT COMMITTEE ON THE HAKE-DIRECTED LONGLINE PILOT STUDY CONDUCTED FROM 23 MAY 1994 TO 31 MAY 1995
D.W. Japp (South Africa)

WG-FSA-95/21	THE EFFECTS OF AN EXPERIMENTAL HAKE *MERLUCCIUS CAPENSIS/PARADOXUS* LONGLINE FISHERY ON PROCELLARIIFORM SEABIRDS IN SOUTH AFRICA - A PRELIMINARY INVESTIGATION K. Barnes (South Africa)
WG-FSA-95/22	PRELIMINARY ASSESSMENT OF LONGLINE EXPERIMENT: WEST COAST HAKE H. Geromont, D. Butterworth, D. Japp and R. Leslie (South Africa)
WG-FSA-95/23	DATA AVAILABILITY FOR THE *DISSOSTICHUS* WORKSHOP Secretariat
WG-FSA-95/24	POPULATION STATUS AND ESTABLISHING A TAC FOR *CHAMPSOCEPHALUS GUNNARI* IN THE SOUTH GEORGIA AREA (48.3) K.V. Shust (Russia)
WG-FSA-95/25 Rev. 2	CATCH AND EFFORT DATA FOR THE LONGLINE FISHERY IN SUBAREA 48.3 - COMPARISON OF DATA REPORTED TO CCAMLR AND DATA ACQUIRED BY THE UK G. Parkes (United Kingdom)
WG-FSA-95/26	1995 ASSESSMENT OF THE FALKLANDS LONGLINE FISHERY FOR TOOTHFISH, *DISSOSTICHUS ELEGINOIDES* R. Baranowski, G. Kirkwood and S. des Clers (UK)
WG-FSA-95/27 Rev. 1	LENGTH COMPOSITION, SEX RATIO, AND PRE-SPAWNING MIGRATION OF *DISSOSTICHUS ELEGINOIDES* IN SUBAREA 48.3 DURING 1995 D.J. Agnew (Secretariat)
WG-FSA-95/28	THE METAZOAN ENDOPARASITE FAUNA OF THE PATAGONIAN TOOTHFISH *DISSOSTICHUS ELEGINOIDES* SMITT, 1898 (PISCES: NOTOTHENIIDAE) OFF CENTRAL CHILE: TAXONOMIC, ECOLOGICAL AND ZOOGEOGRAPHIC ASPECTS L. Rodriguez and M. George-Nascimento (Chile)
WG-FSA-95/29	INVESTIGACION MONITOREO CAPTURAS DE BACALAO DE PROFUNDIDAD AL SUR 47° L.S. 1994 Instituto de Fomento Pesquero, Chile
WG-FSA-95/30	INVESTIGACION CTP BACALAO DE PROFUNDIDAD AL SUR 47° L.S. 1994 Instituto de Fomento Pesquero, Chile
WG-FSA-95/31	INFORME FINAL - INVESTIGACION CTP BACALAO DE PROFUNDIDAD AL SUR 47° L.S. 1995 Instituto de Fomento Pesquero, Chile

WG-FSA-95/32	VARIATIONS IN THE CHRONOLOGY OF OVARIAN MATURATION IN THREE CHANNICHTHYIDS AT SOUTH GEORGIA I. Everson (UK), K.-H. Kock (Germany) and G. Parkes (UK)
WG-FSA-95/33	THE USE OF STOCK DEPLETION MODELS FOR THE ASSESSMENT OF LOCAL ABUNDANCE OF TOOTHFISH *DISSOSTICHUS ELEGINOIDES* G. Parkes (UK), C. Moreno (Chile), G. Pilling (UK) and Z. Young (Chile)
WG-FSA-95/34	A COMPARISON OF DENSITIES AND LENGTH DISTRIBUTION OF THE *CHAMPSOCEPHALUS GUNNARI* STOCK IN SUBAREA 48.3 BETWEEN YEARS 1994 AND 1995 E. Marschoff, B. Gonzalez and J. Calcagno (Argentina)
WG-FSA-95/35	RESULTS OF *E.L. HOLMBERG* 1995 FISH SURVEY IN SUBAREA 48.3 E. Marschoff, B. Gonzalez, A. Madirolas, J. Calcagno, G. Tossonotto and C. Balestrini (Argentina)
WG-FSA-95/36	ANALYSIS OF THE DIET OF *CHAMPSOCEPHALUS GUNNARI* IN SUBAREA 48.3, DR *E. HOLMBERG* SURVEY, FEBRUARY 1995 E. Barrera-Oro, R. Casaux and E. Marschoff (Argentina)
WG-FSA-95/37	AGE-LENGTH KEY FOR *CHAMPSOCEPHALUS GUNNARI* FROM SUBAREA 48.3; *HOLMBERG* SURVEY, FEBRUARY 1995 E. Barrera-Oro, E. Marschoff and R. Casaux (Argentina)
WG-FSA-95/38	DISTRIBUCION, ESTRUCTURA DE TALLAS, ALIMENTACION Y PESCA DE LA MERLUZA NEGRA (*DISSOSTICHUS ELEGINOIDES* SMITH, 1898) EN EL MAR ARGENTINO M. C. Cassia y R.G. Perrotta (Argentina)
WG-FSA-95/39	VACANT
WG-FSA-95/40 Rev. 1	BYCATCH OF FISHES CAPTURED BY THE KRILL FISHING VESSEL *CHIYO MARU NO. 2* IN STATISTICAL AREA 58 (JANUARY TO MARCH 1995) G. Watters (USA)
WG-FSA-95/41	A GENERALISED MODEL FOR EVALUATING YIELD AND THE LONG TERM STATUS OF FISH STOCKS UNDER CONDITIONS OF UNCERTAINTY A.J. Constable and W.K. de la Mare (Australia)
WG-FSA-95/42	MORTALIDAD INCIDENTAL DE AVES EN LA PESQUERIA DE *DISSOSTICHUS ELEGINOIDES* EN EL AREA 48.3 (TEMPORADA 1995) C.A. Moreno (Chile), E. Marschoff (Argentina), P.S. Rubilar (Chile) and L. Benzaquen (Argentina)
WG-FSA-95/43	POTENTIAL INTERACTIONS BETWEEN WANDERING ALBATROSSES AND *DISSOSTICHUS ELEGINOIDES* FISHERIES AT SOUTH GEORGIA J.P. Croxall and P.A. Prince (UK)

WG-FSA-95/44	INTERSESSIONAL WORK ON SEABIRDS INCIDENTAL MORTALITY IN LONGLINE FISHERIES Secretariat
WG-FSA-95/45	A FIRST INSIGHT INTO THE LONGLINE FISHING OPERATIONS BASED IN PATAGONIA AND THEIR EFFECTS ON WILDLIFE A. Schiavini, E. Frere, N. García and E. Crespo (Argentina)
WG-FSA-95/46	RESULTADOS DE LA OBSERVACION CIENTIFICA A BORDO DEL B/P *ISLA CAMILA* EN LA SUBAREA 48.3 E. Balguerías y F. Quintero (España)
WG-FSA-95/47	COMPOSITION AND VERTICAL DISTRIBUTION OF NEAR-BOTTOM ICHTHYOFAUNA IN THE SOUTHERN KERGUELEN RIDGE (STATISTICAL DIVISION 58.4.3) A.S. Piotrovsky (Ukraine)
WG-FSA-95/48	REPORT OF THE WORKSHOP ON METHODS FOR THE ASSESSMENT OF *DISSOSTICHUS ELEGINOIDES* (Hobart, Australia, 5 to 9 October 1995)
WG-FSA-95/49	OBSERVACION CIENTIFICA DE LA PESCA DE *DISSOSTICHUS ELEGINOIDES* A BORDO DEL B/P *ARBUMASA XXII* EN LA SUBAREA 48.3 (25 DE MARZO AL 15 DE MAYO) José P. Maraboli A. (Scientific Observer, Chile)
WG-FSA-95/50	OBSERVACION CIENTIFIC DE LA PESCA DE *DISSOSTICHUS ELEGINOIDES* A BORDO DEL B/P *ESTELA* EN LA SUBAREA 48.3 (06 DE MARZO AL 29 DE MAYO 1995) Mario Acevedo Gyllen (Scientific Observer, Chile)
WG-FSA-95/51	OBSERVACION CIENTIFICA DE LA PESCA DE *DISSOSTICHUS ELEGINOIDES* A BORDO DEL B/P *MARUNAKA* EN LA SUBAREA 48.3 (06 DE MARZO AL 26 DE ABRIL DE 1995) Pedro S. Rubilar (Scientific Observer, Chile)
WG-FSA-95/52	OBSERVACION CIENTIFICA DE LA PESCA DE *DISSOSTICHUS ELEGINOIDES* A BORDO DEL B/P *ESTELA* EN LA SUBAREA 48.3 (06 DE MARZO AL 16 DE MAYO DE 1995) Cristian Lemaître A. (Scientific Observer, Chile)
WG-FSA-95/53	OBSERVACION CIENTIFICA DE LA PESCA DE *DISSOSTICHUS ELEGINOIDES* A BORDO DEL B/P *MAR DEL SUR II* EN LA SUBAREA 48.3 (20 DE ABRIL AL 16 DE MAYO) Gastón Ojeda Maguire (Scientifc Observer, Chile)

WG-FSA-95/54	OBSERVACION CIENTIFICA DE LA PESCA DE *DISSOSTICHUS ELEGINOIDES* A BORDO DEL B/P *ARBUMASA XX* EN LA SUBAREA 48.3 (05 DE MARZO AL 25 DE MAYO DE 1995) José R. Pacheo B. (Scientific Observer, Chile)
WG-FSA-95/55	OBSERVACION CIENTIFICA DE LA PESCA DE *DISSOSTICHUS ELEGINOIDES* A BORDO DEL B/P *ARBUMASA XXIII* EN LA SUBAREA 48.3 (20 DE MARZO AL 25 DE MAYO DE 1995) César A. Gordon (Scientific Observer, Chile)
WG-FSA-95/56	BRIEF REPORT ON SCIENTIFIC OBSERVATION UNDER CCAMLR SCHEME ON COMMERCIAL VESSEL SRTMK *ITKUL* (25 APRIL TO 19 JUNE 1995) Delegation of Ukraine
WG-FSA-95/57	INFORME DE LA OBSERVACION CIENTIFICA DE LA PESCA DE *DISSOSTICHUS ELEGINOIDES* A BORDO DEL B/P *ISLA CAMILA* EN LA SUBAREA 48.3 (1º DE MARZO AL 17 DE MAYO DE 1995) Fernando Quintero (Spain)
WG-FSA-95/58	AN INVESTIGATION INTO THE CAUSES OF SEABIRD MORTALITY AND SOLUTIONS TO THIS IN THE SPANISH SYSTEM OF DEMERSAL LONGLINE FISHING FOR PATAGONIAN TOOTHFISH *DISSOSTICHUS ELEGINOIDES* IN THE SOUTH ATLANTIC OCEAN Delegation of Australia

OTHER DOCUMENTS

WG-EMM-95/84	A METHODOLOGICAL PROPOSAL TO MONITOR CHANGES IN COASTAL FISH POPULATIONS BY THE ANALYSIS OF PELLETS OF THE BLUE-EYED SHAG *PHALACROCORAX ATRICEPS* R. Casaux and E. Barrera-Oro (Argentina)
CCAMLR-XIV/8	NOTIFICATION OF AUSTRALIA'S INTENTION TO INITIATE NEW FISHERIES Delegation of Australia
SC-CAMLR-XIV/BG/6	SEABIRD INTERACTIONS WITH TRAWLING OPERATIONS AT MACQUARIE ISLAND Delegation of Australia
SC-CAMLR-XIV/BG/12	CAPTURES ACCIDENTELLES D'OISEAUX MARINS AUTOUR DE KERGUELEN (DIVISION 58.5.1), CAMPAGNE 94/95 Délégation de la France
SC-CAMLR-XIV/BG/13	GUIDELINES FOR OBSERVATIONS OF INCIDENTAL MORTALITY OF SEABIRDS AND MARINE MAMMALS ON BOARD LONGLINE FISHING VESSELS Secretariat

SC-CAMLR-XIV/BG/14	WITHDRAWN
SC-CAMLR-XIV/BG/23	CONVENCION PARA LA CONSERVACION DE LOS RECURSOS VIVOS MARINOS ANTARTICOS (CCRVMA) INFORME FINAL DE MAREA Delegación de Argentina
SC-CAMLR-XIV/BG/24	INSTITUTO NACIONAL DE INVESTIGACION Y DESARROLLO PESQUERO PROGRAMA DE OBSERVADORES INFORME FINAL DE LA MAREA Delegación de Argentina
SC-CAMLR-XIV/BG/25	INSTITUTO NACIONAL DE INVESTIGACION Y DESARROLLO PESQUERO PROGRAMA DE OBSERVADORES CIENTIFICOS DE LA CCRVMA INFORME FINAL DE LA MAREA Delegación de Argentina
SC-CAMLR-XIV/BG/26	INFORME DEL OBSERVADOR CIENTIFICO ARGENTINO EMBARCADO A BORDO DEL PALANGRERO *PUERTO BALLENA* (CHILE) Delegación de Argentina
SC-CAMLR-XIV/BG/27	INSTITUTO NACIONAL DE INVESTIGACION Y DESARROLLO PESQUERO PROGRAMA DE OBSERVADORES INFORME FINAL DE LA MAREA Delegación de Argentina

APPENDIX D

DATA REQUIREMENTS FOR THE WORKING GROUP

I Data Required by WG-FSA-94	II Data Received by WG-FSA-95	III Data Requested by WG-FSA-95
1. *D. eleginoides*, Subarea 48.3: • studies on hook selection factors required; • studies on loss rates of fish.	None Some information in WG-FSA-95/46	*D. eleginoides*, Subarea 48.3: Studies on hook selection factors required.
2. *D. eleginoides*, Subarea 48.3: • age and maturity determination required for an expanded range of lengths from historical and current commercial and research catches.	Some information on maturity from observer reports.	*D. eleginoides*, Subarea 48.3: Age determination required (paragraph 3.38).
3. Representative length frequency from the commercial catch of *C. gunnari* in Subarea 48.3 should be reported for the most recent years of the fishery and required from historical fishery.	None	
4. 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 ; • historical data required.	None None	
5. *E. carlsbergi*: • clarification of position and time of catch of 1 518 tonnes reported for Subarea 48.2 in 1990/91; • clarification of position and time of catch of 50 tonnes in Subarea 48.1 in 1991/92.	None None	

I Data Required by WG-FSA-94	II Data Received by WG-FSA-95	III Data Requested by WG-FSA-95
6. Call for historic information from surveys to assist the Workshop on the Design of Bottom Trawl Surveys in investigating the internnual variability in the occurrence of fish aggregations. Also required for validation of MVUE methods.	Data now being submitted in the required format.	
7. *D. eleginoides*, Subarea 48.3: • stock identification studies; • data on the position or bearing of each end of longlines especially in preparation for workshop.	WG-FSA-95/28 provides information on parasite load. Now incorporated in CCAMLR database.	*D. eleginoides*, Subarea 48.3: Stock identification studies (Appendix E, paragraph 2.72).
8. Crab fishery, Subarea 48.3: Investigations on the use of time-release devices, escape ports and pot selectivity.	None, but expected to be forthcoming from the present fishery.	Crab fishery, Subarea 48.3: Investigations on the use of time-release devices, escape ports and pot selectivity.
9. Additional data from *D. eleginoides* fishery.	All now requested and most data being reported.	
10. All observer data should be reported if possible.	All data now reported.	
11. *D. eleginoides*: Data requested from outside CCAMLR Convention Area.	Data acquired (see paragraph 5.10).	

APPENDIX E

REPORT OF THE WORKSHOP ON METHODS FOR THE ASSESSMENT OF *DISSOSTICHUS ELEGINOIDES*

(Hobart, Australia, 5 to 9 October 1995)

REPORT OF THE WORKSHOP ON METHODS FOR THE ASSESSMENT OF *DISSOSTICHUS ELEGINOIDES*

(Hobart, Australia, 5 to 9 October 1995)

INTRODUCTION

1.1 The Workshop on Methods for the Assessment of *Dissostichus eleginoides* (WS-MAD) was held at CCAMLR Headquarters, Hobart, Australia from 5 to 9 October 1995. The Convener, Dr W. de la Mare (Australia), chaired the Workshop. The terms of reference of the Workshop were agreed by the Scientific Committee at its 1994 meeting (SC-CAMLR-XIII, paragraph 2.17).

1.2 The Convener welcomed participants to the Workshop, noting with pleasure the presence of two invited experts, Mr D. Japp from the Sea Fisheries Research Institute, South Africa and Dr A. Zuleta from the Instituto de Fomento Pesquero, Chile.

1.3 The Provisional Agenda was adopted unchanged. The Agenda is included in this report as Attachment A and the List of Participants as Attachment B. Documents submitted to the 1995 Working Group on Fish Stock Assessment (WG-FSA) and referred to in this report are listed in Appendix C of this annex.

1.4 The report was prepared by Drs I. Everson, G. Kirkwood and G. Parkes (UK), K. Sullivan (New Zealand) and Mr R. Williams (Australia).

REVIEW OF POSSIBLE ASSESSMENT APPROACHES

2.1 Under this agenda item, the Workshop first carried out an initial review of the approaches taken in previous CCAMLR assessments of *D. eleginoides*, and of the approaches used in the assessments of the longline fishery for *D. eleginoides* in Chile and the trawl and longline fishery for hake in South Africa. Following this, key problem areas in CCAMLR assessments were identified and potential solutions were discussed in subgroups, drawing particularly on the experience in the Chilean and South African fisheries. Conclusions reached by the Workshop are recorded under this or subsequent agenda items.

Previous CCAMLR Assessments

2.2 The Workshop considered the current state of knowledge as reflected in previous CCAMLR assessments of *D. eleginoides* under four headings: biology and demography, stock identity, abundance and yield.

Biology and Demography

2.3 Discussion on biology and demography of *D. eleginoides* centred on the topics of growth, reproduction, diet and condition.

Growth

2.4 Otolith and scale readings have been used to determine the age of individual fish. Both these methods are widely used in fisheries biology. Shortcomings have been noticed with both methods for *D. eleginoides* which would affect the accuracy of age/length keys derived from them. Results from both methods have been used together in the past and it is therefore important to reconcile any systematic differences between the two methods.

2.5 In the case of otoliths, false checks are occasionally noted which, if not recognised, would cause the age of the individual fish to be overestimated.

2.6 In the case of scales, there is some uncertainty about the time taken for completion of the nucleus and hence the age at which the first annual ring appears. This effect could lead to the underestimation of the fish's age by one year (SC-CAMLR-XI, Annex 5, paragraph 6.124). The annual rings seen on scales tend to blend together towards the edge leading to an underestimation of the age of older, larger fish (SC-CAMLR-XI, Annex 5, paragraph 6.124).

2.7 The Workshop recommended that further efforts be made to improve age determination using otoliths and scales.

2.8 Length frequency distributions derived from samples of fish from trawl catches frequently contain modes at intervals equivalent to years of growth (WG-FSA-91/20[1]). The modes are indistinguishable for fish older than five years; the method is therefore only applicable for juvenile fish.

[1] Everson, I. 1991. Stock assessment of the Patagonian toothfish (*Dissostichus eleginoides*) at South Georgia. Document *WG-FSA-91/20*. CCAMLR, Hobart, Australia.

2.9 There is evidence that longlining selects large fish (a key factor is the gear itself). Refinements in selectivity can be obtained through variations of both hook and bait. Rigorous trials have not been conducted for longlining of *D. eleginoides* with the result that age/length keys derived from longline data may be biased towards large fish for the younger age classes and smaller fish for the older age classes.

2.10 The Workshop recommended that experiments be designed using trawls and longlines, and be undertaken to determine the magnitude of biases in estimated age/length keys caused by the use of different gear types and sizes, and different bait sizes and species (trawls generally fish in shallower water than longlines).

2.11 Samples from commercial trawl and trawl survey catches may underestimate the proportion of larger and therefore older fish. This is further discussed in paragraph 3.10.

2.12 Given the possible biasing effects of size selectivities, the Workshop agreed that it would be useful to compare growth rates for young and old fish. To examine this, a table of estimates of size-at-age was prepared using data from both trawl catches and surveys and longline catches (Figure 1).

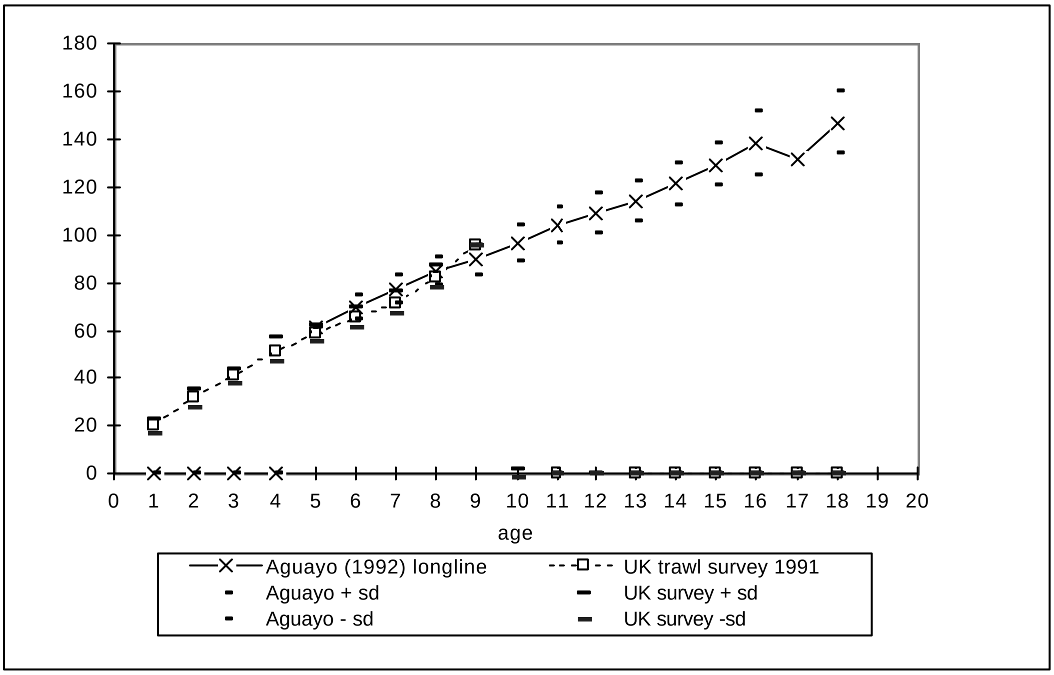


Figure 1: Estimates of size-at-age from both trawl catches and surveys and longline catches.

2.13 Lengths-at-age for *D. eleginoides* from longline fisheries on the Patagonian shelf, around Southern Chile and in the South Georgia and Kerguelen regions were reviewed in 1992 (SC-CAMLR-XI, Annex 5, paragraphs 6.122 to 6.129 and Appendix G). An age/length key not used in this review is available in the CCAMLR database for pre-recruits from a UK trawl survey on the continental shelf around South Georgia in January 1991 (SC-CAMLR-XIII, Annex 5, paragraph 4.24).

2.14 No other age/length data are available.

2.15 A number of problems with the existing data were identified in the review of 1992:

- age/length keys from Kerguelen Island area were based on small numbers of fish from a limited size range;

- at South Georgia, ages were determined from scale readings (see discussion of problems in paragraph 2.6);

- generally, age/length characteristics of an entire stock are unlikely to be represented in the longline catches used to generate these keys (see SC-CAMLR-XI, paragraphs 6.125 and 6.126); and

- most estimates were derived using Ford-Walford plots, which are less reliable than non-linear regressions.

2.16 The available data, except those from the Kerguelen area, were used to generate estimates of the von Bertalanffy growth parameters. A non-linear estimation procedure based on the Levenberg-Marquardt method was used. In these analyses, mean length-at-age was not used; each length-at-age datum was weighted by the number of fish in the sample which were observed with that value. Exploratory analyses were undertaken to investigate the influence of a number of sampling problems on the estimation of the parameters. The analyses comprised the following:

(i) estimation of L_∞, K and t_0 for all samples (males, females, combined);

(ii) using all samples (combined sexes only), estimation of K in all samples with a fixed L_∞ and t_0, where L_∞ was chosen as 170.8 (SC-CAMLR-XI, Annex 5, Appendix G, Table G.4) and t_0 =0; and

(iii) estimation of K as previously but removing size classes likely to be incompletely sampled. The size ranges used were:

UK 1991 trawl survey	all fish < 60 cm
longline catches	all fish > 100 cm.

2.17 The results are presented in Table 1.

Table 1: Estimates of von Bertalanffy growth parameters for *D. eleginoides* in Subarea 48.3 from age/length keys available in the CCAMLR database and in WG-FSA-92/30. See paragraph 2.16 for details. Var = variance; L/L = longline; T = trawl

South Georgia Samples		Sample Method	Estimates from All Data				FIX L_{∞} = 170.8; t_0 = 0					
							All Data		Trawl: Length < 60		Longline: Length > 100	
			Linf	K	t_0	Var	K	Var	K	Var	K	Var
Aguayo (1992)*:												
1. Feb-May 1991	Males	L/L	170.3	0.086	-0.015	49						
2. Feb-May 1991	Females	L/L	177.5	0.082	+0.35	65						
3. Combined (1 + 2)	Feb-May 1991	L/L	170.9	0.087	0.16	58	0.085	58.1			0.09	57.4
4. Apr-May 1991	Females	L/L	169.8	0.086	-0.01	59						
5. Apr-May 1991	Males	L/L	170.1	0.087	-0.02	54						
6. Combined (4 + 5)	Apr-May 1991	L/L	171.0	0.087	-0.01	57	0.086	57.1			0.089	55.4
7. Feb-Mar 1991	Males	L/L	165.1	0.085	-0.61	42						
8. Feb-Mar 1991	Females	L/L	172.5	0.088	0.162	62						
9. Combined (7 + 8)	Feb-Mar 1991	L/L	170.2	0.088	0.162	62	0.086	52.1			0.09	49.1
SUN 1986		T	182.3	0.074	0.819	9	0.074	11.5	n = 2			
UK trawl 1991:	Female	T	159.9	0.081	-0.69	14						
	Male	T	163.8	0.082	-0.51	19						
	Combined sexes	T	162.0	0.081	-0.60	16	0.088	23.5	0.091	19.4		

* Aguayo, M. 1992. Preliminary analysis of the growth of *Dissostichus eleginoides* from the austral zone of Chile and South Georgia. Document *WG-FSA-92/30*. CCAMLR, Hobart, Australia.

Reproduction

2.18 Spawning generally occurs during winter although there are some references to spent fish being taken in December. This may indicate that the gonad maturation and recovery processes are prolonged.

2.19 There is no precise information on spawning location or whether the fish aggregate during the spawning season.

2.20 The few ova that have been found, have been near the surface in deep water. Post larvae and early juveniles spend at least one year in midwater before settling to the bottom. Juvenile fish tend to be found on the shelf and it is thought that they migrate into deeper water as they get older and become sexually mature.

2.21 The maturity scale developed for nototheniids (SC-CAMLR-VIII, Annex 6, Appendix 4) has been used by observers examining catches from the *D. eleginoides* fishery.

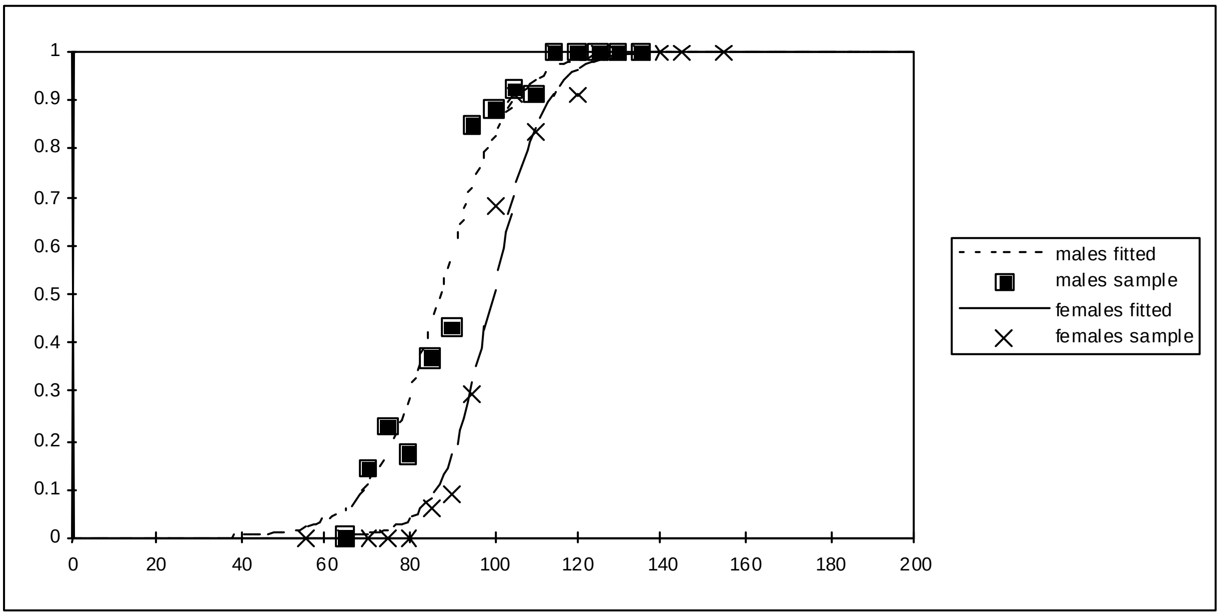
2.22 The results from observer reports available at the meeting were considered by the Workshop. There were major differences in the shape of maturity ogives and length at 50% maturity (L_{m50}) values derived from data from the different vessels.

2.23 From an examination of the data on maturity stages of female fish, the Workshop concluded that these data were inconsistent, indicating that there had been difficulties in recognising specific maturity stages. Examples of distributions are shown in Figure 2 and the results from all observer data are summarised in Table 2.

Table 2: Estimates of size at sexual maturity from data collected by observers working on different commercial longliners. (?, - = Insufficient or no data to provide an estimate.)

		Sample Size	Length-at-Sexual Maturity (cm) (Stages II to V)	Length-at-Spawning (cm) (Stages III to V)
Estela Cruise 1	Males	135	90	100
March 1995	Females	265	75	105
Estela Cruise 2	Males	106	70	85
April to May 1995	Females	168	?	95
Marunaka	Males	205	70	90
March to May 1995	Females	284	90	95
Isla Camila	Males	3272	75	90
March to May 1995	Females	353	95	?
RK-1	Males	815	-	75
June to September 1994	Females	864	-	95

Marunaka



Isla Camila

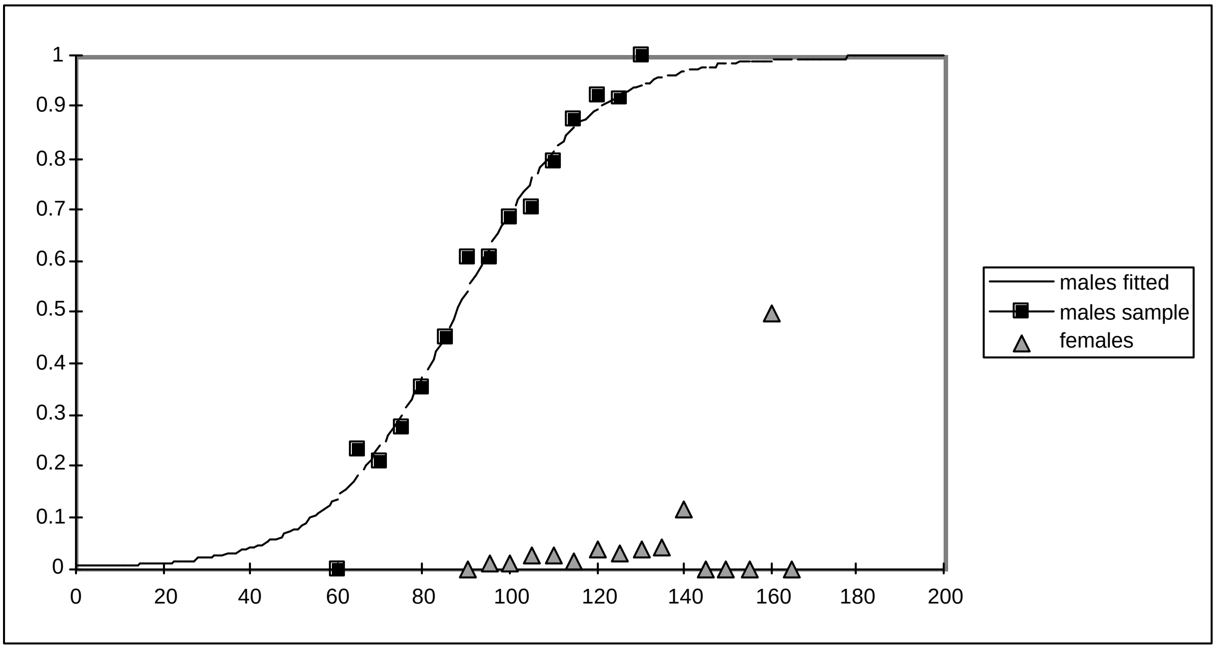


Figure 2: Length-at-first spawning derived from scientific observer data obtained during the 1994/95 season from two vessels, *Marunaka* and *Isla Camila*.

2.24 The Workshop recommended the following future work:

- clearer and more expansive description of the maturity stages augmented, if possible, by photographs;

- information should be collected on gonad maturity stages from as many months as possible in order to determine the spawning season more precisely;

- estimates of spawning stock biomass should be made based on the proportion of fish in stages III to V;

- L_{m50} should be estimated from data obtained during the month immediately prior to spawning; and

- determine locations of spawning.

2.25 It was agreed that refinement of estimates of age-at-maturity would arise from such detailed investigations and also in conjunction with improvements in methods for age determination.

Diet

2.26 The Workshop considered whether information on diet might provide indications of vertical movement based on the known distribution of the prey items. The Workshop agreed that at this stage there was insufficient information available on which to base firm conclusions.

Condition

2.27 A condition known as 'jellymeat' has been reported previously (SC-CAMLR-XIII, Annex 4, paragraph 4.28). No information was available to indicate the cause of this condition. Concern was expressed that fish with the jellymeat condition were being discarded and might not be included in the reported catch. It was unknown whether such finfish might have higher mortalities and/or reduced spawning success.

Stock Identity, Structure and Movements

2.28 Discussion on stock identity, structure and movements of *D. eleginoides* centred on the topics of distribution, extent and timing of movements, segregation by sex and age, aggregations and stock separation.

Distribution

2.29 The distribution of *D. eleginoides* is generally known on a broad scale. It is widespread in the sub-Antarctic zone, being found around the east and west coasts of South America, South Georgia and Shag Rocks, South Sandwich Islands, Kerguelen Plateau, Crozet Island, Ob and Lena Banks, and Macquarie Ridge.

2.30 There are, however, some areas of uncertainty, including the southern limit of distribution in the South Orkney/Antarctic Peninsula and southern Kerguelen Plateau areas, where the distribution may be confused with that of *Dissostichus mawsoni*. Recent findings of *D. eleginoides* on the South African shelf and the Campbell Plateau south of New Zealand, as well as a much larger population than previously thought on the Macquarie Ridge demonstrate that our knowledge of the distribution of this species is still imperfect (Figure 3). It is likely that fish occur in other areas which have not yet been investigated.

2.31 The Workshop noted that sperm whales are known to feed on both *Dissostichus* species, and that there is some information available on sperm whale stomach contents from Russian data. It was agreed that this information should be examined and a summary prepared for discussion at next year's meeting.

2.32 Information from the Chilean fishery demonstrates that catches have been made to 2 900 m depth off southern Chile (WG-FSA-95/29), so that *D. eleginoides* apparently can move in depths to around 3 000 m. Catch rates in terms of weight increase below 1 500 m in much of the Chilean fishery, however, little is known about the catch rates in numbers of fish. This does indicate that a significant proportion of the population, at least in the Chilean area, could live between 1 500 m and 3 000 m. Also, there is no information on the extent to which *D. eleginoides* is capable of movement over long distances in midwater.

2.33 No bathymetric maps of sufficient detail were available in the CCAMLR collection except for the South Georgia/Patagonian region. Given the uncertainty of present distribution and the capability of this fish to exist in waters around 3 000 m deep, the Workshop was unable to draw any conclusions on the likely extent of movement between populations in different areas.

Extent and Timing of Movements

2.34 Movements occur on several time and spatial scales.

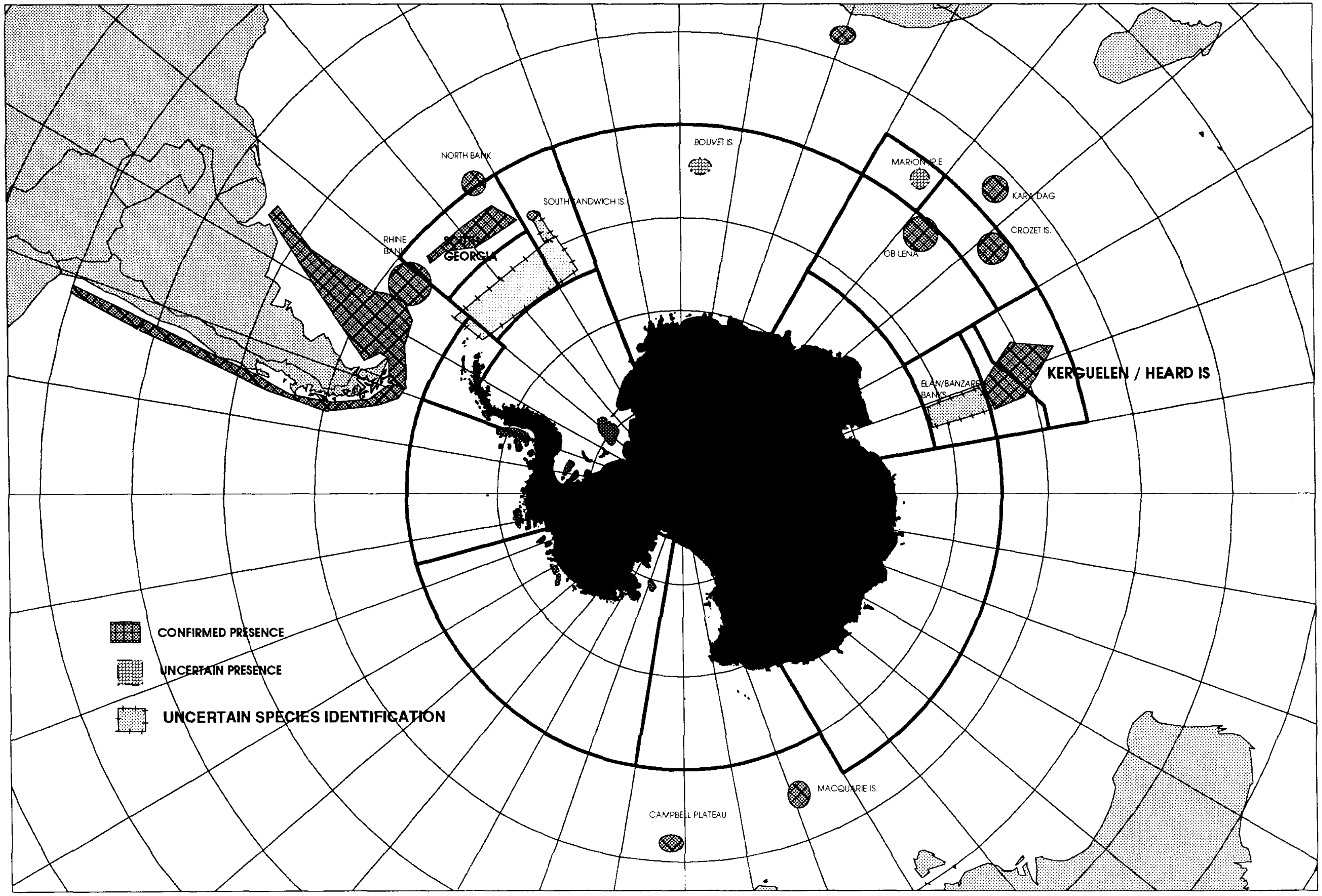


Figure 3: Known distribution of *D. eleginoides*.

2.35 There is some evidence for movements on the time scale of a few days. Data from the trawl fishery at Macquarie Island and the depletion experiments in Subarea 48.3 suggest that fish move into an area of localised harvesting to replenish stock removed by fishing. This will tend to reduce the usefulness of CPUE data on local scales.

2.36 Movements on a seasonal time scale of large numbers of fish will confound results of biomass surveys and analysis of catch and CPUE. There is very weak evidence for lunar cycles in CPUE which may involve migration or other activity patterns. Spawning is presumed to take place during winter in mid-slope depths. Some circumstantial evidence on migrations is available for the South Georgia/Shag Rocks area (WG-FSA-95/27).

2.37 As eggs, larvae and small juveniles are pelagic, egg and larval surveys could possibly provide information on the time and place of spawning as well as on the size of the spawning stock. However, the Workshop agreed that useful results from such surveys will take some time to collect given the potentially large geographic spawning area of *D. eleginoides* (paragraph 2.30).

2.38 The presence of larger fish in deeper water seems well established, but details may be different between areas. This may be mediated by temperature or some other factor(s). It is necessary to know that the depth distribution of fish by size, sex and spawning condition in survey results are representative and to ensure that the interpretation of fishery data is not biased. Therefore a description of distribution patterns by depth for each area is necessary, using fishery-independent surveys and haul-by-haul analysis of fishery data.

2.39 The Workshop noted that the different available length frequency distributions from shallow and deeper waters may be partially confounded by the different selectivity patterns of trawls and longlines. This has been further considered in section 3 of this report.

2.40 There is no direct information on movements over long distances between geographic areas (e.g., South Georgia to South America or Kerguelen Plateau to Macquarie Ridge). There is some indirect information from parasite loadings that the Chilean population is split at 47°S, and that fish from southern Chile to the southern Patagonian shelf have similar origins, whereas there are greater differences between the southern Patagonian shelf and South Georgia (WG-FSA-95/28). More data on egg and larval distribution and further studies on biochemical markers and parasite loadings may give indirect evidence on the extent of movement.

2.41 The Workshop agreed that the most promising method for obtaining direct observations on movements on all time and spatial scales was from tagging experiments in areas subject to fisheries, and it recommended that high priority be given to such studies in the future.

Segregation by Sex and Age

2.42 There is some direct evidence for segregation by sex and age from fishery experience; Chilean data indicate that in the deepest strata fished, down to 1 500 m, larger female fish predominate (WG-FSA-91/11[2]). This needs to be quantified and investigated to see whether it is consistent over all areas so that survey and fishery analysis are representative. Research data and any appropriate fishery data could be analysed for sex ratio by time, position and depth. Length frequency data could be analysed along the same lines for age segregation.

Aggregations

2.43 There do not appear to be any known spawning or feeding aggregations, but many fisheries exploit areas of consistent higher-than-average abundance, e.g. the two zones on the Kerguelen Plateau, and the Argentine fishery centres on an area southwest of the southern Patagonian shelf. It is not known whether aggregations are solely on the bottom, in midwater, or both. Feeding behaviour suggests both. Acoustic methods using deep-towed bodies may provide some information on this. These questions need to be answered so that appropriate survey methods can be applied in order to optimise biomass estimates.

Stock Separation

2.44 There is no information at present on the number of stocks of *D. eleginoides*. Direct investigation by analysis of mitochondrial DNA has encountered technical problems. Too little is known about other aspects of the biology and behaviour as described above to make any meaningful inferences. More information on oceanographic conditions would also help interpretation of biological data, e.g. how currents in the upper 200 m might affect drift of larvae and juveniles. Further work on parasite loadings, allozyme polymorphisms and otolith microchemistry may yield more information on this important subject. Conventional studies of meristic and otolith morphology were felt unlikely to shed much further light on stock separation.

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[2] Moreno, C.A. Hook selectivity in the longline fishery of *Dissostichus eleginoides* (Nototheniidae) off the Chilean coast. Document *WG-FSA-91/11*. CCAMLR, Hobart, Australia.

Abundance

2.45 Discussion on methods for estimating abundance of *D. eleginoides* centred on the topics of local abundance, inter- and intra-seasonal depletion studies, commercial trawl data, trawl survey data, fishing radius of longlines and age-based methods. The Workshop also discussed the accuracy of the reported total catch data under this heading.

Local Abundance

2.46 At previous meetings, WG-FSA has made a number of attempts to estimate local abundance using a Leslie depletion model (Leslie and Davis, 1939[3]). No consistent depletion has been detected in these previous studies.

2.47 The Workshop noted that for local depletion to be expected, a number of assumptions had to be made. The principal assumption was that the rate of removal was substantially greater than the rate of movement. This raised questions of the rate of movement and the distances over which movements take place (see section on stock identity, structure and movements). There was also considerable uncertainty concerning the area of influence of a longline. If fish are attracted into the area of a longline, over what distances might this occur? This process has both horizontal and vertical components - the fish are likely to be dispersed both across the seabed and within the water column. The distribution of fish within the water column is unknown (see section on stock identity, structure and movements).

2.48 Despite the difficulties in interpreting the results of previous analyses, some possible further analyses may be warranted. For instance, some localities might show greater potential for local depletion than others, due to differences in local conditions. However, considerable time had already been spent on this approach with little return in terms of results on which to base management advice. It was agreed that work on other approaches should take precedence at the Workshop.

Inter- and Intra-seasonal Depletion Studies

2.49 Longer term depletion-type analyses have also been attempted by WG-FSA at previous meetings (e.g., WG-FSA-91). However, these had not revealed any consistent pattern and

[3] Leslie, P.H. and D.H.S. Davis. 1939. An attempt to determine the absolute number of rats on a given area. *J. Anim. Ecol.*, 8: 94-113.

resulting abundance estimates included considerable uncertainty. The Workshop considered that this might be the result of a large number of variables influencing the catch per unit effort (CPUE) and its relationship with abundance.

2.50 Standardisation of the CPUE series was considered to be a high priority. The first step was an initial data analysis to identify the key variables for an analysis of variance. One immediate concern was the degree of overlap between periods of vessel activity to analyse seasonal and year effects. Other possible explanatory variables were fishing ground, vessel and gear type.

2.51 There were a number of possibilities for the dependent variable (CPUE). Both catch per hook and catch per hook-hour could be investigated as part of the analysis of variance.

2.52 A subgroup was assigned the task of carrying out an analysis of the CPUE data using Generalised Linear Models (GLMs). The results are discussed in section 3.

Commercial Trawl Data

2.53 *D. eleginoides* have been taken in trawl fisheries in various parts of the Convention Area, including as a by-catch in the bottom trawl fishery in Subarea 48.3 during the 1980s and early 1990s, and a directed trawl fishery in Subarea 58.5 (Kerguelen). Interactions between trawl and demersal longline fisheries targetting the same resource have been studied in other parts of the world, particularly in South Africa.

2.54 There has not been any detailed analysis of the trawl by-catch taken in the 1980s in Subarea 48.3. There has been little overlap between the trawl and longline fisheries in Subarea 48.3 due to the decline in the trawl fishery during the early 1990s. There was therefore little scope for interactions between the two fisheries.

2.55 The Workshop considered that the monitoring of abundance using these data would be difficult, but it might be possible to generate an index of recruitment. Some preliminary exploratory data analysis was required to investigate the extent of the data available and possible methods of analysis. However, it was considered that data analysis should be undertaken during the intersessional period rather than during the Workshop or WG-FSA.

Trawl Survey Data

2.56 A large number of bottom trawl surveys have been undertaken on the shelf in Subarea 48.3 during the last 20 years. These surveys were not targetted specifically at *D. eleginoides*, covering only the shallower part of their range, however, catches of young fish were occasionally taken. The subgroup considered that it might be possible to determine which age classes were fully represented in the trawl survey catches and to develop an index of potential recruitment to the size classes fished by longlines. An analysis of fish density at length was suggested as a means of investigating this. The progress of this analysis is described in section 3.

Fishing Radius of Longlines

2.57 Some work has been done by WG-FSA on the estimation of local density directly from catches on individual longlines and assumptions about the size of the area from which fish are attracted to the baits. This approach has promise in that it might provide estimates of absolute abundance. It is also needed to extrapolate from local depletion abundance estimates to the whole fishable area. The Workshop had almost no information on the process of attraction of fish to the longlines, such as the range at which baits could be detected, swimming speed of the fish and current speeds at depth. Investigations of fishing radius in other longline fisheries, undertaken by Norwegian scientists, have been reported in the literature and might provide some guidance in this area.

Age-based Methods

2.58 The use of age-based methods of assessment, such as virtual population analysis (VPA), was discussed. The main limitation at this stage is the length of the time series. This approach might prove useful in the future.

Estimates of Total Catches

2.59 Considerable evidence exists that there has been an increasing amount of catches of *D. eleginoides* by longliners in Subarea 48.3 that have not been reported to CCAMLR.

2.60 Many of the methods of estimating the abundance of *D. eleginoides* rely on estimates of total removals. The Workshop therefore agreed that every effort should be made to estimate these as accurately as possible.

2.61 Several possible methods for estimating total removals were identified and a subgroup was assigned the task of obtaining best estimates. The results are discussed in section 3.

Yield

2.62 Estimates of sustainable yields in previous CCAMLR assessments have been calculated from yield-per-recruit analyses. In this approach, the catch-biomass ratio was calculated from a yield-per-recruit analysis with an $F_{0.1}$ reference fishing mortality rate and multiplied by the estimated biomass to determine a long-term sustainable yield (WG-FSA-93). The calculations undertaken were deterministic, but account was taken of demographic uncertainty by presenting ranges of possible total allowable catches (TACs) corresponding to likely ranges of values of demographic parameters.

2.63 An alternative method for estimating precautionary yields was used for the myctophid *Electrona carlsbergi* (WG-FSA-94/21[4]) and subsequently used for *D. eleginoides* at Heard Island (WG-FSA-94). This was similar to the method originally developed for estimating precautionary TACs for krill (the krill yield model, Butterworth *et al.*, 1994[5]). A generalised version of the fish yield model was described in WG-FSA-95/41.

2.64 The generalised fish yield model in WG-FSA-95/41 takes account of both demographic uncertainty and stochastic variability by carrying out stock projections over a specified number of years into the future. This method is very similar to that currently being used for *D. eleginoides* assessments in Chile (WG-FSA-95/30 and 31).

2.65 The Workshop agreed that as a method to be used at the forthcoming meeting of WG-FSA, it preferred the stock projection approach taken in WG-FSA-95/41 over the yield-per-recruit approach.

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4 Constable, A.J. and W.K. de la Mare. 1994. Revised estimates of yield for *Electrona carlsbergi* based on a generalised version of the CCAMLR krill yield model. Document *WG-FSA-94/21*. CCAMLR, Hobart, Australia.

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

2.66 It noted, however, that there were several matters that required further discussion and that possible amendments to the method would be required before it could be applied to the established fishery for *D. eleginoides* in Subarea 48.3. These relate to the appropriate biomass levels to be used as constraints on final spawning stock biomass, the number of years for forward projection, and the manner in which historical catches were to be taken into account in the projections.

2.67 The Workshop agreed that further discussion on these topics should be deferred to the meeting of WG-FSA. Since application of an amended stock projection method would involve changes to existing computer programs, however, it agreed that yield-per-recruit calculations should also be carried out at that meeting.

Assessment Methods Used in Comparable Fisheries

2.68 As agreed by the Scientific Committee, two experts had been invited to the Workshop. Dr Zuleta described the stock assessment carried out for the Chilean fishery for *D. eleginoides* between 47° and 57°S. Dr Japp described comparative studies of trawl and longline fisheries for hake and kingklip off South Africa.

2.69 The Chilean fishery for *D. eleginoides* has annual landings of 5 000 to 7 000 tonnes. The fishery has operated since 1991, in recent years under the limit of a TAC set annually by the Chilean government. The assessment of stock size has been based on an analysis of the catch-at-age data assuming an equilibrium age structure and constant recruitment. A yield-per-recruit model gave estimates of the various reference fishing mortality rates. Papers WG-FSA-95/30 and 31 describe the procedure used to calculate the TAC in the fishery. In 1995 the projections incorporate uncertainty both in natural mortality and recruitment. A stock projection approach was suggested for use in the future when fitting the CPUE abundance indices derived from the commercial longline fishery.

2.70 The South African trawl fishery for hake has operated for many years on two main species of *Merluccius*: *M. paradoxus* (deep-water species) and *M. capensis* (shallow-water species). Following the decline of the kingklip stock, an experimental longline fishery directing effort at hake was initiated (WG-FSA-95/20). It was pointed out that caution was needed when introducing a longline fishery on top of an already established trawl fishery. The South African experience with kingklip had shown that the different selectivity patterns of the two gear types had resulted in a recruitment problem. Longlines targetted the spawning stock and could lead to a reduction in recruitment to both the trawl and longline fisheries.

2.71 The hake-directed pilot study aimed firstly at comparing the potential yields of longline and trawl, given the selectivity patterns of the two gear types. This study showed that longlines and bottom trawls catch different sizes of fish (WG-FSA-95/20). Longlines exploit only larger hake whilst trawls catch a much broader spectrum of sizes. These differences were mainly attributed to differences in the target species, area fished and the sex of the fish caught. Seasonal patterns and vessel effects (see paragraph 3.7) were also important. Paper WG-FSA-95/22 presents yield-per-recruit results which show that higher yields could be expected from the longline fishery. The hake-directed pilot study was seen as an example of how specific data could be collected in a scientifically controlled manner. This information could then be used to determine the potential of any future longline fishery.

Possible New Assessment Methods

2.72 The Workshop discussed methodologies which could overcome some of the difficulties previously encountered in CCAMLR stock assessments for *D. eleginoides*. The various research techniques were classified into four broad categories based on their practicality and feasibility.

(i) Possible to complete currently:

(a) analysis of standardised CPUE data from the fishery; and
(b) improved stochastic projection methods.

(ii) Possible to complete in the near future:

(a) tagging at the vessel (trawl, longline or crab pot) or by hook tags for analysis of movement and migration;

(b) research using bottom and midwater trawling to study vertical distribution;

(c) comparative fishing studies (longline and trawl);

(d) validation of age estimates from scales/otoliths;

(e) analysis of previous plankton samples for eggs/larvae of *D. eleginoides*; and

(f) maturity ogives.

(iii) Long-term studies:

(a) trawl or longline survey in deep water over range of species distribution;

(b) stock identification studies using otolith chemistry, parasite or genetic studies; and

(c) experimental longline fishing (directed) with standard gear.

(iv) New studies:

- acoustic survey with deep-towed body;
- camera studies (flash or low-light sensitive equipment) to assess distribution and abundance;
- plankton surveys (egg production assessment methods and studies of larval distribution); and
- studies on fish foraging behaviour to improve biomass estimation from longline surveys and to study the effective fishing area of each hook.

REVIEW OF DATA AND ANALYSES

Estimation of Total catch in Subarea 48.3

3.1 The use of abundance indices in stock assessment requires that the total removals are known. The complete catch history is also required to estimate the size of the unexploited stock, which determines the scale of the fishery and the target stock size. Accurate catch information is therefore critical for both assessment and management of the fishery.

3.2 It is clear from circumstantial evidence and confidential records that the reported catches from the longline fishery in Subarea 48.3 do not represent the true level of removals:

(i) the presence of fishing vessels in Subarea 48.3 in months outside the CCAMLR season clearly indicates fishing in excess of allowable catch levels;

(ii) many catches of *D. eleginoides* reported from areas just outside 200-mile limits represent misreporting to avoid the constraints of national and CCAMLR catch limits; and

(iii) fishermen have confided in scientists working in the fishery about misreported catch.

3.3 The Workshop has attempted to estimate the total removals from Subarea 48.3 and adjacent banks (Rhine and North Banks) using all available sources of data (Table 3). The procedure required the use of confidential records which are not available in an official capacity. The column labelled 'estimate of additional catch' in the table includes:

(i) the amount of catch which cannot be accounted for in the official statistics reported from different countries. The official statistics correspond to catches within the CCAMLR season, catches taken in non-CCAMLR fishing grounds and those clearly misreported from zones which are far from Subarea 48.3, but which are not appropriate for *D. eleginoides*;

(ii) catches where the area of capture is known but the dates do not correspond with the CCAMLR season; and

(iii) catches estimated from sightings of fishing vessels in the area outside the fishing season. The assumption was made that these vessels catch the equivalent volume of fish per trip, as they reported during the CCAMLR season. The total catch estimated will probably be an underestimate because not all vessels may be sighted.

Table 3: Estimates of total catches *D. eleginoides* in Subarea 48.3 and adjacent Rhine and North Banks.

Split-year	CCAMLR Catch (tonnes)	Estimate of Additional Catch	Best Estimate of Real Catches[1]
1990	8156.0	345	8501.0
1991	3639.0	565	4206.0
1992	3841.6	3470	7309.6
1993	3088.5	2500	5588.5
1994	459.5	6145	6604.5
1995	3301.1[2]	2870	6171.1

1 Include the adjacent banks
2 Includes 180 tonnes taken by Bulgaria in August 1994

3.4 In conclusion, the total removals in Table 3 for each year is an approximation and likely to be slightly underestimated. However, it is apparent that over the last four years the CCAMLR reported catch is only about 40% of the total catch from Subarea 48.3 and adjacent areas.

Standardisation of Longline CPUE Data

3.5 A preliminary analysis of the CPUE data was completed to identify key variables for analysis of variance. The individual longline sets from 1992 to 1995 were edited to remove data where area was unknown and where effort was recorded as zero. However, zero catches were included in the data set. The level of overlap in fishing activity between vessels was fairly limited but sufficient to carry out the analysis.

3.6 One method of standardising catch and effort data is to use GLMs. This approach was adopted for the preliminary analysis, and four independent variables (vessel, year, month and area) were included in the model. The dependent variable of CPUE used was kilogram per hook.

3.7 The vessel effect was found to be highly significant. This variable includes all the differences between vessels, including fishing gear (longline method, baiting efficiency and hook type), experience of the skipper and nationality. Area was also found to be a significant variable in the model, but month explained very little of the deviations. Although month did not show up as a significant factor, it still may be an important determinant of catch rates in the fishery, particularly if seasonal migrations occur. The data set was dominated by hauls taken in only a few months of the year.

3.8 The standardised approach appears very promising and highlights the value of reporting by individual haul. Comparison with raw CPUE indices from each fleet and the use of alternative models would be useful as the GLM analysis can be sensitive to outliers in the data. Analysis of the CPUE data will continue during WG-FSA including use of kilogram per hook-hour as the dependent variable and the possible effect of depth on catch rates.

Selectivity of Fishing Methods

3.9 Although the size frequency of *D. eleginoides* in catches indicates major differences between longline and trawl methods, much of this difference may be attributed to the fishing grounds and depth fished. An attempt was therefore made to compare size distribution obtained using both methods in the same area. Limited data sources were available at the Workshop, but more data are available to enable this comparison to be made in future.

3.10 Although the available data were not widespread, there appears to be major differences in the size selectivity of the fishing gear. In the Kerguelen area, the fish taken by trawl were much smaller than catches from longlines in a similar depth (300 to 600 m) and area (Figure 4). Data from the Argentinian longline and trawl fisheries operating on the Patagonian shelf showed a similar pattern, but with a greater separation between the two selectivity curves (Figure 5). The differences observed are affected by hook size and type, bait used and the size distribution of the population. However, a number of tentative conclusions could be made from this comparison. Small fish, even if present in the area, may not be taken by the lines. Therefore trawls may be more useful to map the distribution and abundance of small fish throughout the depth range.

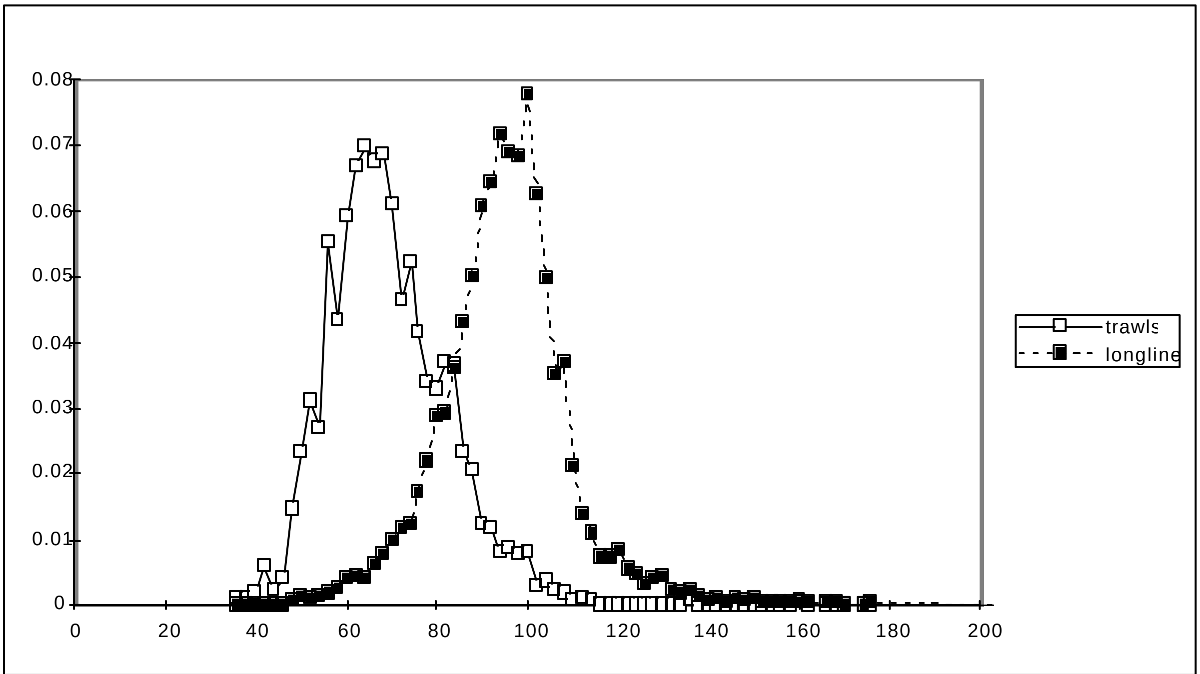

Figure 4: Length frequency distribution of *D. eleginoides* from trawl and longline catches in western Kerguelen from 1992 to 1994, from similar areas and depths (300 to 600 m).

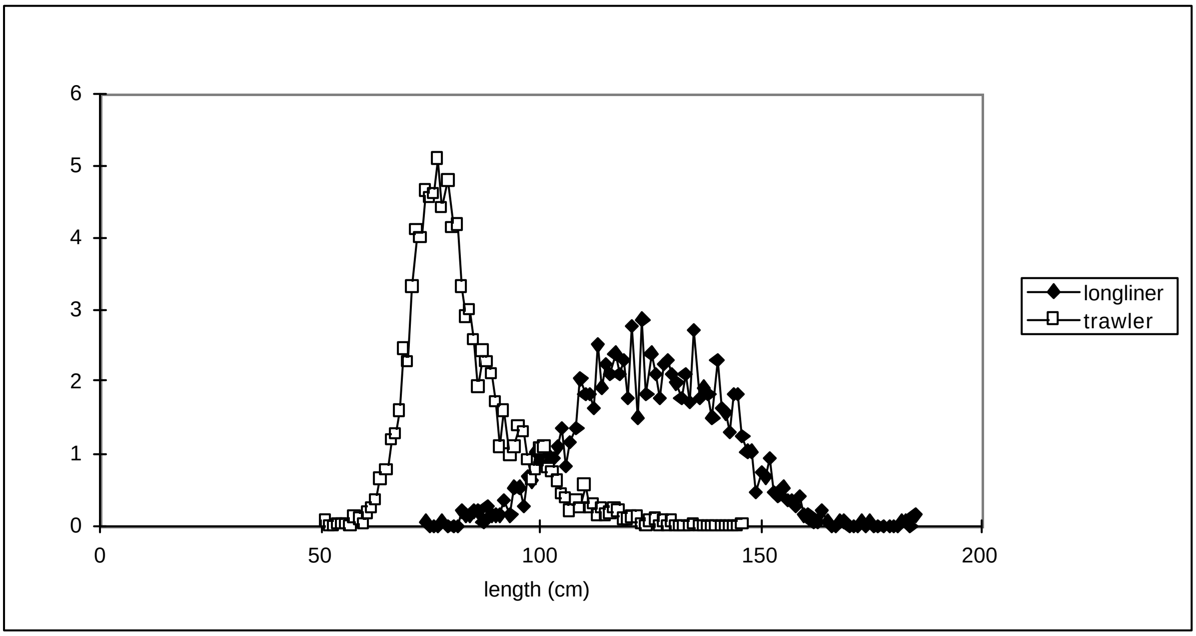

Figure 5: Comparison of Argentinian trawler and longline data from fine scale position 54°S 62°W.

Length-Density Analysis

3.11 Paper WG-FSA-95/23 listed the research surveys for which *D. eleginoides* has been recorded and data have been reported to CCAMLR. This includes 12 surveys in Subarea 48.3 over the period 1987 to 1995 and three surveys from Heard Island from 1990 to 1993. Most of these surveys have been based on a random stratified survey design, using a bottom trawl to sample at stations between 50 and 500 m deep. One survey (1987) used a pelagic net to fish close to the bottom. The surveys cover only part of the known depth distribution of *D. eleginoides*. From what is known about the size composition of the catches it appears that they sample only the younger age classes. It may be possible to use these data to develop a series of indices of the abundance of younger fish, which are considered to be well sampled by the surveys. These estimates can then be stochastically projected forwards to the adult population, using known catches.

3.12 A procedure for analysis of the trawl survey data was developed and preliminary data processing undertaken. The Workshop recommended that this data analysis should be continued by WG-FSA.

3.13 Length data from the trawl surveys will be analysed to determine year class strength. The abundance at length of fish sampled by the surveys is decomposed into separate age classes using mixtures of normal distributions. The method involves a maximum likelihood fit to the length data from individual trawl stations (de la Mare, 1994[6]). The method is similar to the method using MIX software in MacDonald and Pitcher, 1979[7], but overcomes errors in variance estimation of the area under the curve (year class strength).

RECOMMENDATIONS TO WG-FSA

4.1 The Workshop had four main areas of recommendations:

A. An experimental approach to assessing stock abundance must be initiated.

(i) Research programs must be developed, particularly on estimates of absolute abundance. It is clear that attempts to use relative abundance indices derived from commercial data have to date provided inconclusive results.

(ii) An experimental approach is therefore required. The Workshop considered that such an approach would include:

(a) fisheries dependent data: collection of data by observers to allow standardisation of the CPUE series to be improved, should be considered a high priority;

(b) fisheries independent data: directed research surveys are required; and

(c) experimental/directed fishing should be considered (e.g., with standardised gear).

B. Data consistency and quality from the commercial fishery must be improved.

(i) Every effort must be made to estimate total removals as accurately as possible. This could be improved by increasing confidence in the accuracy of the reported quantity and location of catches.

---

[6] de la Mare, W.K. 1994. Estimating krill recruitment and its variability. *CCAMLR Science*, Vol. 1: 55-61.

[7] MacDonald, P.D.M. and T.J. Pitcher. 1979. Age groups from size frequency data: a versatile and efficient method of analysing distribution mixtures. *J. Fish. Res. Board Can.*, 36: 987-1001.

(ii) It was recognised that the best data acquired from the fishery so far had been that from the 1995 observer program. Nevertheless,

(a) improvements in completeness of both historical and future records for catch, effort, location, bait type, hook type, depth and soak time are needed;

(b) additional data such as environmental factors - current, wind strength, sea state, temperature at sea surface and depth should be gathered; and

(c) WG-FSA is urged to give consideration to the most appropriate mechanism for acquiring different types of data from both trawl and longline fisheries (e.g., through scientific observers or vessel masters). Further consideration should be given to the level of observer coverage required to achieve these results.

C. Estimates of biological and demographic parameters must be improved.

(i) The age distribution using data from commercial and research sources should be determined. This should proceed by, in order of execution,

(a) developing methods in order to validate ageing from otoliths and scales; and

(b) an experimental approach to determine the magnitude of biases in estimated age/length keys caused by use of different hook type and sizes and different species and bait size.

(ii) The level of mixing of *D. eleginoides* between different regions should be determined. This includes tagging experiments to determine mobility and stock identification. Other methods to investigate stock identification are genetic, parasite markers etc., but these probably should not be considered a priority.

(iii) Further studies should be made to determine times and locations of spawning. Accurate identification of maturity stages is needed to determine maturity ogives.

D. Specific recommendations for assessments at WG-FSA-95 should be made.

(i) The length-density analyses described in paragraphs 3.11 to 3.13 should be completed by WG-FSA during its 1995 meeting.

(ii) WG-FSA should determine which of the estimates of von Bertalanffy growth parameters are appropriate for yield calculations in the light of size selectivity of different fishing methods.

(iii) WG-FSA should perform stock projections and yield analysis using the information derived above.

(iv) The CPUE standardisation described in paragraph 2.50 should be completed by WG-FSA during its 1995 meeting.

ADOPTION OF THE REPORT AND CLOSE OF THE WORKSHOP

5.1 The report of the Workshop was adopted.

5.2 In closing the meeting the Convener thanked the rapporteurs, Secretariat and all participants for cooperating well to complete a successful workshop. In particular, he thanked Mr Japp and Dr Zuleta for providing their expert assistance to the deliberations of the Workshop.

5.3 Dr Kirkwood delivered a vote of thanks to the Convener, Dr de la Mare, for conducting a productive Workshop.

5.4 The Convener then closed the meeting.

ATTACHMENT A

AGENDA

Workshop on Methods for the Assessment of *Dissostichus eleginoides*
(Hobart, Australia, 5 to 9 October 1995)

1. Introduction
   (i) Appointment of Chairman
   (ii) Appointment of Rapporteurs
   (iii) Adoption of Agenda

2. Review of Possible Assessment Approaches
   (i) Previous CCAMLR Assessments
   (ii) Assessment Methods used in Comparable Fisheries
   (iii) Possible New Assessment Methods

3. Review of Data and Analyses
   (i) Longline fisheries
   (ii) Trawl fisheries

4. Application of Possible Methods to Selected Data Sets

5. Recommendations to WG-FSA
   (i) Using Existing Types of Data
   (ii) New or Refined Data Requirements
   (iii) Using New Methods (directed research and/or data collected during commercial fisheries)

6. Adoption of Report

7. Close of Workshop.

LIST OF PARTICIPANTS

Workshop on Methods for the Assessment of *Dissostichus eleginoides*
(Hobart, Australia, 5 to 9 October 1995)

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Nigel WILLIAMS (Computer Systems Administrator)

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Australia

STRUCTURE OF THE GENERALISED YIELD MODEL

(by Drs A. Constable and W. de la Mare)

The generalised yield model is introduced in WG-FSA-95/41 and paragraphs 3.44 to 3.47 of this report. The rationale for assessing the status of stocks using stochastic projections is discussed in SC-CAMLR-XIII, paragraphs 5.18 to 5.26. This appendix describes the manner in which projections are undertaken within the yield model and the way in which the spawning stock is monitored under specified catch regimes.

STRUCTURE OF A PROJECTION RUN

2. Figure 1 shows the basic structure of a projection run. Mean recruitment and natural mortality are determined for each run from specified functions to take account of uncertainty in the estimates of these parameters (e.g., see paragraphs 5.70 to 5.72; random normal and random uniform functions were used respectively in the *D. eleginoides* assessment).

3. The remainder of the run is made up of three parts:

I. Establishment of the Age Structure and Spawning Biomass at Time 0

4. The age structure at time 0 of the projection can be determined using two methods:

(i) The first method (used by Butterworth et al., 1994[1]) is to start with a set number of recruits (in the case of Butterworth et al., 1994, this was equal to 1.0 at age 0) and to apply the value of M for the run (modified by the age-specific mortality coefficient) to each successive age class to obtain a deterministic age structure. This population is then projected for a number of years, equivalent to at least the number of age classes in the stock, with recruitment varying from year to year within the bounds of recruitment variability specified in the recruitment function.

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

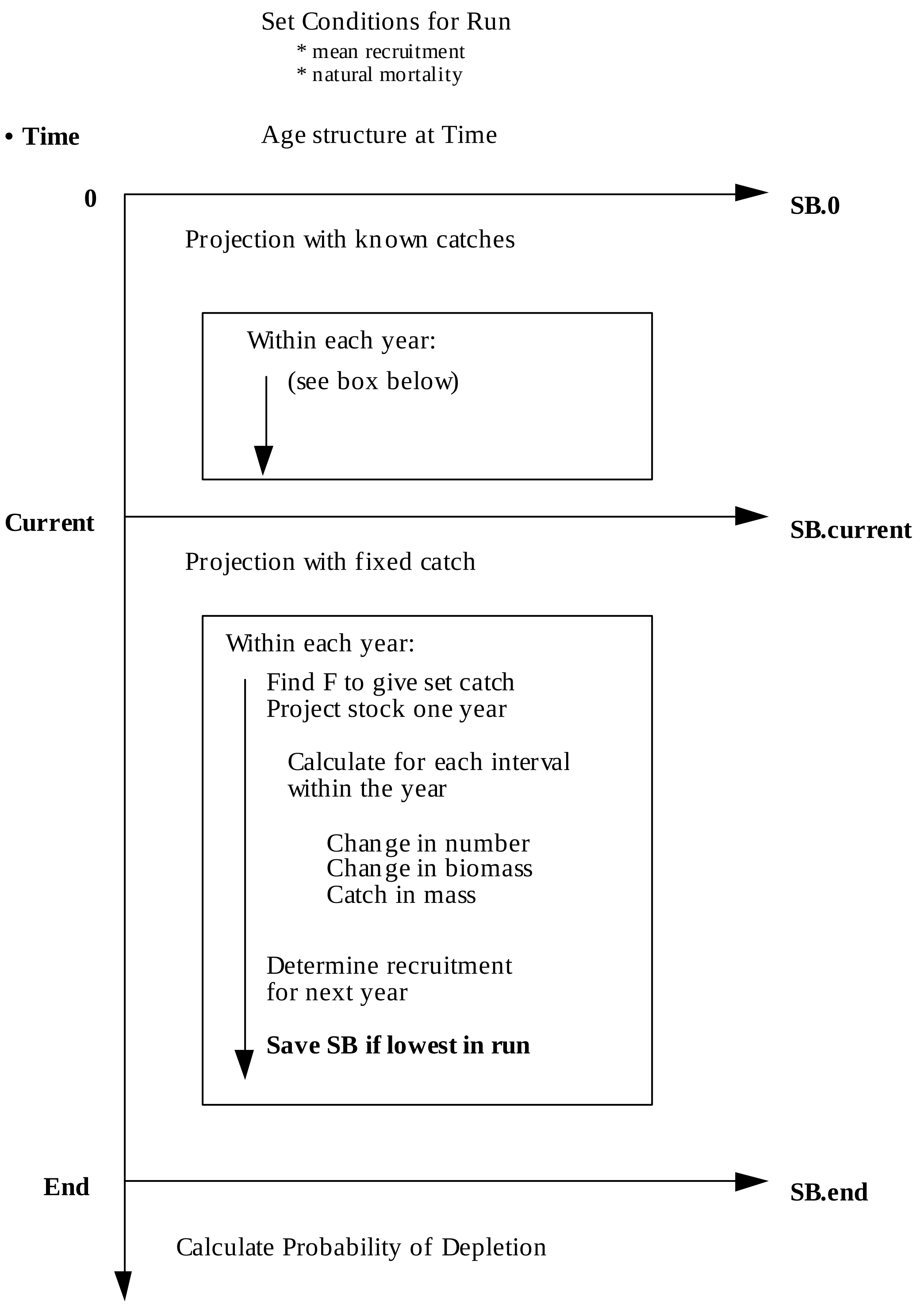


Figure 1: Flow chart of a projection run in the generalised yield model (GLM).

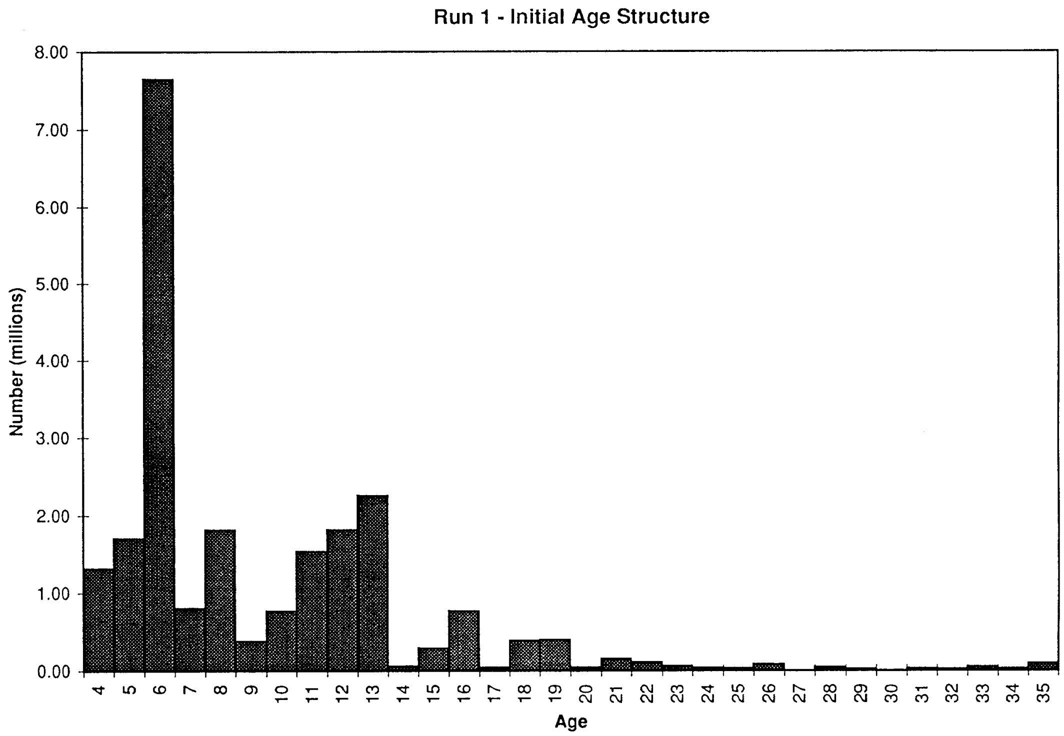
This removes the influence of the initial deterministic age structure. At time 0, the spawning biomass is determined. The stock is then ready for phases II and III of the projections (see below).

(ii) The second method introduces recruitment variability into the formulation of the initial age structure, eliminating the need to project the stock forward one generation. In this formulation, each age class is assigned a different level of recruits at age 0 (or a specified starting age, such as 4 for *D. eleginoides*). These are drawn from the random recruitment function that incorporates recruitment variability. Each of these recruitments is then projected forward using the natural mortality function to the required age to give the number at age in the stock. A plus class can be included in this formulation.

5. After the initial age structure is set up, the spawning biomass at time 0 can be calculated using the maturity-at-age and length-at-age functions and the weight-at-age function specified in the input parameters.

6. In the case of the projections used in the assessment of *D. eleginoides*, the second option was chosen, with ages 4 to 34 years and a plus class. The initial age structures for two example projection runs are shown in Figure 2. Note that the age structure in real numbers is dependent on the random recruitments, yielding a structure that is different to a deterministic stable age distribution. The difference between the initial age structures of the two runs results from the random recruitments generated by the recruitment function, combined with the estimates of mean recruitment derived for each run.

7. If estimates of actual recruitment are used as inputs into the model, then the estimate of spawning biomass at time 0 will be an estimate of the actual spawning biomass of the stock, given the uncertainties in the input parameters and M. This differs from the model of Butterworth et al. (1994) who were seeking to find the proportion of the estimate of pre-exploitation biomass which could be exploited while satisfying the decision rules for γ_1 and γ_2. As a consequence, ther model outputs of Butterworth et al. were relative to B_0 and did not operate in the domain of actual biomasses.



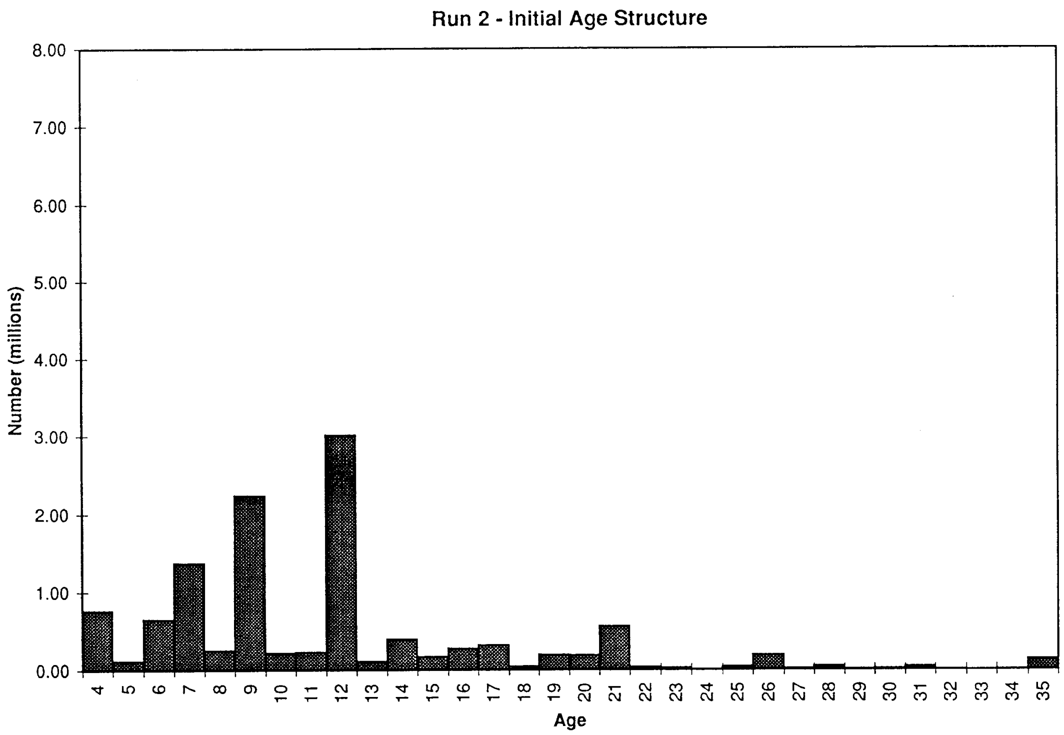


Figure 2: Initial age structure from example runs 1 and 2 in a projection for *D. eleginoides* in Subarea 48.3. The input parameters for the projection are presented in this report (paragraph 3.46). The projection included uncertain mean recruitment, interannual recruitment variability, M = 0.16 and a constant catch rate in the projection period with fixed catch of 5 400 tonnes. The age class 35 was a plus class established to include ages 35 to 55.

II. Projection of Stock through a Period of Known Catches

8. A projection through a period of known catches from time 0 to current (Figure 1) is then undertaken. For each year, F is calculated to yield the appropriate catch identified in the catch history. This level of fishing mortality was then used as a basis for projecting the stock forward for one year.

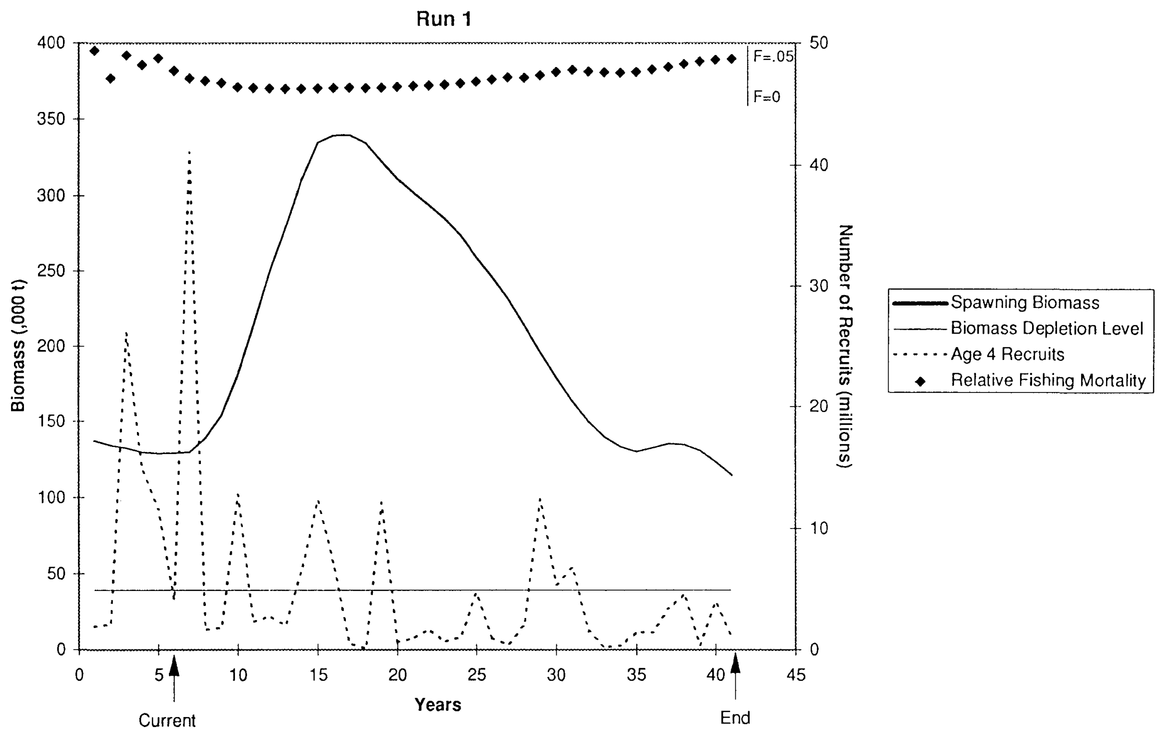
III. Projection of Stock for a Specified Period to Examine Performance Under a Specified Catch Regime

9. The main projection extends from the current time to the end of the projection period (Figure 1). In a single run, the model can project the stock forward under three different options: (i) a constant catch set as a proportion of an estimate of the pre-exploitation spawning stock (time 0 in the run); (ii) a constant catch specified in the input file; or (iii) a constant fishing mortality, e.g. $F_{0.1}$.

10. The first option is that used by Butterworth et al. (1994). This does not require knowledge of the number of recruits. The second option allows an examination of the performance of the stock under a constant catch scenario with real catches specified. In this case, estimates of real levels of recruitment are required. Both of these options require the determination of F for each year to yield the requisite catch before projecting the stock forward. The third option allows the performance of the stock to be examined under a set fishing mortality.

11. Figure 3 shows the trajectory of the spawning stock over the two example runs in the assessment of *D. eleginoides*, with a constant catch of 5 400 tonnes. These two runs show the influence of random recruitment on the outcomes. Fishing mortality varies each year to yield the requisite catch.

12. During the projection period, the program monitors the status of the spawning stock and, for each run, notes the minimum spawning biomass that occurred during the projection period. At the end of all runs this minimum is compared to the median spawning biomass at time 0. In the assessment of *D. eleginoides*, 1 001 runs were undertaken for each scenario. The probability of depletion under each catch scenario was determined as the proportion of runs in which the spawning stock descended below 0.2 of the median B_0 level at any time during the projection run. Run 2 in the example was one such run where the stock was depleted. In this run, fishing mortality continually increased in order to obtain the same level of catch each year. This was a result of low levels of recruitment throughout the run. In contrast, the stock in Run 1 was never considered as depleted during the projection period. Recruitment was much greater early in the projection period.



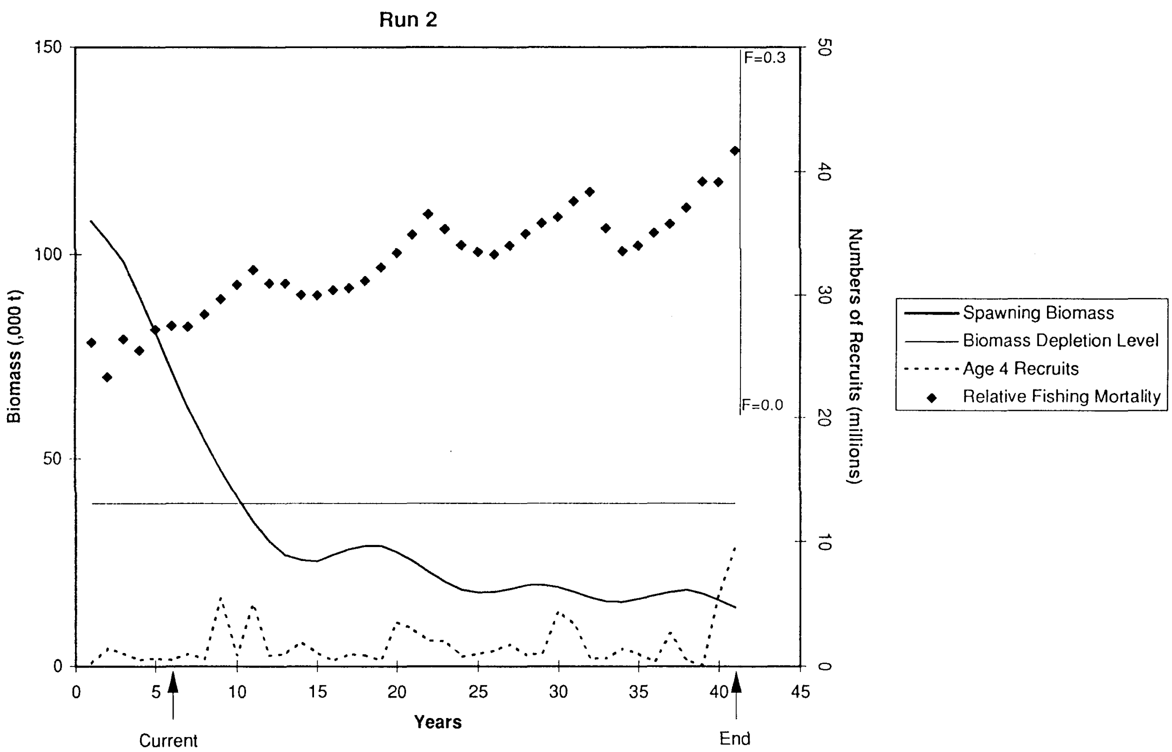


Figure 3: Spawning biomass, recruitments and levels of F in the two example projection runs from the initial age structures in Figure 2. The biomass depletion level was 0.2 of the median spawning biomass at Time 0.

PROJECTION WITHIN EACH YEAR

13. An adaptive Runge-Kutta procedure (Press et al., 1992[2]) is used to integrate the catches taken over one year and to project the numbers-at-age forward one year. This procedure solves the following set of differential equations which specify the growth rate of the stock and the rate of catch to be expected in each interval for each age of fish:

(i) change in numbers-at-age in a specified time interval:

$$-(m_t \bullet M(t) + f_t \bullet F(t)) \bullet Y_0$$

where m_t = coefficient to modify natural mortality;
M = natural mortality;
f_t = coefficient to modify fishing mortality;
F = fishing mortality;
t = time increment in year; and
Y_0 = numbers-at-age at the beginning of the time interval.

(ii) change in biomass-at-age during that time interval:

$$-(m_t \bullet M(t) + f_t \bullet F(t)) \bullet Y_0 \bullet \text{Weight}(t) + Y_0 \bullet dWt(t)$$

where Weight(t) = weight of an individual at time t; and
dWt(t) = rate of change in weight of an individual at time t

(iii) catch (in mass) of that age class in that time interval:

$$f_t \bullet F(t) \bullet Y_1$$

where f_t = coefficient to modify fishing mortality;
F = fishing mortality;
t = time increment in year; and
Y_1 = biomass-at-age at the beginning of the time interval.

14. Paper WG-FSA-95/41 illustrates how the coefficients f_t and m_t are derived from the biological parameters and the parameters that influence fishing mortality for fish at each age and time of the year.

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2 Press, W.H., B.P. Flannery, S.A. Teukolsky and W.T. Vetterling. 1992. *Numerical Recipes. The Art of Science Computing (FORTRAN Version)*. Cambridge University Press, Cambridge, UK.

MODEL OUTPUTS

15. The outputs of the model at the end of a set of projection runs include estimates of the spawning stock at time 0, the end of the catch period (current) and the end of the projection period, as well as counts of the number of runs when the spawning stock became depleted at some time compared to the median spawning stock biomass at time 0 (i.e., depletion was 0.2 * median B_0). These estimates take into account uncertainty in the estimates of the input parameters. The frequency distributions of the estimates of spawning biomass at the three critical times for *D. eleginoides* in the scenario of 5 400 tonnes are shown in Figure 4. The median estimates are also shown. The same results, but for the projection scenario of a constant catch during the projection period of 4 000 tonnes, are shown in Figure 5.

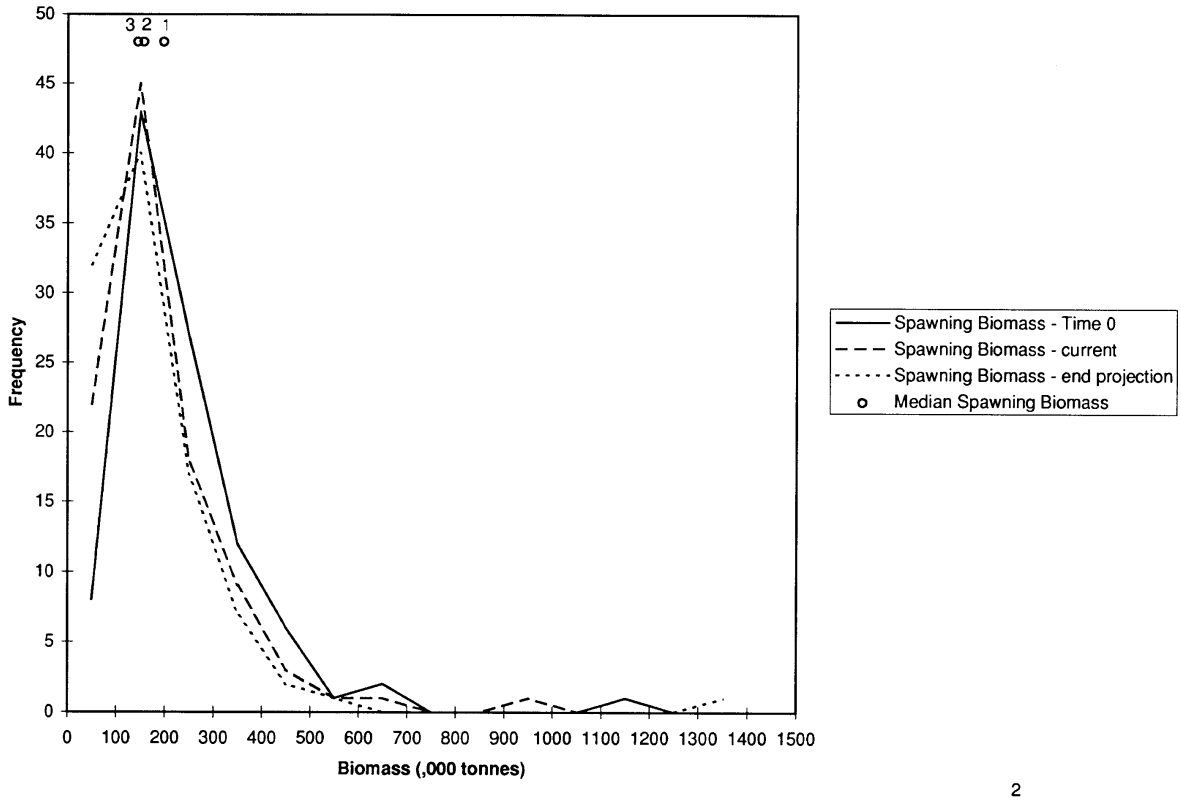

Figure 4

Figure 4: Results of the projection for a fixed catch of 5 400 tonnes. Relative frequencies of estimates of spawning biomass in 1989 (time zero), 1995 (current) and projected status after 35 years - 2030 (end projection). Median values of these distributions are shown (diamonds: 1 = B1989, 2 = B1995, 3 = B2030).

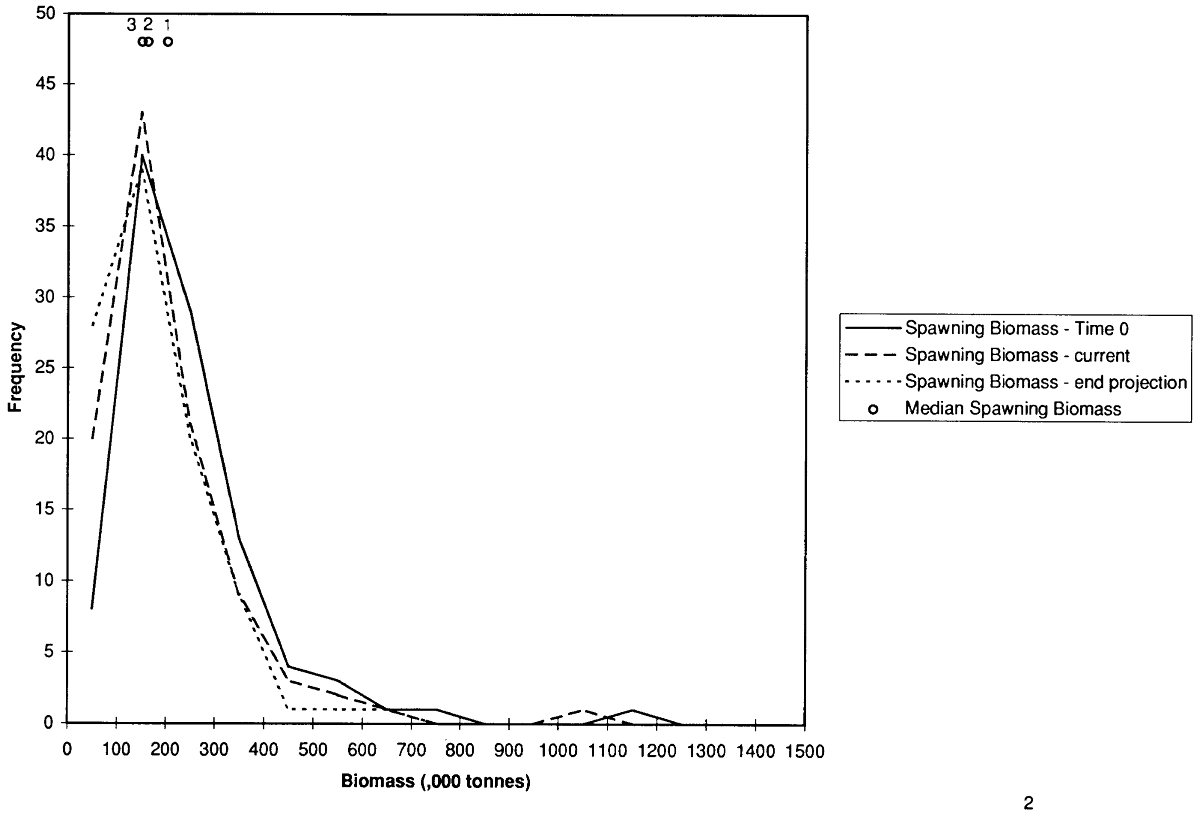

Figure 5: Results of the projection for a fixed catch of 4 000 tonnes. Relative frequencies of estimates of spawning biomass in 1989 (time zero), 1995 (current) and projected status after 35 years - 2030 (end projection). Median values of these distributions are shown (diamonds: 1 = B1989, 2 = B1995, 3 = B2030).

METHODOLOGY APPLIED IN THE ANALYSIS OF *DISSOSTICHUS ELEGINOIDES* CPUE DATA USING GENERALISED LINEAR MODELS (GLMS)

SUBAREA 48.3 (SOUTH GEORGIA)

Following preliminary work conducted by the Workshop on Methods for the Assessment of *Dissostichus eleginoides* (WS-MAD) (Appendix E of this annex, paragraphs 3.5 to 3.8), five variables were selected as predictors for standardising the CPUE data with Generalised Linear Models (GLMs): vessel, year, month, geographic area and depth. Vessel, year, month and area were modelled as factors whereas depth was modelled as a continuous covariate.

2. Individual vessels were considered to be levels for the vessel factor. Twenty-three vessels from six different fleets (Argentina, Bulgaria, Chile, Korea, Russia and Ukraine) were included in the analysis. The area factor had five levels; east South Georgia, northwest South Georgia, south South Georgia, Shag Rocks and west of Shag Rocks. Figure 1 in the main text of this annex maps the boundaries of the area factors.

3. The predictor variables were used to model four CPUE indices; kilogram per hook, numbers per hook, kilogram per hook-hour and numbers per hook-hour.

4. The GLMs were fitted to *D. eleginoides* haul-by-haul data from Subarea 48.3 over the period 1992 to 1995. The data were screened according to the rules outlined in the following list.

For all models omit:

(i) all records from hauls taken in unknown areas;

(ii) all records where catch is greater than zero and effort either not reported or reported as zero;

(iii) all records where depth at start of set was not reported; and

(iv) single outlier where depth at start of set was reported as 6 065 m.

For models with hook-hours used as effort omit:

(v) all records with soak-time less than or equal to zero or soak time not reported (soak time was calculated as time at start of hauling minus time at start of setting); and

(vi) single outlier where soak time was reported as 104.5 hours.

5. Depth was taken as depth at start of setting. It was not possible to calculate a mean depth for each haul because many of the records in the haul-by-haul database do not have information on the depth at end of setting.

6. In general, the predictor effects were considered to be multiplicative, so standardised catch rates ($CPUE_{STD}$) were modelled with the following equation:

$$CPUE_{STD} = CPUE_0 \; . \; vessel_i \; . \; year_j \; . \; month_k \; . \; area_l \; . \; depth_i \; . \; E_i$$

Interaction terms were not included in the model.

7. $CPUE_0$ is the catch rate for a set of reference predictors (vessel = ‘1’; year = ‘1992’; month = ‘1’ and area = ‘east South Georgia’). $Vessel_i$, $year_j$, $month_k$, $area_l$ and $depth_i$ represent, respectively, the effects of vessel, year, month, area and depth. The error terms (E_ns) were distributed according to a γ distribution with variance proportional to $CPUE_{STD}$.

8. The multiplicative model was linearised with a log transformation;

$$ln(CPUE_{STD}) = ln(CPUE_0) + ln(vessel_i) + ln(year_j) + ln(month_k) + ln(area_l) + ln(depth_i) + \ln(E_i)$$

9. The model was fitted using an iterative re-weighted least squares procedure (McCullagh and Nelder, 1983[1]), and predictions were made from the fitted GLMs to provide standardised catch rates by vessel and year (Figures 2 and 3 in the main text of this annex).

1 McCullagh, P. and J.A. Nelder. 1983. *Generalised Linear Models*. Chapman and Hall, London.

DRAFT OUTLINE OF INFORMATION TO BE INCLUDED IN SCIENTIFIC OBSERVER SUMMARIES TO CCAMLR

Information of the type outlined below should be included in the summaries of work undertaken by scientific observers submitted to CCAMLR. Wherever possible, specific items of information should be summarised in a consolidated form (e.g., summary tables, figures) and observers are encouraged to summarise whatever information they consider pertinent. This draft outline will be kept under review and modified as necessary.

1. Introduction

A brief outline of work undertaken and reasons for scientific observer's presence aboard vessel.

____

____

____

2. Scientific Observer and Vessel Details

CRUISE NUMBER: _________________

SCIENTIFIC OBSERVER DETAILS:

Name: __________________________________

Nationality: ______________________________

Employing Organisation: __________________

Dates of Observation: from ______ to ______

Location of Boarding: ____________________

Location of Debarkation: __________________

Area, Subarea(s) Covered: _________________

VESSEL DETAILS:

Name of Vessel: ________________________________

Flag State: ________ Port of Registration: ________

Call Sign: _____________________________________

Vessel Type: _______ Fishing Gear*: _________

Size (GRT): _________ Length (LOA): _________

On-board Acoustic Equipment: ___________________

Position-fixing Equipment: _______________________

Vessel Monitoring System: ______________________

Processing of catch on the vessel:

Type of catch processing (e.g., frozen whole fish, gutted fish, fillets, etc.)	Conversion factor for calculation of the nominal catch, if used

* For longlines include hook type, size and number/line if possible.

3. Cruise Itinerary:

Port/Date Departure: ____________________________________

Transit Dates/Activities: _________________________________

Fishing Dates/Activities: _________________________________

Transit Dates/Activities: _________________________________

Port/Date Return: ______________________________________

4. Summary of Gear/Bait/Fishing Operations

Area: ____

Coordinates: ______________ S ____________ W/E

Dates: ____

Average Depth: ____

Ship Days:

In fishing area ______________________________________

Actual fishing ______________________________________

Total number trawls/hauls/pots: __________________________

Longline Set:

Cartridges ____

1 000s hooks set ____________________________________

Bait:

Species ____

Estimated baiting efficiency as percentage _______________

Catch (kg):

Total ____

Per ship day actual fishing ____________________________

Per 1 000 hooks set _________________________________

Average frozen produce per ship day actual fishing (kg):

____

Comments: ____

____

____

5. Summary of Work Carried Out on Fish

Number of catches sampled: ____________________________

Number of hooks set (in thousands): ______________________

Total number of all fish species measured comprised:

Species	No.

Total number of fish analysed by:

Species	No.

Analyses undertaken: Length distribution / Age / Weight / Maturity

Total fish sampled for age determination comprised:

Species	No.	
	Otoliths	Scales

Location where samples are archived: ____

Frozen fish products produced (in tonnes): _________________

6. Summary of Meteorological Conditions

Days fishing lost to weather: ____________________________

Prevailing sea conditions: Mild / Moderate / Stormy

Short description on weather and sea conditions:

____

____

____

7. Summary of Fishing Strategy

Brief outline of fishing strategy (including information such as 'pilot fishing trails using short longlines')

____

____

____

____

8. Summary of Biological Observations

Information to be provided in summary form (e.g., of composite length frequency), if so desired.

(Attach if necessary)

9. Summary of Work on Seabird Incidental Mortality

Proportion of haul (in terms of number of hooks) observed:

Recorded for all hauls: ☐

Recorded for hauls no.: _________

Streamer line details recorded:

Specification (e.g., CCAMLR, other) ____

No. of streamer lines _________

Location of deployment __________________

Diagram

Offal discharge:

Location __________________

Timing ____________________

Birds killed:

Recorded for all hauls: ☐

Recorded for hauls no.: __________

Bird samples:

Whole specimens retained

Species	No.

Leg and head samples retained

Species	No.

Where deposited ____

Contact scientist (if known) ____

Details of banded/marked birds

Species	Band No./Mark

Bird observations:

Densities recorded: during set ☐

at other times ☐

Additional observations recorded ☐

10. Summary of Marine Mammal Observations

Description of mitigating measures: ____

____

____

Observations on marine mammals/fishery interactions:

Species involved ______________________

Loss of fish assessed ☐

Loss of fishing gear recorded ☐

Other observations of marine mammals: ____

____

____

11. Difficulties Encountered

Identify difficulties in:

- observer tasks as prescribed by the *Scientific Observers Manual*
- operational work aboard the vessel
- any other areas/activities
- reporting of data

APPENDIX I

1995 ASSESSMENT SUMMARIES

Assessment Summary: *Notothenia rossii*, Subarea 48.3

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]
Recommended TAC	0							
Agreed TAC	300	300	0					
Landings	2	1	1	0	2	1		
Survey Biomass	1481[a]	4295[c]	7309		6600			
	3915[b]	10022[d]						
	3900[b]							
Surveyed by	UK/POL[a]	UK[c]	UK		UK			
	USSR[b]	USSR[d]						
Sp. Stock Biomass[3]		No information						
Recruitment (age...)		available						
Mean F (.....)[1]		since 1985/86						

Weights in tonnes, recruits in ....

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

[2] Over period 1982 to 1992

[3] From VPA using (..........)

Conservation Measures in Force: 2/III, 3/IV and 85/XIII

Catches:

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

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1995/96: Recommend continued closure.

Assessment Summary: *Champsocephalus gunnari*, Subarea 48.3

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]
Recommended TAC	12000		8400-61900	9200-15200	0			
Agreed TAC	8000	26000	0	9200				
Landings	8027	92	5	0	13	10		
Survey Biomass	72090[a]	27111[a]	43763[a]		16088[+a]			
	442168[b]	192144[b]			4870[*a]			
					2012[+b]			
					67259[*b]			
Surveyed by	UK/POL[a]	UK[a]	UK[a]		UK[a]			
	USSR[b]	USSR[b]			Arg[b]			
Stock Biomass[3]	50	50.5						
Recruitment (age 1)	(millions)							
Mean F (.....)[1]			0					

Weights in '000 tonnes

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

[2] Over period 1982 to 1992

[3] From VPA (2+)

[*] Shag Rocks

[+] South Georgia

Conservation Measures in Force: 19/IX and 86/XIII

Catches: Research catch only of 10 tonnes.

Data and Assessment: No new assessment was perfomed.

Fishing Mortality: None.

Recruitment:

State of Stock: Stock has increased since 1993/94 but the magnitude of this increase is unknown.

Forecast for 1995/96:

Assessment Summary: *Patagonotothen guntheri*, Subarea 48.3

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]
Recommended TAC	-	20-36000	0					
Agreed TAC	12000	0	0					
Landings	145	0	0	0	0	1		
Survey Biomass		584[a] 16365[b]	12764		4589			
Surveyed by		UK[a] USSR[b]	UK		UK			
Sp. Stock Biomass[3]	na							
Recruitment (age 1)	na							
Mean F (3 - 5)[1]	na							

Weights in tonnes
[1] ... weighted mean over ages (...)
[2] Over period 1982 to 1992
[3] From VPA using (..........)

Conservation Measures in Force: 76/XIII

Catches:

Data and Assessment: No new assessment was performed.

Fishing Mortality:

Recruitment:

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

Forecast for 1995/96: Recommend conservation measures presently in force be retained.

Assessment Summary: *Dissostichus eleginoides*, Subarea 48.3

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]
Recommended TAC	-					-		
Agreed TAC	-	2500[4]	3500	3350	1300	2800		
Landings	8311	3843	3703	2990	604	6171[5]		
Survey Biomass	9631*[a] 335+[a] 1693*[b] 3020+[b]	19315* 885+	3353* 2460+		14923*[a] 4831+[a]		2012*[b] 67259+[b]	
Surveyed by	POL/UK[a] USSR[b]	UK	UK		UK[a] Arg[b]			
Stock Biomass[3]	20745 - 435817			11000- 17000				
Recruitment (age...)	na							
Mean F (.....)[1]	na							

Weights in tonnes

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

2 Over period 1982 to 1992

3 Estimated from cohort projections

4 TAC from 1 November 1990 to 2 November 1991

5 Estimated by WS-MAD from various sources

* Shag Rocks

\+ South Georgia

Conservation Measures in Force: 69/XII, 77/XIII and 81/XIII

Catches: Reported catches: 1994/95 split-year - 3 301.1 tonnes; 1994/95 season (March to May 1995) - 3 062.1 tonnes.

Data and Assessment: Total removal estimated by Working Group over the period 1990 to 1995. Standardisation of CPUE series using generalised linear model. Analysis of the effects of various harvest strategies using the generalised yield model to project over 35 years.

Fishing Mortality: Strategy of $F_{0.1}$ shown to have a high probability of failing the γ_1 decision criterion.

Recruitment: Estimated from trawl survey data over the period 1990 to 1995 using length-density analysis (de la Mare, 1994[1]).

State of Stock: Current estimated median spawning stock biomass in the region of 100 000 to 200 000 tonnes according to simulations over the period of estimated total removals (1989 to 1995).

Forecast for 1995/96: Total removals of 4 000 tonnes per annum fulfill γ_1 decision criteria with current model input, including uncertainty in recruitment.

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

Assessment Summary: *Notothenia gibberifrons*, Subarea 48.3

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]
Recommended TAC			500-1500					
Agreed TAC			0					
Landings	11	3	4	0	4	1		
Survey Biomass	17000	25000	29600		23566			
Surveyed by	UK USSR	UK USSR	UK		UK			
Sp. Stock Biomass[3]	4300	6200						
Recruitment (age 2)	27000	25000						
Mean F (.....)[1]	0.014	0.0002						

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

Conservation Measures in Force: 76/XIII and 85/XIII

Catches:

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1995/96: Recommend directed fishery remain prohibited.

Assessment Summary: *Chaenocephalus aceratus*, Subarea 48.3

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]
Recommended TAC	0	300	300-500					
Agreed TAC	300	300	0					
Landings	2	2	2	0	2	0	1272	1
Survey Biomass	14226[a] 14424[b] 17800[b]	13474[c] 18022[d]	12500		9695			
Surveyed by	UK/POL[a] USSR[b]	UK[c] USSR[d]	UK		UK			
Sp. Stock Biomass[3]	5098[4]							
Recruitment (age 2)	4047[4]							
Mean F (.....)[1]								

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: 76/XIII and 85/XIII

Catches:

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1995/96: Recommend directed fishery remain prohibited.

Assessment Summary: *Pseudochaenichthys georgianus*, Subarea 48.3

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]
Recommended TAC	0	300	300-500					
Agreed TAC	300	300	0					
Landings	1	2	2	0	1	0	1661	1
Survey Biomass	5761[a]	13948[c]	13469		5707			
	12200[b]	9959[d]						
	10500[b]							
Surveyed by	UK/POL[a]	UK[c]	UK		UK			
	USSR[b]	USSR[d]						
Sp. Stock Biomass[3]								
Recruitment (age 1)								
Mean F (.....)[1]								

Weights in tonnes, recruits in '000s

[1] ... weighted mean over ages 3 to 6

[2] Over period 1982 to 1992

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

Conservation Measures in Force: 76/XIII and 85/XIII

Catches:

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1995/96: Recommend directed fishery remain prohibited.

Assessment Summary: *Lepidonotothen squamifrons*, Subarea 48.3

Source of Information:

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]	Mean[2]
Recommended TAC	0	300	300						
Agreed TAC	300	300	0						
Landings	0	0	0	0	0	0	1553	0	563
Survey Biomass	1359[a] 534[b]	1374	1232						
Surveyed by	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: 76/XIII and 85/XIII

Catches:

Data and Assessment:

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1995/96: Recommend conservation measures presently in force be retained.

Assessment Summary: *Electrona carlsbergi*, Subarea 48.3

Source of Information:

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]	Mean[2]
Recommended TAC	-	-	-						
Agreed TAC	-	-	245000	200000[4]					
Landings	23623	78488	46960	0	0	0			
Survey Biomass									
Surveyed by									
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

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

2 Over period 1982 to 1992

3 From VPA using (..........)

4 43 000 tonnes at Shag Rocks (Conservation Measure 67/XIII)

Conservation Measures in Force: 54/XI, 84/XIII - TAC 200 000 tonnes

Catches:

Data and Assessment: No new assessment.

Fishing Mortality:

Recruitment:

State of Stock: No new estimate of biomass.

Forecast for 1995/96:

Assessment Summary: *Notothenia rossii*, Division 58.5.1

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings	155	287	0	0	0	0			
Survey Biomass									
Surveyed by									
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

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

2 Over period 1982 to 1992

3 From VPA using (..........)

Conservation Measures in Force: Conservation Measure 2/III and Resolution 3/IV. Limitation of trawlers allowed on fishing grounds each year. Arrêté Nos: 18, 20, 32 (for details see SC-CAMLR-VIII, Annex 6, Appendix 10, p. 290).

Catches:

Data and Assessment: No new data from 1995 season.

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1995/96: No data - fishery remains closed.

Assessment Summary: *Lepidonotothen squamifrons*, Division 58.5.1

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings	1262	98	1	0	0	0			
Survey Biomass									
Surveyed by									
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

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

2 Over period 1982 to 1992

3 From VPA using (..........)

Conservation Measures in Force:

Catches:

Data and Assessment: No new data from the 1995 season.

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1995/96: No data - fishery remains closed, although two French trawlers will be required to operate up to 10 days each surveying *L. squamifrons* fishing grounds to provide CPUE and length frequency data.

Assessment Summary: *Champsocephalus gunnari*, Division 58.5.1

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings (Kerguelen)	226	12644	44	0	12	3936	25852	0	
Landings (Combined)									
Survey Biomass									
Surveyed by									
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....
1 ... weighted mean over ages (...)
2 Over period 1982 to 1994
3 From VPA using (..........)

Conservation Measures in Force: None. Recommendation that the fishery be closed until at least the 1997/98 season, and any fishing in that season to be preceded by a pre-recruit biomass survey in the 1996/97 season (paragraph 5.152).

Catches: A relatively low catch on the strong cohort expected to be present in the 1994/95 season produced a decline in CPUE from 2 tonnes/hour to <0.3 tonnes/hour.

Data and Assessment: Length frequency and CPUE data from Ukraine trawl fishery.

Fishing Mortality:

Recruitment: The expected strong cohort recruited in 1994/95 was much less abundant than previous strong cohorts.

State of Stock: Estimated abundance of the expected strong adult cohort in 1994/95 was much lower than for previous strong cohorts.

Forecast for 1995/96: No strong cohort is expected to be recruited to the fishery in the 1995/96 or 1996/97 seasons.

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.1

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]	Mean[2]
Recommended TAC									
Agreed TAC									
Landings	1062	1848	7492	2722	5083	5534	7492	121	
Survey Biomass									
Surveyed by									
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

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

2 Over period 1982 to 1994

3 From VPA using (..........)

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

Catches: Catches are from three areas: western slope (Ukrainian longliners), northern slope (French trawlers) and eastern slope (French trawler). Catches in the western and northern areas have been fairly steady over the last few years. The eastern area was fished for the first time in 1995.

Data and Assessment: CPUE for longline and trawl fisheries (northern area) have been ± steady for several years. This suggests that stock size is stable and the fishery is at an appropriate level.

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1995/96: Similar stock status and catches as in 1994/95.

Assessment Summary: *Champsocephalus gunnari*, Division 58.5.2

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]	Mean[2]
Recommended TAC					311				
Agreed TAC					311	311			
Landings	0	0	0	0	0				
Survey Biomass		4585	3111		31701				
Surveyed by		Australia							
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

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

2 Over period 1982 to 1992

3 From VPA using (..........)

Conservation Measures in Force: 78/XIII - TAC 311 tonnes.

Catches: None.

Data and Assessment: No new data or assessment.

Fishing Mortality: Nil.

Recruitment:

State of Stock:

Forecast for 1995/96:

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.2

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]	Mean[2]
Recommended TAC					297	297			
Agreed TAC									
Landings	0	0	0	0	0	0			
Survey Biomass		17714	3179		11880				
Surveyed by		Australia							
Sp. Stock Biomass[3]									
Recruitment (age...)									
Mean F (.....)[1]									

Weights in tonnes, recruits in ....

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

2 Over period 1982 to 1992

3 From VPA using (..........)

Conservation Measures in Force: 78/XIII - TAC 297 tonnes.

Catches: None.

Data and Assessment: TAC re-assessed using revised estimates of biological parameters, the generalised yield model and γ_2 calculated using 50% escapement from the fishery. TAC remains at 297 tonnes.

Fishing Mortality:

Recruitment:

State of Stock:

Forecast for 1995/96:

Assessment Summary: *Lepidonotothen squamifrons*, Division 58.4.4

Source of Information: This report

Year:	1990	1991	1992	1993	1994	1995	Max[2]	Min[2]	Mean[3]
Recommended TAC (Lena Bank)									
Agreed TAC									
Landings (Ob Bank[a])	867	?	0	0	0	0	4999	0	1151
Landings (Lena Bank[a])	596	?	0	0	0	0	6284	0	1335
Landings (Combined[b])	1463	575	0	0	0	0	11283	27	2487
Survey Biomass (Ob Bank)									
Survey Biomass (Lena Bank)									
Surveyed by									
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, 4/V and 87/XIII

Catches: Nil.

Data and Assessment: No new data.

Fishing Mortality:

Recruitment:

State of Stock: Unknown.

Forecast for 1995/96: