ANNEX 5

# REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

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

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## INTRODUCTION

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

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

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

## GENERAL MATTERS AND APPOINTMENT OF RAPPORTEURS

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

5. The following were appointed rapporteurs:

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

## ADOPTION OF THE AGENDA

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

## POSSIBLE IMPROVEMENTS IN THE SCIENTIFIC COMMITTEE'S ABILITY TO PROVIDE MANAGEMENT ADVICE

7. In paragraph 3.49 of SC-CAMLR-VIII, the Scientific Committee had asked the Convener of the WG-FSA to advise on what would be needed to improve the Scientific Committee's ability to provide advice for the management of fish stocks. The Convener had prepared a draft document which was edited and amended during the Meeting and is attached as Appendix D.

## REVIEW OF MATERIAL FOR THE MEETING

### Catch and Effort Statistics

8. Data submissions were incomplete at the start of the Meeting and although some data were provided during the Meeting, the data were still incomplete when the analyses were undertaken. Indications of the data submitted and gaps in the dataset are shown in SC-CAMLR-IX/BG/5.

### Size and Age Composition Data

9. Submissions of size and age composition data for 1989/90 were incomplete and did not always correspond with locations and times of catch and effort data. The status of the different datasets is shown in SC-CAMLR-IX/BG/5.

By-Catch of Fish Larvae and Juvenile Fish in the Krill Fishery

10. The Working Group noted that this topic has been raised several times over the past few years, initially at the BIOMASS Working Group on Fish Ecology and more recently within CCAMLR. No action has been taken by CCAMLR to quantify the by-catch of fish in the krill fishery in spite of considerable concern expressed by many Members.

11. Several papers have been published which either report catches of fish in krill trawls, or else indicate situations when krill trawls might catch significant quantities of fish. Relevant summary information abstracted from these papers is given in the following paragraphs.

12. Rembiszewski *et al.* (1978) undertook a study from January to March 1976 in the Atlantic sector of the South Ocean. 27 species of fish were caught in association with krill swarms. Juvenile Channichthyidae were the dominant group in the catches. Hauls made on the shelf at South Georgia during the night contained about 5% of Channichthyidae by weight. This amount was considered by the authors to be insignificant in terms of contamination of the krill catch but could be significant in affecting recruitment of these fish species. There are indications that the fish tend to be present on the edges of krill swarms. Hauls made in the centre of large krill swarms generally contain few fish.

13. Slosarczyk and Rembiszewski (1982) studied fish by-catch in krill trawls in the Bransfield Strait and Elephant Island region from February to March 1981. Juvenile and post-larval Channichthyidae and Nototheniidae were present in nearly all the hauls made on the shelf in the Bransfield Strait, Elephant Island and north of South Shetland Islands. The authors concluded that, although these fish represent only a small proportion of the total catch, if these catch rates are representative of the commercial fishery there could be significant adverse effects on fish recruitment.

14. Slosarczyk (1983a) found significant numbers of *Trematomus bernacchii* and *Pagothenia brachysoma* in trial hauls on the shelf in the vicinity of the Balleny Islands from January to February 1978. This is an area where the author noted that a significant amount of krill fishing has taken place in the past.

15. Slosarczyk (1983b) found large numbers of Nototheniidae and Channichthyidae in experimental krill catches in the vicinity of Clerke Rocks at the eastern end of South Georgia.

16. On 11 April 1977, off Clerke Rocks, Kompowski (1980a) noted juvenile (18 to 23 cm total length) *Champsocephalus gunnari* in krill concentrations. In several hauls these fish constituted about 20% of the catch by weight. During this study krill were being processed into meal by a large fishing fleet and large numbers of juvenile fish were observed in the krill catches.

17. In the same study, Kompowski (1980b) found significant numbers of juvenile *Chaenocephalus aceratus* (7.8 to 11.2 cm total length) in the catches of krill trawls. These fish were found to have been feeding exclusively on krill, dawn and dusk being the times of the most intensive feeding activity.

18. During the BIOMASS/SIBEX experiment in the Antarctic Peninsula region the largest concentrations of juvenile fish were found in hauls made in the Bransfield Strait (Slosarczyk and Cielniaszek, 1985). The authors concluded that juvenile fish of commercial species do not occur in great numbers associated with krill swarms during the period December to March in this area.

19. Williams (1985) analysed results from a series of RMT hauls in the Prydz Bay area. The largest by-catches of fish were taken in hauls on the shelf or near to the shelf break. He found up to 13% by weight of juvenile fish in all RMT hauls directed at krill swarms, rising to 19% in aimed hauls on the shelf. 95% of the fish were young *Pleuragramma antarcticum*, with the balance comprising juvenile channichthyids.

20. Skora (1988), during a study in the 1986/87 season found 24 fish species belonging to six families in a series of hauls using a krill trawl in the South Shetlands area. He noted an increased frequency of *Chaenodraco wilsoni* and fewer *Chaenocephalus aceratus* in the catches compared with previous seasons.

21. These results from research vessel surveys demonstrate that, under certain circumstances and in some regions, large numbers of fish are likely to be taken in the course of the directed fishery for krill. The results also indicate that the by-catch of juvenile and larval Nototheniidae and Channichthyidae is greatest on the shelf and near to the shelf break. It is not clear whether this effect is present during the winter months at South Georgia when the krill fishery there is at its peak (Everson and Mitchell, 1989). No information was available to the Meeting on the distribution of young fish in winter at South Georgia.

22. It was noted that the only information available to the Working Group on the by-catch of fish in commercial krill trawls was anecdotal and remained unsubstantiated.

23. It was agreed that the problem of by-catch of fish in the krill fishery should be investigated further. Two approaches were considered necessary. Firstly, rigorous monitoring of the commercial krill fishery in order to determine the magnitude of the problem. Secondly, determinations of the locations and times of year when the demersal fish are at greatest risk. For example, at South Georgia, results from young fish surveys in winter would be of particular importance.

24. Mr D. Miller (South Africa), Convener of the Working Group on Krill (WG-Krill), reported on discussions at the recent meeting in Leningrad. During WG-Krill, Prof. T. Lubimova (USSR) had stated that the USSR had initiated a monitoring program to determine the quantity of fish taken as by-catch in the USSR krill fishery. Dr K. Shust (USSR) indicated that the results would be available at the Ninth Meeting of the Scientific Committee. The USSR monitoring protocol was not available to this WG-FSA Meeting.

25. The WG-Krill had provided a modified version of the USSR krill catch monitoring record sheet to include a section on by-catch of fish in the catch. This was seen by WG-FSA as a useful start but, because there was no provision for quantitative information or species composition, this form was considered inadequate for assessing by-catch of fish in krill catches.

26. The WG-FSA agreed that, in view of the observations recorded in the work described in paragraphs 12 to 20, it may be prudent for the Scientific Committee to recommend the prohibition of krill fishing in areas considered to be fish nursery areas until further data are collected and analysed.

27. The Working Group recommended that in order to obtain the necessary data, a program monitoring the by-catch of fish in the krill fishery should be initiated as soon as possible. The following is an outline of the program that the Working Group considered would provide information that would allow it to assess the magnitude of the problem.

(i) Data Collection: The Secretariat was asked to prepare a Daily Logsheet for recording the information. A draft will be circulated to Members for comment (see paragraph 300).

(ii) Field Personnel: Observers would need to be designated to monitor the krill catches whilst onboard commercial krill fishing vessels.

(iii) Species identification: The observers would be trained to identify juvenile specimens of the main species likely to appear in the krill catches. All post-larval fish would be counted and preserved for examination in a laboratory. It was noted that there had been offers in the past for the use of plankton sorting facilities. It was felt that making use of such facilities would provide a useful means of standardisation of sample analysis.

(iv) Duration: It was recommended that the program be conducted initially for a period of five years.

28. The Working Group draws the attention of the Scientific Committee to the fact that establishing and running such a program will have financial implications.

29. The WG-Krill had also discussed use of separator panels in the codend of trawls to minimise the by-catch of fish in the commercial fishery. WG-FSA was unaware of any such developments in pelagic fisheries but felt that such devices might be effective. It was agreed that, even if such devices were developed now, they would be unlikely to be used widely for several years.

Other Available Biological Information

30. New information was provided on Myctophidae in WG-FSA-90/18, 19, 20, 21, 23, 35, and 36.

31. In 1989/90 the fishery was conducted in two areas, deep water around the South Polar Frontal Zone to the north of South Georgia; and, on the shelf around Shag Rocks. A midwater trawl is used with a vertical opening and width of 30 metres. Tows normally last from one to five hours. Fishing vessels search for temperature discontinuities and then survey the area acoustically to determine optimum locations for fishing. Most of the catch is converted to meal and oil although some is frozen for experimental food production.

32. Catches larger than one tonne tend to be of pure *Electrona carlsbergi*. Smaller catches tend to contain other species such as *Gymnoscopelus nicholsi*.

33. Avian predators do not appear to congregate in the vicinity of myctophid aggregations. It is not clear which are the major predators on *E. carlsbergi.*

34. Two papers (WG-FSA-90/7 and 34) were tabled on the toothfish *Dissostichus eleginoides*.

35. There is no evidence to support the view that the fish taken in the commercial longline fishery are senescent as stated at CCAMLR-VIII (CCAMLR-VIII, paragraph 106). All available evidence indicates that these fish are either sexually mature or immature.

36. Analysis of data from longlining before the start of the fishery had been used to determine constants of the von Bertalanffy growth equation. Some Members suggested that, since only fish up to age 18 years were represented in the samples and this species is known to live longer, this could lead to an overestimate in the parameter 'k' which would have consequences for the subsequent length cohort analyses.

37. New information on age and growth in *Notothenia rossii* from the South Shetland Islands was provided in WG-FSA-90/9. There was good agreement between results from ageing using otoliths and scales for juvenile fish. Differences between results presented at the Meeting and some other published results were attributed to:

(i) population/geographical variations of the fish sampled;

(ii) size-specific as opposed to age-specific offshore migration (the larger sized fish of an age class are thought to migrate offshore first); and

(iii) different criteria used in the interpretation of annual growth rings.

38. Analysis of data from trammel net hauls at Potter Cove, South Shetland Islands over a period of eight years indicated that there had been a decline in the abundance of *N. rossii* and *Notothenia gibberifrons* (WG-FSA-90/14). It was thought that the cause was unlikely to be due to an increase in numbers of predators because *Notothenia neglecta*, a species that does not migrate out of the bays, showed no decline. The most likely cause appears to be that the decline is a consequence of the level of fishing in the early 1980s in the area.

39. A pilot study on stock separation in *C. gunnari* at South Georgia using protein electrophoresis (WG-FSA-90/10) indicated that there is evidence for there being separate stocks at South Georgia and Shag Rocks. It is planned to continue this study on a larger scale in the forthcoming season. Additional studies, using different techniques such as mitochondrial DNA, were reported using samples from Kerguelen and Heard Island. Dr Kock, Mr R. Williams (Australia), Mr E. Balguerias (Spain) and Dr Everson agreed to try to

collect samples from their own study areas to supply to other analysts, as there are advantages in including samples from widely spaced as well as close locations for the analyses.

40. Information on growth in *C. gunnari* using vertebrae was provided in WG-FSA-90/33. The length at age was similar to that determined from several studies using otoliths. There is a larger difference between all these results and those derived from daily growth increments in otoliths.

Mesh Selectivity and Related Experiments

41. Further information on mesh selectivity in *C. gunnari* around South Georgia was provided in WG-FSA-90/32 which gave essentially similar results to studies previously presented to the Working Group.

42. It was noted that this is a topic on which the Working Group had been asked to provide advice in the past (CCAMLR-VI, paragraph 84 and CCAMLR-VII, paragraph 87) and had done so through the Scientific Committee (SC-CAMLR-VIII, paragraph 3.18). Some Members noted with regret that this advice with respect to modification of mesh size regulations contained in Conservation Measure 2/III had been rejected (CCAMLR-VIII, paragraphs 80 to 83).

Assessments Prepared by Member Countries

43. Assessments were considered by species within statistical subareas.

Subarea 48.3

44. New assessments on *C. gunnari* were presented in papers WG-FSA-90/26, 27 and 34.

45. Concern was expressed that age composition data from research vessels rather than commercial vessels had been used for the analyses. The research vessel catches had been made using bottom trawls whereas the commercial fleet was restricted to the use of midwater trawls by Conservation Measure 13/VIII. It was pointed out that there are difficulties in obtaining such information from the commercial fleet.

46. In response to criticisms expressed at last year's meeting (SC-CAMLR-VIII, Annex 6, paragraph 66), a multiplicative model had been used to standardise fishing effort indices. This incorporates components for vessel power, gear type and time of year.

47. It was noted that in the process of adjusting the model, an unestimable source of variation is associated with the number of hauls within a month. It was also noted that previous experience in the use of multiplicative models for CPUE standardisation indicates that this effect is reasonable so long as the factors are reasonably balanced. A logarithmic transform will stabilize the variances so long as the effort is not too small (de la Mare, 1987).

48. Assessments on *Patagonotothen brevicauda guntheri* were provided in WG-FSA-90/12 and 28.

49. Catches had been low during the 1989/90 season due to the imposition of a 12 mile limit which closed most of the fishing grounds around Shag Rocks.

50. Analysis of fine-scale data submitted to CCAMLR indicated that catches of *P.b. guntheri* had been reported from areas where they have never been found during surveys. It was suggested that the location of these catches may have been incorrectly reported. An alternative explanation is that a significant by-catch of other species may have been taken and reported as *P.b. guntheri*. This species is also reported as a by-catch in fishing targeted at larger species (e.g., *C. gunnari*) for which a mesh size regulation applies, and this suggests that illegal nets may have been used.

51. An assessment of *C. aceratus* and *Pseudochaenichthys georgianus* was provided in WG-FSA-90/6.

Subarea 48.2

52. A re-assessment of the stock of *N. gibberifrons* was provided in WG-FSA-90/16.

Subarea 58.5

53. A re-analysis of data from *C. gunnari* from the Kerguelen Shelf and Skif Bank was provided in WG-FSA-90/17.

54. An analysis of *N. rossii* at Kerguelen was provided in WG-FSA-90/41. Some discrepancies were noted between catches submitted to CCAMLR and those provided in the paper. This is probably due to the use of calendar year in WG-FSA-90/41 instead of split-year as commonly used in CCAMLR.

Subarea 58.4

55. An assessment of the stocks of *Notothenia squamifrons* on the Ob and Lena Banks was provided in WG-FSA-90/37. Some differences were noted between the catch figures included in the paper and those reported to CCAMLR (see Figure 1). Although the data had been reported by calendar year, this did not fully explain the large discrepancy in total catch of *N. squamifrons* in Division 58.4.4. The Data Manager was asked to investigate further.

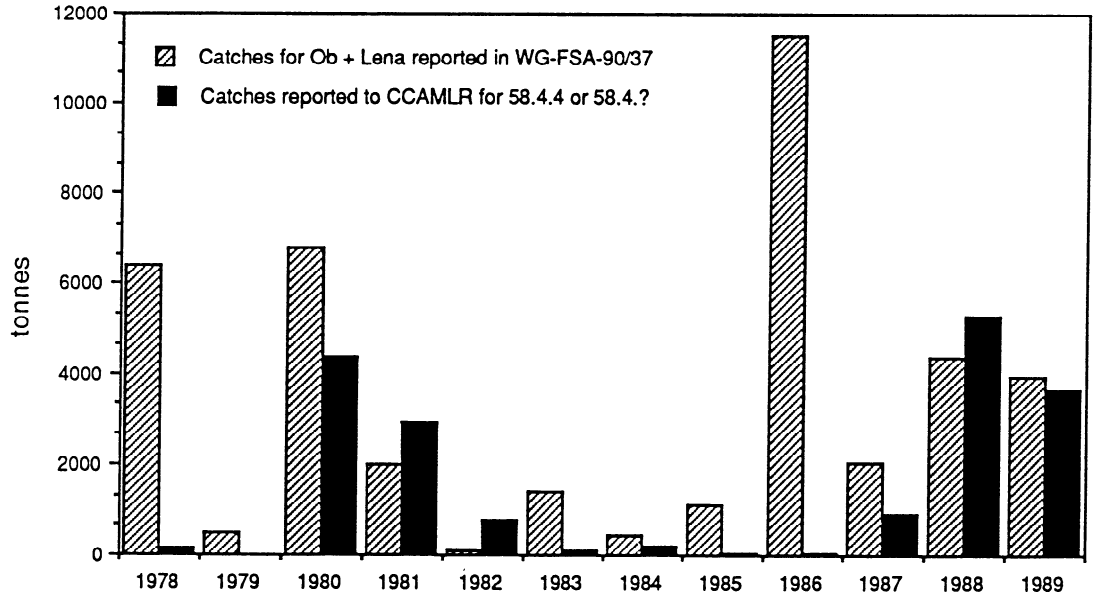


Figure 1: Comparison of reporting of catches from Division 58.4.4 (Ob and Lena Banks).

Other Relevant Documents

56. Results of demersal fish surveys around South Georgia were reported in documents WG-FSA-90/11, 13, 29 and 30 and from Kerguelen in WG-FSA-90/38 and from Heard Island in WG-FSA-90/42.

57. Results of integrated Soviet research expeditions in the Indian Ocean sector were provided in WG-FSA-90/39 and 40. First results of Italian research activities on the coastal ichthyofauna in Terra Nova Bay (Ross Sea) were provided in WG-FSA-90/43.

58. Revised estimates of areas of seabed for specified depth strata within Subarea 48.3 were provided in WG-FSA-90/8.

59. Descriptions of assessment software available in the Secretariat were provided in WG-FSA-90/22 and the analyses undertaken during the 1989 Meeting of the Working Group were described fully in WG-FSA-90/5.

## METHODOLOGIES USED FOR SURVEYS AND ASSESSMENTS

60. The Working Group asked the Secretariat to compile a list of publications relevant to the main assessment methodologies currently available for use by the Working Group.

61. Biomass estimates for fish stocks taken in Subarea 48.3 have been calculated using areas ($km^2$) of seabed calculated within selected depth ranges. The areas of such depth strata in each region were compiled in 1987 (Everson, 1987). The area calculations for Subarea 48.3 were revised in WG-FSA-90/8. These were then used to standardise biomass estimates of *C. gunnari* and *N. gibberifrons* determined from research vessel surveys conducted between 1984 and 1990 (Appendix E).

62. At its 1989 Meeting, the Working Group highlighted the importance of biomass surveys to the Working Group's assessment work and emphasised that the availability of full details of such surveys is crucial in interpreting survey results (SC-CAMLR-VII, Annex 6, paragraph 206). Consequently, the Working Group had recommended that full details of survey design and haul-by-haul data should be included with submissions containing or reporting survey results.

63. To a large degree, the above recommendation has not been complied with and the Working Group felt that the problem may be resolved if Members were provided with guidelines on the minimum level of information to be included in papers submitted to the Working Group reporting results of stock assessments both survey and analytically based.

64. A small task group under the Convenership of Dr Basson was therefore tasked with listing the minimum information to be contained in working papers on, or data from, surveys, stock assessments and other analyses. The terms of reference of this group were:

(i) to develop guidelines on the minimum information requirements of papers to be submitted to the Working Group;

(ii) to identify the information required from assessment surveys with respect to:

(a) vessels undertaking assessment surveys (including gear specifications);

(b) survey design;

(c) data collected; and

(d) methods of analysing survey data;

(iii) to identify the information required in the presentation of results of stock assessment analyses (principally Virtual Population Analyses) and related stock assessment projections (e.g., yield-per-recruit analyses or TAC calculations) prior to meetings of WG-FSA with respect to:

(a) input data;

(b) output data; and

(c) analysis methods used;

(iv) to identify the basic requirements for the presentation of other assessment related analyses (e.g., estimation of natural mortality or growth parameters) in general terms.

65. The results of the Task Group's deliberations are to be found in Appendix F.

66. The Working Group was informed that UK and Soviet scientists had participated in a workshop to review the results of two surveys conducted in Subarea 48.3 during January 1990 (reports of the two surveys are presented in WG-FSA-90/11, Rev. 1 and

WG-FSA-90/29). A report of the Joint UK/USSR Workshop, 23 to 27 July 1990 was submitted (WG-FSA-90/13).

67. One of the recommendations in the report of the Joint Workshop was that the analyses of survey data should be undertaken separately for major areas such as Shag Rocks and South Georgia. In the light of this and reported evidence of the possibility of more than one stock of *C. gunnari* in Subarea 48.3 (WG-FSA-90/10), it was felt that, in the future, it may become necessary to do separate assessments for South Georgia and Shag Rocks.

68. Currently, catch data from the commercial fishery are not available for South Georgia and Shag Rocks separately. If reliable fine-scale data were submitted as agreed by the Commission in 1987, it would be possible to group the data to deal with multiple stocks, if they are found to exist.

69. Dr Shust felt that clear evidence of more than one stock in Subarea 48.3 was required before more effort could be directed to the collection and analyses of biological data, particularly with respect to ageing and the construction of age/length keys.

70. Others felt that where possible, biological data should be collected and analysed on a fine-scale basis.

71. It was agreed that when analysing trawl survey data for biomass estimation, Shag Rocks and South Georgia should be treated as separate strata.

72. If fine-scale data are not submitted it will be prudent to take some action so that, in the future, catches can be split up to reflect the presence of separate stocks, if this is found to be the case. This can be achieved by, for example, creating a subarea around Shag Rocks.

73. To date, fine-scale data for only one season (1987/88) have been submitted. The USSR scientists informed the Working Group that the collection and reporting of fine-scale data was proving extremely difficult to carry out and that this situation was unlikely to change unless action, such as having scientific observers onboard fishing vessels to oversee or undertake the task, was implemented.

74. The Joint UK/USSR Workshop noted that in conducting the surveys significant damage to fishing gear had been sustained in trying to sample areas where the sea bottom is extremely rough. It recommended that such areas should be identified to assist the planning of future surveys and further study undertaken to determine how necessary it is to obtain

samples within them (WG-FSA-90/13, paragraph 77). The Working Group agreed that it was not essential to survey these areas (e.g., grid square 20 for the South Georgia area as specified in WG-FSA-90/13) and that density-estimates from adjacent grids could be used in the estimation of 'absolute' biomass. If only relative estimates of biomass are required, no such adjustment would be necessary and those grid squares could be excluded from the analyses altogether.

75. Analyses of the 1989/90 data from around South Georgia, from the RV *Hill Cove* and the RV *Akademik Knipovich* surveys (see WG-FSA-90/13), using the standard swept area method produced estimates of biomass with very high coefficients of variation, mainly because of the presence of very large hauls at some stations. The sensitivity of results to the large hauls and the large coefficients of variation make interpretation of the results difficult.

76. Various alternative methods were considered and further analyses are planned using those methods.

77. It was suggested that better results may be obtained by applying the swept area method to transformed data. It was, however, pointed out that although the coefficient of variation of the estimate from the transformed data may be very low, the coefficient of variation is often very high once the estimate has been transformed back to the original 'scale'.

78. Attention was drawn to the BMRT *Anchar* survey (WG-FSA-90/30) which produced a large estimate of biomass for *C. gunnari*, with a relatively low coefficient of variation. One possible explanation was that the lower coefficient of variation may be due to the diurnal vertical migration of this species and the fact that all hauls on this survey were made during the day. On the *Hill Cove* and *Akademik Knipovich* surveys, not all hauls were made during the day.

79. Dr P. Gasiukov (USSR) informed the Meeting of work done by USSR scientists on diurnal migration of *C. gunnari* from fishing data showing evidence of very strong patterns of vertical migration. A paper describing these results was tabled too late for consideration by the Working Group. The Working Group encouraged the submission of the paper in an updated version for the next meeting.

80. The possible influence of diurnal migration on the results was recognised at the Joint UK/USSR Workshop and the report (WG-FSA-90/13) suggests that bottom trawl surveys be conducted only in daylight (WG-FSA-90/13, paragraph 70).

81. An alternative explanation for the lower coefficient of variation of the biomass estimate from the *Anchar* survey was that it was a seasonal effect. The *Anchar* survey was conducted during April and during that period fish may be more randomly distributed. The *Hill Cove* and *Akademik Knipovich* surveys were conducted during January and February when large aggregations may form.

82. It was suggested that serial correlation between hauls in the surveys may significantly effect the coefficient of variation. The Working Group recommended that this possibility be investigated.

83. It was suggested that comparative studies of gear type used in the different surveys be conducted.

84. The Working Group agreed that investigations on the catchability coefficients of surveys were necessary. This is of particular importance when biomass estimates from surveys are used as estimates of absolute biomass. Two approaches to this problem were identified: an experimental approach which uses direct field observations; and, an analytical approach which uses mathematical or statistical models to estimate catchability. The Working Group encouraged further work on this subject using both approaches.

85. The first approach would be to focus on developing appropriate methods to deal with the kind of data obtained from surveys of patchily distributed species (e.g., the data from the *Hill Cove* and *Akademik Knipovich*). The second approach would be to focus on improving or changing the survey design and timing to try to avoid or minimise the problem of unusually large hauls.

86. With respect to the second approach, the urgency to obtain fisheries data in order to determine spatial and temporal scales of variation in the distribution of *C. gunnari*, as well as other species, was emphasised. It was agreed that additional information on the density and extent of aggregations encountered during research surveys would be very useful (see Appendix F).

87. It was suggested that a relatively simple method of improving the survey design would be to allow for time, after the survey had been completed, to return to areas of high abundance (which are usually associated with areas of high variance in density) and sample at additional, randomly chosen stations.

88. The Working Group recommended that the random survey design stratified by depth and area used by the *Hill Cove* and *Akademik Knipovich* (WG-FSA-90/13) should be used in future surveys around South Georgia, until further investigations lead to suggestions on improvements or changes to this survey design.

89. The Working Group recommended that biomass calculations from survey data are done according to the standard swept area method by three depth strata (see WG-FSA-90/13) until further investigations lead to suggestions on changes to this approach. The Working Group recommended that the problems associated with using the swept area method to survey data on species that are patchily distributed should be further investigated.

90. It was suggested that data from previous surveys around South Georgia be re-analysed according to the three depth strata outlined in WG-FSA-90/13 and new seabed areas (WG-FSA-90/8) for comparative purposes.

91. It was agreed that the problem should first be addressed by Members through correspondence. Results will be analysed at a meeting to be held between the next meeting of WG-FSA and SC-CAMLR-X. A list of main points to be discussed was prepared:

- definition of acceptable levels for CVs;
- strategies for identifying and sampling different types of fish distributions;
- utility of two-phase surveys;
- properties of the estimators of biomass;
- sources of error in comparisons between surveys;
- cost effective allocation of sampling resources; and
- need for external consultancy.

92. A paper presenting results on acoustic surveys used to estimate the biomass of myctophids, was submitted to the Meeting (WG-FSA-90/19). The problems identified and recommendations made by WG-Krill with respect to the estimation of biomass from acoustic surveys was thought to be of relevance in this regard (Annex 4, paragraphs 16 to 23).

93. The details that should be included in papers presenting results from acoustic surveys are outlined in Appendix F.

## ASSESSMENT WORK

94. Summaries of the assessments presented in the following section are given in Appendix L. The Working Group felt that it would appreciate comments from the Scientific Committee and Commission on the usefulness and clarity of these summaries.

### South Georgia (Subarea 48.3)

95. The history of catches taken around South Georgia is given in Table 1 and Figure 2. The figure demonstrates how fishing has shifted from one species to another which, in conjunction with a high variability in recruitment of *C. gunnari* and the establishment of total allowable catches by CCAMLR, has led to a high variability in annual catches. The total catch of all species in 1989/90 catch of 40 148 tonnes was only approximately 60% of that in 1988/89. The commercial catch of *C. gunnari* * did not exceed the TAC of 8 000 tonnes set by the Commission in 1989 (Conservation Measure 13/VIII). The catch of *P.b. guntheri* dropped to only 145 tonnes despite a TAC of 12 000 tonnes set by the Commission (Conservation Measure 16/VIII) in 1989. The reason for the decline in the catch of *P.b. guntheri* was that fishing grounds inside 12 miles around Shag Rocks have not been fished by the Soviet fleet. Catches of *D. eleginoides* in the longline fishery increased by a factor of 2 to 8 311 tonnes, whereas catches of the lanternfish *E. carlsbergi* of 23 623 tonnes in the South Polar Frontal Zone north of South Georgia were slightly less than in 1988/89. The very low reported catches of *N. rossii*, *C. aceratus*, *P. georgianus* and *N. gibberifrons* are due to the exclusive use of midwater trawls and a by-catch provision of 500 tonnes in the *C. gunnari* fishery in accordance with Conservation Measure 13/VIII, and to the prohibition of directed fishing on these species in accordance with Conservation Measure 14/VIII.

* No STATLANT data have been submitted by Poland for the 1989/90 season and as a consequence, the preliminary catch figures from the CCAMLR catch reporting system have been used to calculate the total catch of *C. gunnari* in Table 1.

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

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

[a] Includes 13 724 tonnes of unspecified fish caught by the Soviet Union
[b] Includes 2 387 tonnes of unspecified Nototheniidae caught by Bulgaria
[c] Includes 4 554 tonnes of unspecified Channichthyidae caught by the GDR
[d] Includes 11 753 tonnes of unspecified fish caught by the Soviet Union

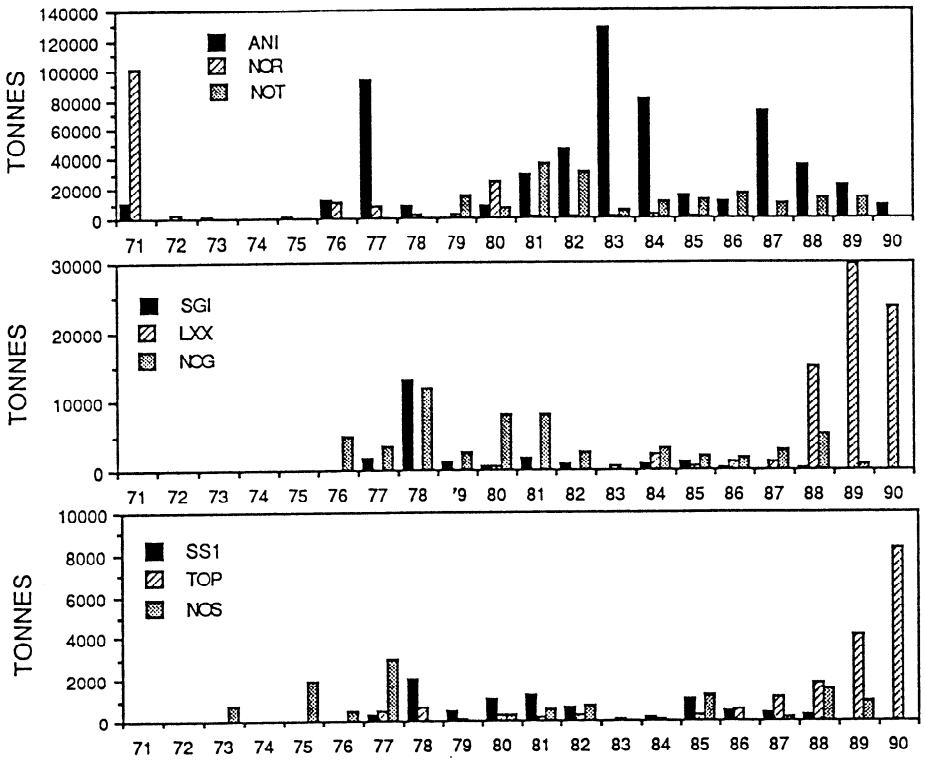


Figure 2: Catches of major species in Subarea 48.3.

*Notothenia rossii* (Subarea 48.3)

96. The Commission's Conservation Measures in force since 1985 have aimed to keep the catches of the species to a level as low as possible. Reported catches in 1989/90 were only 2 tonnes.

97. There were no new data available from the commercial fishery. Length compositions from research vessel catches (*Hill Cove, Akademik Knipovich*) consisted mostly of 45 to 60 cm long fish with mean lengths of 52 to 53 cm which were comparable to observations from previous seasons. Biomass estimates from the UK/Polish survey (*Hill Cove*) and two USSR surveys (*Akademik Knipovich, Anchar*) were 1 481 to 3 900 tonnes. This indicates that the stock remained at a very low level.

Management Advice

98. In view of the current low level of the stock of *N. rossii*, all Conservation Measures for this species should be kept in force.

*Champsocephalus gunnari* (Subarea 48.3)

99. The total catch in 1989/90 was 8 027 tonnes. This included 387 tonnes taken by research vessels.

100. No length frequency or age data from the commercial fishery were reported. The lack of length frequency data from the commercial fishery poses serious problems for the assessment of the stock and the interpretation of VPA results based on length frequency data from research surveys.

101. Results from three bottom trawl surveys were presented in (WG-FSA-90/13 and WG-FSA-90/30). Estimates for South Georgia and Shag Rocks were available from the *Hill Cove* and *Akademik Knipovich* surveys, whereas the *Anchar* survey only covered the area around South Georgia. Estimates for South Georgia only (i.e., excluding Shag Rocks) range between 95 405 tonnes (*Hill Cove* survey) and 971 000 tonnes (*Akademik Knipovich* survey). This compares to a stock biomass estimate of 21 069 tonnes for the UK/Poland trawl survey in 1988/89 (WG-FSA-89/6). A summary table of estimates is given below:

| | | Shag Rocks | | South Georgia | | Total |
|---|---|---|---|---|---|---|
| | | Biomass | (%CV) | Biomass | (%CV) | Biomass |
| *Hill Cove* survey (WG-FSA-90/13) | | | | | | |
| 1. Standard swept area method (SAM) | [47][(1)] | 279 | (83) | 95 | (63) | 374 |
| 2. SAM with mean 'large haul' | [60] | 54 | (38) | 95 | (63) | 149 |
| 3. SAM with large haul adjustment | [62] | 232 | (-) | 95 | (63) | 327 |
| *Akademik Knipovich* survey (WG-FSA-90/13) | | | | | | |
| 4. Standard swept area method (SAM) | [47] | 109 | (31) | 878 | (69) | 987 |
| 5. SAM, 2 areas (a)[(2)] | [53] | 109 | (31) | 936 | (43) | 1045 |
| 6. SAM, 2 areas (b)[(3)] | [53] | 109 | (31) | 971 | (69) | 1080 |
| 7. SAM with mean large haul | [60] | 109 | (31) | 333 | (42) | 442 |
| 8. SAM with large haul adjustment[(2)] | [62] | 109 | (31) | 437 | - | 546 |
| 9. SAM with large haul adjustment[(3)] | [62] | 109 | (31) | 537 | - | 646 |
| *Anchar* survey (WG-FSA-90/30) | | | | | | |
| 10. Standard swept area method (SAM) | | | | 887 | (31) | NA |

(1) Reference to paragraph number in WG-FSA-90/13
(2) 2 areas = grids 12 to 18, and remainder of South Georgia, see WG-FSA-90/13
(3) 2 areas = east and west South Georgia, see WG-FSA-90/13

102. The Working Group agreed to use the biomass estimates from the *Hill Cove* and the *Akademik Knipovich* based on the swept area method with an adjustment for the very large hauls, as outlined in WG-FSA-90/13.

103. These estimates for South Georgia and Shag Rocks combined are around 150 000 tonnes and 442 000 tonnes with coefficients of variation of 42% and 33% respectively.

104. Some Members felt that these coefficients might be underestimations of CV values mainly because:

(i) under model 3 (WG-FSA-90/13) the total variance is the sum of variances at catch level plus twice their covariances which are unknown, and assumed 0; and

(ii) model 3 arose as a modification of a design (model 1, WG-FSA-90/13) based on a two fixed factors model.

The mean estimation under model 3 depends on whether or not the proportion of stations allocated to each rectangle at a given depth matches the corresponding fraction of seabed.

105. An assessment of *C. gunnari* in Subarea 48.3, using virtual population analysis (VPA) was presented in WG-FSA-90/26. The analysis was tuned to standardised catch-per-unit effort using the Laurec-Shepherd method of tuning. The method of standardisation was based on a multiplicative model and details of the method and results are given in WG-FSA-90/27. The analysis assumed that the length frequency distribution of the commercial catches would be similar to length frequency distributions from the *Hill Cov*e survey, from samples taken to the north of the island and Shag Rocks (see WG-FSA-90/13 and 26). The authors felt that this assumption would be reasonable since most of the catches were taken in that area and the mesh size of the trawl used by the *Hill Cove* was thought to be similar to those of commercial vessels.

106. It was pointed out that the *Hill Cove* used a net with a 45 mm mesh codend and a 20 mm mesh liner (WG-FSA-90/11 Rev. 1), although the intention was to use a net with a 80 mm mesh codend and a 40 mm mesh liner (WG-FSA-90/13, Annex 4).

107. The VPA results indicate that a strong year class entered the fishery in 1987/88 as 1 year old fish.

108. Some Members felt that the effort data used for the regression analysis in WG-FSA-90/27 violates the assumption of a constant variance common to all observations. In the present situation it means that:

(i) reported correlation coefficients are not correct; and

(ii) parameter estimates are not least squares estimates.

109. This situation arises from the fact that fine-scale commercial catches are reported as the sum of varying quantities of hauls, therefore the fitting of a multiplicative model for standardisation of CPUE data may require the use of data reported on a haul-by-haul basis.

110. One of the two assessment modifications in WG-FSA-90/26 used the frequencies for age classes 1 and 2, based on the frequencies in these age classes from trawl survey results.

111. The analyses presented in WG-FSA-90/26 estimated the 1989/90 biomass level of *C. gunnari* at between 163 000 tonnes and 191 000 tonnes. Results from the VPAs and recent estimates of relative biomass from surveys are presented in Figure 3.

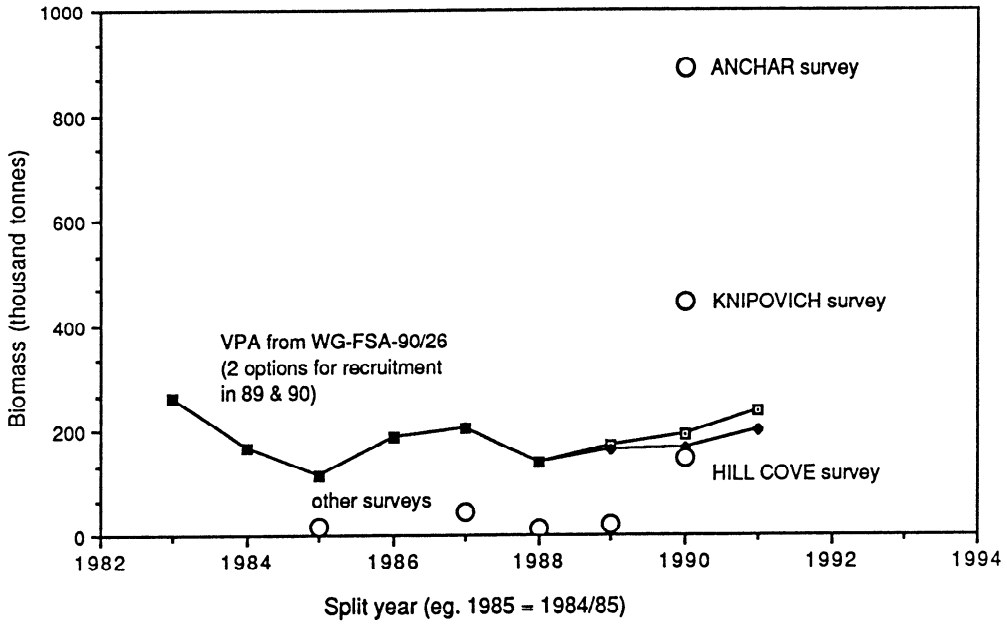


Figure 3: Biomass estimates for *C. gunnari* in Subarea 48.3.

112. Figure 4 illustrates the different ranges of values obtained from the VPA estimates of uncorrected biomass from the surveys. Ranges of survey results are calculated as the point estimate plus and minus 1 standard deviation under the assumption of a log-normal distribution.

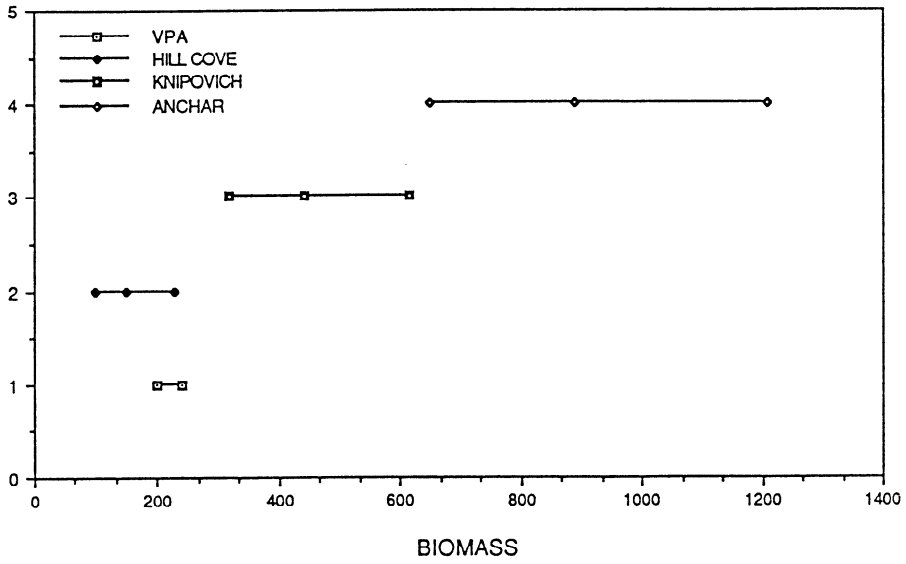


Figure 4: VPA estimates of uncorrected biomass for *C. gunnari* in Subarea 48.3 (survey results).

113. The USSR Delegation pointed out that biomass estimates from trawl surveys, given in the tables and Figure 3, were obtained under the assumption that the catchability coefficient of trawls used to take *C. gunnari*, equals 1, and this assumption is unrealistic.

114. A number of simultaneous biomass estimates were made for *C. gunnari*, based on results of trawl surveys and VPA analysis from 1984/85 and 1988/89 (WG-FSA-89/6):

| | 1984/85 | 1986/87 | 1987/88 | 1988/89 |
|---|---|---|---|---|
| Biomass estimate from trawl survey: ($B_{RV}$) | 15.821 | 50.414 | 15.086 | 21.069(1) |
| Biomass estimate from VPA analysis ($B_{VPA}$) | 117.4 | 204.4 | 141.8 | 163.8 |
| Proportionality coefficient ($_q$) $B_{RV} = qB_{VPA}$ | 0.14 | 0.25 | 0.11 | 0.13 |

(1) Survey covered South Georgia only

115. The mean value of this coefficient equals 0.16, maximum value - 0.25. Therefore, based on the VPA assessment in WG-FSA-90/26, the hypothesis that the catchability coefficient for *C. gunnari* from the trawl surveys conducted during 1984/85 to 1988/89 equals 1, underestimates the biomass by about 4 to 6 times.

116. It was pointed out that this analysis is unlikely to be reliable because the VPA biomass estimates are from late in the VPA projections where the biomass calculations are uncertain. In addition, the VPA is tuned to effort data on the assumption that fishing mortality at different stock biomass is proportionally related to effort. Finally, the most recent surveys

which give biomass estimates greater than the VPA biomasses have not been included in this analysis, but provide estimates of the catchability coefficient greater than 1.0. Based on the 1989/90 estimates of biomass from the tuned VPA (with two modifications) and the uncorrected swept area method estimates for each of the surveys carried out in 1990, the following values of the coefficient of proportionality were found.

| | Uncorrected Swept Area Method Survey Biomass | VPA Biomass (Modification 2) Estimate = 167 000 Proportionality Coefficient | VPA Biomass (Modification 1) Estimate = 191 000 Proportionality Coefficient |
|---|---|---|---|
| *Hill Cove* | 374 000 | 2.24 | 1.96 |
| *Akademik Knipovich* | 987 000 | 5.91 | 5.17 |
| *Anchar*[(1)] | 887 000 | 5.31 | 4.64 |

[(1)] South Georgia only, catchability coefficient underestimations

117. Some Members felt that although the assumption of a catchability coefficient of 1 may imply the underestimation of true biomass, there may be other factors (such as herding or the patchy distribution of fish) which may lead to overestimation of true biomass.

118. The Working Group attempted to do further VPAs using biomass estimates from bottom trawl surveys as relative indices of abundance and using the Laurec-Shepherd method of tuning. Two major problems were encountered in the process.

119. The first problem was due to the fact that no length frequency data from the commercial fishery were submitted. The catch-at-age data from WG-FSA-90/26 were used and, as an alternative assumption, the length frequency distribution from one of the stations (No. 23) on the *Hill Cove* was used to obtain catch-at-age data. Commercial fishing vessels were operating in that area during the survey. These two assumptions produced quite different values of catch-at-age and results from the VPA were sensitive to these assumptions.

120. The second problem was associated with estimates of biomass-at-age from the *Hill Cove* survey. Two sets of estimates were presented, one in WG-FSA-90/26 and one set in WG-FSA-90/11, which had to be corrected for the seabed area in each depth stratum. Even after correction, these two sets of estimates were very different and the problem could not be resolved at the Meeting, since the length frequencies by haul were not available to the Working Group.

121. An alternative approach to assessing the current status of the stock and estimating TACs was therefore considered. Estimates of biomass from the surveys (*Hill Cove* and *Akademik Knipovich*, WG-FSA-90/13) were used in projection calculations with values of

$\mathbf{F_{0.1}}$ to calculate TACs. The values that were chosen are from the bottom end of the range of both surveys. The estimates from the standard swept area method were not used because of the problems associated with applying this method to these particular data sets (see WG-FSA-90/13). The biomass estimates that were used, with coefficients of variation (CV) are:

| Survey | Biomass | CV |
|---|---|---|
| *Hill Cove* | 149 598 | 0.42 |
| *Akademik Knipovich* | 442 168 | 0.33 |

122. The USSR Delegation believed that these estimates should be corrected for the assumed catchability coefficient of surveys of 0.25 from the table in paragraph 114. The adjusted biomass values from the trawl surveys are:

| Survey | Biomass | CV |
|---|---|---|
| *Hill Cove* | 598 392 | 0.42 |
| *Akademik Knipovich* | 1 776 672 | 0.33 |

123. Other Members of the Working Group suggested that estimates of catchability derived from VPA and survey results for 1984/85 to 1988/89 (paragraph 114) should not be applied to biomass estimates for surveys conducted during 1989/90 since, as described in paragraph 116, the catchability coefficients for surveys conducted during 1989/90 are different from those for earlier surveys. It was also pointed out that the coefficients of variation for the adjusted estimates in paragraph 122 are too small because statistical uncertainty in the estimate of catchability was not included in the calculations.

124. The estimates of biomass were split into biomass-at-age using both sets of percentages-at-age referred to in paragraph 120 above. Two values of natural mortality ($\mathbf{M}$=0.48 and $\mathbf{M}$=0.56) were used to project the population forward to 1 July 1990. Biomass levels in 1990/91 and 1991/92, as well as, catches based on $\mathbf{F_{0.1}}$ were calculated. The $\mathbf{F_{0.1}}$ calculations for $\mathbf{M}$=0.48 and $\mathbf{M}$=0.56 were based on the analysis in WG-FSA-90/5. Results are given in Table 2a and 2b and explained fully in WG-FSA-90/5.

Table 2a: Using biomass-at-age data from WG-FSA-90/26 (in thousand tonnes).

| Survey Estimate | 1990/91 | | 1991/92 | |
|---|---|---|---|---|
| | Stock | Catch | Stock | Catch |
| **M**=0.48, $\mathbf{F_{0.1}}$=0.33 | | | | |
| 150 | 222 | 44 | 189 | 36 |
| 442 | 627 | 129 | 477 | 101 |
| **M**=0.56, $\mathbf{F_{0.1}}$=0.38 | | | | |
| 150 | 214 | 46 | 164 | 34 |
| 442 | 603 | 137 | 407 | 94 |

Table 2b: Using biomass-at-age data from WG-FSA-90/11 Rev. 1 (in thousand tonnes).

| Survey Estimate | 1990/91 | | 1991/92 | |
|---|---|---|---|---|
| | Stock | Catch | Stock | Catch |
| **M**=0.48, $\mathbf{F_{0.1}}$=0.33 | | | | |
| 150 | 236 | 50 | 201 | 39 |
| 442 | 670 | 146 | 512 | 109 |
| **M**=0.56, $\mathbf{F_{0.1}}$=0.38 | | | | |
| 150 | 228 | 52 | 173 | 36 |
| 442 | 644 | 154 | 435 | 101 |

125. Taking into account the annual catchability coefficient of surveys of 0.25, the adjusted calculations of projected biomass and catch are given in Tables 3a and 3b.

Table 3a: Adjusted calculations of projected biomass and catch from WG-FSA-90/26 (in thousand tonnes).

| Survey Estimate | 1990/91 | | 1991/92 | |
|---|---|---|---|---|
| | Stock | Catch | Stock | Catch |
| **M**=0.48, $\mathbf{F_{0.1}}$=0.33 | | | | |
| 598 | 888 | 176 | 756 | 144 |
| 1 777 | 2 508 | 516 | 1 908 | 404 |
| **M**=0.56, $\mathbf{F_{0.1}}$=0.38 | | | | |
| 598 | 856 | 184 | 656 | 136 |
| 1 777 | 2 412 | 548 | 1 623 | 376 |

Table 3b: Adjusted calculations of projected biomass and catch from WG-FSA-90/11 Rev. 1 (in thousand tonnes).

| Survey Estimate | 1990/91 | | 1991/92 | |
|---|---|---|---|---|
| | Stock | Catch | Stock | Catch |
| **M**=0.48, $\mathbf{F_{0.1}}$=0.33 | | | | |
| 598 | 944 | 200 | 804 | 156 |
| 1 777 | 2 680 | 584 | 2 048 | 936 |
| **M**=0.56, $\mathbf{F_{0.1}}$=0.38 | | | | |
| 598 | 912 | 208 | 692 | 144 |
| 1 777 | 2 576 | 616 | 1 740 | 404 |

126. Some Members suggested that adjusted calculations of projected biomass described in paragraph 125 are invalid because the correction factor, as described in paragraph 124, should not be applied to survey biomass estimates for 1989/90.

127. The USSR Delegation expressed doubt as to the validity of the estimates $\mathbf{F_{0.1}}$ when **M**=0.48 and **M**=0.56, which were used in these calculations. The values $\mathbf{F_{0.1}}$=0.33 and $\mathbf{F_{0.1}}$=0.38 were obtained under the assumption that *C. gunnari* is being fully exploited from 2 years of age. This is reflected in the following coefficients of partial recruitment (PR):

| Age | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| PR | 0 | 1 | 1 | 1 | 1 | 1 |

128. VPA analysis, however, shows that the coefficient of partial recruitment for age group 2 equals 0.44. This leads to $\mathbf{F_{0.1}}$=0.497 when **M**=0.48 and $\mathbf{F_{0.1}}$=0.570 when **M**=0.56.

129. Results of TAC calculations from the VPA assessment presented in WG-FSA-90/26 are summarised below.

Table 4: Projections for 1990/91 (all units in thousand tonnes).

| | Modification 1 | | Modification 2 | |
|---|---|---|---|---|
| | Stock | Catch | Stock | Catch |
| **M**=0.48, $\mathbf{F_{0.1}}$=0.497 | 198 | 53 | 215 | 57 |
| **M**=0.56, $\mathbf{F_{0.1}}$=0.570 | 238 | 64 | 200 | 54 |

130. Results from the VPA (paragraph 129) and the projections based on survey estimates, unadjusted for catchability (paragraph 124) suggest a range of biomass values of between 198 000 tonnes and 670 000 tonnes with associated TAC values of between 44 000 tonnes and 64 000 tonnes. When results from projections based on survey estimates adjusted for catchability (paragraph 125) are considered, the range for total biomass is extended to 2 680 000 tonnes and the range of TAC values is extended to 616 000 tonnes. If the actual stock biomass is reasonably well estimated by the *Hill Cove* survey results, setting a TAC based on the *Akademik Knipovich* survey will lead to a substantial depletion of the stock.

131. In each case the projected population level would be less in 1991/92 than in 1990/91 if recruitment is average.

132. In addition to the large differences between the survey estimates of biomass on which the projections are based, all estimates have associated levels of uncertainty. In the case of the projections based on biomass surveys, the coefficients of variation can be used to investigate the effect of this uncertainty on the calculation of TACs.

133. The fact that the biomass is measured with some degree of error implies that there is a probability that the true biomass may be lower or higher than the estimated biomass. If the distribution that describes the probabilities was normal, there would be a 50% probability that the true biomass was higher than the point estimates. However, if we assume that the distribution which describes these probabilities is derived from a log-normal distribution of the biomass estimate, the implication is that there is a 31% probability that the true biomass is higher than the estimated biomass and there is a 69% probability that the true value is lower.

134. The implication of this is that, if a TAC is based on the point estimate, there is a 69% probability (or 69% risk) that it would be too high. If the TAC is based on a biomass value that is HIGHER than the point estimate, the probability that the TAC is too high increases. Conversely, if the TAC is based on a biomass value that is LOWER than the point estimate, the probability that the TAC is too high decreases. A schematic illustration of this is given in Figure 5. The figure is based on the assumption that there is a log-normal probability distribution around the point estimate.

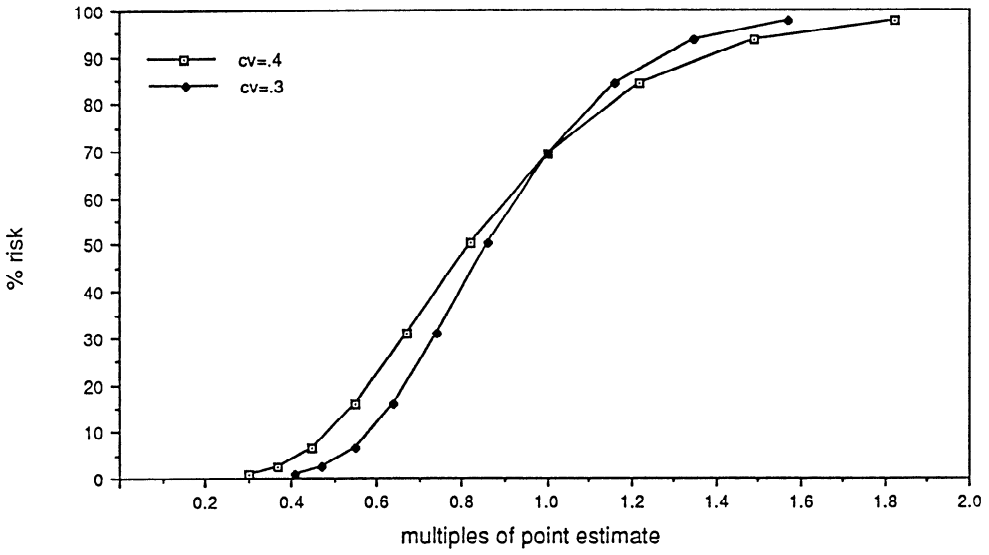


Figure 5: Estimation of probability of TAC for *C. gunnari* in Subarea 48.3 being too high.

135. There are many assumptions involved in the above example. Firstly, the probability distribution may not be log-normal, but is almost certainly skewed. Secondly, although there is a level of uncertainty associated with each individual survey estimate, there is a much

larger, overall level of uncertainty as reflected by the large difference between the estimates. The basic principle remains the same, however, as catch levels increase, the associated risk (that catches are too high) increases.

136. As an illustration of how the TAC is affected, Table 5 summarises TAC levels associated with the lowest biomass estimate (i.e., 150 000 tonnes) minus 1 standard deviation and plus 1 standard deviation of the natural log of the point estimate. Taking into account catchability coefficient similar calculations give the following results:

Table 5: Biomass estimate from *Hill Cove* Survey, CV=42%. Using biomass-at-age as in Section A, Table 2 and **M**=0.48, $\mathbf{F_{0.1}}$=0.33. Biomass in thousand tonnes (SD=standard deviation).

| Biomass Used in Projection | 1990/91 | |
|---|---|---|
| | Stock | Catch |
| 150 *($e^{-CV}$)= 98 | 151 | 29 |
| 150 | 222 | 44 |
| 150 *($e^{+CV}$)= 228 | 331 | 67 |

## Management Advice

137. As was the case last year, the wide range of results from the assessments pose serious problems in presenting management advice to the Commission.

138. If the actual stock biomass is reasonably well estimated by the *Hill Cove* survey results, setting a TAC based on the *Akademik Knipovich* survey will lead to a substantial depletion of the stock. If the stock biomass is more correctly estimated by the *Akademik Knipovich* survey, setting a TAC based on the *Hill Cove* survey results will result in a substantial increase in the stock.

139. The Working Group therefore, taking account of the fact that survey results in earlier years had all been somewhat lower than the recent estimates as well as VPA results given in WG-FSA-90/26, believed that a TAC from the lower end of the range of results would be appropriate. The low end of the appropriate range is given by the *Hill Cove* survey using **M**=0.48 and gives a TAC of 44 000 tonnes. The high end of the range is given by the VPA results in WG-FSA-90/26 and give a TAC of 64 000 tonnes.

140. No length and age data of *C. gunnari* from the commercial fleet was reported to CCAMLR. The Working Group felt this was a serious problem especially given the wide

range of TACs calculated using research vessel data. Because of these uncertainties, the Working Group recommends a conservative TAC be adopted to reduce the probability of overexploiting the species.

141. Concern was expressed about the earlier patterns of exploitation in the fishery in which fishing appeared to concentrate selectively on a single year class. This undermines the basis on which $\mathbf{F_{0.1}}$ calculations are made, rendering them too high. Some Members also pointed out that keeping the TAC low would lead to improvements in the age structure of the stock by allowing more fish to survive to older ages. This would help ensure stable recruitment from a larger spawning stock biomass. Other Members believed that a good spread of age classes now existed in the stock and that this issue was not of current concern. They also considered, taking into account that the trawl surveys need to be corrected for catchability, that the TAC range above is likely to be conservative.

*Patagonotothen brevicauda guntheri* (Subarea 48.3)

142. Conservation Measure 16/VIII limited the catch of this species to 12 000 tonnes in the 1989/90 season. However, the actual catch was 145 tonnes because fishing occurred only outside 12 miles from Shag Rocks.

143. The only catches of this species that have been reported to CCAMLR as fine-scale data are from the South Georgia area in 1987 and 1988, where they have not been found by research surveys (paragraph 50). This was viewed with great concern by some Members as it introduces doubt as to the accuracy of fine-scale data reported to CCAMLR.

144. Catch and effort data from Soviet BMRT vessels from 1978/79 to 1988/89 were available, as was a biomass estimate of 81 000 tonnes from the Spanish survey in 1986/87.

145. At the 1989 Meeting, the Working Group concluded that in the absence of reliable estimates of natural mortality and information on current stock size, catch levels should not be based on VPA results using $\mathbf{F_{0.1}}$ and assumptions about recruitment.

146. WG-FSA-90/28 presented an assessment of the stock based on VPA analysis, after attempting to reduce the uncertainty in the estimates of **M**. Last year the Working Group concluded that **M** is unlikely to be higher than 0.7 and **M** values used were 0.48 and 0.63. The analysis in WG-FSA-90/28 suggested that higher values of **M** were more likely and presented results using **M**=0.9.

147. The method used in WG-FSA-90/28 for testing the applicability of **M** values was a new variation on the method of Paloheimo (Ricker, 1975). The new feature of the method was that fishing mortality coefficients from VPA analysis using a trial series of values of **M** were regressed against standardised fishing effort. In principle, if **M** is correct the regression line will pass through the origin.

148. Some Members of the Working Group were concerned that this procedure would not produce reliable results. The amount of information on **M** from a time series of catch-at-age and effort data is low (de la Mare, 1989; Shepherd and Nicholson, 1986). There were unresolved statistical problems with the regressions used in the method because estimates of **F** from the VPA are not independent from the standardised efforts. Moreover, a functional rather than simple linear regression would be more appropriate because the standardised efforts are themselves random variables. Without full confidence intervals associated with the estimates or further analysis of the properties of the method based on analytic or simulation studies, the Working Group was unable to assess the reliability of the results presented.

149. Other Members of the Working Group felt that the proposed method complemented assessments made in 1989, making it possible to refine them and obtain a well-founded value for **M**. In choosing a value for **M** this method does not require calculating the confidence interval, but is based on verification of a statistical hypothesis that the intercept equals 0 in the regression equation. Taking into account sample size, this hypothesis is not rejected for **M**=0.9, but when **M**=0.48 and **M**=0.63 this hypothesis is not supported by data. Since these methods of assessing the natural mortality coefficient are based on various principles and data, it was suggested that **M**=0.9 is more realistic.

150. The assessment presented to the Meeting (WG-FSA-90/28) was based on the same data as last year (WG-FSA-89/21). No additional catch-at-age or effort data was available. The series of catch and effort data from 1978/79 to 1988/89 (Figure 6) was used to calibrate the VPA for a range of **M** values from 0.48 to 1.06. The change in biomass over that period for two values of **M** is shown in Figure 7. The large catches in 1980/81 (36 791 tonnes) and 1981/82 (31 403 tonnes) reduced the biomass at that time.

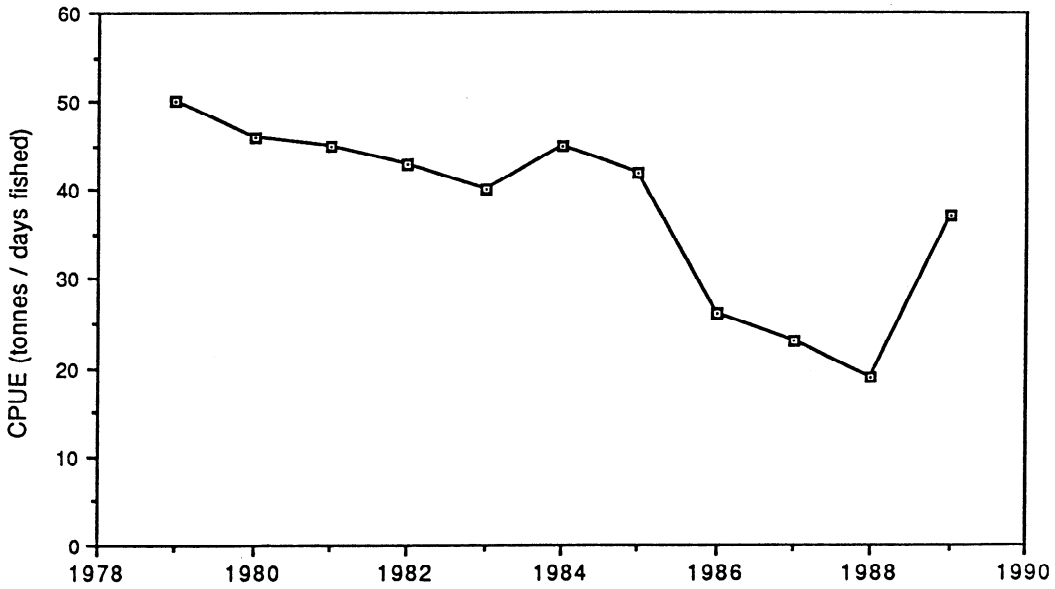


Figure 6: Catch-per-unit effort (tonnes/days fished) for *P.b. guntheri* in Subarea 48.3 (from WG-FSA-90/28, Table 3).

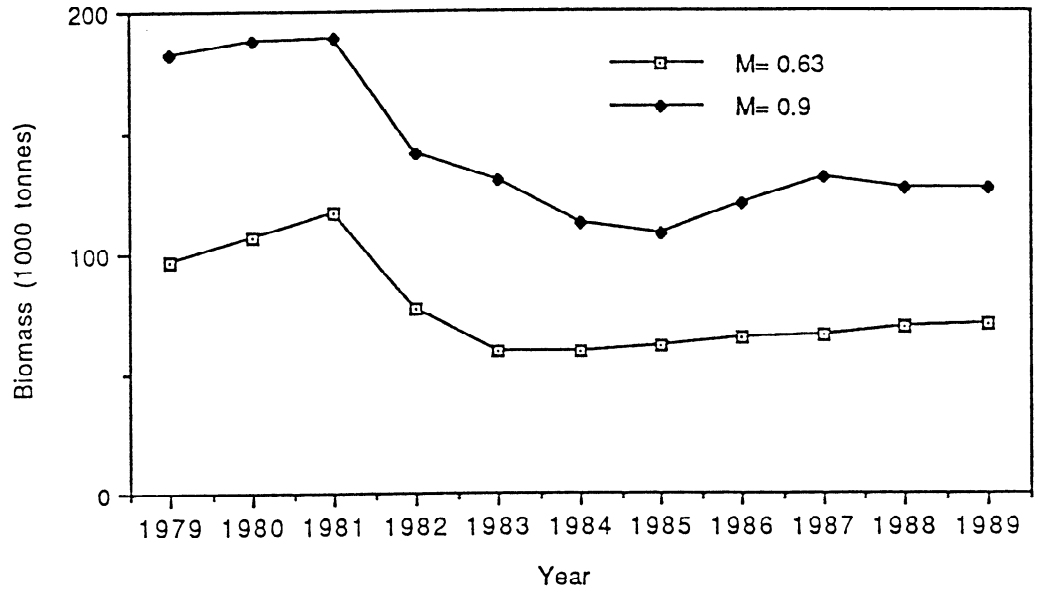


Figure 7: Results of VPA analyses for *P.b. guntheri* in Subarea 48.3.

151. The biomass estimate for 1988/89 from the VPA was projected forward one further year to predict the stock size in 1990/91 and to calculate yield estimates. In these projections, the average value of recruitment from the historical sequence of age classes in the VPA was used. The values of $\mathbf{F_{0.1}}$ were taken from the yield-per-recruit analyses in WG-FSA-90/28 and WG-FSA-90/5.

| Natural Mortality | $F_{0.1}$ | Projected Biomass 1990/91 (tonnes) | $F_{0.1}$ Yield Estimate (tonnes) | Proportion of Catch from Ages 1 to 3 | Proportion of Catch from Ages 1 to 2 |
|---|---|---|---|---|---|
| 0.48 | 0.56 | 83 663 | 20 315 | 37.9% | 4.5% |
| 0.63 | 0.78 | 96 375 | 25 167 | 43.6% | 5.9% |
| 0.9 | 1.32 | 143 896 | 36 356 | 62.4% | 14.9% |

The yield projection from this year is higher than that given last year. With the reduction in the fishery in 1989/90, fishing mortality is assumed to have been reduced. However, the yield projections are based on the assumption of constant recruitment at the average value.

152. The different rates of **M** give widely different stock sizes and yield estimates from the exploited part of the population. However, with higher values of **M** the importance of recruitment in the last few years also increases. The VPA gives no information on the strength of these recent age classes, which are nevertheless of critical importance to the estimates of projected yield in 1990/91 (particularly the 3 year old age class).

## Management Advice

153. To estimate yields for *P.b. guntheri*, an estimate of biomass and the current age structure are needed. Data on the age distribution of the catches are required for the most recent year.

154. Recruitment levels to the *P.b. guntheri* stock in recent years are unknown. Unfortunately, the current status of the stock depends critically on the strength of incoming age classes to the fishery. This effect is more apparent when higher values of natural mortality are used. In the absence of any index of pre-recruit abundance (mainly 1 and 2 year old fish), yield estimates given here should be used with caution. It may be inappropriate to base recommended catch levels on the assumption of constant recruitment. The absence of fishing in the 1989/90 season should have resulted in an increase in *P.b. guntheri* abundance and biomass. However, the importance of recruitment in the projections decreases with lower rates of natural mortality. To reduce the risk from uncertainty in the true value of **M** and the greater uncertainty concerning current recruitment levels, the TAC should be at the lower end of the range (20 000 to 36 000 tonnes).

*Dissostichus eleginoides* (Subarea 48.3)

155. Catches of *D. eleginoides* have been reported since 1976/77. Until 1985/86 catches were several hundred tonnes per year, except in 1977/78 when 1 920 tonnes were taken. Most catches were probably taken in the Shag Rocks/Black Rocks area where the species is a common by-catch in the *P.b. guntheri* fishery. Since 1985/86 catches have increased from 564 tonnes to 4 138 tonnes in 1988/89 and again to 8 311 tonnes in 1989/90. Prior to 1988/89, catches of this species would have been mainly juveniles taken by trawls. Since 1988/89 almost all catches have been taken by longlining.

156. The Working Group considered new information from the fishery presented in WG-FSA-90/34. The paper gave estimates of growth parameters based on a relatively small aged sample (124 fish). The paper also gave estimates of natural mortality given below.

| Method | Estimate |
|---|---|
| Alverson-Carnee | 0.18 |
| Rikhter-Efanov | 0.16 |

157. It was noted that these values seemed high compared with the von Bertalanffy growth parameter **K** value of 0.072. These values of **K** and **M** imply that very few fish would survive to reach full size. It was suggested that the catch composition would reflect size and selection factors related to hook size and that this would lead to over-estimation of **M**. The Working Group had used the value **M**=0.06 in its calculations of potential yield at its last meeting taken from Kock, Duhamel and Hureau (1985). The Working Group agreed to use the values 0.06 and 0.18 in the calculations in this Meeting.

158. However, Soviet representatives expressed the view that the value of **M**=0.06 is too low. The simple checking of both values using the Sparre method (SC-CAMLR-VIII, Annex 6, Appendix 5) shows that **M**=0.06 gives the life expectancy for *D. eleginoides* of 75 years, whereas **M**=0.18 gives a life expectancy of 25 years which is more consistent with the observed age data. Furthermore, the calculation of **M** in WG-FSA-90/34 is performed using the information from the Shag Rocks study area, whereas Kock's data are based on Zakharov and Frolkina (1976) where the study was conducted on *D. eleginoides* from the Patagonian shelf (i.e., from a completely different region) and **M** was calculated by the method of Pauly (1980) using a temperature of 4°C.

159. It was pointed out that the calculation of 'life expectancy' as defined by Sparre depends on the assumption that **M** is independent of age. However, a wide range of animals

have natural mortality increasing with age, with the effect that lower values of **M** can be compatible with shorter life expectancy than would be obtained using Sparre's definition. It was also pointed out that the catch of much longer individuals implies that the fish live to much greater ages, and that such fish will be under-represented in trawl samples, and from the longline fishery because of hook selection factors.

160. No direct estimates of total biomass of this stock are available. Reliable future direct estimates are unlikely to be obtainable because the range of mature fish extends to considerable depths and they are also semipelagic. Accordingly, indirect methods of assessment will need to be used. It was recommended that a mark-recapture experiment be undertaken.

161. WG-FSA-90/7 investigated the reproductive status of a small sample of fish from the USSR longline fishery. The fish were found to be developing towards spawning condition. The authors concluded that the assertion that the longline fishery takes senescent fish (CCAMLR-VIII, paragraph 106) is almost certainly in error.

162. The data on size and age composition presented in WG-FSA-90/34 showed that fish aged 8 to 18 years and lengths 60 to 120 cm predominate in the catch. Since the species reaches maturity at 8 to 10 years, the data from the catch indicate that it is unlikely that any substantial proportion of the catch would be senescent.

163. WG-FSA-90/34 also presented an attempt at an assessment using a length based cohort model (Jones, 1981). The results gave an exploitable stock of 68 318 tonnes with a TAC of approximately 8 000 tonnes.

164. With respect to the growth parameters used, it was also pointed out that these should be derived from samples of the entire range of size classes in the population. In the case of longline fishing, any effects of size selection attributable to the fishing method would introduce bias in the estimation of growth parameters based on length data from the fishery alone. Consequently, the use of biased growth parameters will also affect results of length based cohort analyses.

165. Some Members of the Working Group stressed that the results could not be considered to be reliable because the length composition of the stock would not yet have responded to the effects of fishing. The method used is not reliable when fishing has been conducted for only a

few years. Additional calculations given in Appendix G show that the results obtained from length cohort analysis are very sensitive to the growth parameters used. The available parameters had been estimated from relatively small samples.

166. Other Members of the Working Group feel that Jones' cohort analysis is sufficiently well-founded to be applicable in assessing *D. eleginoides* stocks. Reasons for this are:

- long life expectancy; this allows one to expect a lack of wide fluctuations in recruitment; and

- low fishing intensity which has no effect on population equilibrium.

This last aspect is supported by the fact that over the period 1986 to 1990 there was no apparent decrease in catch per-unit-effort. The applicability of Jones' cohort analysis here is consistent with the use of summarised information obtained over a number of years on catch size structure.

167. Biomass estimates for this species have been obtained by trawl surveys, but these are known to be underestimates because they cover only the upper end of the bathymetric range for the species (WG-FSA-90/13). A crude estimate of biomass was attempted by assuming that the *Hill Cove* and *Akademik Knipovich* surveys correctly estimate the biomass of the cohorts two to five. The biomass for the whole stock can then be extrapolated using a growth curve, length-weight relationship and natural mortality to produce a factor by which the survey biomass at each age must be multiplied to yield the stock biomass. The calculation depends on a number of assumptions:

- the surveys correctly estimate the biomass of the young year classes;
- the young year classes represent average levels of recruitment;
- mortality rates in young fish are the same as in adult fish; and
- natural mortality and growth curve parameters are accurately estimated.

It is not possible to ensure that these assumptions are fulfilled and failures of any or all of them could produce substantial inaccuracy in the calculated biomass. Accordingly, considerable and unquantifiable uncertainty is attached to the results of the calculations.

168. The results of these calculations are shown in Table 6. Table 7 gives corresponding estimates of MSY based on rates derived from Beddington and Cooke (1983). The details of these calculations given are recorded in the summary of assessments carried out at this Meeting which will be submitted to the next meeting.

Table 6: Estimated exploitable biomass of *D. eleginoides* at Shag Rocks. HC=*Hill Cove* survey, AK=*Akademik Knipovich* survey. The values based on each age have been calculated separately.

| | Mortality Coefficient **M**=0.06 | | | Mortality Coefficient **M**=0.18 | | |
|---|---|---|---|---|---|---|
| | | Biomass by | | | Biomass by | |
| Age | Factor | HC | AK | Factor | HC | AK |
| 2 | 614.3 | 1426702 | 250795 | 157.09 | 366832 | 64484 |
| 3 | 204.9 | 130271 | 22900 | 59.4 | 37766 | 6639 |
| 4 | 98.5 | 28720 | 5049 | 32.2 | 9387 | 1650 |
| 5 | 57.9 | 157575 | 27700 | 21.3 | 58072 | 10208 |

Table 7: MSY from method of Beddington and Cooke. All estimates are based on a single age class.

| | **M**=0.06 | | **M**=0.18 | |
|---|---|---|---|---|
| Age | HC | AK | HC | AK |
| 2 | 27392 | 4815 | 21129 | 3714 |
| 3 | 2501 | 440 | 2175 | 382 |
| 4 | 551 | 97 | 541 | 95 |
| 5 | 3025 | 532 | 3345 | 588 |
| Average 2 to 5 | 8367 | 1471 | 6798 | 1195 |

169. The USSR Delegation expressed doubt as to the usefulness of projecting young cohorts as a method of assessing *D. eleginoides* biomass based on the following:

(i) in accordance with conclusions reached by scientists from the UK and the USSR (WG-FSA-90/13) it was acknowledged that trawl surveys do not reflect adequately the *D. eleginoides* stock status and, consequently, cannot be used in calculations;

(ii) calculation of *D. eleginoides* stock size-structure using trawl survey data was based on an algorithm which does not correspond to the swept area method (WG-FSA-90/14);

(iii) a sample of 124 specimens was used to determine age-structure of *D. eleginoides* (WG-FSA-90/11). This illustrates that a range of lengths of *D. eleginoides* (from

20 to 200 cm) precludes one from correctly constructing an age/length key. Moreover, as pointed out in WG-FSA-90/11, this method of *D. eleginoides* age determination is yet to be properly studied; and

(iv) a lack of data on the catchability coefficient, which makes it impossible to use absolute estimates rather than relative biomass indexes from trawl surveys. This makes all subsequent results unreliable.

Management Advice

170. The Working Group noted that the assessment of *D. eleginoides* will continue to be very difficult as direct estimates of stock size are unlikely to be obtainable. Indirect assessment methods require that the effects of exploitation are monitored over a long period so that sufficient data are accumulated to produce statistically reliable results. However, the rate of exploitation does have to be a reasonable fraction of the MSY to produce a great enough effect on the stock to be detected, but if the exploitation rate is too high, an excessive stock decline will be likely before any unambiguous signs of over-fishing appear.

171. Bearing these points in mind, the Working Group concluded that a TAC in the range 1 200 to 8 000 tonnes would be appropriate pending improved assessments.

*Electrona carlsbergi* (Subarea 48.3)

172. Last year, the USSR reported that they had begun an experimental fishery for *E. carlsbergi* (SC-CAMLR-VIII, Annex 6, paragraph 7). Catches up to 1986/87 were low, varying from 500 to 2 500 tonnes. In 1987/88 and 1988/89, catches had increased to 14 868 and 29 673 tonnes respectively. The catch in the 1989/90 season remained around this level, with 23 623 tonnes taken. Fine-scale reports from 1988 showed that most catches occurred in the vicinity of Shag Rocks and South Georgia Island (Subarea 48.3) in that year (CCAMLR Statistical Bulletin, Volume 2, 1990, Figure 24). Since 1988, the catches have been taken south of the Antarctic Polar Front north of South Georgia. Length composition of catches was submitted in 1990 for Subareas 48.3, 48.4, and 48.6. Length composition and an age/length key for catches from Subarea 48.4 in 1989 are also available (SC-CAMLR-IX/BG/5).

173. A review of recent USSR research publications on mesopelagic fish prepared by the Secretariat (WG-FSA-90/23) summarised general distribution and biological characteristics of the major myctophid species found in the Antarctic. Additional papers that were presented detailed the results of surveys in the region of the Antarctic Polar Front by the USSR between 1987 and 1989. These surveys included the northern part of Subarea 48.3. The information presented was concerned with the feeding ecology of *E. carlsbergi* (WG-FSA-90/18), its pattern of reproduction (WG-FSA-90/20) and demography (WG-FSA-90/21), and seasonal and annual variability in its spatial distribution (WG-FSA-90/35).

174. The results suggest that the longevity of *E. carlsbergi* is four to five years with a maximum length ranging between 95 and 105 mm. A large proportion of the fish sampled north of the Antarctic Polar Front were 3 to 4 years old while to the south the majority were 2 to 3 years old. *E. carlsbergi* is not a truly Antarctic species, concentrating to the north of and around the Antarctic Polar Front where its prey is densely concentrated. Its distribution is known to extend to 70°S, although few specimens have been found south of the Weddell-Scotia Confluence in the Atlantic Ocean sector.

175. Reproductive development was found mostly in fish sampled to the north of the Antarctic Polar Front. In samples from the south of the Polar Front, *E. carlsbergi* was found to be mostly immature. Maturity seems to occur around 3 years old. A high proportion of 2 year old fish were found to be immature. Spawning occurs from April over the winter period.

176. The results of the surveys led the authors to propose subdivisions of the region around the Antarctic Polar Front including the northern part of Subarea 48.3 (WG-FSA-90/21 and WG-FSA-90/36). They suggested in these papers that *E. carlsbergi* found south of the Polar Front (in Subarea 48.3) were unable to reproduce and that oceanographic conditions prevented their return to the region north of the Polar Front where reproduction was possible. As a result, the authors considered that exploitation of this species in this area would not jeopardise the reproductive capacity of the population and the only concern would be to prevent depletion of this part of the South Atlantic stock to a level that would interfere with species dependent on the myctophids.

177. However, aspects of the data indicate that more research on the population dynamics of myctophids is required before such a conclusion can be reached. The length-frequency and age data in WG-FSA-90/21 indicate that mostly immature 2 year olds were found in the survey samples from the area south of the Antarctic Polar Front. No data were available to assess whether these juvenile myctophids are unable to migrate to the north of the

Convergence after entering the Antarctic Ocean. As the Polar Front is a surface phenomenon and *E. carlsbergi* is distributed to at least 250 m in depth, the Working Group considered that the Antarctic Polar Front should not prevent these fish from returning to sub-Antarctic waters.

178. An estimate of biomass of myctophid species from acoustic survey data collected between 1987 and 1989 was presented in WG-FSA-90/19. An estimate of 1.7 million tonnes was calculated to be present in the region 48 to 56°S and 8 to 48°W. Although the variance associated with this estimate was not given, the authors indicated that this estimate may vary depending on the oceanographic conditions. Most of the survey area had a low density of myctophids. In the dense concentrations, *E. carlsbergi* was the predominant species. The bulk of the biomass came from near the Antarctic Polar Front.

179. The Working Group recognised the similarities between estimating biomass of myctophids and the problems being addressed by the WG-Krill in estimating the abundance of krill using acoustic data. Specific questions that need to be given priority are concerned with survey design and data analysis and interpretation. The Working Group felt that, although the target strengths used to calculate the above estimate appear reasonable, the presentation of the data used to calculate the target strength of *E. carlsbergi* would be useful for developing a standard methodology for assessing myctophid abundance.

180. The Working Group identified a further problem with the management of this fishery in that the catch taken in Subarea 48.3 comes from part of a larger stock that has a distribution extending to the north of the CCAMLR Convention Area and in the terms of the Convention, this is an associated species. The Working Group recommends that the Scientific Committee address the problem of how to provide management advice on such a fishery. All catches on this stock have been reported to occur in Subarea 48.3. The Working Group recommends that, if they occur, catches of myctophids in the vicinity of the Antarctic Polar Front to the north of Subarea 48.3 should also be reported to CCAMLR with a breakdown of catches into fine-scale areas.

181. The Working Group acknowledged the paucity of data concerned with the role of myctophids in the Antarctic ecosystem. The relative importance of these species as prey in the South Georgia region should be considered by the Scientific Committee.

Management Advice

182. In order for the Commission to be able to take full account of the factors affecting the myctophid fishery in Statistical Area 48, the Working Group recommends that the reporting of catches of myctophids found in the CCAMLR Convention Area should include all catches of these species taken to the north of Statistical Area 48. All catch data should be reported in the fine-scale format.

183. Recognising the many problems associated with biomass estimates from acoustic data, the Working Group recommends that a priority be given to developing a methodology for the design of myctophid biomass surveys and the subsequent analysis of data.

*Notothenia gibberifrons* (Subarea 48.3)

184. The total catch of *N. gibberifrons* decreased from 838 tonnes in 1988/89 to 11 tonnes in 1989/90.

185. The catch rates for this species as a by-catch in midwater trawls were analysed in WG-FSA-90/15. These results showed that substantial catch rates of *N. gibberifrons* could occur even with midwater trawls. In 1987/88 the catch rate was estimated to be about 0.68 tonnes per haul. In 1988/89 the catch rate had declined to 0.1 tonnes per haul.

186. The Working Group noted that these results show that even though no by-catch was reported from the 1989/90 season, it cannot be presumed that future fishing with midwater trawls will always result in negligible by-catch.

187. Three new estimates of biomass from trawl surveys were available.

| Survey | Biomass (CV) | Reference |
|---|---|---|
| *Hill Cove* | 12 417 (28%) | WG-FSA-90/13 |
| *Akademik Knipovich* | 21 891 (23%) | WG-FSA-90/13 |
| *Anchar* | 53 600 (21%) | WG-FSA-90/30 |

188. Concern was expressed at the disparity between the results from the three surveys. It was noted that the *Anchar* survey did not cover areas within 12 miles and that catch rates (density) outside 12 miles were generally higher. Hence, extrapolating the results from outside 12 miles for the area within 12 miles would bias the estimates upwards. In order to

determine whether this effect alone would account for the discrepancy, the *Hill Cove* results were re-analysed excluding the hauls made within 12 miles. The results of these calculations (Appendix H) show that the lack of samples taken within 12 miles does not explain the difference in results.

189. The Working Group agreed that the biomass estimate of *N. gibberifrons* from the *Anchar* survey should not be used because it gave a result much larger than any of the six other surveys conducted in recent years.

190. Assessment efforts for *N. gibberifrons* in Subarea 48.3 were hampered by the lack of fine-scale catch and effort data and biological data (i.e., age/length keys for 1988/89 and 1989/90).

191. The results of trawl surveys conducted during 1984/85 and 1985/86 to 1989/90 were used to tune two VPA analyses for the period 1975/76 to 1989/90. The first analysis used an estimate of biomass during 1989/90 (21 891 tonnes) obtained by Soviet scientists aboard the *Akademik Knipovich* while the second analysis used a lower estimate (12 417 tonnes) obtained by UK scientists aboard the *Hill Cove*.

192. The VPA analyses were tuned by minimising the sum of squared differences between the VPA estimates of total biomass and the survey estimates in each year. This approach, which assumes that bottom trawl surveys provide absolute rather than relative measures of abundance, was criticised on grounds that bottom trawl surveys tend to underestimate biomass in absolute terms.

193. In response to the criticism, it was pointed out that:

(i) an attempt to treat the survey estimates as relative measures had produced impossible results; and

(ii) the inprecision in survey results suggested that the underestimation was small in comparison to the variance inherent in biomass estimates, and for some years (1986/87 to 1988/89) the VPA estimates of biomass were actually equal to or lower than survey estimates.

194. The VPA results show that the abundance of *N. gibberifrons* has declined over the period of fishing. VPA and bottom trawl surveys indicate that abundance declined from

about 40 000 tonnes in 1975/76 to about 13 000 tonnes in 1981/82 and has remained low since that time (see Figure 8).

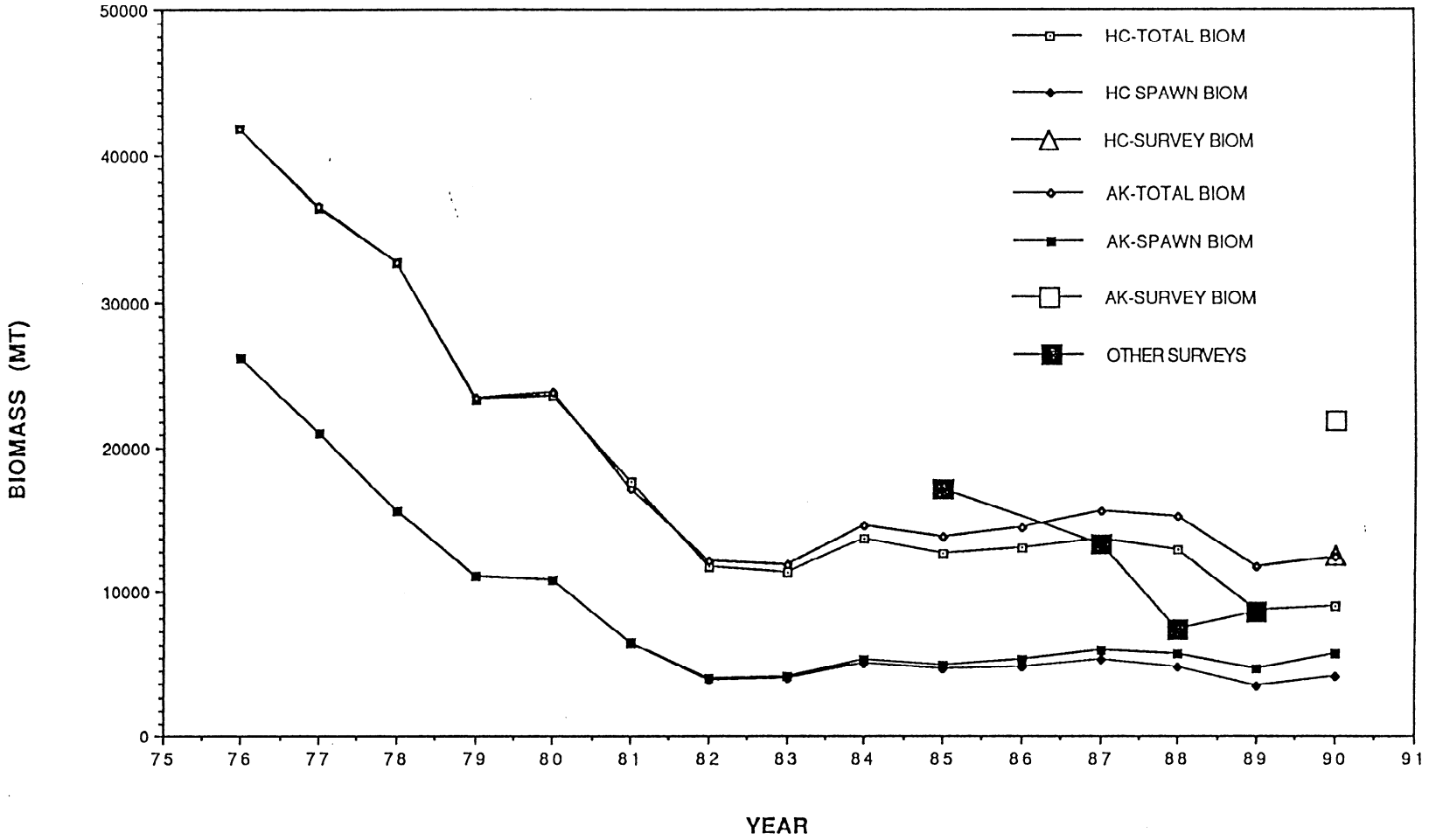


Figure 8: VPA results for *N. gibberifrons* in Subarea 48.3.

195. VPA estimates of current biomass, biomass projections for 1990/91 to 1991/92 and TAC calculations are summarised in the table below. In calculating TAC values, fishing mortality rates of $\mathbf{F_{0.1}}$=0.09 $yr^{-1}$ were assumed.

TAC projection and VPA tuned to *Akademik Knipovich* survey in 1990:

| | Current 1989/90 | Projected 1990/91 | Projected 1991/92 |
|---|---|---|---|
| Biomass | 12 784 | 14 129 | 14 420 |
| TAC | | 1 134 | 1 161 |

TAC projection and VPA tuned to *Hill Cove* survey in 1990:

| | Current 1989/90 | Projected 1990/91 | Projected 1991/92 |
|---|---|---|---|
| Biomass | 8 523 | 9 606 | 10 101 |
| TAC | | 667 | 723 |

Management Advice

196. Current stock size is about 20 to 30% of the level existing at the start of fishing. The most recent assessments indicate that the stock may not be as depleted as had been found in previous assessments. The Working Group recommends, however, that there should be no directed fishery for *N. gibberifrons* because this may lead to excessive by-catch of other species.

197. The likely slow rate of increase of the stock suggests that catches below the $\mathbf{F_{0.1}}$ level are appropriate and that the by-catch of *N. gibberifrons* should be restricted to not more than 500 tonnes.

*Chaenocephalus aceratus* and
*Pseudochaenichthys georgianus* (Subarea 48.3)

198. Reported catches of both species have been relatively small in recent years, exceeding 2 000 tonnes of *C. aceratus* only in 1987/88 and only 2 tonnes were taken in 1989/90. However, catches of these species have only been reported by Poland, the German Democratic Republic and Bulgaria, but never by the Soviet Union, which takes the majority of the catches in Subarea 48.3, although the species were a regular by-catch in the bottom

trawl fishery, such as in 1977/78. The Soviet Union reported large catches in the category 'Pisces nei' during this period. WG-FSA-90/6 hypothesised that these catches were made up largely of *C. aceratus* and *P. georgianus* and has attempted to reconstruct the fishery by re-allocating 75% of the catch of 'Pisces nei' reported by the Soviet Union to the two species in the same proportion as these species were reported in the Polish catches (Table 8).

Table 8: Reported and adjusted catch of *C. aceratus* and *P. georgianus*.

| | *C. aceratus* | | *P. georgianus* | |
|---|---|---|---|---|
| Year | Reported Catch | Adjusted Catch | Reported Catch | Adjusted Catch |
| 1977 | 293 | 1 972 | 1 608 | 10 815 |
| 1978 | 2 066 | 3 986 | 13 015 | 21 220 |
| 1979 | 464 | 1 726 | 1 104 | 3 660 |
| 1980 | 1 084 | 3 258 | 665 | 1 990 |
| 1981 | 1 272 | 3 576 | 1 661 | 4 670 |
| 1982 | 676 | 2 145 | 956 | 3 032 |
| 1983 | 0 | 2 753 | 0 | 6 062 |
| 1984 | 161 | 647 | 888 | 3 572 |
| 1985 | 1 042 | 2 395 | 1 097 | 2 522 |
| 1986 | 504 | 626 | 156 | 194 |
| 1987 | 339 | 1 389 | 120 | 456 |
| 1988 | 313 | 709 | 401 | 1 045 |
| 1989 | 1 | 15 | 1 | 5 |

199. Input parameters to the assessments have been extensively described in WG-FSA-90/6. In *P. georgianus* major discrepancies were detected between ageings and resultant growth coefficients reported for the species in the late 1970s and the most recent years (Figure 9). This was most likely due to the different methods used for ageing. VPA calculations were performed with different values of **M**. The VPA with the best fit to the survey data in *C. aceratus* was that with input **M**=0.30 and in *P. georgianus* with input **M**=0.4.

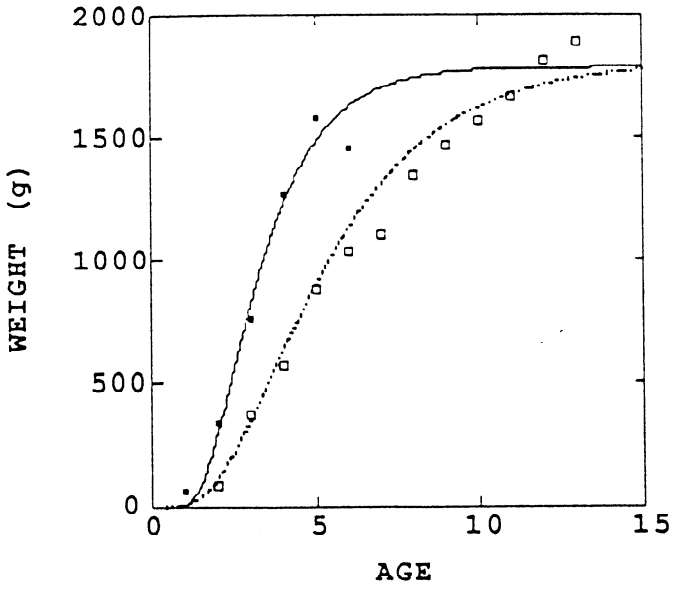


Figure 9: Mean weight-at-age for *P. georgianus* from Polish 1988 and 1989 data (■) with fitted von Bertalanffy growth curve (——), and Mucha's data for 1977 to 1979 (□) with the growth curve given by Kock *et al*. (1985).

200. Results of the VPA for *C. aceratus* indicate that the pristine stock size may have been around 18 000 to 19 000 tonnes and has been reduced to approximately 40% in 1987. Stock size has increased slowly since then to approximately 9 000 in 1988/89 which, however, is not apparent from biomass estimates obtained during research vessel surveys from 1987 to 1989 (Figure 10). Biomass estimates from research vessel surveys in the 1989/90 season, however, were higher than from previous seasons. They were 14 226 tonnes (*Hill Cove*), 14 424 tonnes (*Akademik Knipovich*) and 17 800 tonnes (*Anchar*). A stock-recruit relationship was evident from the VPA (Figure 11).

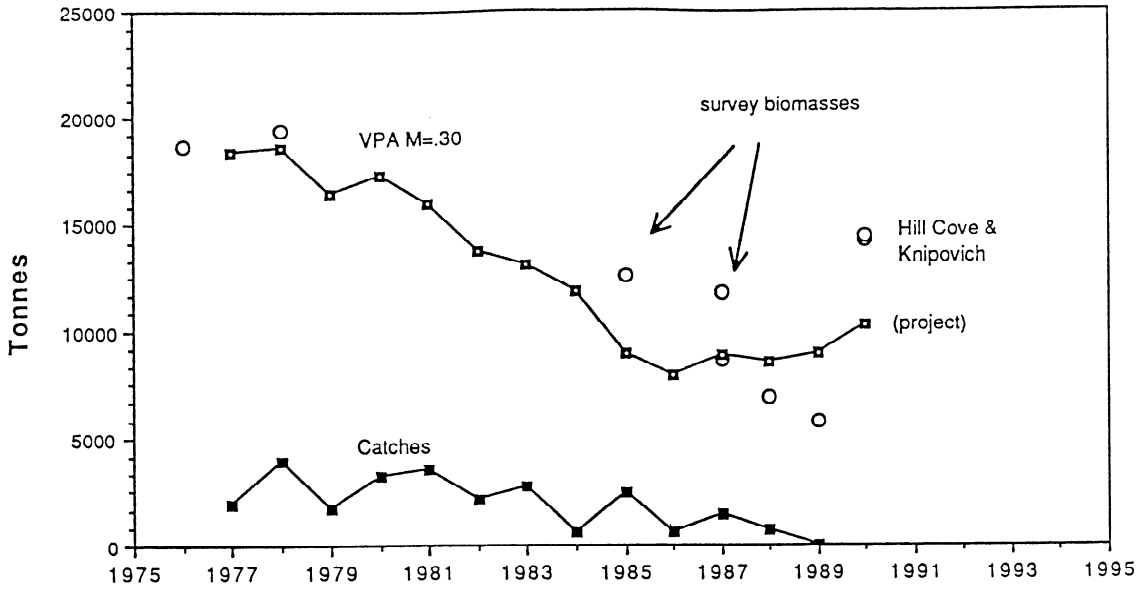


Figure 10: VPA and survey biomasses for *C. aceratus*.

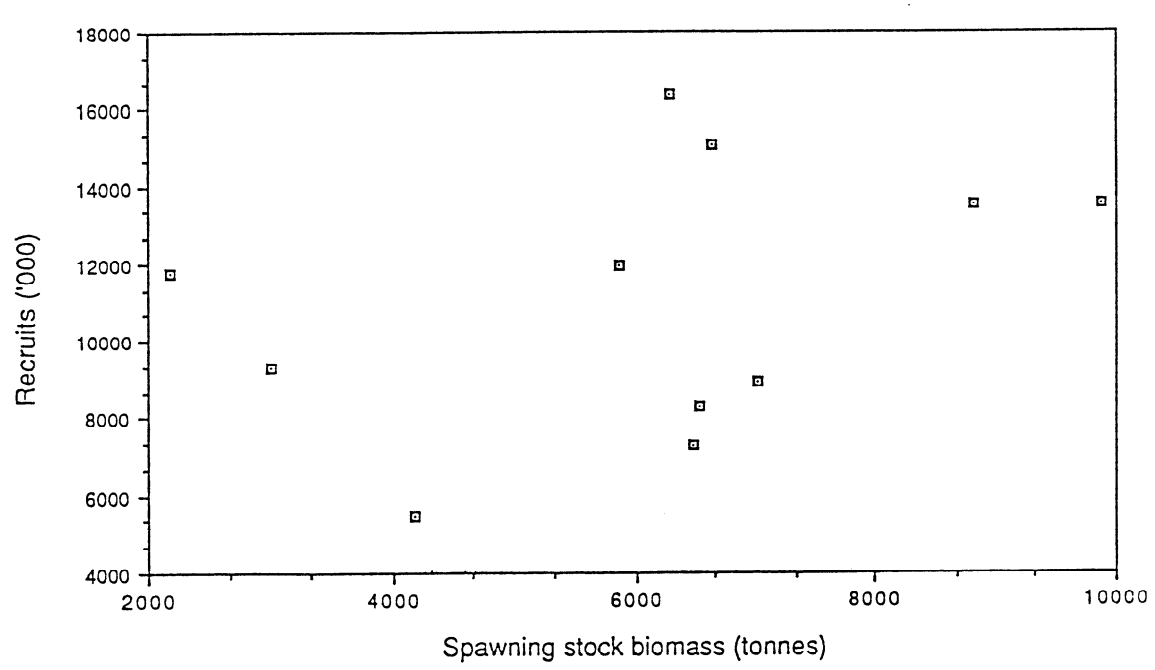


Figure 11: Stock recruit relationship for *C. aceratus*.

201. Results of the VPA for *P. georgianus* indicate that the current biomass is around 10 000 tonnes and that the pristine biomass was about 39 000 to 44 000 tonnes dependent on

the level of **M** (Figure 12). Biomass estimates obtained during the 1989/90 season were in the same order of magnitude: 5 761 tonnes, *Hill Cove*; 12 200 tonnes, *Akademik Knipovich*; and, 10 500 tonnes, *Anchar*.

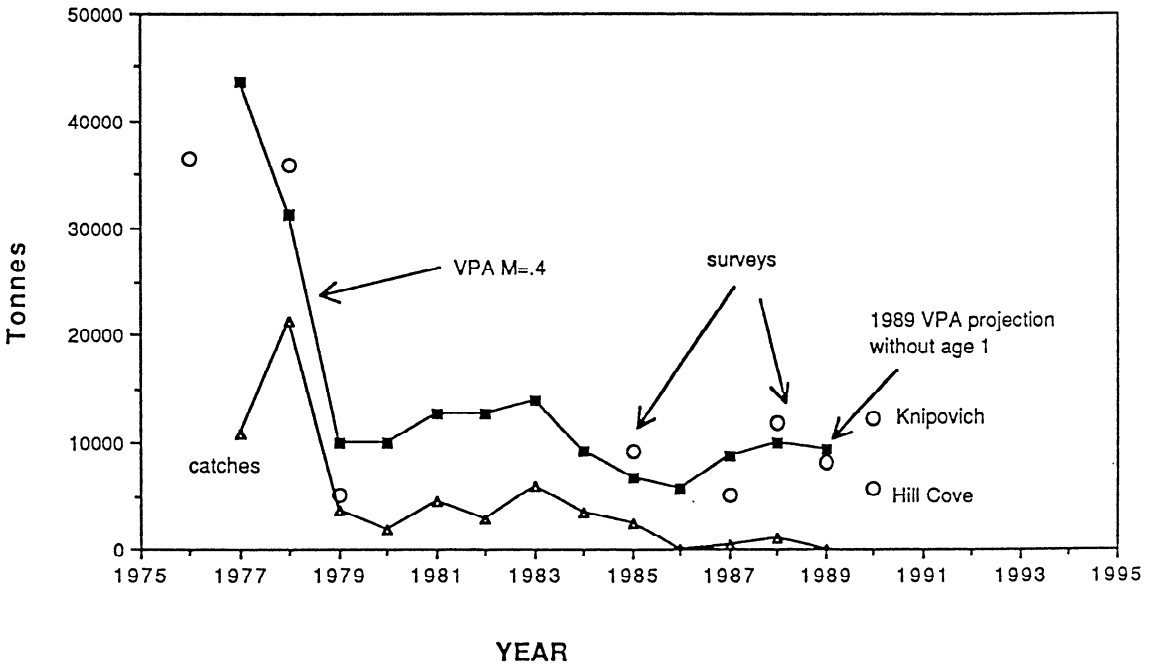


Figure 12: Results of VPA and adjusted survey biomasses for *P. georgianus* in Subarea 48.3.

Note: VPA biomass from VPA in 1989 is projection only; it does not include an estimate for recruitment and is therefore an underestimate.

202. Yield-per-recruit analysis in *C. aceratus* with **M**=0.3 resulted in $\mathbf{F_{max}}$=0.327 and $\mathbf{F_{0.1}}$=0.195. These results were comparable with those of Kock *et al.* (1985), who obtained $\mathbf{F_{0.1}}$ values of 0.15 to 0.18 using the Beverton and Holt (1957) model with **M**=0.2. Yield-per-recruit analysis in *P. georgianus* produces $\mathbf{F_{max}}$=1.44 and $\mathbf{F_{0.1}}$=0.626 with **M**=0.4. Y/R calculations by Kock *et al.* (1985) using growth parameters obtained in the late 1970s and **M**=0.3 showed $\mathbf{F_{0.1}}$=0.3 to 0.4.

203. Short-term projections were performed using the 1990 stock sizes of both species from the VPA with **M**=0.3 (*C. aceratus*) and **M**=0.4 (*P. georgianus*). The results are set out in Tables 9 and 10.

Table 9: Results of short-term projections in *C. aceratus*.

| | Catch (tonnes) | | Stock Biomass 1 July (tonnes) | |
|---|---|---|---|---|
| | 1990 | 1995 | 1990 | 1995 |
| tac=300 tonnes | 300 | 300 | 10 268 | 13 472 |
| $\mathbf{F_{0.1}}$=0.214 | 1 597 | 1 172 | 10 268 | 7 844 |

Table 10: Results of short-term projection in *P. georgianus*.

| | Catch (tonnes) | | Stock Biomass 1 July (tonnes) | |
|---|---|---|---|---|
| | 1990 | 1995 | 1990 | 1995 |
| tac=300 tonnes | 300 | 300 | 9 969 | 16 559 |
| $\mathbf{F_{0.1}}$=0.626 | 3 576 | 2 516 | 9 969 | 8 897 |
| 50% of $\mathbf{F_{0.1}}$=0.313 | 2 043 | 2 002 | 9 969 | 11 456 |

204. Short-term projections in *C. aceratus* showed that at $\mathbf{F_{0.1}}$=0.214 the stock will increase slowly from 7 200 tonnes to 8 700 tonnes in 1995, with a TAC of 300 tonnes a year set as a by-catch provision by the Commission (Conservation Measure 13/VIII). The low expectation of sustainable yield for this stock is largely a result of the low levels of recruitment observed from the VPA.

205. The fishing regimes used for the projections in *P. georgianus* were those of 300 tonnes as established by the Commission in 1989, $\mathbf{F_{0.1}}$ and 50% $\mathbf{F_{0.1}}$. The analysis showed that fishing at $\mathbf{F_{0.1}}$ at the present stock size would cause a slow decline stock size.

206. The outcome of the analysis of *P. georgianus* is largely affected by the reliability of ageing in this species. From the analysis presented in WG-FSA-90/6 which involved only age classes 1 to 6 and a resultant fast growth rate, it appears that the stock may have highly variable recruitment. However, if the true growth rate of this species was much lower, as some investigations suggest which describe up to 13+ age classes being present in the stock, the details of the analysis presented in WG-FSA-90/6 could change considerably. This would particularly affect **M**, $\mathbf{F_{0.1}}$ and the recruitment estimates.

## Management Advice

207. The analysis presented in WG-FSA-90/6 indicates that the stock of *C. aceratus* seems to be very vulnerable to overfishing at relatively low levels of fishing effort. The

spawner-recruit relationship and low initial stock size indicates that the stock may not sustain a high yield when it recovers. Management at $\mathbf{F_{0.1}}$ at the present stock size appear to be inappropriate for both *C. aceratus* and *P. georgianus*. A TAC of 300 tonnes, as presently established as a by-catch provision, which is much lower than $\mathbf{F_{0.1}}$ would appear to allow a more rapid recovery in stock biomass of both species.

*Notothenia squamifrons* (Subarea 48.3)

208. A TAC of 300 tonnes as a by-catch provision (Conservation Measure 13/VIII) was established by the Commission in 1989. The catch in the 1989/90 season was only 24 tonnes.

209. Despite the long catch history since 1971/72, very little information on length and no information on age composition has been submitted to CCAMLR. Biomass estimates obtained in 1989/90 differed widely: 1 359 tonnes (*Hill Cove*), 6 391 tonnes (*Akademik Knipovich*) and 133 800 tonnes (*Anchar*).

210. Biological characteristics of the closely related Kerguelen population indicate that the species is long living with a large number of age classes present in the stock. Due to the absence of information on catch-at-age, recruitment or mortality estimates the Working Group was unable to assess the state of the stock.

Management Advice

211. In the absence of information for an assessment of the stock the Conservation Measure presently in force should be retained.

South Orkney Islands (Subarea 48.2)

212. Catches in Subarea 48.2 were only substantial in the late 1970s. Since then, catches of all species have been usually in the order of a few thousand tonnes only except in 1982/83 and 1983/84 when 18 412 and 15 056 tonnes were taken.

Table 11: Catch by species in Subarea 48.2.

| | *Champsocephalus gunnari* | *Notothenia gibberifrons* | *Notothenia rossii* | Pisces nei | Total |
|---|---|---|---|---|---|
| 1978 | 138 895 | 75 | 85 | 2 603 | 141 659 |
| 1979 | 21 439 | 2 598 | 237 | 3 250[(1)] | 27 524 |
| 1980 | 5 231 | 1 398 | 1 722 | 6 217[(2)] | 14 548 |
| 1981 | 1 861 | 196 | 72 | 3 274 | 5 403 |
| 1982 | 557 | 589 | | 2 211 | 3 357 |
| 1983 | 5 948 | 1 | | 12 463[(3)] | 18 412 |
| 1984 | 4 499 | 9 160 | 714 | 1 583 | 15 956 |
| 1985 | 2 361 | 5 722 | 58 | 531 | 8 672 |
| 1986 | 2 682 | 341 | | 100 | 3 123 |
| 1987 | 29 | 3 | | 3 | 35 |
| 1988 | 1 336 | 4 469 | | | 5 805 |
| 1989 | 532 | 601 | | 1 | 1 134 |
| 1990 | 2 528 | 340 | | | |

(1) Mainly *Chaenocephalus aceratus*
(2) *P. georgianus* and unidentified nototheniids and channichthyids
(3) Unknown species

213. Catch figures for the 1989/90 season have been submitted for *C. gunnari* and *N. gibberifrons* only, although length compositions have been submitted to CCAMLR also for *N. rossii* and *Chionodraco rastrospinosus*. Catches of *C. gunnari* increased by a factor of 5 from 532 tonnes in 1988/89 to 2 528 tonnes in 1989/90, while catches of *N. gibberifrons* were 340 tonnes.

214. Although some new information on *C. gunnari*, *N. gibberifrons*, *N. rossii* and *Chionodraco rastrospinosus* from the 1988/89 and the 1989/90 fishing seasons had been submitted to CCAMLR, the lack of biomass estimates since 1986/87 and gaps in the time series of up to several years made it impossible to assess the present state of the stocks.

215. An assessment provided on *N. gibberifrons* carried out by the Working Group in 1988 encountered difficulties in matching biomass estimates from two research vessel surveys in 1977/78 and 1984/85 with the trend in biomass from VPA analysis. By allocating 75% of the catches of 'Pisces nei' reported in 1979/80 to 1982/83 to *N. gibberifrons* (see below), WG-FSA-90/16 was able to match both trends in biomass. The results indicated that the stock was reduced to 60% of its initial level in 1977/78 by 1985/86 and that a substantial part of the catches had consisted of juveniles. The current state of the stock is unknown.

| | Before Reallocation | | After Reallocation | |
|---|---|---|---|---|
| | *N. gibberifrons* | Pisces nei | *N. gibberifrons* | Pisces nei |
| 1979 | 2 598 | 133 | 2 598 | 133 |
| 1980 | 1 398 | 501 | 1 772 | 452 |
| 1981 | 196 | 2 770 | 2 274 | 114 |
| 1982 | 589 | 2 181 | 2 275 | 359 |
| 1983 | 1 | 12 349 | 9 266 | 3 819 |
| 1984 | 9 160 | 1 389 | 9 160 | 1 389 |
| 1985 | 5 722 | 522 | 5 722 | 522 |
| 1986 | 341 | 100 | 341 | 100 |
| 1987 | 3 | 1 | 3 | 1 |
| 1988 | 4 469 | 0 | 4469 | 0 |
| 1989 | 601 | 0 | 601 | 0 |

216. To provide new assessments of the stocks around the South Orkney Islands, length and age data from the catches since the mid 1980s, in particular *C. gunnari* and *N. gibberifrons*, are needed. An estimate of current stock biomass from a research vessel survey is highly desirable.

Management Advice

217. Due to the lack of new information the Working Group had asked for in its 1989 report, the Working Group was unable to provide management advice for either species.

Antarctic Peninsula (Subarea 48.1)

218. No commercial fishing took place in Subarea 48.1 in 1989/90.

219. No new information was available to the Working Group on any of the stocks in the Antarctic Peninsula region.

Management Advice

220. Due to the absence of data, the Working Group was unable to give management advice for any species.

Statistical Area 58

221. In 1989/90, fishing took place in Subarea 58.4 and Division 58.5.1.

222. In addition, research programs, including biomass surveys, took place in Divisions 58.5.2 and 58.4.2 in the 1990 season.

223. A summary of catches reported from Statistical Area 58 is given in Table 12. As in previous years, harvesting has been confined to Divisions 58.4.4 (Ob and Lena Banks) and 58.5.1 (Kerguelen). The major harvested species remain *Notothenia squamifrons* (Subareas 58.4 and 58.5) and *C. gunnari* and *D. eleginoides* (Division 58.5.1).

Subarea 58.5

Division 58.5.1 (Kerguelen)

224. Assessment of the Kerguelen fishery was extremely difficult in the absence of any French delegate or anyone else with direct knowledge of the fishery. It is hoped that Dr Duhamel will be able to attend future Working Group meetings to provide data and assessment.

*Notothenia rossii* (Division 58.5.1)

225. No new data derived from catches have become available since 1988 when directed fishing on the stock was prohibited. By-catch levels in the last few years have been of the order of a few hundred tonnes with some 155 tonnes being taken in 1989/90.

226. A recent Soviet analysis of catch data prior to 1984 (1970 to 1984) (WG-FSA-90/41) confirms earlier analyses undertaken by WG-FSA despite the fact that data for the period under consideration has not been complete.

Table 12: Total catches by species and subarea in Statistical Area 58. Species are designated by abbreviations as follows: ANI (*Champsocephalus gunnari*), LIC (*Channichthys rhinoceratus*), TOP (*Dissostichus eleginoides*), NOR (*Notothenia rossii*), NOS (*Notothenia squamifrons*), ANS (*Pleuragramma antarcticum*), MZZ (Unknown), SRX (*Rajiformes spp.*), WIC (*Chaenodraco wilsoni*).

| Split | ANI | | LIC | WIC | TOP | | | | NOR | | | NOS | | | ANS | | MZZ | | | SRX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YEAR | 58 | 58.5 | 58.5 | 58.4 | 58 | 58.4 | 58.5 | 58.6 | 58 | 58.4 | 58.5 | 58 | 58.4 | 58.5 | 58 | 58.4 | 58 | 58.4 | 58.5 | 58.5.1 |
| 1971 | 10231 | | | | XX | | | | 63636 | | | 24545 | | | | | 679 | | | |
| 1972 | 53857 | | | | XX | | | | 104588 | | | 52912 | | | | | 8195 | | | |
| 1973 | 6512 | | | | XX | | | | 20361 | | | 2368 | | | | | 3444 | | | |
| 1974 | 7392 | | | | XX | | | | 20906 | | | 19977 | | | | | 1759 | | | |
| 1975 | 47784 | | | | XX | | | | 10248 | | | 10198 | | | | | 575 | | | |
| 1976 | 10424 | | | | XX | | | | 6061 | | | 12200 | | | | | 548 | | | |
| 1977 | 10450 | | | | XX | | | | 97 | | | 308 | | | | | 11 | | | |
| 1978 | 72643 | 250 | 82 | | 196 | - | 2 | - | 46155 | | | 31582 | | 98 | 234 | | 261 | | | |
| 1979 | | | | 101 | 3 | - | - | - | | | | 1307 | | | | | 1218 | | | |
| 1980 | | 1631 | 8 | 14 | | 56 | 138 | - | | | 1742 | | 4370 | 11308 | | | | 239 | | |
| 1981 | | 1122 | 2 | | | 16 | 40 | - | | 217 | 7924 | | 2926 | 6239 | | | | 375 | 21 | |
| 1982 | | 16083 | | | | 83 | 121 | - | | 237 | 9812 | | 785 | 4038 | | 50 | | 364 | 7 | |
| 1983 | | 25852 | | | | 4 | 128 | 17 | | | 1829 | | 95 | 1832 | | 229 | | 4 | 17 | 1 |
| 1984 | | 7127 | | | | 1 | 145 | - | | 50 | 744 | | 203 | 3794 | | | | | *611 | 17 |
| 1985 | | 8253 | | 279 | | 8 | 6677 | - | | 34 | 1707 | | 27 | 7394 | | 966 | | 11 | 7 | 4 |
| 1986 | | 17137 | | 757 | | 8 | 459 | - | | - | 801 | | 61 | 2464 | | 692 | | | | 3 |
| 1987 | | 2625 | | 1099 | | 34 | 3144 | - | | 2 | 482 | | 930 | 1641 | | 28 | | 22 | | |
| 1988 | | 159 | | 1816 | | 4 | 554 | 488 | | - | 21 | | 5302 | 41 | | 66 | | | | |
| 1989 | | 23628 | | 306 | | 35 | 1630 | 21 | | | 245 | | 3660 | 1825 | | 47 | | 23 | 24 | |
| 1990 | | 226 | | 339 | | | 1062 | | | | 155 | | 1450 | 1262 | | | | | 2 | |

* Mainly *Rajiformes* spp.

NB: Before 1979/80 catches reported in Statistical Area 58 mainly concern Division 58.5.1 (Kerguelen Subarea)

227. Similarly, results of Soviet trawling surveys in 1987 and 1988 (WG-FSA-90/18) indicate that the species biomass was lower than reported to the Working Group in 1988 and 1989 (WG-FSA-88/22 and WG-FSA-89/10). Although the authors of the Soviet report conclude that their estimate may be an underestimate of stock biomass, they support the need for integrated surveys of pre-spawner and spawner biomass as recommended by WG-FSA at its last meeting (SC-CAMLR-VIII, Annex 6, paragraph 170).

228. French research (SC-CAMLR-VIII, Annex 6, paragraph 169) concluded that there has been some increase in the abundance of juveniles of this species and that an increase in recruitment to the mature stock should be apparent for a few years.

### Management Advice

229. Conservation measures (no directed fishery) should continue to protect the adult stock. Trends in the abundance of the juvenile part of the stock need to continue to be monitored. Biomass surveys will be required to establish whether the stock has made a substantial recovery prior to any resumption of exploitation.

### *Notothenia squamifrons* (Division 58.5.1)

230. In the 1990 season, 1 262 tonnes were caught which is similar to catches in the last few years, but well below the catch levels before 1984.

231. The only new data available are biomass estimates in WG-FSA-90/38.

232. In spite of detailed requests for data made at the last meeting of the Working Group, no new data have been received. Consequently, no further assessment can be made on this stock despite evidence from last year's meeting that this stock has been significantly depleted and that only about 15% of the current stock biomass is comprised of adults.

### Management Advice

233. Present catch levels are of the same order of magnitude as the biomass estimates given in WG-FSA-90/38. Continuation of catches at those levels will prevent recovery of the stock size to optimal levels.

*Champsocephalus gunnari* (Division 58.5.1)

234. Only 226 tonnes were caught in the 1990 season and no new data were available to extend the cohort analysis to 1990.

235. New figures for the biomass of the 1985 cohort of *C. gunnari* in 1988 were available from two sources: a re-calculation of the cohort analysis performed at last year's Working Group meeting (WG-FSA-90/17), and a re-evaluation of the Soviet-French biomass survey in 1988 (WG-FSA-90/38).

236. The re-calculation of the biomass in WG-FSA-90/17 was based on the assumption that a negligible number of the cohort survive to age 4 (i.e., are fished out at age 3). This resulted in an estimated stock size of 22 711 tonnes in 1989. The Soviet re-calculation of the results of the biomass survey conducted in 1988 (WG-FSA-90/38) suggests a stock size of an order of magnitude greater (200 000 to 230 000 tonnes).

237. The re-calculated cohort derived biomass (WG-FSA-90/17) appears to be the more realistic estimate as it is more consistent with previous biomass calculations for the 1979 and 1982 cohorts at age 2 and the assumption of effective extinction of the cohort at the end of the fourth year is supported by the fact that the catch in the 1990 season was only 226 tonnes, despite a considerable effort applied.

238. There appears to be a trend of declining stock size with successive cohorts, although at the moment this is only based on three data sets (Figure 13).

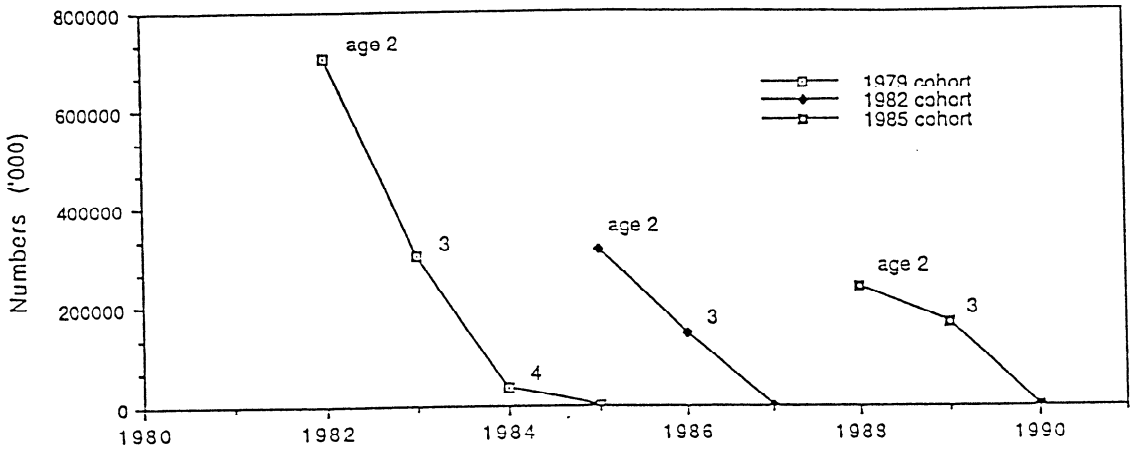


Figure 13: *C. gunnari* stock numbers from Kerguelen shelf.

## Management Advice

239. The 1985 cohort now appears extinct and no management advice can be given until the condition of the 1988 cohort is known. The results of WG-FSA-90/17 and the low catch in the 1990 season indicate that the high mortality occurs in 3 year old fish. As pointed out in last years' report, it is not known whether the extinction of 3-group fish is due to fishing or natural mortality. The 1988 cohort is expected to be recruited to the fishery in the 1990/91 season. The cause of mortality could be resolved this season by restricting the catch to a relatively low level and conducting a biomass survey prior to the 1990/91 and 1991/92 fishing seasons.

## *Dissostichus eleginoides* (Division 58.5.1)

240. 557 tonnes were caught in the 1990 season, which is lower than the average of the past few seasons. In some recent seasons the catch of *D. eleginoides* has been low because of re-direction of effort to the *C. gunnari* fishery. In the 1990 season the catches of both species were low.

241. At last year's meeting, WG-FSA noted that the evaluation of the total stock biomass is likely to be difficult due to inaccessability of part of the adult stock and due to incomplete knowledge of the species' biology.

242. Available biomass survey results tend to confirm the conclusion with recently reported estimates of abundance providing a range of values of 114 000 (WG-FSA-88/22 Rev. 1), 43 000 (SC-CAMLR-VIII, Annex 6, paragraph 161) and 12 700 tonnes (WG-FSA-90/78).

## Management Advice

243. In the absence of more refined estimates of abundance, WG-FSA was unable to develop additional advice to that given last year. Further assessment of the stock is urgently required to estimate the level of catch necessary to stabilize the stock. Such assessment should also entail the collection of length frequency and age/length data in order to facilitate elucidation of stock dynamics.

Division 58.5.2 (Heard Island)

244. There is no fishery in this area at present. During the 1990 season, a biomass survey was conducted by Australia (WG-FSA-90/42). Based on a random stratified design, the results of this survey indicate that the most abundant species was *D. eleginoides* with a biomass of just over 18 000 tonnes. Other species of commercial interest, *C. gunnari* and *N. squamifrons*, had a total biomass of 14 200 and 7 900 tonnes respectively. This survey is the first to cover the entire shelf area of Heard Island since the Australian EEZ was declared in 1979. Although comparison with other survey results is difficult, the survey tends to confirm the presence of a small concentration zone of *C. gunnari* to the northeast of Heard Island. Despite being a first attempt at a comprehensive survey of the shelf area, it has indicated an otherwise low biomass of fish.

Division 58.4.4 (Ob and Lena Banks)

245. For the first time, catch data for *N. squamifrons* have been reported individually for Ob and Lena Banks for the years 1978 to 1989 (WG-FSA-90/37). This has permitted more detailed assessment of these stocks. The catch data given in WG-FSA-90/37, however, differ significantly from those submitted to CCAMLR (see Figure 1). These two versions need to be reconciled. The history of catches from this area is shown in Figure 14. Although the catches have been reported by calendar year (WG-FSA-90/37), the total catch is much greater than previously reported, particularly in 1986. For the purposes of stock assessment, the catch data by calendar year from 1978 to 1989 have been used.

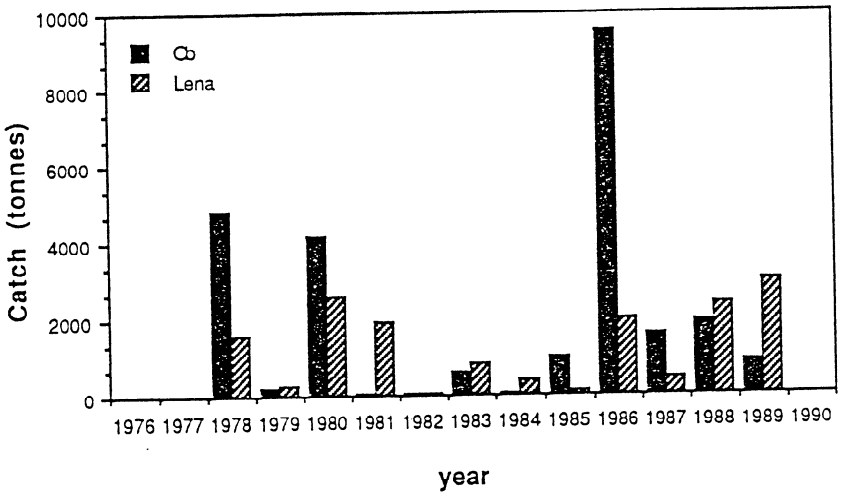


Figure 14: *N. squamifrons* - catches at Ob and Lena Banks.

*Notothenia squamifrons* (Division 58.4.4)

Lena Bank

246. In 1989/90, the catch for Ob and Lena Bank was reported as 1 450 tonnes, but no area separation was given. To approximate the catch from Lena Bank in 1989/90, the same ratio of catches from the two seamounts was used as reported in 1988/89 (WG-FSA-90/37). The estimated catch in 1989/90 was 1 112 tonnes from Lena Bank and 338 tonnes from Ob Bank.

247. The results of trawl surveys on Lena Bank from 1980 to 1989 were also reported in WG-FSA-90/37. A number of different vessels and nets were used throughout this time in different months of the year. However, the details of the results were not provided and there is a possibility that the non-random design of the surveys may have over-estimated abundance. The 1980 and 1986 surveys were considered to be the most reliable by the author of WG-FSA-90/37. Stock size is reported based on the swept area method using wingspread estimates with a catchability coefficient of 0.5.

248. A series of catch and effort indices from 1978 to 1989 was presented in WG-FSA-90/37 and was used to carry out a VPA for each area in Division 58.4.4. However, no catch-at-age data or fishing mortality estimates were provided. The biomass estimates resulting from this assessment are unusual, showing an upward trend at Lena Bank (Figure 15) at a time when catches were increasing (1986 to 1989). This upward trend in biomass estimates from the VPA suggests that the effects of fishing are not adequately represented by the fit of the model. Therefore, the stock assessment for Lena Bank was re-calculated by VPA, using the survey estimates to calibrate changes in biomass.

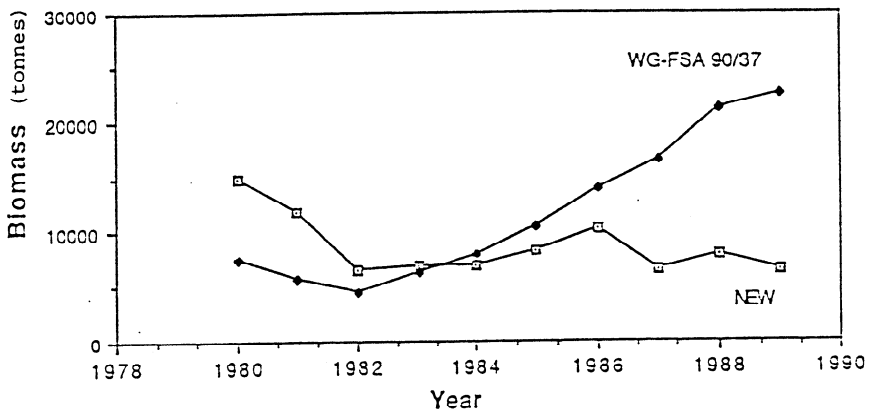


Figure 15: Trends in biomass of *N. squamifrons* on Lena Bank from VPAs provided in WG-FSA-90/37 and after re-calculation by the Working Group.

249. The catch-at-age data for Lena Bank was based on the proportions at each age previously used in the assessment (WG-FSA-89/5). The catches-at-age were scaled up to the total catch reported for the Lena Bank using weights-at-age given in WG-FSA-90/37. The distributions of catches-at-age for 1988 and 1989 were both based on the 1987 sample distributions.

250. In the revised assessment, the trawl survey estimates of biomass in 1980 (19 800 tonnes) and 1986 (11 800 tonnes) were used as relative measures of abundance. The VPA was tuned so that the biomass at the end of 1986 was 60% of the biomass at the end of the 1980 fishing season. Estimates of the catchability coefficients for the surveys, based on the VPA model were 0.9 in 1986 and 1.2 in 1980. Based on this assessment, the Lena Bank stock shows a decrease in biomass from 1980 to 1989 (Figure 15). This is more consistent with the catch history of the fishery, when the rate of natural mortality and age distribution is considered.

251. Fishing mortality in 1988/89 was estimated to be 0.8 for fully recruited age classes. The projection to 1989/90, based on a catch of 1 112 tonnes, results in fishing mortality of 0.47. The stock was further projected to 1990/91 using average values of recruitment from the VPA.

252. The yield estimate based on $\mathbf{F_{0.1}}$ of 0.13 was 305 tonnes using the projected biomass in 1990/91 of 3 454 tonnes.

## Management Advice

253. Although the catch data from 1978 to 1989 (by calendar year) were presented in WG-FSA-90/37, catches were not reported separately from the two seamounts in 1990. Length frequency and age composition data are also required for the years since 1987. Details of the design and results from trawl surveys from 1980 to 1989 for Ob and Lena Bank should be provided to the Working Group.

254. Recent values of fishing mortality for Lena Bank are much higher than the $\mathbf{F_{0.1}}$ level, and the stock has decreased in size in recent years. As this species is slow growing and long lived (15+ years), catches at historical levels will not be sustainable. Catches should be limited to the level of $\mathbf{F_{0.1}}$ yield.

Ob Bank

255. Catches of *N. squamifrons* from 1978 to 1989 on Ob Bank are shown in Figure 14. The maximum catch occurred in 1986 when 9 531 tonnes were reported. Catches in most years were low, reflecting little fishing effort on this species. However, there are two main periods of fishing from 1978 to 1980 and from 1985 to 1989. Based on the distribution of catches in Division 58.4.4 in 1988/89, the 1989/90 catch was estimated at 338 tonnes.

256. Two trawl surveys were reported for the Ob Bank (WG-FSA-90/37) carried out in 1980 and 1986, and analysed using a catchability coefficient of 0.5. For the Lena Bank assessment described earlier, catchability coefficients of 0.9 and 1.2 were calculated for surveys in 1980 and 1986, using the same vessel and gear as used in the Ob Bank surveys. Assuming a catchability coefficient of 1.0 for these surveys gives biomass estimates of 5 100 tonnes (1980) and 5 500 tonnes (1986).

257. Catch-effort indices from 1978 to 1989 were used to carry out the VPA reported in WG-FSA-90/37. The trend in biomass from 1978 to 1989 is shown in Figure 16. After a drop in biomass following the large catch in 1986, the biomass shows an upward trend. As catch-at-age and fishing mortality estimates were not provided, it is not possible to evaluate the fit of the model to the Ob Bank fishery.

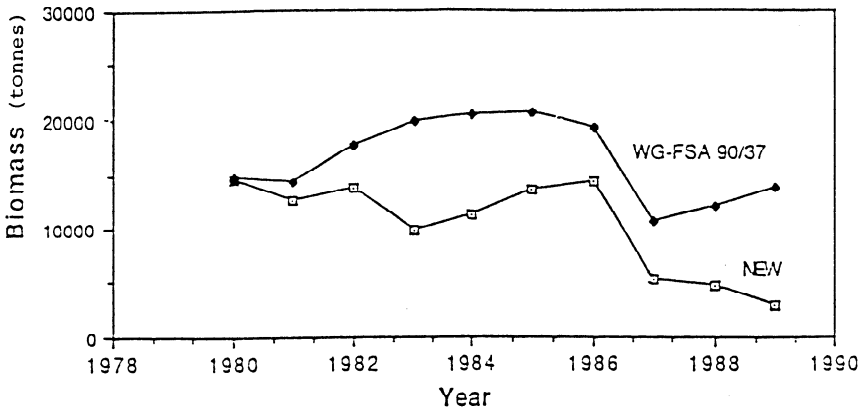


Figure 16: Trends in biomass of *N. squamifrons* on Ob Bank from VPAs provided in WG-FSA-90/37 and after re-calculation by the Working Group.

258. The Ob Bank stock was also re-assessed by VPA using the biomass estimate from the 1986 survey to calibrate the model. Catch-at-age data have not been available since 1987. In addition, the catch-at-age for 1980 to 1987 from the Ob Bank has not been estimated, although the data on length and age composition from the commercial fishery have been

submitted. The relative proportions at each age from Lena Bank data for the years 1980 to 1989 were used as input to the assessment.

259. The results of the VPA using the trawl survey estimate are shown in Figure 16. The trend in biomass differs from that in WG-FSA-90/37, particularly in the most recent years. The fishing mortality in 1988/89 was estimated to be 0.4 for fully recruited age classes. A projection to 1989/90 results in a fishing mortality estimate of 0.17. Using a further projection to 1990/91 resulted in a biomass of 2 949 tonnes and an $\mathbf{F_{0.1}}$ yield estimate of 267 tonnes.

## Management Advice

260. As for the Lena Bank stock, the provision of catch data separated by area and the details of surveys carried out in the Ob Bank is recommended. The assessment of this stock should be re-analysed as soon as catch-at-age and separate catch data for each bank are available.

261. The level of fishing mortality on the Ob Bank stock has been higher than $\mathbf{F_{0.1}}$ for a number of years. As a result of the large catch in 1986, the stock is currently depleted. Catches should be reduced below $\mathbf{F_{0.1}}$ levels for a few years to allow the stock to rebuild to optimum levels.

### Subarea 58.4

262. Although it was agreed at the last meeting of WG-FSA that care should be taken to report catch by species correctly, *C. wilsoni* catches in Division 58.4.2 are still being reported as *C. gunnari*. Also, no fine-scale catch reports or analysis have been submitted for *P. antarcticum* in Subarea 58.4 although the desirability of these data was stressed at the last meeting and by Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) (Annex 6).

#### Division 58.4.2

263. A Soviet survey in Prydz Bay and the shelf areas to the west revealed the presence of some dense concentrations of *C. wilsoni* and *Trematomus eulepidotus*. Catches reported by

the Soviet Union for these species were 339 and 148 tonnes respectively. Biomass estimates of the two species from both trawl and acoustic surveys were provided together with preliminary biological data, but the lack of age composition data, fine-scale catch and effort data and more detailed information on the conduct of the survey makes further assessment impossible at this stage.

264. Fine-scale catch and effort data for all previous catches of *C. wilsoni* in this division, have not been submitted despite the request at last year's meeting. In addition, fine-scale catch and effort data and biological data are required for all species taken in future seasons.

### Management Advice

265. Due to the lack of data no management advice could be provided.

## GENERAL ADVICE TO THE COMMISSION

266. In addition to the recommendations concerning stock assessments, the Working Group reviewed:

- Conservation Measures established in 1989;
- the progress of data submission; and
- questions posed by the Commission to the Scientific Committee.

### Review Of Conservation Measures

267. Conservation measures established in 1989 were reviewed on the basis of available data and assessments conducted by the Working Group. Conservation measures of an administrative nature were not included in these discussions.

#### Conservation Measure 13/VIII: Limitation of the Total Catch of *Champsocephalus gunnari* in Statistical Subarea 48.3 in the 1989/90 Season

268. The TAC for *C. gunnari* needs to be revised in the light of the assessments and advice presented in paragraphs 137 to 141 and Appendix L.

269. From the reported catches this year, the by-catch in the mid-water trawl fishery for *C. gunnari* appeared to be very low. The Working Group agreed that Provision 5 of this Conservation Measure, which prohibits bottom-trawling in Subarea 48.3, should be retained. The Working Group also felt that the retention of by-catch provisions would not hinder the midwater trawl fishery for *C. gunnari* but would maintain a safeguard for the species listed in Provision 2 of the Conservation Measure (see paragraph 95).

270. The Working Group agreed that the by-catch limit of 300 tonnes should be retained for all species in Provision 2, except *N. gibberifrons*. For the latter species, 500 tonnes was noted as the possible limit to by-catch (see assessment summary, Appendix L). However, some Members expressed caution that an allowable by-catch of 500 tonnes may have detrimental effects on other depleted species because of the inability to control by-catch and the possibility of mis-identifying or not recognising the smaller catches of these other species.

271. The Working Group agreed that the fishery in Subarea 48.3 should close if any of these by-catch levels are reached as detailed in Provision 3.

272. It was also agreed that Provision 4, where the fishing vessel must move to another fishing ground within the subarea if any of the by-catch species exceed 5% in any haul, should be retained and that the catches be reported as described in Provision 6.

Conservation Measure 14/VIII: Prohibition of Directed Fishery on *Notothenia gibberifrons, Chaenocephalus aceratus, Pseudochaenichthys georgianus* and *Notothenia squamifrons* in Statistical Subarea 48.3 in the 1989/90 Season

273. The Working Group agreed that this Conservation Measure should be retained.

Conservation Measure 15/VIII: Closed Seasons in the 1989/90 Season in Statistical Subarea 48.3

274. The Working Group felt that it was unable to comment on the closed season between 20 November 1989/90 and 15 January 1990 as it was an administrative matter. The closed season between 1 April and 4 November 1990 was set in place to protect the stock during its spawning period, and the Working Group agreed that because the spawning season may vary from year to year in an unpredictable manner and that *C. gunnari* has been reported to spawn

in April (Kock, 1990, CCAMLR Selected Scientific Papers 1989, SC-CAMLR-VIII/BG/16) this closed season should be retained to protect spawning.

### Conservation Measure 16/VIII: Catch Limit on *Patagonotothen brevicauda guntheri* in Statistical Subarea 48.3 for the 1989/90 Season

275. The Working Group agreed that the TAC for *P.b. guntheri* should be revised. Two views were expressed on the nature of the revision. WG-FSA-90/12 made it clear that the reported catches of this species did not correspond to the fine-scale data, which suggested that catches came from both South Georgia and Shag Rocks. As *P.b. guntheri* is a small fish that requires a small net for capture, trawling for this species around South Georgia may take a by-catch of depleted species that the Commission is trying to protect (see paragraph 50). Some Members felt that until reliable data are submitted the fishery should be closed.

276. The discrepancies in the data will be investigated by the Members from the USSR. In their view, the problem was one of reporting rather than of exploitation and, as such, the TACs for this species should be set in line with the assessments (see paragraphs 151 and 154, and Appendix L).

### Conservation Measure 17/VIII: Catch Reporting System in Statistical Subarea 48.3 in the 1989/90 Season

277. The Working Group considered that it should only comment on paragraph 2, regarding the data to be reported, as the remainder of this measure is administrative. However, it was felt that access to this data for analyses prior to the Working Group meeting was useful and that effort data would also be useful in this regard. Accordingly, the Working Group agreed that in addition to the data requested in this paragraph, effort data should be submitted in accordance with the indices specified in the STATLANT B forms (total catch, days and hours fished).

### Resolution 5/VIII: Protection of Seabirds from Incidental Mortality Arising from Longline Fishing

278. The Working Group felt it was unable to comment on this resolution.

Resolution 6/VIII: Protection of *Notothenia gibberifrons* in the Peninsula Area (Statistical Subarea 48.1) and around South Orkneys (Statistical Subarea 48.2)

279. The Working Group noted that in light of the Commission's request to refrain from directed fishing for *N. gibberifrons* and to ensure that by-catch of this species be avoided, there had been no fishing in Subarea 48.1 but, in Subarea 48.2, a directed fishery on *C. gunnari* took 340 tonnes of *N. gibberifrons* as by-catch. Due to the lack of information from a number of seasons the Working Group was unable to assess the present state of *N. gibberifrons* in Subarea 48.2.

Submission of Data

280. The list of data requested for submission by the Working Group at its 1989 Meeting is contained in Appendix 9 of its report (SC-CAMLR-VIII, Annex 6). The submission of these data and other requests by the Scientific Committee was endorsed by the Commission at its last meeting (CCAMLR-VIII, paragraph 63). These are summarised in Appendix I, which also summarises the data received by the Working Group and the data from this list that are still required by the Working Group.

281. Overall, very little of the data from this list has been submitted to CCAMLR. The Working Group agreed that the failure to submit data, endorsed as necessary by the Commission, was a serious problem. While the Working Group provides the best assessments it can using all the scientific data available, the Working Group agreed that its understanding of the fisheries would be enhanced with the submission of all the data requested. The Working Group also agreed that when formulating advice for the Scientific Committee it needs to take the uncertainty associated with stock assessments into account. The level of uncertainty can be reduced with the submission of more data. While the uncertainty remains high, the Working Group has no option but to recommend conservation measures that tend towards higher probabilities of preventing depletion of the stocks as well as providing for more stable fisheries.

Questions from the Commission

282. Last year the Commission requested that the Scientific Committee provide advice on the following questions concerned with new and developing fisheries (CCAMLR-VIII, paragraph 123):

(a) the types of information needed to characterise and estimate the potential yield of unexploited and under-exploited fishery resources;

(b) the types of information needed to determine an initial threshold level above which catches should not be allowed to increase without programs in place to assess the effects of the catches, including by-catch, on target, dependent and associated species;

(c) how the needed baseline information can best be obtained;

(d) how the developing fishery might best be regulated in order to identify and efficiently achieve, but not exceed, the maximum catch levels consistent with Article II of the Convention;

(e) how the identified information needs might best be met; and

(f) how long it might take to acquire the required knowledge.

283. The Working Group considered that the answers to these questions were interrelated and that detailed answers will vary depending on the fishery to be developed. The Working Group, therefore, decided to provide a more general discussion on the issues that arose from these questions.

284. The potential yield of a stock is that catch level that is consistent with the objectives of CCAMLR set out in Article II. This can be assessed using estimates of biomass, natural mortality, growth parameters, and age and size at sexual maturity. The precision and accuracy of the initial estimate of the potential yield will depend on the quantity and quality of data presented for the initial analysis and the resulting level of uncertainty in each of the parameters used in the calculations.

285. The magnitude of the error (uncertainty) in the estimate of potential yield provides the lower and upper bounds for defining the risks to the stock (0-100% respectively) when establishing catch levels. The risks to the stock are those of failing to meet the objectives of Article II by catching more than the potential yield. For each point within the range between these bounds the fishery will pose a corresponding risk of exceeding the potential yield that depends on the relationship between the stock, the fishery and the ability to estimate the necessary biological parameters.

286. The consideration of risk also needs to incorporate those risks to the ecosystem as a whole. In cases where the species to be targeted has an important role in the ecosystem, the maximum allowable catch may need to be less than the potential yield.

287. In the very early stages of the fishery, the availability of data will be low. Therefore, the danger of exceeding the potential yield consistent with Article II will be relatively high compared to an established fishery. Consequently, it was agreed that the development of the fishery should be directly linked with the process of elaborating scientific advice and management.

288. A first step in the development of a fishery could be to determine the level of catch at which there would be no possibility of exceeding the potential yield, i.e. the lower boundary of the estimate of potential yield (modified for the ecosystem interactions if necessary). Catches below this level could be essentially unregulated. For example, myctophids are known to have a high abundance, although the exact biomass is not known. It is conceivable that a commercially viable level of catch could be taken from these stocks without jeopardising the stocks. The important point is to determine the level at which regulation may need to be applied to the fishery to prevent the risks detailed above.

289. The Working Group identified the following information that would be important for assessing this initial catch level, below which there would be no regulation:

(i) biological information from comprehensive research/survey cruises, such as distribution, abundance, demographic data and information on stock identity;

(ii) details of dependent and associated species and the likelihood of them being affected in some way by the proposed fishery;

(iii) the nature of the proposed fishery, including target species, methods of fishing, proposed region and any minimum level of catches that would be required to develop a viable fishery; and

(iv) information from other fisheries in the region or similar fisheries elsewhere in the world that may assist in the evaluation of potential yield.

290. The Working Group felt that such information should be submitted before the fishery begins to develop so that the development of the fishery fulfils the objectives of CCAMLR. The information detailing the proposed fishery was considered to be important because it

would allow the Scientific Committee to specify the data requirements necessary for the formulation of advice for the particular fishery to be developed. Each species, fishing method and area to be fished have unique characteristics that will need to be considered when formulating advice. In this context, the Scientific Committee will need to address the problem of stock designation and identify discrete management areas based on biological characteristics of the stock.

291. During this initial phase of the fishery, biological and catch data could be obtained that will be useful to:

(i) refine the precision and accuracy of the estimated potential yield, thereby reducing the uncertainty in the estimate; and

(ii) provide assessments on how the fishery could be developed to achieve catches at the potential yield.

292. As a result of these continuing revisions of the potential yield and its associated errors the uncertainty associated with allowable catch levels will be reduced and the fishery will become more predictable.

293. One possible method for incorporating the uncertainty associated with estimates of biomass and potential yield in calculations of the level of total allowable catch, which would ensure the objectives in Article II are achieved, is outlined in SC-CAMLR-IX/BG/14. In this method, estimates of stock parameters and their associated errors are used to calculate the probability of the stock declining below its existing level as well as for it maintaining a level above an estimated 'Greatest Net Annual Increment' (GNAI), given a nominated catch rate over a 20 to 30 year period. This method would help estimate the risk of depleting the stock when fishing at selected levels.

294. The Working Group recognised the desirability of proactive management that fully accounts for the uncertainty in the estimates of population parameters and the degree of unpredictability in the stocks themselves in the development of a fishery. This would ensure that the development of the fishery does not outpace the ability of the Commission to achieve the objectives in Article II.

## FUTURE WORK

### Data Requirements

295. A table of data requirements identified by the Working Group throughout the rport is given in Appendix I. Appendix I also gives details of data requirements identified in Appendix 9 of the 1989 Working Group report.

296. It was emphasised that much of the data from the commercial fishery in 1990, specifically fine-scale catch data and biological data, was unavailable to the Working Group. It was noted that the acquisition of this data was vital for the correct functioning of the Working Group and it was also mandatory under Articles IX and XX of the Convention.

297. In particular, the fine-scale data are of great value to the work of the Working Group, and steps should be taken to ensure their quality and timely submission.

298. The Working Group specifically sought information on the potential predators of *E. carlsbergi* in order to determine the impacts that this fishery is likely to have on dependent species. It was also requested that in order to determine the full impact of this fishery, fine-scale catch data should be reported for *E. carlsbergi* from areas outside the Convention Area, in addition to the existing requirement for reporting these data within the Convention Area.

299. Data on the size selectivity of the longline fishery for *D. eleginoides* are required for future assessments of this species. Dr C. Moreno (Chile) reported that similar investigations had been carried out by Chilean scientists for the *D. eleginoides* fishery conducted off Chile, and a report of these activities will be available to the Working Group at its next meeting. In addition, a description of the Soviet fishery operation was requested by the Working Group.

300. The Working Group re-emphasised the urgent need to obtain data on the by-catch of fish in the krill fishery (paragraph 27). It recommended that the reporting format described in Appendix J should be developed for the reporting of by-catch data from commercial krill trawls. The Secretariat was asked to distribute a draft for comment as soon as possible.

301. The Working Group requires data from research vessel surveys to be reported haul-by-haul so that additional analyses can be undertaken when required. Accordingly, it was recommended that survey data be reported haul-by-haul to the CCAMLR Data Centre. The Data Manager was asked to develop and distribute details of reporting formats for survey

data which should include *inter alia* details of haul number, vessel call sign, date and position in degrees and minutes.

302. The Working Group also recommended that where possible haul-by-haul data of this nature should be reported to CCAMLR from experimental fisheries.

303. In addition to taking note of the guidelines for reporting assessment results to the Working Group identified by the Task Group in Appendix F, the Working Group endorsed the form described in Appendix K for use when reporting details of intended and completed research surveys to the Scientific Committee and Working Group.

304. Incidental information obtained during research surveys concerning the distribution of young fish would be of use to the Working Group, especially when considering the impacts of incidental mortality in the krill fishery.

Data Analyses and Software to be Prepared Prior to the Next Meeting

305. The Working Group thanked the Secretariat for providing excellent support to the Working Group during the Meeting. In particular, it was noted that hardware facilities had been upgraded this year to include an MS-DOS machine and that a wider range of stock assessment programs were available to the Working Group. All the requests of the Working Group in 1989 had been addressed.

306. A request was made that a simpler interface be made between DOS machines and the Secretariat's printers.

307. The Draft Statistical Bulletin (SC-CAMLR-IX/BG/2) was available to the Working Group for the first time during this Meeting. The Working Group considered the Bulletin to be a welcome addition to the Secretariat's publications and a number of comments were made concerning the format of the Bulletin.

308. It was noted that SC-CAMLR-IX/BG/5 provided details of currently available biological data. The document also contained details of data access protocols. Several Members had accessed this data during the year for use in analyses presented at the Meeting, and Members were encouraged to use this facility for similar analyses in the future.

309. Following the assessment of *C. gunnari* presented in WG-FSA-90/27 it was suggested that the Data Manager investigate the relationship between standardised CPUE data from STATLANT reports and stock biomass as estimated, for example, by VPA analysis. The fisheries for *C. gunnari* and *N. gibberifrons* in Subarea 48.3 could be used as starting points for this investigation.

310. It was agreed that the Secretariat should compile a summary of all the data on each species in each area and an introduction to the assessments performed on those species in the past, and provide it to next year's Working Group meeting.

311. It was suggested that the Secretariat produce a paper at the next meeting summarising the performance of successive working groups. This would include a description of changes in the assessments undertaken and the advice provided by the Working Group at successive meetings, and how this advice has been treated by the Scientific Committee and the Commission.

Organization of the Next Meeting

312. The Working Group agreed that the late submission of papers to the Meeting this year meant that delegates were unable to give full consideration to some papers. The Working Group agreed that in future

- papers that arrive at the Secretariat later than the day before the meeting will not be considered at that meeting; and

- the deadline for submission of papers for consideration at the meeting will be re-named the 'recommended date' for submission. Papers submitted by this date will be distributed prior to the meeting.

313. The Convener informed the Working Group that he would be stepping down from the position following the 1991 Meeting of the Working Group.

314. Last year an intersessional meeting was arranged between the Convener of the Working Group, the Chairman of the Scientific Committee and the Data Manager. This Meeting was considered valuable for the pre-meeting organization of work by the Secretariat, and whilst it was thought unnecessary to arrange travel specifically for this purpose in 1991

the Working Group felt that another meeting should take place during the next intersession if circumstance allows.

## ADOPTION OF THE REPORT

315. The Report of the Meeting was adopted.

## CLOSE OF THE MEETING

316. The Convener closed the Meeting and thanked the participants for their willing collaboration and patience. He also thanked the rapporteurs and the Secretariat for their excellent support in conducting the Meeting.

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APPENDIX A

## LIST OF PARTICIPANTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 9 to 18 October 1990)


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APPENDIX B

# AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 9 to 18 October 1990)

1. Opening of the Meeting

2. Organization of the Meeting and Appointment of Rapporteurs

3. Adoption of the Agenda

4. Possible Improvements in the Scientific Committee's Ability to Provide Management Advice

5. Review of Material for the Meeting
   - 5.1 Questions Raised and Information Needed by the Commission
   - 5.2 Catch and Effort Statistics
   - 5.3 Size and Age Composition Data
   - 5.4 By-Catch of Fish Larvae and Juvenile Fish in the Krill Fishery
   - 5.5 Other Available Biological Information
   - 5.6 Mesh Selectivity and Related Experiments
   - 5.7 Assessments Prepared by Member Countries
   - 5.8 Other Relevant Documents

6. Methodologies Used for Surveys and Assessments

7. Assessment Work
   - 7.1 Organisation of Assessment Work
   - 7.2 Discussion of Assessments Carried Out by Member Countries and During the Meeting
     - 7.2.1 South Georgia (Subarea 48.3)
       - 7.2.1.1 *Notothenia rossii*
       - 7.2.1.2 *Champsocephalus gunnari*
       - 7.2.1.3 *Patagonotothen brevicauda guntheri*
       - 7.2.1.4 *Dissostichus eleginoides*

8.2 South Orkney Islands (Subarea 48.2)
- 8.2.1 *Champsocephalus gunnari*
- 8.2.2 *Notothenia gibberifrons*
- 8.2.3 Other species

8.3 Antarctic Peninsula (Subarea 48.1)
- 8.3.1 *Champsocephalus gunnari*
- 8.3.2 *Notothenia gibberifrons*
- 8.3.3 Other Species

8.4 Kerguelen Islands (Division 58.5.1)
- 8.4.1 *Notothenia rossii*
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| WG-FSA-90/6 | AN ASSESSMENT OF *CHAENOCEPHALUS ACERATUS* AND *PSEUDOCHAENICHTHYS GEORGIANUS* IN SUBAREA 48.3<br>D.J. Agnew and K.-H. Kock |
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| WG-FSA-90/12 | THE FISHERY FOR *PATAGONOTOTHEN BREVICAUDA GUNTHERI* IN CCAMLR SUBAREA 48.3<br>Inigo Everson and Catherine Mitchell |
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| WG-FSA-90/14 | DECLINING TREND IN THE ABUNDANCE OF FJORD FISH OF THE SPECIES *NOTOTHENIA ROSSII* MARMORATA AND *NOTOTHENIA GIBBERIFRONS* OBSERVED AT TWO LOCALITIES OF SOUTH SHETLAND ISLANDS<br>Esteban Barrera-Oro and Enrique Marschoff (Argentina) |
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APPENDIX D

# CAN WE IMPROVE MANAGEMENT ADVICE FOR CCAMLR FISH STOCKS - LIVING WITH UNCERTAINTY

## INTRODUCTION

Since 1984, proposals have been put forward in the Scientific Committee and the Commission with increasing support each year for more stringent measures regulating finfishing, including its prohibition in Statistical Area 48 or Statistical Subarea 48.3. These have not been adopted because fishing countries have argued that the scientific advice was uncertain due to:

(i) the unavailability or lack of information required for the assessment of some stocks;

(ii) the late and inadequate submission of data from some fisheries which have been operating for a number of years; and

(iii) the lack of information from recently developed fisheries, such as the longline fishery on *Dissostichus eleginoides* or the midwater trawl fishery on the myctophid *Electrona carlsbergi* in the South Polar Frontal Zone.

2. As a result the Working Group on Fish Stock Assessment (WG-FSA) was only able to assess the state of 14 out of 32 stocks for which catches have been reported.

3. The continuous lack of sufficient information which should have been available from the fisheries in accordance with Article XX of the Convention resulted in the adoption of Conservation Measures which are not sufficient to ensure the recovery of most of the stocks. This has led to a lowering of the credibility of CCAMLR in the eyes of the public and a strong polarisation of opinions inside CCAMLR.

4. Following a request by the Scientific Committee (SC-CAMLR-VIII, paragraph 3.49), an attempt is made in the following to outline data and analyses required to improve the knowledge on the stocks and, hence the outcome of the work of the WG-FSA.

## STOCK IDENTITY

5. The knowledge of stock identity is a prerequisite in any (fish) stock assessment. Vast oceanic areas in between shelf areas in the Southern Ocean have led to the general conclusion that these isolated shelf areas host separate populations (stocks). The problem of stock separation has been investigated using morphometric and meristic characteristics in a number of species, such as *D. eleginoides*, *Notothenia rossii* or *Champsocephalus gunnari* but the statistical methods involved in the analysis were often inadequate to resolve the problem. Recently, investigations on stock separation have been started in *C. gunnari* using protein electrophoresis and mitochondrial DNA which have indicated, for example, the possible presence of more than one stock of *C. gunnari* around South Georgia and Shag Rocks. Similar studies should be carried out for other species, in particular those species with an extended bathymetric range such as *D. eleginoides* and *Notothenia squamifrons* for which deeper water may not form the anticipated stock boundary and in pelagic species such as *Pleuragramma antarcticum* and *E. carlsbergi*.

## DATA COLLECTION

### Field Sampling

#### Research Vessel Surveys

6. Research vessel surveys could ideally provide the following information:

- standing stock biomass for all species (exploited and unexploited);
- length and age structure from the exploited populations;
- length-to-weight relationships;
- maturity ogives;
- geographical and bathymetric range of stocks; and
- year class strength of pre-recruits.

7. The objective of research vessel surveys is to estimate the density of fish in the survey area. These density estimates are used in a stratified survey design to estimate the biomass of the exploited population and of the pre-recruits of the target species. A number of alternative techniques exist including:

- bottom trawl survey;
- mid-water trawl survey;
- acoustic survey;
- egg production method; and
- mark-recapture experiments.

8. All these techniques have problems inherent to the methodology used (e.g., catchability coefficients, target strength, etc.). As the most commonly used method is the bottom trawl survey the following discussion mainly refers to our experience with this technique in the Convention Area.

9. The only fishing area covered by fishery-independent surveys conducted over a number of years is South Georgia, where at least one bottom trawl survey has been carried out per season since 1984/85. The coordination of surveys and collaboration in the analysis of the results such as undertaken by UK and USSR in 1989/90 (see WG-FSA-90/11 and 13) have the potential to provide a substantial advance in the work of the WG-FSA.

10. In Subarea 48.3 fisheries have recently developed on *E. carlsbergi* and *D. eleginoides*. *E. carlsbergi* is a pelagic species which can be surveyed acoustically with net hauls to provide essential biological information. The methods are still undergoing development. *D. eleginoides* is found over a wide depth range and is currently taken in a longline fishery. New techniques need to be developed for its assessment.

11. The other fishing grounds are much less covered by research vessel surveys, in particular the South Orkney Islands. The Federal Republic of Germany carried out a number of surveys around Elephant Island between 1983 and 1987 but will probably be unable to continue this on an annual or biennial basis. Fishery-independent surveys in fishing areas other than South Georgia are particularly crucial for the assessment of these stocks because the irregular nature of the fishery on these grounds often prevents the utilisation of common assessment methods, such as the Virtual Population Analysis. One approach to increase the frequency of surveys might be multinational surveys with logistic and financial support provided by a number of Members and coordinated through CCAMLR.

12. A protocol for the submission of survey data to CCAMLR has been recently developed containing all relevant information (survey design, wing spread of the trawl, etc.) for stock assessment purposes.

13. Abundance estimates from bottom trawl surveys with a stratified random survey design have their limitations in species which are highly gregarious, such as *C. gunnari* and *N. rossii*, when these surveys are not stratified according to fish density. This is usually impossible prior to a survey, as fish concentrations are not stable seasonally and annually (see WG-FSA-90/11). Other types of surveys, such as pre-recruit surveys may be more feasible to estimate year class strength in these species.

14. There is uncertainty as to the relationship between estimates of biomass from trawl surveys and actual stock biomass. This uncertainty has become important in recent years as the number of survey biomass estimates available for assessment work has increased. The relationship between survey estimates of abundance and actual abundance should be investigated for important stocks. Methods used to study these relationships will require careful evaluation by the Working Group since the statistical problems involved are significant.

15. Abundance indices from pre-recruit surveys are commonly utilized in the assessment work of fisheries organisations in other parts of the World Ocean, such as in ICES (e.g., International Young Fish Survey). They have been mentioned repeatedly in CCAMLR in the last few years as one means to better assess the recovery of some stocks, such as *N. rossii* and *C. gunnari*.

16. Pre-recruit surveys based on trammel net catches of *N. rossii* in the Kerguelen Islands since 1984 indicate a slow but continuous recovery of the stock (Duhamel, 1990). A similar program carried out in Potter Cove (King George Island) demonstrated a decline in the abundance of juvenile *N. rossii* (see WG-FSA-90/14). A similar shore-based trammel net survey at South Georgia would help to assess the state of the stock of *N. rossii* in that area.

17. Results from pre-recruit surveys on *C. gunnari* were available to CCAMLR only once, when a report on a Soviet pre-recruit survey carried out in June to July 1985 was submitted (Boronin *et al.*, 1987). However, its results were difficult to incorporate in the work of the WG-FSA as it was only a point estimate and the survey design was inadequately described. Intensifying pre-recruit surveys, designed either to estimate the abundance of 0 group or 1 group fish, would certainly improve the assessment of the stocks of *C. gunnari* considerably and may be an alternative or complement to the bottom trawl surveys currently carried out. They require, however, a sound knowledge of the horizontal and vertical distribution of the 1 group fish, which may not be available at present. Abundance of 0 group fish may be monitored according to the scheme proposed by North (1987).

18. The results from all survey methods are subject to uncertainty arising from a number of sources. The results are subject to statistical uncertainty arising from sampling error, which, because fish usually have patchy distributions, remains high even with large amounts of survey effort. Additionally the distribution and abundance of fish can change considerably from year to year. Other technical factors have to be estimated to convert survey results into estimates of absolute abundance, and these are also estimated with uncertainty. Consequently the results of a series of surveys can show large fluctuations over time, which may or may not be due to variations in the abundance of fish. While increased scientific effort can reduce the uncertainty to some extent, particularly over a long time-scale, all the uncertainty cannot be eliminated, and in most practical situations it is likely to remain considerable.

## Commercial Fishery

### Catch Statistics

19. Accurate catch statistics are a prerequisite for any fish stock assessment and Members are obliged to submit catch data annually (Article XX). The WG-FSA has discussed this matter repeatedly and has listed a number of areas and stocks over the last years where the Working Group felt that catch statistics were inadequate. Problems ranged from non-reporting of species, such as *Pseudochaenichthys georgianus* and *Chaenocephalus aceratus,* misidentification of species, such as *Chaenodraco wilsoni*, reporting of catches where the species does not occur, such as *Patagonotothen brevicauda guntheri* (see WG-FSA-90/12), lumping of catch statistics from separate fishing grounds, such as Ob and Lena Banks, to the lack or unavailability of historical catch statistics. Detailed lists of catch data needs are contained in the reports of the Scientific Committee since 1984.

20. The collection of catch statistics is carried out under national responsibility. The adoption of conservative Conservation Measures by the Commission might be one of the means to encourage Members to improve their data submission in compliance with Article XX.

### Fine-Scale Catch and Effort Statistics

21. Fine-scale catch and effort statistics are the primary source for the WG-FSA for information on patterns of commercial fishing and catch-per-unit effort. The timely submission of this information is a prerequisite for the work of the WG-FSA and will become

even more crucial in the near future when a time series of these data is available. Although the Commission in 1987 agreed that fine-scale catch and effort data for finfish should be submitted from the 1987/88 season onwards, this kind of information has been submitted to CCAMLR only for the 1987/88 season but not for the 1988/89 and 1989/90 seasons. Furthermore, it was evident from WG-FSA-90/12 that some of the information contained in the fine-scale data was not adequate for assessment work. According to the fine-scale data the catches of *P.b. guntheri* were mainly taken around the mainland of South Georgia where this species has never been found before.

### Discards

22. Uncertainties about the amount of discards (i.e., fish caught, but not landed) form a substantial problem in fish stock assessment in other parts of the World Ocean, such as in the Northwest and in the Northeast Atlantic. This problem has found little attention in the work of the WG-FSA, although it is likely to be less substantial as most fish are either processed or reduced to fish meal and oil. However, some deep water fish occurring in the diet of wandering albatross at South Georgia were likely to be discards rather than taken alive close to the surface. Reports from the fishing nations on discards and the presence of observers onboard fishing vessels to estimate the amount of discards would help the WG-FSA to better assess the magnitude of that problem for their assessment work.

### Conversion Rates

23. Conversion rates are commonly used to extrapolate commercial and even research vessel catches from the weight of various types of fish products. Information on the various products and their conversion factors is sparse and originates from investigations in the 1970s which were sometimes carried out only on a trial basis. Given the improvements in the processing technology since then, these values are likely to be out of date, and could lead to considerable bias in catch statistics if still in use. Conversion rates and their differences between fishing fleets as a potential source of bias in catch statistics has never been considered by the WG-FSA. An account of the conversion rates used in the various fishing fleets is needed for comparative purposes.

## Biological Sampling

24. The basic requirement for a number of assessment models, such as the VPA, is the length/weight and age composition of the catches. This is crucial as the exploited stock may have a length and age composition which is very different from the population as a whole. This is particularly obvious in *C. gunnari* (see WG-FSA-90/11). Non-representative sampling may then lead to a considerable bias in the age composition and hence in the assessments.

25. In the past, Members were often unable to cover their fishing fleet adequately by biological sampling. As a result, age compositions of the 'by-catch' species, such as *Notothenia gibberifrons*, but also the target species were often lacking, in particular from the more southern fishing grounds in the Atlantic sector of the Southern Ocean.

26. One way to improve biological sampling from the commercial fishery would be that non-fishing members could assist fishing countries by sending additional observers on fishing vessels via coordination by CCAMLR.

## New or Developing Fisheries

27. Members who intend to start a fishery should provide CCAMLR with the following information:

- the proposed fishing operation, including target species, methods of fishing, proposed region and any minimum level of catches that would be required to develop a viable fishery; and

- details of the stock size, abundance, demography (e.g., growth parameters, size and age at sexual maturity).

28. The Scientific Committee and its Working Groups should then compile:

- a description of the components of the ecosystem, highlighting those species at the primary level and their likelihood of being affected in some way by the proposed fishery, including summaries of current applicable scientific knowledge; and

- a review of other fisheries that may have similar effects on the same or related components of the Antarctic marine ecosystems as the proposed fishery (CCAMLR-VIII, Annex E, Appendix 1).

This would then allow the Commission to decide on the rational use of this resource.

## Ageing

29. Reliable ageing and the compatibility of ageing results between investigations are crucial to assessment work. But these two requirements are fulfilled only in a few species. This was evident from the comparative ageings of the CCAMLR otolith/scales/bones exchange (Kock, 1990) and earlier compilations of age and growth data (Kock *et al.*, 1985). Problems of ageing require detailed discussion involving not only technical aspects but also various aspects of the life history of a species. They are thus too time-consuming to be dealt with during meetings of the WG-FSA and require additional workshops comparable but more specific to the one held in Moscow in 1986. If ageing is to become more reliable and age readings between laboratories would become more compatible, a number of assessments could be considerably improved.

# ASSESSMENTS

## Assessment Techniques

30. The assessment models commonly in use in the WG-FSA (virtual population analysis, cohort analysis, separable virtual population analysis, yield-per-recruit and catch prediction) are those utilized in many working groups on fish stock assessment of other fisheries conventions. There are a number of new techniques, such as the multi-species VPA, being developed for fish population studies but the data base on Antarctic fish species is limited compared to other fish stocks, such as in the North Sea. Therefore, many of the more sophisticated approaches will not be appropriate and may even be misleading. The main problem is determining or knowing the robustness of these techniques. The introduction of new assessment techniques may bear the potential of improving our assessments, but need careful consideration before being introduced. This matter could definitely not be dealt with during one of the regular meetings of the WG-FSA when participants are fully occupied with the assessment work itself, thus leaving little room for additional discussions. The investigation of new assessment techniques and their potential utilisation for our work could

best be done by a small task group comprised of participants of the WG-FSA experienced in this field and possibly one or two consultants at a meeting during the intersessional period.

Natural Mortality

31. Estimates of the coefficient of natural mortality **M** are still based on very limited information and have been often determined by inadequate techniques (see SC-CAMLR-VIII, Appendix 5, for discussion). More information from the first years of fishing, preferably from the exploratory phase of the fishery, such as from 1965 to 1969 around South Georgia, is needed to increase the precision of estimates of **M**. This information has been requested and provided for *C. gunnari* in Subarea 48.3 during the 1990 Meeting of the WG-FSA.

Single or Multi-Stock (Species) Approach?

32. The Commission has been setting Conservation Measures for individual stocks over the last few years. This approach, common also in fisheries conventions, has been questioned as it bears the risk that catches from depleted stocks which had suffered from recruitment failure may not be sufficiently small to ensure their recovery. This may particularly be the case in 'by-catch' species, such as *Chaenocephalus aceratus* or *Notothenia gibberifrons.* Hence, the goal to secure a sustainable yield at $\mathbf{F_{0.1}}$ or even $\mathbf{F_{max}}$ for each stock separately becomes illusory.

33. Two approaches seem possible:

(i) the bottom-up approach, where we look at each stock separately and add an appropriate risk or uncertainty term; and

(ii) the top-down approach where we look at the system or exploited fish assemblages as a whole in terms of energy flow, catch, production etc.

34. The first approach which has been followed to some extent already in previous years seems to be more promising on the short-term if we include a sufficiently large safety margin. This may involve a closure of the fishery for a short period but may also include the prohibition of certain types of fishing gear, such as bottom trawls, as has been done for the 1990 season.

35. It is unlikely that current multi-species approaches are easily transferrable to the Southern Ocean. Fish species interactions at least in the Atlantic Ocean sector are likely to be low compared to areas such as the North Sea, and most species are directly dependent on *Euphausia superba* and other euphausiids and hyperiids. If predation is a major cause for natural mortality in fish species, marine mammals and birds are the most likely cause. Multi-species models which still need to be developed or transferred will have their merits to help to understand the dynamics of the Antarctic or the shelf water ecosystems, but even simple multi-species models are difficult if not impossible to turn into effective management tools at the present stage of knowledge. Hence, multi-species considerations should be used to improve single-species management rather than applying multi-species models at the present stage.

## DISCUSSION

36. The foregoing sections have highlighted a number of activities which can be carried out under the auspices of CCAMLR that are likely to improve the quality of assessments done by the WG-FSA. These are:

- cooperation in the conduct of surveys and the analysis of results;
- an increase in the number of surveys to estimate current standing stock biomass;
- the introduction of regular pre-recruit surveys;
- the improvement of catch and effort statistics;
- information on the amount of discards and conversion rates of various fish products;
- length/weight and catch-at-age and biological data of all commercially exploited stocks, also of those species in which the fishery is still in an exploratory phase or a fishery is intended to be developed; and
- an increase in the reliability and compatibility of ageing results.

37. However, even if all this information was available there is still great uncertainty inherent to fisheries stock assessment in general. In addition to the low precision of research

vessel surveys, there are potential biases in the biomass estimates. These are due to differences in catchability between vessels and between years. Any bias is likely to be increased by the patchy distribution of some of the target species. There are also biological uncertainties associated with the:

- separation of stocks;
- rates of growth and natural mortality; and
- relationship between spawning stock size and recruitment.

38. These difficulties are compounded where the commercial fishery fails to provide accurate and complete information.

39. In addition to the many problems outlined above which are common to fisheries stock assessments worldwide, there is additional uncertainty associated with the unique circumstances prevailing in the Southern Ocean. This uncertainty is directly attributable to a general lack of information on Southern Ocean fisheries which has been compounded by the region's geographic remoteness, its large area and international jurisdiction. Furthermore, all natural systems are subject to considerable environmental unpredictability making it difficult to forecast biotic variability using currently available statistical techniques. Both these sources of uncertainty are likely to severely limit the employment of robust feedback policies in stock assessment and management.

40. Therefore, given the wide range of uncertainty highlighted, it must be concluded that advice provided by the WG-FSA can rarely be considered unequivocal and should be accepted as 'the best scientific evidence currently available'.

## CONCLUSIONS

41. The quality of stock assessment and management advice by the WG-FSA will be improved by an increase in the number of research surveys and an improvement in the quality of catch and effort statistics.

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

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APPENDIX E

## CALCULATION OF STANDARDISED BIOMASS ESTIMATES

The area of seabed within three depth strata in the Shag Rocks and South Georgia regions of Subarea 48.3 was calculated in 1987 (Everson, 1987) and revised in 1990 (Everson and Campbell, 1990). The three depth strata were 50 to 150 m, 151 to 250 m and 251 to 500 m. Balguerías (1989) summarised the 1987 measurements by depth strata in each region.

2. The ratio of 1990 data to 1987 data in each depth strata in each region (Table 1) was used to standardise *Notothenia gibberifrons* (Table 2) and *Champsocephalus gunnari* (Table 3) biomass estimates calculated from data collected aboard research vessels during 1985 through 1990 as:

$$B_{ijk} = \sum_{l=1}^{3} R_{jl} \, B_{ijkl}$$

where **B** = biomass estimates,
**R** = ratio of 1990 seabed areas to 1987 seabed areas ($km^2$),
**i** = species (*N. gibberifrons* or *C. gunnari*),
**j** = regions (Shag Rocks or South Georgia),
**k** = year of survey (1985 through 1990), and
***l*** = depth strata (50 to 150 m, 151 to 250 m, or 251 to 500 m).

3. Biomass estimates for 1984/85 (FRG), 1986/87 (US/Polish), 1986/87 (Spanish), 1987/88 (US/Polish), 1988/89 (UK/Polish) and 1989/90 (*Hill Cove* and *Akademik Knipovich*) were presented by Kock (pers. comm.), Gabriel (1987), Balguerías (1989), MacKenna and Saila (1988), Parkes *et al.* (1989) and WG-FSA-90/13 respectively.

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Table 1: Ratios of areas of seabed within depths ranges around Shag Rocks and South Georgia, calculated in 1987 and 1990.

| Area/Depth (m) | 1987 Area[(a)] | 1990 Area[(b)] | Ratio $\frac{1990}{1987}$ |
|---|---|---|---|
| Shag Rocks | | | |
| 50 to 150 | 3 100.7 | 1 473.5 | 0.475 |
| 151 to 250 | 5 855.0 | 1 870.6 | 0.319 |
| 251 to 500 | 2 411.3 | 1 610.0 | 0.668 |
| South Georgia | | | |
| 50 to 150 | 8 588.7 | 8 860.4 | 1.032 |
| 151 to 250 | 18 096.7 | 19 204.3 | 1.061 |
| 251 to 500 | 10 609.0 | 8 201.9 | 0.773 |

(a) BALGUERIAS, E. 1989. Informe de resultados 'Antártida 8611'. Biología Pesquera. *Publicaciones Especiales del Instituto Español de Oceanografía, número 2*: 267-483.
(b) WG-FSA-90/8.

Table 2: Standard biomass estimates for Subarea 48.3 - *N. gibberifrons* (area ratios calculated in Table 1).
P = biomass estimates calculated using unrevised area data
S = biomass estimates standardised by revised area calculations

| Area/ Depth (m) | Area Ratio | 1984/85 | | 1986/87 | | 1986/87 | | 1987/88 | | 1988/89 | | *Hill Cove* | *Akademik Knipovich* | *Anchar* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P | S[(a)] | P[(b)] | S | P[(c)] | S | P[(d)] | S | P[(e)] | S | S[(f)] | S[(f)] | S |
| Shag Rocks | | | | | | | | | | | | | | |
| 50-150 | 0.475 | - | - | 349 | 166 | 8986 | 4268 | 538 | 256 | - | - | - | - | |
| 151-250 | 0.319 | - | - | 51* | 16 | 72599 | 23159 | 60 | 19 | - | - | - | - | |
| 251-500 | 0.668 | - | - | 0 | 0 | 105 | 70 | 10 | 7 | - | - | - | - | |
| Total | | - | - | 400 | 182 | 81690 | 27497 | 608 | 282 | - | - | 267 | 0 | |
| South Georgia | | | | | | | | | | | | | | |
| 50-150 | 1.032 | - | 3126 | 1920 | 1981 | 250 | 258 | 1834 | 1893 | 2422 | 2500 | - | - | |
| 151-250 | 1.061 | - | 11422 | 7567 | 8029 | 2163 | 2295 | 4404 | 4673 | 4635 | 4918 | - | - | |
| 251-500 | 0.773 | - | 2559 | 4057 | 3136 | 866 | 669 | 950 | 734 | 1453 | 1123 | - | - | |
| Total | | - | 17107 | 13544 | 13146 | 3279 | 3222 | 7188 | 7300 | 8510 | 8542 | 12417 | 21891 | |

(a) K.-H. Kock, pers. comm.
(b) SC-CAMLR-VI/BG/12 Rev.1
(c) BALGUERIAS, E. 1989. Informe de resultados 'Antártida 8611'. Biología pesquera. *Publicaciones Especiales del Instituto Español de Oceanografía, número 2*: 267-483.
(d) SC-CAMLR-VII/BG/23
(e) WG-FSA-89/6
(f) WG-FSA-90/13

Table 3: Standard biomass estimates for Subarea 48.3 - *C. gunnari* (area ratios calculated in Table 1).
P = biomass estimates calculated using unrevised area data
S = biomass estimates standardised by revised area calculations

| Area | Area Ratio | 1984/85 | | 1986/87 | | 1986/87 | | 1987/88 | | 1988/89 | | *Hill Cove* | *Akademik Knipovich* | *Anchar* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P | S[a] | P[b] | S | P[c] | S | P[d] | S | P[e] | S | S[f] | S[f] | S |
| Shag Rocks | | | | | | | | | | | | | | |
| 50-150 | 0.475 | - | - | 5551 | 2637 | 235 | 112 | 225 | 107 | - | - | - | - | |
| 151-250 | 0.319 | - | - | 4992 | 1592 | 62425 | 19914 | 1188 | 379 | - | - | - | - | |
| 251-500 | 0.668 | - | - | 0 | 0 | 7 | 5 | 34 | 23 | - | - | - | - | |
| Total | | - | - | 10 543 | 4229 | 62667 | 20034 | 1447 | 509 | - | - | 232289 | 108652 | |
| South Georgia | | | | | | | | | | | | | | |
| 50-150 | 1.032 | - | 1188 | 10224 | 10551 | 3405 | 3514 | 3557 | 3671 | 2093 | 2160 | - | - | |
| 151-250 | 1.061 | - | 15285 | 32634 | 34625 | 143929 | 152709 | 10878 | 11542 | 18752 | 19896 | - | - | |
| 251-500 | 0.773 | - | 759 | 7556 | 5841 | 3959 | 3060 | 651 | 503 | 223 | 172 | - | - | |
| Total | | - | 17232 | 50414 | 51017 | 151293 | 159283 | 15086 | 15716 | 21068 | 22328 | 95405 | 437261 | |

[a] K.-H. Kock, pers. comm.
[b] SC-CAMLR-VI/BG/12 Rev.1
[c] BALGUERIAS, E. 1989. Informe de resultados 'Antártida 8611'. Biología pesquera. *Publicaciones Especiales del Instituto Español de Oceanografía, número 2*: 267-483.
[d] SC-CAMLR-VII/BG/23
[e] WG-FSA-89/6
[f] WG-FSA-90/13

APPENDIX F

# TASK GROUP FOR INFORMATION REPORTED TO THE WORKING GROUP

The following appendix contains the results of the deliberation of the Task Group on the information requirements for working papers submitted to the WG-FSA, convened by Dr M. Basson (UK) and consisting of Drs D. Agnew (Secretariat), P. Gasiukov (USSR), K. Sullivan (New Zealand) and Mr E. Balguerías (Spain) and D. Miller (South Africa).

2. For each of the categories of information identified in paragraph 64 in the body of this report, the appropriate types of information required are listed in this Appendix.

3. It was suggested by the Task Group that this information should be regarded as a minimum requirement when papers were submitted for consideration of the Working Group, but that the precise manner of presenting such information be left up to the discretion of authors.

## I. STOCK ASSESSMENT SURVEYS - VESSELS, DESIGN AND DATA COLLECTION

SURVEY AREA

- Survey area
- Geographical boundaries: Latitude and Longitude
- Map of area surveyed (preferably including bathymetry)

DESCRIPTION OF VESSEL

- Name of vessel
- Vessel size: Length (m), GRT (t)
- Vessel type
- Whether vessel included in CCAMLR register
- Commercial vessels or research vessels

DESCRIPTION OF FISHING AND OTHER GEAR

- Description of gear used, e.g. bottom, semipelagic, midwater, other, acoustics
- Auxiliary gear (groundrope, dan leno assembly etc.)

Mesh size in codend (mm)
Type of mesh (diamond, square, other)

DESCRIPTION OF ACOUSTIC EQUIPMENT

Frequency used
Calibration method (hydrophone or standard sphere)
Calibration details
Source level
Pulse length
Directivity index
Receiving sensitivity
Calibration constant (source level plus receiving sensitivity)
TVG correction details
Target strength (TS)
Other information: TS/length relationship, length/weight relationship

SURVEY DESIGN

Survey design: Semi-random random, other
Target species
Stratification (if any) e.g. according to depth zones, fish density, other
Details of sources for stratification (e.g. seabed areas – Everson 1984)
Standard haul duration (preferably 30 min) (min)
Number of stations (planned and carried out)
Map of station positions should be included

METHODS OF SURVEY DATA ANALYSES

Swept area method
Acoustic survey
Stratification of survey results

DATA COLLECTED BY SURVEYS (haul-by-haul data)

Date and time
Start and end position of trawl
Duration at trawl depth
Trawling depth
Trawling speed
Net mouth opening (headline and wingspread)
Catch by species in weight and numbers

Length frequency information
Length composition
Age/length information
Species composition
Maturity stage information
Feeding information
Other (detail)

4. As far as possible summaries of this type of information should be provided in tabular form.

5. Most of this data should be submitted to CCAMLR on a haul-by-haul basis (Forms C1, B2, B3 and B4), and in the reporting format identified in paragraph 301 in the body of this report. The location of this information should be specified in the paper submitted to the Working Group.

## II. RESULTS OF ANALYSES OF SURVEY DATA

6. As far as possible, the following details on the analyses of survey data, in particular the estimation of biomass, should be included. Details on:

- input data used, e.g. haul-by-haul data, see Section I above;
- input parameters, e.g. net mouth opening;
- method(s) of estimation (e.g. swept area method) including references to relevant papers if applicable;
- any modifications to the standard method with references and equations if applicable;
- method of stratification used;
- estimates of biomass within each stratum and the coefficients of variation; and
- estimate of total biomass and its coefficient of variation.

7. In the case of acoustic surveys, details on the following should also be included:

- value of target strength used to estimate biomass;
- how this value was estimated or reference; and
- area over which biomass was estimated.

8. With respect to biological data, see Section I above. If aggregated or overall data are presented, the method of aggregation should be described in detail. In particular, with respect to: overall length compositions; and age compositions.

## III. STOCK ASSESSMENT ANALYSES

### VIRTUAL POPULATION ANALYSIS (VPA) AND POPULATION PROJECTIONS

9. The presentation of VPA results in papers presented to the Working Group should contain the following information in detail.

(i) Input data:

(a) the fish stock (area and species) covered by the assessment;

(b) for each year the total catch by the commercial fishery;

(c) a description of the fishing methods and vessel types for each year, with catch weights by each method;

(d) fishing effort by method and area, standardised CPUE and source of data;

(e) length composition data and age/length key used to determine catch-at-age matrix. State source of data used;

(f) weight-at-age for each year and source of data;

(g) population parameters of **M** (natural mortality), $\mathbf{A}_{r}$ (age of recruitment) and $\mathbf{A}_{mat}$(age of maturity), including ogives of recruitment and maturity and references to sources.

(h) growth parameters, length-weight relationship and source;

(i) tuning method used and reference;

(j) other available data for this stock. This should include any trawl or acoustic survey results available and the source of this information;

(k) previous assessment results and sources;

(l) outline of any problems with the data, the fitting of the VPA model and comments on the assessment;

(ii) Output data:

(a) catch-at-age and weight-at-age data used as input data;

(b) stock numbers and biomass for each age in each year;

(c) a matrix of fishing mortality values for each age in each year;

(d) terminal fishing mortality rate and how determined;

(e) the exploitation pattern (selectivity) at age in the terminal year;

(f) biomass and spawning biomass for each year;

(g) average recruitment of first age class and the period of years used for calculation. Any stock recruitment relationship should be shown;

(h) catchability coefficient of trawl surveys based on VPA biomass estimates;

(iii) Population projection:

(a) population number-at-age in terminal year and source;

(b) weights-at-age used for year of projection and source;

(c) selection pattern of **F** and how determined, values of $\mathbf{F_{0.1}}$ and $\mathbf{F_{opt}}$ and source;

(d) number of recruits in first age class and how it was determined (e.g. mean recruitment from VPA and period of years used);

(e) estimates of biomass, spawning biomass and yield for **F** values for following year;

(f) status of stock relative to virgin biomass and optimum level;

(g) estimate of optimum long-term yield;

(h) any information on the strength of recruit and pre-recruit age classes in the current year (e.g. from surveys);

(i) comments.

YIELD-PER-RECRUIT AND ASSOCIATED ANALYSES

10. When presenting analyses of these types, the full set of input data should be supplied, together with the source of this data. In particular, the data and source of the following should be supplied:

- natural mortality used;
- selection/recruitment patterns;
- weight-at-age in the catch and stock; and
- maturity ogive.

## IV. GENERAL ANALYSES

11. With respect to any analyses (e.g. estimation of natural mortality and rates or growth parameters), the following information should be included:

- the data used, the source of the data;
- all input parameters used;
- methods used to estimate parameters;
- assumptions of the methods; and
- estimates with coefficients of variation.

APPENDIX G

# EFFECT OF UNCERTAINTY IN GROWTH PARAMETERS ON LENGTH COHORT ANALYSES

E. Balguerías - 14 October 1990

Document WG-FSA-90/34 presents an assessment of *Dissostichus eleginoides* in Subarea 48.3 using the Length Cohort Analyses (LCA) (Jones, 1981). The paper suggests values for **L□** and **K** calculated from a reduced number of age classes ranging from 1 to 16 years. Assuming *D. eleginoides* as a longlife species living probably more than 30 years, the estimates of **L□** and **K** contained in that paper may be underestimated and overestimated respectively.

2. The LCA is very sensitive to any change in the input values of the growth parameters. To show this effect, two sets of LCA simulations have been carried out using the original data set provided in document WG-FSA-90/34 and introducing small modifications in **L□** and **K**.

3. The first set of simulations assumes constant values for **K** (0.0717) and **M** (0.18) and three different values of **L□** (190, 200, 210). The results (Table 1, Figure 1) show that increases of 10 cm and 20 cm in **L□** produce reductions in the stock size (number of individuals) of 32% and 45% respectively.

4. In the second set of simulations **L□** (190) and **M** (0.18) remain constant. The values of **K** used in the simulations were 0.0717, 0.06 and 0.05. Table 2 and Figure 2 show that very small decreases in **K** lead to increases of 103% and 522% in the stock size.

REFERENCES

JONES, R. 1981. The use of length composition in fish stock assessment (with notes on VPA and cohort analysis). *FAO Fish. Circ. (734)*: 55.

Table 1: Effect of changes in **L**□ (maximum theoretical length) in stock size calculated using the Jones length cohort model.

| Length (cm) | N.ind (x1000) **L**□ = 190 **K**=0.0717 **M**=0.18 | N.ind (x1000) **L**□ = 200 **K**=0.0717 **M**=0.18 | N.ind (x1000) **L**□ = 210 **K**=0.0717 **M**=0.18 |
|---|---|---|---|
| 36 | 1 085 | 753 | 613 |
| 42 | 1 020 | 711 | 581 |
| 48 | 957 | 670 | 549 |
| 54 | 894 | 629 | 517 |
| 60 | 829 | 584 | 482 |
| 66 | 754 | 531 | 439 |
| 72 | 679 | 476 | 394 |
| 78 | 610 | 428 | 354 |
| 84 | 543 | 380 | 315 |
| 90 | 471 | 327 | 271 |
| 96 | 389 | 264 | 218 |
| 102 | 298 | 194 | 157 |
| 108 | 215 | 129 | 102 |
| 114 | 153 | 83 | 62 |
| 120 | 112 | 54 | 39 |
| 126 | 84 | 36 | 25 |
| 132 | 65 | 26 | 17 |
| 138 | 51 | 19 | 12 |
| 144 | 39 | 14 | 8 |
| 150 | 30 | 10 | 6 |
| 156 | 21 | 7 | 4 |
| 162 | 14 | 5 | 3 |
| 168 | 9 | 3 | 2 |
| 174 | 4 | 2 | 1 |
| Total | 9 325 | 6 336 | 5 171 |
| | 100.00 | 67.95 | 55.45 |
| % Reduction | | 32.05 | 44.55 |

Table 2: Effect of changes in **K** (growth coefficient) in stock size calculated using the Jones length cohort model.

| Length (cm) | N.ind (x1000) **L□** = 190 **K**=0.0717 **M**=0.18 | N.ind (x1000) **L□** = 190 **K**=0.06 **M**=0.18 | N.ind (x1000) **L□** = 190 **K**=0.05 **M**=0.18 |
|---|---|---|---|
| 36 | 1 085 | 2 364 | 8 013 |
| 42 | 1 020 | 2 180 | 7 211 |
| 48 | 957 | 2 003 | 6 460 |
| 54 | 894 | 1 832 | 5 759 |
| 60 | 829 | 1 665 | 5 100 |
| 66 | 754 | 1 492 | 4 475 |
| 72 | 679 | 1 324 | 3 893 |
| 78 | 610 | 1 171 | 3 365 |
| 84 | 543 | 1 026 | 2 881 |
| 90 | 471 | 880 | 2 430 |
| 96 | 389 | 729 | 2 004 |
| 102 | 298 | 574 | 1 606 |
| 108 | 215 | 435 | 1 256 |
| 114 | 153 | 328 | 972 |
| 120 | 112 | 250 | 747 |
| 126 | 84 | 192 | 568 |
| 132 | 65 | 148 | 425 |
| 138 | 51 | 113 | 310 |
| 144 | 39 | 84 | 217 |
| 150 | 30 | 60 | 145 |
| 156 | 21 | 41 | 90 |
| 162 | 14 | 25 | 50 |
| 168 | 9 | 14 | 24 |
| 174 | 4 | 6 | 8 |
| Total | 9 325 | 18 935 | 58 010 |
| | 100.00 | 203.05 | 622.07 |
| % Increasing | | 103.05 | 522.07 |

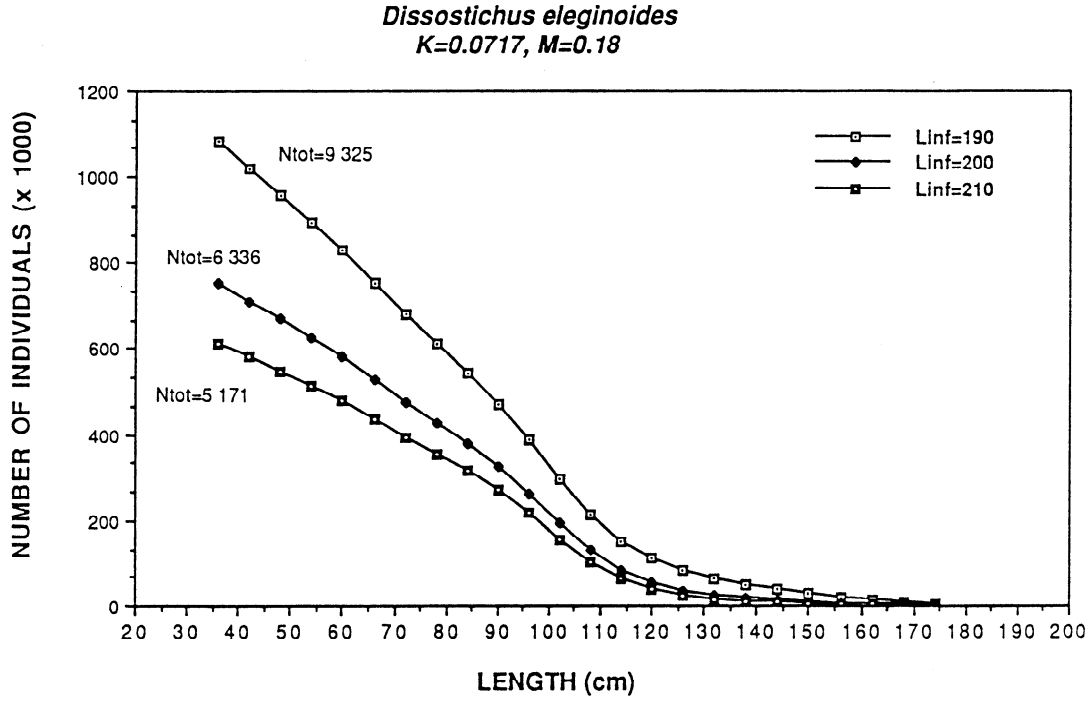


Figure1: Effect of changes in **L□** (maximum theoretical length) in stock size calculated using the Jones length cohort model.

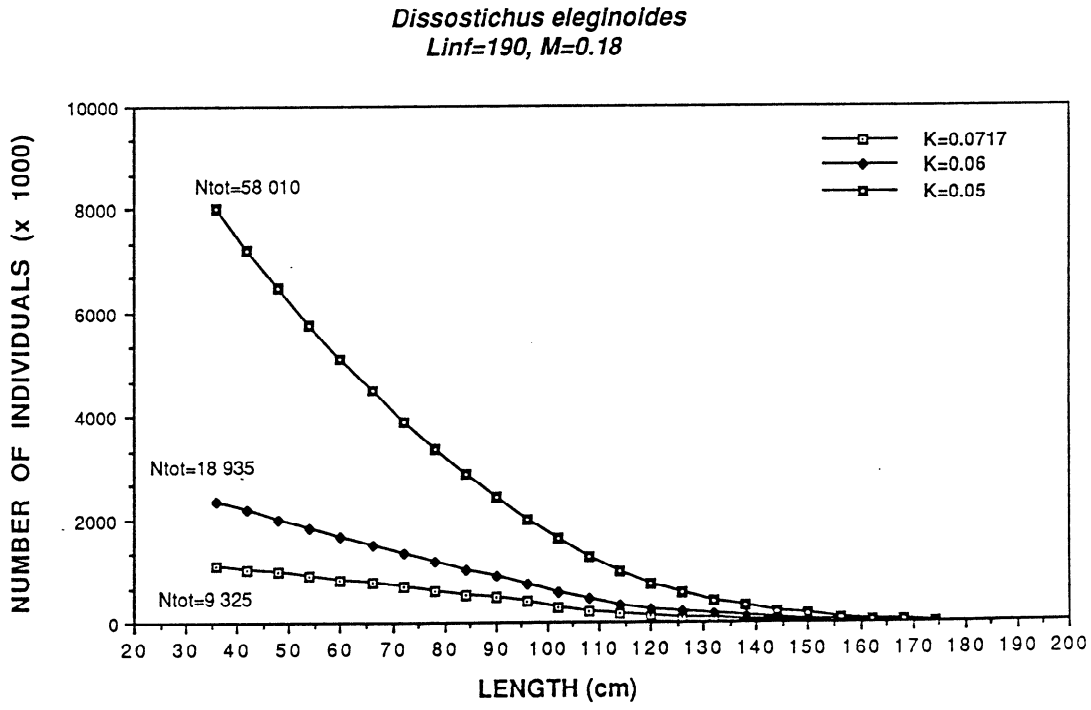


Figure 2: Effect of changes in **K** (growth coefficient) in stock size calculated using the Jones length cohort model.

APPENDIX H

# ESTIMATED ABUNDANCE OF *NOTOTHENIA GIBBERIFRONS* FROM COMPARISON OF *ANCHAR* SURVEY WITH *HILL COVE* SURVEY EXCLUDING HAULS WITHIN 12 MILES OF SOUTH GEORGIA

E. Marschoff

Three different estimations for the biomass of *Notothenia gibberifrons* around South Georgia and its coefficient of variation have been tabled:

Bhc=12 417 tonnes, CVhc=28% (*Hill Cove*, WG-FSA-90/13)
Bak=21 891 tonnes, CVak=23% (*Akademik Knipovich*, WG-FSA-90/13)
Ban=53 650 tonnes, CVan=21% (*Anchar*, WG-FSA-90/30).

2. Sampling units have been defined in accordance with the fine-scale reporting system. In each sampling unit, three depth strata (50 to 150, 150 to 250 and 250 to 500 m) have been used as appropriate, and trawls performed in positions selected independently of the distribution of fish.

3. WG-FSA-90/8, Table 3, gives the total area of seabed in each stratum:

| | | Proportion |
|---|---|---|
| 50 to 150 m: | 8 860.4 | (0.2443) |
| 150 to 250 m: | 19 204.3 | (0.5295) |
| 250 to 500 m: | 8 201.9 | (0.2262) |
| 50 to 500 m: | 36 266.6 | |

4. In order to obtain an easily comparable measure of each survey, calculations were performed in order to obtain a 'weighted mean haul (WMH)' for the cruise as the weighted mean of the mean hauls at each stratum; the weighting coefficients used are the corresponding proportions of seabed (WG-FSA-90/8). All hauls have been corrected to a net opening of 20 m and a duration of 30-minutes. It is assumed that the speed remained constant since no data were available on the speed of each haul.

5. It was suggested that the high value of the biomass from the *Anchar* cruise might originate from the fact that *Anchar* did not fish closer than 12 miles from the shore. This hypothesis was examined by recalculating WMH for *Hill Cove*, but not using the hauls taken in the 12 mile zone (*Hill Cove** in the table below omits the hauls within 12 miles of South Georgia). It is clear that this might not be the cause.

| | 50 to 150 m | | 150 to 250 m | | 250 to 500 m | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | N | Mean | N | Mean | N | WMH | N |
| *Akademik Knipovich* | 29.80 | 15 | 28.97 | 35 | 75.85 | 20 | 39.78 | 70 |
| *Anchar* | 56.98 | 15 | 104.45 | 35 | 52.39 | 31 | 81.09 | 81 |
| *Hill Cove* | 8.51 | 8 | 35.92 | 39 | 13.17 | 12 | 24.08 | 59 |
| *Hill Cove** | 13.38 | 5 | 31.57 | 29 | 11.97 | 11 | 22.69 | 45 |

APPENDIX I

## DATA REQUIREMENTS FOR THE WORKING GROUP

| | I | II | III |
|---|---|---|---|
| | Data Required by Appendix 9 of WG-FSA-89 | Data Received by WG-FSA | Data Required by WG-FSA-90 |
| 1. | Catch and effort data for *D. eleginoides*[1] (Also recommended by SC-CAMLR-VIII, paragraph 3.12) | No fine-scale longline data reported<br>Data on STATLANT submitted | Commercial data required (length and biological)<br>Fine-scale data required |
| 2. | Growth and mortality of *C. gunnari* in Subarea 48.3, year by year[3] | Data are contained in WG-FSA-90/31 and WG-FSA-90/33<br>Data from 1960s submitted | – |
| 3. | Biological information on incidental catch of *N. rossii* in Subarea 48.3[4] | Length composition from 1990 research data only | Biological information on incidental catch of *N. rossii* in Subarea 48.3[4] |
| 4. | Length and age, *N. squamifrons*, Subarea 48.3 - commercial data[5] | Research data on lengths<br>Biomass estimates from recent surveys | Length and age, *N. squamifrons*, Subarea 48.3 - commercial data[5] |
| 5. | *C. gunnari* and *N. gibberifrons* length and age data, Subarea 48.2 Research survey data[6] | No survey data of biomass<br>Research data only for 1989 and 1990 length frequencies | *C. gunnari* and *N. gibberifrons* length and age data, Subarea 48.2 Research survey data[6] |
| 6. | Commercial age and length data for *N. gibberifrons*[7] | Research data only | Commercial age and length data for *N. gibberifrons*[7] |
| 7. | Fine-scale catches of *P. antarcticum*, Subarea 58.4[8] | No fine-scale data | Fine-scale catches of *P. antarcticum*, Subarea 58.4 |
| 8. | Catches reported as *C. gunnari* from Division 58.4.2 should be *C. wilsoni* [9] | Corrected by Secretariat but new catches also mis-reported | Catches reported as *C. gunnari* from Division 58.4.2 should be *C. wilsoni* |
| 9. | Data from recent trawl surveys in Division 58.4.4 should be re-submitted[10] | Data not reported | – |
| 10. | Catch data for *N. squamifrons*, Division 58.4.4 should be submitted[11] | Catches presented in WG-FSA-90/37 | STATLANT catches of *N. squamifrons* reported from Division 58.4.4 should be corrected to agree with those in WG-FSA-90/37<br>Catches should be reported for Ob and Lena Banks |
| 11. | Age/length data from catches of *C. gunnari* in Division 58.5.1 prior to 1980[12] | No data | Age/length data from catches of *C. gunnari* in Division 58.5.1 prior to 1980[12] |

| I | II | III |
|---|---|---|
| 12. Various data from *N. squamifrons* in Division 58.5.1:<br>• length and ALK data<br>• catch data separated for Division 58.5.1<br>• data consistency(13) | No new biological data<br>No further separation performed | Various data from *N. squamifrons* in Division 58.5.1:<br>• length and ALK data<br>• catch data separated for Division 58.5.1<br>• data consistency(13) |
| 13. Reports requested from *Slavgorod, Borispol, Passat 2* fishing in October 1989 (SC-CAMLR-VIII, paragraph 3.7) | No reports received by WG-FSA | Reports requested from *Slavgorod, Borispol, Passat 2* fishing in October 1989 (SC-CAMLR-VIII, paragraph 3.7) |
| 14. Data from *E. carlsbergi* requested (SC-CAMLR-VIII, paragraph 3.23) | Target species was not identified in reported catches<br>No fine-scale data | Report on ELC rather than MZZ<br>Fine-scale data from Convention Area and areas north of convergence requested (this report, paragraph 180) |
| 15. Biomass and biological data of *E. carlsbergi* requested (SC-CAMLR-VIII, paragraph 3.23) | Biological and biomass survey data presented in WG-FSA-90/18, 20, 21, 23, 25<br>Some length and ALK data from Subareas 48.3, 48.4, 48.6<br>No fine-scale data | –<br>Biological data from historical catches requested<br>Fine-scale data requested |
| 16. | – | – | Data on size selectivity of longline fishery |
| 17. | – | – | Want haul-by-haul information from research vessel surveys and experimental fisheries |
| 18. | – | – | An increase in availability of biological data from commercial catches (general) |
| 19. | – | – | Information on levels of discarding and conversion rates from fish products to nominal weight are required (Item 4) |
| 20. | – | – | Representative length-frequency from the commercial catch of *C. gunnari* in Subarea 48.3 should be reported for recent years (this report, paragraph 100) |

( ) Numbers in superscripted parenthesis refer to item numbers in Appendix 9 of the 1989 WG-FSA report (SC-CAMLR-VIII, Annex 6).

**FIELD SAMPLING LOGSHEET - BY-CATCH OF FISH IN COMMERCIAL KRILL CATCHES**

SHIP: ..... NATIONALITY: ..... DATE: .....

NET TYPE: ..... MESH: ..... SUBAREA: .....

| Haul No. | Position | | Water Depth | | Fishing Depth | | Speed of Vessel | | Net Dimensions | | Time (GMT) | | Krill Catch (kg) | Subsample Weight (kg) | Fish | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Start | End | Start (m) | End (m) | Start | End | Start | End | Start | End | Start | End | | | Species | Number | Weight |
| | ° ‘ “ S | ° ‘ “ S | | | | | | | | | h m | h m | | | | | |
| | ° ‘ “ W/E | ° ‘ “ W/E | | | | | | | | | | | | | | | |
| | ° ‘ “ S | ° ‘ “ S | | | | | | | | | h m | h m | | | | | |
| | ° ‘ “ W/E | ° ‘ “ W/E | | | | | | | | | | | | | | | |
| | ° ‘ “ S | ° ‘ “ S | | | | | | | | | h m | h m | | | | | |
| | ° ‘ “ W/E | ° ‘ “ W/E | | | | | | | | | | | | | | | |

Page ____ of ____

APPENDIX J

APPENDIX K

**DETAILS OF INTENDED AND COMPLETED RESEARCH SURVEYS**

SURVEY DETAILS

Survey Area: _____

Geographical boundaries: Latitude _____ to _____

Longitude _____ to _____

Map of area surveyed (preferably including bathymetry)

Dates of survey: _____ / _____ / _____ (Y/M/D)

DESCRIPTION OF VESSEL

Name of vessel: _____

Vessel size:

Length: _____ (m) GRT _____ (t)

Vessel type: _____

Vessel included in CCAMLR register: _____ YES _____ NO

Commercial vessel: _____ YES _____ NO

Research vessel: _____ YES _____ NO

DESCRIPTION OF FISHING AND OTHER GEAR

Description of gear used:

Bottom trawl _____

Semipelagic trawl _____

Midwater trawl _____

Other (specify) _____

Acoustics _____

Auxiliary gear (groundrope, dan leno assemble etc.):

_____

_____

Mesh size in codend: _____ mm

Diamond mesh: _____

Square mesh: _____

Other (specify): _____

DESCRIPTION OF ACOUSTIC GEAR

Frequency _____

Calibration details:

Calibration method _____ Hydrophone _____ Standard sphere

Source level _____ (dB re 1uPa @1m)

Pulse length _____ (ms)

Directivity index _____ (dB)

Volt. rec. sens. _____ (dB re 1V uPa-1 @ max TVG)

Calibration control (source level & voltage response)

TVG correction _____ YES _____ NO

Details _____

Target strength (TS) _____ (dB)

Other information:

TS/length relationship _____

Length/weight relationship _____

SURVEY DESIGN

Survey design: Semi-random _____ Random _____

Target species: _____

Stratification (if any) according to:

Depth zones (list): _____

Fish density (list): _____

Other (specify): _____

Details of sources for stratification (e.g., seabed areas (Everson, 1984)):

_____

Standard haul duration (preferably 30 min) _____ (min)

No. of stations:

Planned _____ Carried out _____

Map of stations to be included

METHODS OF SURVEY DATA ANALYSES

Swept area method _____ YES _____ NO

Acoustic survey _____ YES _____ NO

Other (detail) _____

Stratification of survey results _____

_____

_____

*HAUL-BY-HAUL DATA

**Haul number

**Date and time (GMT)

**Start and end position of trawl _____ S _____ W/E

**Duration at trawl depth _____ hrs/min

**Trawling depth

**Trawling speed

**Net mouth opening

***Catch by species in weight and numbers

***Length frequency information

* As far as possible summaries of this type information should be provided in tabular form.

** & *** Most of this data should be submitted to CCAMLR on a haul-by-haul basis (Forms C1, B2, B3 and B4).

*BIOLOGICAL DATA

Length composition _____ YES _____ NO

Age-length information _____ YES _____ NO

Species composition _____ YES _____ NO

Maturity stage information _____ YES _____ NO

Feeding information _____ YES _____ NO

Other (detail) _____ YES _____ NO

* Most of this information should be included in haul-by-haul information reported to CCAMLR and therefore it should be clearly indicated where it can be found.

APPENDIX L

# 1990 ASSESSMENT SUMMARIES

APPENDIX L

# 1990 ASSESSMENT SUMMARIES

Assessment Summary: *Notothenia rossii*, Subarea 48.3

**Source of Information**: This Report

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Max[2] | Min[2] |
|---|---|---|---|---|---|---|---|---|
| Recommended TAC | | | | | | 0 | | |
| Agreed TAC | | | | | | 300 | | |
| Landings | 1891 | 70 | 216 | 197 | 152 | 2 | 24897 | 2 |
| Survey Biomass | 12781 | | 11471[a]<br>1634[b] | 1699 | 2439 | 1481[a]<br>3915[b]<br>3900[b] | | |
| Surveyed by | FRG | | Spain[a]<br>USA/POL[b] | USA/POL | UK/POL | UK/POL[a]<br>USSR[b] | | |
| Sp. Stock Biomass[3] | No information available since 1985/86 | | | | | | | |
| Recruitment (age...) | | | | | | | | |
| Mean F (.....)[1] | | | | | | | | |

Weights in tonnes, recruits in .....

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

[2] Over period 1980 to 1990

[3] From VPA using (.....)

**Conservation Measures in Force**: 3/IV, 13/VIII.

**Catches**: Since the prohibition of a directed fishery on the species in 1985, annual reported catches were always less than 250 tonnes.

**Data and Assessment**: No analytical assessment carried out in 1989 and 1990 due to the lack of relevant data. Biomass estimates available for the recent five years.

**Fishing Mortality**: No recent information but probably low.

**Recruitment**: No recent information but may be influenced by increased predation by fur seals (see SC-CAMLR-VIII, Annex 4, Appendix 10).

**State of Stock**: Recent biomass estimates gave no evidence for a recovery of the stock. Stock size probably less than 5% of pristine level.

**Forecast for 1990/91**:

| Option Basis | 1990 | | | 1991 | | | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| | F | SSB | Catch | F | SSB | Catch | |
| | | | | | | | |

Weights in tonnes

Assessment Summary: *Champsocephalus gunnari*, Subarea 48.3

**Source of Information**: This Report

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Max[2] | Min[2] |
|---|---|---|---|---|---|---|---|---|
| Recommended TAC | | | | 31500 | 10200 | 12000 | | |
| Agreed TAC | | | | 35000 | - [4] | 8000 | | |
| Landings | 14148 | 11107 | 71151 | 34619 | 21359 | 8027 | 128194[6] | 7592 |
| Survey Biomass | 17232 | | 159283 | 15716 | 22328[5] | | | |
| Surveyed by | | | Spain | USA/POL | USA/POL | | | |
| Sp. Stock Biomass[3] | | | | | | | | |
| Recruitment (age...) | | | | | | | | |
| Mean F (.....)[1] | | | | | | | | |

Weights in tonnes

[1] ... weighted mean over ages (...)
[2] Over period 1980 to 1990
[3] From VPA using (.....)
[4] Prohibition from 4 November 1988
[5] Standard estimate from Appendix D
[6] Maximum catch in 1983

**Conservation Measures in Force**: 13/VIII, 15/VIII

**Catches**: The total catch in 1989/90 was 8 027 tonnes. This included 387 tonnes taken by research vessels

**Data and Assessment**: No commercial length or age data were submitted. A VPA assessment tuned to standardised effort was presented in WG-FSA-90/26. Population projections based on biomass estimates from trawl surveys were carried out.

**Fishing Mortality**: Fishing mortality from VPA is low for 1989/90.

**Recruitment**: The last known strong year class entered the fishery in 1987/88.

**State of Stock**: Assessments and surveys indicate that the 1989/90 stock is at a much higher level than that projected for 1989/90 at the previous meeting. Assessments are subject to significant uncertainty.

**Forecast for 1990/91**:

| Option Basis | 1990 F | 1990 Stock | 1990 Catch | 1991 F | 1991 Stock | 1991 Catch | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| [1] $\mathbf{F_{0.1}}$(**M**=0.48) | | | | 0.33 | 222 | 44 | If stock is much higher than assumed here, the stock will increase under these TAC levels |
| [2] $\mathbf{F_{0.1}}$(**M**=0.56) | | | | 0.57 | 238 | 64 | |

Weights in '000 tonnes [1] WG-FSA-91/5 [2] WG-FSA-90/26

Assessment Summary: *Patagonotothen brevicauda guntheri*, Subarea 48.3

**Source of Information**: This Report

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Max[2] | Min[2] |
|---|---|---|---|---|---|---|---|---|
| Recommended TAC | | | | | - | - | | |
| Agreed TAC | | | | | 13000 | 12000 | | |
| Landings | 11923 | 16002 | 8810 | 13424 | 13016 | 145 | 36788[4] | 5029 |
| Survey Biomass | | | 81000 | | | | | |
| Surveyed by | | | Spain | | | | | |
| Sp. Stock Biomass[3] | | | | | | na | | |
| Recruitment (age 1) | | | | | | na | | |
| Mean F (3 - 5)[1] | | | | | | na | | |

Weights in tonnes

[1] ... weighted mean over ages (...)
[2] Over period 1980 to 1990
[3] From VPA using (.....)
[4] Maximum catch in 1989

**Conservation Measures in Force**: 16/VIII

**Catches**: 145 tonnes in 1989/90.

**Data and Assessment**: WG-FSA-90/28. Catch-at-age 1978/79 to 1988/89.

**Fishing Mortality**: Close to zero 1989/90. Age classes 3 and 4 fully recruited.

**Recruitment**: Insufficient information available.

**State of Stock**: Uncertain.

**Forecast for 1990/91**:

| Option Basis | 1990 | | | 1991 | | | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| | F | SSB | Catch | F | SSB | Catch | |
| **M**=0.48 | | | | 0.56 | | 20315 | |
| **M**=0.63 | | | | 0.78 | | 25167 | |
| **M**=0.90 | | | | 1.32 | | 36356 | |

Weights in tonnes

Assessment Summary: *Dissostichus eleginoides*, Subarea 48.3

**Source of Information**: This Report

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | | Max[2] | Min[2] |
|---|---|---|---|---|---|---|---|---|---|
| Recommended TAC | | | | | | - | | | |
| Agreed TAC | | | | | | - | | | |
| Landings | 285 | 564 | 1199 | 1809 | 4138 | 8311 | | 4138 | 109 |
| Survey Biomass | 8159 | | 1208 | 674 | 326 | 9631[*] | 335[+] | | |
| | | | | | | 1693[*] | 3020[+] | | |
| Surveyed by | FRG | | USA/POL[4] | USA/POL[4] | UK/POL[4] | | | | |
| Stock Biomass[3] | | | | | | 20745 - 435817 | | | |
| Recruitment (age...) | | | | | | na | | | |
| Mean F (.....)[1] | | | | | | na | | | |

Weights in tonnes

[1] ... weighted mean over ages (...)
[2] Over period 1980 to 1989
[*] Shag Rocks
[3] Estimated from cohort projections
[4] Survey excluding Shag Rocks
[+] South Georgia

**Conservation Measures in Force**: No Conservation Measures in force. Resolution 5/VIII.

**Catches**: Catches have doubled in past two seasons following commencement of longline fishery at Shag Rocks.

**Data and Assessment**: Length based cohort analysis and extrapolation analysis of single year class. Both methods subject to criticism.

**Fishing Mortality**: No information available.

**Recruitment**: No information available.

**State of Stock**: Assessments indicate that catch currently at/or substantially above MSY. Both assessments subject to significant uncertainty.

**Forecast for 1990/91**:

| Option Basis | 1990 | | | 1991 | | | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| | F | SSB | Catch | F | SSB | Catch | |
| | | | | | | | |

Weights in tonnes

Assessment Summary: *Notothenia gibberifrons*, Subarea 48.3

**Source of Information**: This Report

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Max[2] | Min[2] |
|---|---|---|---|---|---|---|---|---|
| Recommended TAC | | | | | | | | |
| Agreed TAC | | | | | | | | |
| Landings | 2081 | 1678 | 2844 | 5222 | 838 | 11 | 11758 | 0 |
| Survey Biomass | 17107 | | 13146 | 7300 | 8542 | 12417[a]<br>21891[b]<br>53450[c] | | |
| Surveyed by | FRG | | USA/POL | USA/POL | UK/POL | UK[a]<br>USSR[b]<br>USSR[c] | | |
| Sp. Stock Biomass[3] | 4681 | 4947 | 5462 | 4962 | 3650 | 4145 | 26114 | 3650 |
| Recruitment (age...) | 15573 | 14897 | 13085 | 8509 | 4123 | 153 | | |
| Mean F (.....)[1] | 0.38 | 0.18 | 0.25 | 0.35 | 0.21 | 0.0011 | 0.48 | 0.0011 |

Weights in tonnes, recruits in thousands

[1] ... weighted mean over ages 2 to 19+

[2] Over period 1975/76 to 1989/90

[3] From VPA using UK trawl survey biomass estimate for 1990

**Conservation Measures in Force**: 13/VIII, 15/VIII.

**Catches**: Catches during 1989/90 were 11 tonnes, the lowest on record.

**Data and Assessment**: Two VPA analyses tuned to trawl survey biomass estimates (one based on UK estimate for 1990, the other tuned to USSR estimate for 1990). Population projections assuming $\mathbf{F_{0.1}} = 0.0935\ yr^{-1}$.

**Fishing Mortality**: Fishing mortality during 1989/90 lowest on record, fishing mortality rates exceeded $\mathbf{F_{0.1}}$ in all previous years.

**Recruitment**: Steady during 1975/76 to 1987/88 but some evidence of declines during 1987/88 to 1989/90.

**State of Stock**: Biomass levels stable at low levels since 1981/82.

**Forecast for 1991/92**:

| Option Basis | 1991 F | 1991 SSB | 1991 Catch | 1992 F | 1992 SSB | 1992 Catch | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| VPA - USSR Biomass estimate | $\mathbf{F_{0.1}}$ = 0.0935 | 7594 | 1134 | $\mathbf{F_{0.1}}$ = 0.0935 | 8374 | 1161 | |
| VPA - UK Biomass estimate | | 4947 | 667 | | 5636 | 723 | |

Weights in tonnes

Assessment Summary: *Chaenocephalus aceratus*, Subarea 48.3

**Source of Information**: This Report

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Max[2] | Min[2] |
|---|---|---|---|---|---|---|---|---|
| Recommended TAC | | | | | 1100 | 0 | | |
| Agreed TAC | | | | | 0 | 300 | | |
| Landings | 1042 | 504 | 339 | 313 | 1 | 2 | 1272 | 901 |
| Survey Biomass | 11542 | | 8621 | 6209 | 5770 | 14226[a]<br>14424[b]<br>17800[b] | | |
| Surveyed by | FRG | | USA/POL | USA/POL | UK/POL | UK/POL[a]<br>USSR[b] | | |
| Sp. Stock Biomass[3] | 2174 | 3006 | 4179 | 4156 | 4404 | 5098[4] | | |
| Recruitment (age 2) | 6154 | 6573 | 5375 | 8648 | 6717 | 4047[4] | | |
| Mean F (.....)[1] | 0.57 | 0.19 | 0.17 | 0.13 | 0.002 | | | |

Weights in tonnes, recruits in thousands

[1] ... weighted mean over ages 3 to 11

[2] Over period 1980 to 1990

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

[4] Predicted

**Conservation Measures in Force**: 13/VIII, 14/VIII.

**Catches**: Reported catches were less than 500 tonnes annually after 1985. Note that no catch figures were provided by the USSR.

**Data and Assessment**: These have been extensively described in WG-FSA-90/6 and have been revised during 1990 meeting.

**Fishing Mortality**: Probably low.

**Recruitment**: No independent recruitment surveys. VPA results indicate a spawner-recruit relationship.

**State of Stock**: Surveys up to 1989 and VPA indicate stock size of approximately 50% of initial size in 1975/76.

**Forecast for 1990/91** (from WG-FSA-90/6):

| Option Basis | 1990 F | 1990 SSB | 1990 Catch | 1991 F | 1991 SSB | 1991 Catch | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| TAC 300 t | | 3886 | 300 t | | 4377 | 300 t | |
| $F_{0.1}$ | 0.214 | 3886 | 1597 | 0.214 | 3719 | 2314 | SSB declining when fishing at $F_{0.1}$ |

Weights in tonnes

Assessment Summary: *Pseudochaenichthys georgianus*, Subarea 48.3

**Source of Information**: This Report

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Max[2] | Min[2] |
|---|---|---|---|---|---|---|---|---|
| Recommended TAC | | | | | 1800 | 0 | | |
| Agreed TAC | | | | | | 300 | | |
| Landings | 1097 | 156 | 120 | 401 | 1 | 1 | 1661 | 1 |
| Survey Biomass | 8134 | | 5520 | 9461 | 8278 | 5761[a]<br>12200[b]<br>10500[b] | | |
| Surveyed by | FRG | | USA/POL | USA/POL | UK/POL | UK/POL[a]<br>USSR[b] | | |
| Sp. Stock Biomass[3] | 5564 | 3758 | 5498 | 8090 | 8889[4] | | | |
| Recruitment (age 1) | 5358 | 18197 | 4337 | 1372 | | | | |
| Mean F (.....)[1] | 0.84 | 0.08 | 0.09 | 0.15 | | | | |

Weights in tonnes, recruits in 1 000

[1] ... weighted mean over ages 3 to 6

[2] Over period 1980 to 1990

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

[4] Predicted

**Conservation Measures in Force**: 13/VIII, 14/VIII.

**Catches**: Reported catches were less than 400 tonnes annually after 1985. Note that no catch figures are provided by the USSR.

**Data and Assessment**: These have been extensively described in WG-FSA-90/6. Reliability of assessment is probably low due to unresolved problems with ageing.

**Fishing Mortality**: Probably low in recent years.

**Recruitment**: No independent recruitment survey. VPA results indicate a highly variable recruitment.

**State of Stock**: Present stock size probably at 25% of the pristine stock size in 1975/76.

**Forecast for 1990/91** (from WG-FSA-90/6):

| Option Basis | 1990 | | | 1991 | | | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| | F | SSB | Catch | F | SSB | Catch | |
| TAC=300 t | | 8357 | 300 t | | 8950 | 300 t | |
| $F_{0.1}$ | 0.626 | 7213 | 1857 | 0.626 | 7679 | 2039 | |
| 50% $F_{0.1}$ | 0.313 | 8710 | 1388 | 0.313 | 9273 | 1514 | |

Weights in tonnes

Assessment Summary: *Notothenia squamifrons*, Subarea 48.3

**Source of Information**:

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Max[2] | Min[2] | Mean[2] |
|---|---|---|---|---|---|---|---|---|---|
| Recommended TAC | | | | | | 0 | | | |
| Agreed TAC | | | | | | 300 | | | |
| Landings | 1289 | 41 | 190 | 1553 | 927 | | 1553 | 0 | 563 |
| Survey Biomass | | | 13950 | 409 | 131 | | | | |
| Surveyed by | | | USA/POL | USA/POL | UK/POL | | | | |
| Sp. Stock Biomass[3] | | | | | | | | | |
| Recruitment (age...) | | | | | | | | | |
| Mean F (.....)[1] | | | | | | | | | |

Weights in tonnes, recruits in .....
[1] weighted mean over ages (...)
[2] Over period 1980 to 1989
[3] From VPA using (.....)
[4] Predicted

**Conservation Measures in Force**: 13/VIII, 14/VIII

**Catches**:

**Data and Assessment**:

**Fishing Mortality**:

**Recruitment**:

**State of Stock**:

**Forecast for 1990/91**:

| Option Basis | 1990 F | 1990 SSB | 1990 Catch | 1991 F | 1991 SSB | 1991 Catch | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

Weights in tonnes

Assessment Summary: *Notothenia rossii*, Division 58.5.1

**Source of Information**: This Report

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Max[2] | Min[2] | Mean[2] |
|---|---|---|---|---|---|---|---|---|---|
| Recommended TAC | | | | | | | | | |
| Agreed TAC | | | | | | | | | |
| Landings | 1707 | 801 | 482 | 21 | 245 | 155 | 9812 | 21 | 2531 |
| Survey Biomass | | | | | | | | | |
| Surveyed by | | | | | | | | | |
| Sp. Stock Biomass[3] | | | | | | [4] | | | |
| Recruitment (age...) | | | | | | [4] | | | |
| Mean F (.....)[1] | | | | | | | | | |

Weights in tonnes, recruits in .....

[1] ... weighted mean over ages (...)
[2] Over period 1980 to 1990
[3] From VPA using (.....)
[4] Predicted

**Conservation Measures in Force**: Conservation Measure 2/III. Resolution 3/IV. Limitation of trawlers allowed on fishing grounds each year. Arrêté N°: 18, 20, 32 (for details see SC-CAMLR-VIII, Annex 6, Appendix 10, page 290).

**Catches**:

**Data and Assessment**:

**Fishing Mortality**:

**Recruitment**:

**State of Stock**:

**Forecast for 1990/91**:

| Option Basis | 1990 F | 1990 SSB | 1990 Catch | 1991 F | 1991 SSB | 1991 Catch | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

Weights in tonnes

Assessment Summary: *Notothenia squamifrons*, Division 58.5.1

**Source of Information**: This Report

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Max[2] | Min[2] | Mean[2] |
|---|---|---|---|---|---|---|---|---|---|
| Recommended TAC | | | | | | | | | |
| Agreed TAC | | | 5000 | 2000 | 2000[5]+ | | | | |
| Landings | 7394 | 2464 | 1641 | 41 | 1825 | 1262 | 11308 | 41 | 4057 |
| Survey Biomass | | | | | | | | | |
| Surveyed by | | | | | | | | | |
| Sp. Stock Biomass[3] | | | | | | [4] | | | |
| Recruitment (age...) | | | | | | [4] | | | |
| Mean F (.....)[1] | | | | | | | | | |

Weights in tonnes, recruits in .....

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

[2] Over period 1980 to 1990

[3] From VPA using (.....)

[4] Predicted

[5] TAC set by fishing season, not split-year

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

**Catches**:

**Data and Assessment**:

**Fishing Mortality**:

**Recruitment**:

**State of Stock**:

**Forecast for 1990/91**:

| Option Basis | 1990 | | | 1991 | | | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| | F | SSB | Catch | F | SSB | Catch | |
| | | | | | | | |

Weights in tonnes

Assessment Summary: *Champsocephalus gunnari*, Division 58.5.1

**Source of Information**: This Report

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Max[2] | Min[2] | Mean[2] |
|---|---|---|---|---|---|---|---|---|---|
| Recommended TAC | | | | | | | | | |
| Agreed TAC | | | | | | | | | |
| Landings (Skif Bank) | 223 | 0 | 2625 | 2 | 0 | | 2625 | 0 | 578 |
| Landings (Kerguelen) | 8030 | 17137 | 0 | 157 | 23628 | | 25848 | 0 | 9784 |
| Landings (Combined) | | | | | | 226 | | | |
| Survey Biomass | | | | | | | | | |
| Surveyed by | | | | | | | | | |
| Sp. Stock Biomass[3] | | | | | | [4] | | | |
| Recruitment (age...) | | | | | | [4] | | | |
| Mean F (.....)[1] | | | | | | | | | |

Weights in tonnes, recruits in .....

[1] ... weighted mean over ages (...)
[2] Over period 1980 to 1990
[3] From VPA using (.....)
[4] Predicted

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

**Catches**:

**Data and Assessment**:

**Fishing Mortality**:

**Recruitment**:

**State of Stock**:

**Forecast for 1990/91**:

| Option Basis | 1990 F | 1990 SSB | 1990 Catch | 1991 F | 1991 SSB | 1991 Catch | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

Weights in tonnes

Assessment Summary: *Dissostichus eleginoides*, Division 58.5.1

Source of Information: This Report

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Max[2] | Min[2] | Mean[2] |
|---|---|---|---|---|---|---|---|---|---|
| Recommended TAC | | | | | | | | | |
| Agreed TAC | | | | | | | | | |
| Landings | 6677 | 459 | 3144 | 554 | 1630 | 1062 | 6677 | 40 | 1304 |
| Survey Biomass | | | | | 27200 | | | | |
| Surveyed by | | | | | | | | | |
| Sp. Stock Biomass[3] | | | | | | [4] | | | |
| Recruitment (age...) | | | | | | [4] | | | |
| Mean F (.....)[1] | | | | | | | | | |

Weights in tonnes, recruits in .....

[1] ... weighted mean over ages (...)
[2] Over period 1980 to 1990
[3] From VPA using (.....)
[4] Predicted

**Conservation Measures in Force**: None.

**Catches**:

**Data and Assessment**:

**Fishing Mortality**:

**Recruitment**:

**State of Stock**:

**Forecast for 1990/91**:

| Option Basis | 1990 F | 1990 SSB | 1990 Catch | 1991 F | 1991 SSB | 1991 Catch | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

Weights in tonnes

Assessment Summary: *Notothenia squamifrons*, Division 58.4.4

**Source of Information**: This Report

| Year | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Max[2] | Min[2] |
|---|---|---|---|---|---|---|---|---|
| Recommended TAC (Lena Bank) | | | | | | | | |
| Agreed TAC | | | | | | | | |
| Landings (Ob Bank[a])* | 1023 | 9531 | 1601 | 1971 | 913 | | | |
| Landings (Lena Bank[a])* | 87 | 1977 | 441 | 2399 | 3003 | | | |
| Landings (Combined[b]) | 27 | 61 | 930 | 5302 | 3360 | 1450 | 5302 | 27 |
| Survey Biomass (Ob Bank) | 11000 | | | | 12700 | | | |
| Survey Biomass (Lena Bank) | 11800 | | | | | | | |
| Surveyed by | USSR | | | | USSR | | | |
| Sp. Stock Biomass[3] | | | | | | na | | |
| Recruitment (age...) | | | | | | na | | |
| Mean F (.....)[1] | | | | | | | | |

Weights in tonnes, recruits in .....

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

2 Over period 1985 to 1990

3 From VPA using (.....)

* Calendar Year data

a From WG-FSA-90/37

b From SC-CAMLR-IX/BG/2 Part 2 (Statistical Bulletin)

**Conservation Measures in Force**: 2/III, 4/V.

**Catches:** There are great discrepancies between the catches reported for the individual banks in WG-FSA-90/37 and those for the entire area in the Statistical Bulletin.

**Data and Assessment**:

**Fishing Mortality**: Ob Bank 0.4 (1989) and Lena Bank 0.8 (1989).

**Recruitment**: No data available.

**State of Stock**: Ob Bank - probably significantly depleted. Lena Bank - becoming fully exploited.

**Forecast for 1990/91**:

| Option Basis | 1990 F | 1990 SSB | 1990 Catch | 1991 F | 1991 Biomass | 1991 Catch | Implications/ Consequences |
|---|---|---|---|---|---|---|---|
| $F_{0.1}$ Ob Bank | 0.17 | | | 0.13 | 2949 | 267 | |
| $F_{0.1}$ Lena Bank | 0.47 | | | 0.13 | 3454 | 305 | |

Weights in tonnes