ANNEX 4

REPORT OF THE AD HOC WORKING GROUP ON FISH STOCK ASSESSMENT

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INTRODUCTION

The meeting of the Working Group was held at the CSIRO Marine Laboratories, Battery Point, Hobart, Australia from 1–4 September 1986. Dr R.C. Hennemuth was in the chair. A list of those attending is given in Appendix I. Dr J.A. Gulland was appointed rapporteur. A list of documents presented at the meeting is given in Appendix II.

BASIC DATA

2. At its 1985 meeting, the Group reported considerable improvement in the data reported to the Commission, though there were some shortcomings. The level of reporting of current data is similar to last year, though there are still gaps in the historical data. Summary statistics, as reported on STATLANT A and B forms, were available from all countries for the 1984/85 season. However, the reporting of more detailed information on catch and effort is still falling short of the requirements set out in the annex of the report of the 1984 Meeting of the *Ad Hoc* Working Group. The exception was the fishery around Kerguelen, where very detailed information was collected by the French authorities. A summary of these data was made available to the Working Group (Doc. 3).

3. The collection and reporting of catch and effort data on a fine scale may also become important in connection with ecosystem monitoring. The Working Group for the CCAMLR Ecosystem Monitoring Program has proposed a number of study areas which are smaller than most STATLANT Subareas, though in some cases overlapping two or more subareas. In accordance with the Commission's 'ecosystem' approach to management, it will probably be necessary when detailed ecosystem monitoring is attempted, for catches in these study areas to be reported. Provided that the original data (e.g. from logbooks) are being collected in the agreed detail, this should present no great problem, though it would be important that any precise boundaries specified by the ecosystem group should be consistent with boundaries of the smallest statistical units (i.e. half-degree squares).

4. Length and age data have been reported for most species for those seasons and areas in which significant catches were taken but there are still some important gaps (see

Appendix III). In some cases reporting has not been in accordance with agreed standards, and this is causing problems in analysis (see paragraphs 4.3 to 4.11 of the 1985 Scientific Committee's Report). Problems remain concerning age determination. The Working Group noted that the Age Determination Workshop held in Moscow had discussed the problems, but many remained unsolved. It was hoped that future work (e.g. the exchange of scales and otoliths) would help resolve these. In any case, the Working Group believed that it was important for the problems to be clearly identified. In particular, in order to aid the interpretation of differences in age compositions reported by different countries in their routine data submission to CCAMLR, it would be valuable to have information for each of the major species on the interpretations of the same scale or otolith by different scientists, and the degree to which differences in interpretation increase with the size (and presumed age) of fish.

NEW RESEARCH

5. One working paper presented to the Group (Doc. 2) reported new fish stock assessments. The results of this study, covering the stocks of *N. rossii* and *C. gunnari* at South Georgia, are discussed in a later section. In addition, a number of working papers were presented describing studies relevant to stock assessment. These included surveys around Elephant Island, area 48.1 (Doc. 1), surveys of juvenile *C. gunnari* around South Georgia (Doc. 10), biological observations and exploratory fishing around South Georgia (Doc. 4) and results of mesh selection experiments (Doc. 5).

ASSESSMENTS

General

6. Though significant catches have been taken from the Antarctic for some 15 years, catches from any one stock have, in most cases, been concentrated in one or more periods of no more than two or three years, separated by periods of light and negligible fishing (see Table 1 and Figure 1). For some stocks - the South Georgia stock of *N. rossii* is a good example - this appears to be due to an extreme form of pulse fishing, i.e. the fishing down in one or two seasons of the accumulated stock from several years' natural production. In other cases the pulses may be a natural feature of the stock; catches from some stocks, e.g. of *C. gunnari,* consist now of only one or two year-classes, and if year-class strength is highly

variable, then high catches (and probably also high fishing effort) will be limited to those years in which good year-classes are present.

7. In either situation it is difficult to define 'typical' values of catch, fishing effort or fishing mortality which can be compared with some optimum or target values to provide a basis for management advice under the Convention.

8. The absence of a typical, or expected, value of fishing mortality raises particular problems in the application of virtual population analysis (VPA). This requires the input of a terminal F, i.e. the value of fishing mortality in the last year for which catch-at-age data are available. If there is no clear average value for previous years which can be used as a first approximation, another approach is needed. The most satisfactory in many cases will be an estimate of current biomass (e.g. from research vessel surveys), especially if accompanied by confidence limits (see Doc. 2). While catch and effort statistics and length/age data are important, they often need to be supplemented by other information (e.g. from surveys) if a satisfactory assessment is to be made. This matter is discussed later in relation to future assessment studies.

9. The variability in catches is demonstrated in Table 1 which presents the total catch of all fish species, and a summary of the statistical information given in more detail in SC-CAMLR-V/BG/8. In two areas, more than half the total historical catch has been taken in one season (1977/78 for Statistical Subarea 48.2, South Orkney, and 1978/79 for 48.1, Peninsula). Fishing at South Georgia (48.3) and Kerguelen (58.5) has been more consistent, but in neither area have catches approached those in the initial seasons (1969/70 at South Georgia, and 1971/72 at Kerguelen). It is also apparent from the more detailed data that recent pulses of good catches come increasingly from the shorter-lived species, especially *Champsocephalus gunnari*. At both South Georgia and Kerguelen, catches of this species have declined appreciably from the most recent peak in 1982/83. As a result, the total fish catches in 1984/85 were only some 73,000 tonnes, the lowest annual figure since 1975/76.

South Georgia

Notothenia rossii

10. The 1985 report concluded that this stock had been reduced to a very small proportion of its 1969 abundance, and that recruitment in recent years was also much less than earlier. This was confirmed by new studies. The VPA analysis was repeated using the most recent

age and length data. In this analysis, the terminal F (for the 1984/85 season) was determined using the biomass estimates derived from the surveys reported by Kock (SC-CAMLR-IV/BG/12). The estimated trends in biomass are shown in Figure 2, which indicates that the current biomass is only a few percent of the initial value.

11. Estimates of year-class strengths (derived from the VPA analysis and expressed as numbers of 2 year old fish) are given in Table 2. This shows that recent recruitment has been small. Although recruitment, expressed as a percentage of current stock, has increased, this increase has not been sufficient to balance the decrease in stock size (Doc. 2).

12. Polish survey data during the 1985/86 season indicated some increase in mean length of the samples, and a decrease in the proportion of fish less than 45 cm. There was a decrease in catch per haul compared with previous surveys. However, restrictions were applied which limited the directed fishing on *N. rossii* and also restricted the amount of fishing within 12 miles, so that these changes do not necessarily reflect real changes in the population. There is no indication of any significant improvement in recruitment.

13. In 1985 it was estimated that the current replacement yield*, based on considerations of yield-per-recruit and current recruitment, was less than a thousand tonnes. An alternative approach was examined by Cooke (Doc. 2), based on apparent recruitment as a percentage of current stock numbers. This gave a range of a few thousand tonnes depending on the values used for current stock. The difference between the two approaches derives largely from different implied assumptions about the numbers of fish recruiting to the fishery.

14. Similarly, the expected trends in stock abundance over the next few years in the absence of any fishing depend on the magnitude of recruitment. If recruitment in the immediate future is the same as the average recruitment in previous years, and it is assumed that the 1985/86 catch is the same as in 1984/85, and that catches are zero in 1986/87 and subsequent seasons, the recovery will be as shown in Figure 2. This figure implies a replacement yield of one or two thousand tonnes, which is probably close to the actual values. It is also close to the average level of recent catches.

* Replacement yield is that catch which, if taken during a season, would leave the abundance of the stock at the end of the season at the same level as at the end of the previous season.

N. gibberifrons

15. Based on estimates of mortality derived from average lengths, it was concluded by the 1985 Working Group that this stock was heavily fished, with fishing mortality well in excess of natural mortality. This was confirmed by a VPA analysis, based on Polish length and age data[**], with the terminal F determined from the 1985 survey data reported by Kock (1985). Using a value of natural mortality M = 0.25 (probably an upper limit for a relatively long-lived fish), the average F on 9+ fish from 1976 to 1985 was 0.37, and was much higher in some years (1.35 in 1980/81). This has resulted in a considerable decline in adult biomass, since 1975. Trends in total biomass are less well known, because of difficulties in the VPA in determining the actual abundance of the younger year-classes in the most recent years. The stock trajectory estimated from VPA is shown in Figure 4b.

16. For the same reason, it is difficult to determine the strength of recent year-classes. The most recent year-class for which a reasonably reliable estimate is available is that spawned in 1977 (7 year olds in the 1984/85 season). For this and earlier year-classes, there is no evidence of any significant fall in recruitment, but fishing did not cause any substantial fall in spawning stock until 1978.

17. The replacement yield is almost certainly small, although the precise value will depend on the strengths of the recent year-classes, and these are not well known. The current biomass has been estimated as 15,762 tonnes based on the surveys reported by Kock. Lower catches would allow a recovery of the stock. The expected trend in abundance, if catches were zero from 1986/87 onwards, is indicated in Figure 3.

C. gunnari

18. This species is shorter lived than the *Notothenia* species, and catches in recent years have been based on only one or two year-classes. It was concluded in the 1985 report that this stock was being heavily fished.

19. VPA analysis, based on Polish age/length data and with terminal F set to match the 1984/85 survey data, confirms this conclusion. Fishing mortality has been very high, especially in 1976/77 and in the last couple of seasons.

** The interpretation of scales used in producing these age data differs from those of other scientists. The latter interpretations tend to imply a rather faster growth rate, and use of these interpretations could modify the VPA analysis. A re-examination of the data, and if appropriate, a re-run of the analysis is clearly desirable.

20. The trends in biomass, as estimated from VPA, are shown in Figure 5a. This shows large fluctuations, with a decline until 1978, and then a strong peak in 1982/83 due largely to the strong 1980 year-class, followed by a further sharp decline. Current biomass is very much less than in 1975.

21. Recruitment is highly variable, and therefore it is very difficult to determine whether fishing is having any effect on recruitment.

22. Future trends in abundance, and the values of current replacement yields depend critically on current recruitment and recruitment over the next few years. There is little reliable information on these. However, the stock appeared to recover from a low level of abundance in 1978 under fishing mortalities slightly less than 0.3. The chances of an average or better year-class occurring would probably be increased if catches were kept at a low level (i.e. F less than 0.3) until a good year-class enters the fishery.

23. The Working Group noted that the USSR reports on length composition to the Secretariat included records of substantial quantities of juvenile fish (age-class 1, approximately 17 cm), presumably taken with a small-meshed net. It was explained that these records, which had been reported as coming from commercial catches, actually came from exploratory fishing, and not from the commercial fishery. While recognising the value of exploratory fishing data, the Working Group emphasised the importance of also having data from the commercial fishery, so that accurate knowledge could be obtained of the sizes of all fish being removed from the stock.

Other Species

24. Table 3 sets out the total reported catch, by species, from South Georgia in recent years. This shows that in addition to the large catches of the three species for which assessments are now available, significant catches of *N. guentheri*, and smaller but non-negligible catches of several other species have been reported. In addition, significant quantities of unclassified species continue to be reported, especially by the Soviet Union. The Working Group repeated its concern expressed in last year's report, that every effort should be made to identify fully the species in the catch.

25. *N. guentheri* is a small species, caught only by the Soviet Union in the Shag Rocks area. No information has been provided that could enable the Working Group to attempt an assessment of this stock. In view of the volume of the catches (cumulative catches of over

115,000 tonnes) the Working Group stressed that information should be provided about this stock as a matter of urgency.

26. Length composition data are available for recent commercial (Poland) and research vessel (FRG) catches for *Chaenocephalus aceratus* and *Pseudochaenichthys georgianus*. These indicate little change in size between 1983/84 and 1985/86, with the catches of *P. georgianus* being almost entirely of adults. Since the catch of 13,000 tonnes of *P. georgianus* in the 1977/78 seasons, catches of both species have been at around 1,000 tonnes annually.

Peninsula Subarea (48.1)

Introduction

27. Large-scale harvesting of finfish in the Peninsula region started in 1978/79 and was reported for the two successive seasons and for 1982/83. The main fishing grounds were off Deception Island, off the north coast of King George Island, northeast of Joinville and particularly northwest and west of Elephant Island. Peak catches of 52,000 tonnes were taken in the first season. In the subsequent years, yields dropped substantially: 22,389 tonnes in 1979/80, 5,980 tonnes in 1980/81 and 2,604 tonnes in 1982/83 (Anonymous, 1985). The main target species were *Champsocephalus gunnari* (35,900 tonnes), and *Chaenodraco wilsoni* (10,130 tonnes, exclusively taken off Joinville) in 1978/79 and *Notothenia rossii* (18,763 tonnes) in 1979/80.

28. Research activities were recorded from the area since 1975/76, i.e. before the onset of commercial fishing. By reviewing existing data on length and age compositions and biomass estimates (mostly from research vessel catches and exploratory fishing activities) an attempt is made to assess the effect fishing might have had on the stocks.

29. Analysis is restricted to the commercially most important species *Notothenia rossii*, *N. gibberifrons* and *Champsocephalus gunnari*.

Notothenia rossii

30. Data recently submitted to CCAMLR and those already available in scientific literature give evidence that *N. rossii* in the Peninsula region may form three distinct groups during its life cycle:

(a) juveniles living in the fjords and close to the coast in their first 3–5 years (Argentinean data from Potters Cove, Linkowski and Zukowski, 1980: Admiralty Bay)

(b) females (mostly juveniles) and males (juveniles and fish in their first year of sexual maturity) which are about to recruit to the spawning stock (5–7 years old, mostly belonging to age class 6, by-catches in Polish commercial fisheries in 1978/79, FRG research vessel catches in 1980/81 and 1983/84 to 1985/86) (Kock 1982, 1986) (see Figure 6c).

(c) the spawning stock consisting of some fish from about age class 5 onwards, age class 8 being the first fully recruited age class (Federal Republic of Germany research vessel catches Freytag, 1980; Kock, Duhamel and Hureau, 1985, Figure 19, and Soviet commercial catches in 1979/80) (see Figure 6a and b).

31. This separation into different groups, according to age and maturity, makes it difficult to obtain any estimate of overall abundance and complicates attempts at assessment.

32. The spawning stock (or at least part of it) was found during research trawling in a rather restricted area northwest of Elephant Island in 200–450 m depth. Length and age composition from the catches in 1976/77 and 1977/78 differed little from each other (Freytag, 1980; Kock, Duhamel and Hureau, 1985).

33. Length and age composition of the commercial catches in 1979/80 (see Figures 6a and b) indicates that the same concentration was exploited during the commercial fishery. Attempts to locate the spawning stock after the large-scale fishing in 1979/80 failed. The concentrations located in the research vessel surveys in March 1981, February 1985 and May/June 1986 consisted predominantly of fish of age classes 6 and 7, i.e. the individuals which were about to recruit to the spawning stock.

34. The catch of 18,762 tonnes in 1979/80, which was probably of mature fish exceeded the estimate made of the biomass before exploitation of 9,000 – 15,500 tonnes (Kock, Duhamel and Hureau 1985, Table 51). In view of the difficulties in locating concentrations of spawning fish in later seasons, this suggests that the 1979/80 fishery removed most of the mature fish. In the absence of any reported catch in subsequent years, and the limited supply of survey and other non-fishing data, it is impossible to make any quantitative statement about the current state of the stock, though it is probably well below its initial abundance.

Champsocephalus gunnari

35. Data are available from 1977/78 onwards. Research vessel catches from the Elephant Island area in 1977/78 consisted entirely of individuals of 28–38 cm (age classes 3 to 5 according to USSR age determinations). According to the length compositions, these concentrations were exploited commercially by the Soviet fleet and partly by the Polish fleet. The fish were then 30–40 cm long and belonged to age classes 4–6 (see figures 7a and 7b and Kock, Duhamel and Hureau, 1985, Figures 27, 28). A much smaller part of the catches originated from King George Island and consisted of individuals of 35–47 cm. These were mostly taken by Polish and GDR vessels (Kock et al Figure 28). The same concentrations were exploited by Soviet and Polish vessels in 1979/80.

36. Length and age compositions from Soviet exploratory fishing since 1980/81 demonstrated a high year to year variability in the composition of the catches (see Figures 7a and 7b) without any significant trend. The similarity of length compositions of FRG research vessel catches in 1980/81, 1983/84 and 1984/85 taken off Elephant Island with those reported from Soviet exploratory fishing in the Peninsula Subarea indicate that the latter were also taken around Elephant Island.

37. Elephant Island is the most important fishing ground in the Peninsula Subarea.

38. The catches in 1978/79 were in the order of the (rough) biomass estimate for the whole Peninsula Subarea in 1977/78 (Kock, Duhamel and Hureau, 1985, Table 51). Most of the biomass was formed by 2 or 3 very abundant year-classes which were fished out in 1978/79 and 1979/80. Year-classes of that strength have not been observed since.

39. Stock biomass dropped substantially in the Elephant Island area as a result of the heavy fishing in 1978/79. No significant change is, however, apparent from the length and age compositions over the successive 6–7 years, i.e. in contrast to South Georgia, fishes more than 32 cm obviously still form a significant part of the population. Even when no fishing took place, year to year changes in the length and age compositions indicate a high natural variability which makes it even more difficult to detect any changes brought about by fishing.

Notothenia gibberifrons

40. Catches of about 4,000 tonnes (mostly taken in 1978/79) were less than 10% of the biomass estimated for the whole Peninsula Subarea (Kock, Duhamel and Hureau, 1985,

Table 51). Even if the catches were taken entirely around Elephant Island, they were only 20% of the estimated biomass there. A significant proportion of the catches, however, were obviously juveniles (USSR data submitted to CCAMLR for 1978/79). Neither the length compositions of catches from FRG research vessels, nor the length and age compositions from Soviet exploratory fishing vessels (see Figure 8) give evidence that the stock is significantly affected by fishing.

Other Species

41. Of the other species represented in the statistics, *Chaenocephalus aceratus* and *Chionodraco rastrospinosus* do not seem to have been substantially affected by the fishery. It is not possible to make any statement about *Chionodraco wilsoni*.

South Orkney Subarea (48.2)

Introduction

42. Commercial fishing in this subarea apparently began in the 1977/78 season, when 140,000 tonnes were taken (nearly all *C. gunnari*). Subsequent catches were much smaller, though unlike in the Peninsula area, some catches were taken in each season. Cumulative catches since 1978 are just under 100,000 tonnes i.e. less than in 1977/78. *C. gunnari* continues to be important, but in recent years significant catches of *N. gibberifrons* have also been taken.

Champsocephalus gunnari

43. Age and length data supplied by the USSR indicate that the year-class strength in this stock, as in other stocks of the same species, is highly variable. The very high catches in 1977/78 came from a couple of very good year-classes (those of 1974 and 1975) which, despite the high catches, continued to form the bulk of the stock even in 1980/81, when they were 5 and 7 year olds. In 1980, young fish (less than 4 years old) were virtually absent from the catch. A better year-class entered the fishery in 1983.

44. The USSR age-data was used to construct a VPA, using the FRG survey data to give a terminal F. The estimated trend in biomass is shown in Figure 5b. This indicates a sharp

decline from the peak biomass in 1978, with some recovery in 1983, but then a further decline to a very low level in 1985. Because of the variable year-classes, it is not clear to what extent the abundance in 1978 was typical of the unexploited abundance. The abundance in 1985 may have been under-estimated. However, the decline in biomass evident in Figure 5b is so great that it is clear that the stock has been reduced by fishing.

45. As has been shown for *C. gunnari* in other areas, future trends depend greatly on the strength of year-classes present in the fishery over the next four years. Current catches are largely of relatively old fish, which suggests that the most recently recruited year-classes are weak. In that case, the stock may decline in the immediate future, even in the absence of fishing.

N. gibberifrons

46. Total cumulative reported catches of this species are only about 20,000 tonnes, taken mostly in the 1979, 1984 and 1985 seasons. Sufficient age data are available from the USSR to make a VPA analysis using the survey data for 1984/85 provided by the FRG, to estimate terminal F. The results, in terms of the estimated abundance, are given in Figure 4a. This does not show any marked trend, the estimated abundance actually being highest in 1984. The results depend on the values of M and terminal F. The analysis suggests that fishing mortality in some years was quite high (0.6 – 0.8), indicating that the stock is probably at least moderately heavily fished.

47. Only 1 tonne of this species was reported caught in 1982/83; this was the only year with a large catch of unidentified species (12,349 tonnes) in this area. The reported catch of *Champsocephalus* in 1983/84 was 5,948 tonnes, which is comparable with the following year's catch. If the unidentified fish were primarily *N. gibberifrons*, this could substantially affect the VPA assessments for this stock. A revised VPA was carried out incorporating this catch. This analysis yields higher estimates of stock size in previous years (see broken line in Figure 5a). This revised VPA gives similar quantitative conclusions regarding fishing mortality.

Kerguelen Subarea (58. 5)

48. The data base available for assessing the stocks at Kerguelen is somewhat different from that in other areas, with the result that somewhat different methods have been used.

Prior to 1978, few data were available and this lack of long term series and detailed data from the earlier part of the fishery has made it difficult to apply VPA and similar methods. Since 1979 and the imposition of controls by France, very detailed catch and effort data have been available.

49. Examination of the detailed data, broken down into 9 subareas around the island, has shown that within any one subarea and during any particular season, catches tend to be predominantly of one species. Thus, using the detailed data, it is possible to follow trends in abundance of individual species from the c.p.u.e. However, the usefulness of c.p.u.e. will vary from species to species, depending for example on the degree of aggregation.

Notothenia rossii

50. It was noted in last year's report that, this stock was very greatly depleted by very high catches at the beginning of the fishery, and that with catches continuing at a level of a few thousand tonnes, was probably continuing to decline. A closure has applied to the spawning grounds (on the southeast continental shelf during winter) since 1983. This restriction has reduced the total catch, but has also broken the most representative series of c.p.u.e. data.. A less satisfactory series of c.p.u.e. values is available for the fishery in the summer, in which *N. rossii* is caught incidentally. This gives the following values.

Year	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Catch (tonnes)	1299	1981	462	584	488	788
cpue (t/hr)	1.38	0.80	0.39	1.05	0.81	2.41

51. The higher figure in the most recent years may indicate some recovery, but a more accurate measure of recovery would be from annual experimental fishing on the spawning grounds. It would also be useful to use trammel nets in coastal waters to monitor changes in the abundance of juveniles.

Notothenia squamifrons

52. This species is found mostly during summer in the subareas to the south and southeast of the island. The c.p.u.e. in these areas, together with the total catches from Kerguelen, were as follows:

Season	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86
Total catch (tonnes)	11,308	6,287	4,031	1,815	3,794	7,408	2,464
cpue (t/hr)	3.67	3.11	1.68	1.51	3.68	3.30	2.48

53. The variation in c.p.u.e. is not large, and does not suggest that there have been major trends in abundance during this period.

54. There has been some decrease in the mean length of fish from 34.8 cm in 1979/80 to 32.0 cm in 1985/86; and this is now less than the mean length at first maturity. Age composition data also suggest an increase in total mortality, from 0.38 in 1981 to 0.77 in 1986.

55. Current catches are very much less than those taken in 1970/71 and 1971/72, when a total of 77,000 tonnes were caught. Though no quantitative assessment has been made, the available information suggests that the stock has been considerably depleted from its initial (1970) level, and is now being exploited at an approximately sustainable level, but without recovery. Further studies are clearly needed. The series of data since 1979 may now be sufficient to warrant a VPA approach.

Champsocephalus gunnari

56. This is now the main species in the Kerguelen fishery. There are two distinct fishing areas, around the island itself and on the Skiff Bank. These are probably two distinct stocks.

57. Detailed length data have been collected since 1980 and these show that the fishery has in most years been based on a single cohort (occasionally two). The growth of each cohort can be easily followed in the length composition data, with modal lengths in June of successive years being 9, 18, 26, 29 and 33 cm. Around the island, there have been dominant cohorts in 1979 and 1982. On the Skiff Bank the dominant cohorts have been in 1977 and 1980.

58. Because the catches in any one year are largely of a single cohort, and there is a gap between cohorts, it is possible to estimate the change in numbers of each major cohort (expressed as catch per unit effort) by dividing the total catch per unit effort in weight, by the mean weight of individuals in the cohort.

Season	Catch (tonnes)	Effort (hours)	Cohort	Length (cm)	Mean Weight (g)	Mean cpue (wt)	cpue (number)	Apparent Survival (%)
Shelf								
1981/82	15024	2488	1979	26	96	6.04	6.29	
1982/83	25847	4208	1979	29	189	6.14	4.42	70
1983/84	6241	5708	1979	33	216	1.09	0.50	11
1984/85	8041	1293	1982	26	96	6.22	6.47	
1985/86	17054	2871	1982	29	139	5.94	4.27	66
Skiff Bank								
1980/81	991	618	1977	28	123	1.60	1.30	
1981/82	1024	635	1977	32	194	1.61	0.83	64
1983/84	805	886	1980	28	123	1.10	0.88	
1984/85	250	224	1980	32	194	0.90	0.46	52

59. These figures suggest that while total mortality must be high (as evidenced by the lack of old fish) recruitment may be only partial in the first year (26 cm group on the Shelf, 28 cm on the Skiff Bank). The abundance in any one season is clearly dependent on the strength of the cohort (or cohorts) present; so far there is no evidence that these strengths are influenced by fishing.

60. Because of the lack of data from the early years of the fishery, it is difficult to make definite statements about the relation of current biomass to the average pre-exploitation biomass. This lack of early data, and the variability in recruitment, makes it difficult to estimate the level of sustainable or replacement yields.

Other Areas

61. The Working Group noted that some 10,000 tonnes of fish (mainly *Notothenia squamifrons*) had been taken from Subarea 58.4.4 (probably Ob and Lena sea-mounts) since 1979. Apart from total catch, no information has been reported to the Commission from which it might be possible to make an assessment of these stocks.

MANAGEMENT

Mesh Selection

62. The Polish delegate presented information on some mesh selection experiments carried out by the R.V. *Professor Siedlecki*. Most of the work was done with two cod-ends of mesh-sizes approximately 60 and 100 mm, made of a tape material. This type of netting is

not generally used now, so the selectivity results may not exactly apply to the commercial fleet. Based on a subjective judgement of the flexibility of the two netting materials, it is believed that if there is a difference, the selectivity of the commercial fleet gear might be somewhat greater, though the difference is not likely to be large.

63. For some species, the selection factors of the two nets differed considerably, and it was not possible to reach a clear conclusion about selection. However, for two of the more important species (*C. gunnari*, and *N. gibberifrons*), there was fair agreement between the data sets. These are summarised below.

	60 mm (mean 61.2) 50% point SF		100 mm (mean 101.6) 50% point SF	
Mackerel icefish (*Champsocephalus gunnari*)	22.2	3.63	33.5	3.30
Bumphead Notothenia (*N. gibberifrons*)	21.1	3.45	35.7	3.51

Using the mean selection factors (3.46 and 3.48) and applying these to the legal minimum sizes of 80 mm and 120 mm of *C. gunnari* and *N. gibberifrons* respectively gives the following predicted 50% selection lengths:

C. gunnari	80 mm – 27.7 cm	120 mm – 41.5 cm
N. gibberifrons	80 mm – 27.8 cm	120 mm – 41.8 cm

64. For *C. gunnari*, the 50% selection length corresponding to the 80 mm mesh is greater than the mean length at maturity. The corresponding age is about 3.5 years. The yield-per-recruit calculations given in paragraph 28 of the 1985 Report show that this might be close to the optimum age at first capture, depending on the current level of fishing mortality.

65. When mesh selection studies are made, or mesh regulations introduced, it is important that the measurements are made in a standard manner. A document was prepared by the Secretariat (Doc. 12), setting out the procedures used by some other bodies. The Working Group did not have time to consider the details of that document but endorsed the Scientific Committee's view that standardisation was needed (see paragraph 4.32 of the 1985 Committee Report).

Closed Areas and Incidental Catches

66. As noted in last year's report, the effectiveness of closed areas in reducing fishing mortality as a whole, or on some section of the stock (e.g. juveniles) depends on the degree to which the group of fish to be protected inhabits clearly identifiable areas. For example, juvenile *N. rossii* are found mainly in the coastal zone. In line with these and other findings, the Commission has recommended certain actions, including the prohibition of directed fishing for *N. rossii*, and of fishing within 12 miles of South Georgia. It is too early to see what effect these measures are having.

67. As far as other species are concerned, the detailed catch and effort data for the post-1979 fishing at Kerguelen show that the major catches of most species are concentrated in a limited number of months and a few locations. A large degree of protection for any given species can therefore be achieved through the closure of the appropriate subareas and months. Such a closure is already in place for *N. rossii* at Kerguelen.

68. For other areas, the STATLANT B data are the most detailed catch/effort data reported to the Commission.

69. The STATLANT B data for the South West Atlantic frequently show a mixed species catch and thus indicate that the fishing effort may not be directed towards individual species. The patterns of fishing were discussed in conjunction with the Statlant B data.

70. Most fishing in recent years has been directed towards *Champsocephalus gunnari*. In many months of most seasons this species dominates in the catches, often accounting for over 90% of the total. Fishing vessels move to areas where *Champsocephalus gunnari* is expected to be found, and if found the fleet commences fishing on it. If, however, this species is not found in quantity but other commercial species are present in reasonable quantity, then the majority of vessels fish whilst scouting vessels move off in search of the target species. The occurrence of fishable concentrations of *Champsocephalus gunnari* varies seasonally and in quantity. With the present state of knowledge, the distribution of the target species cannot always be predicted. This accounts for the highly variable catch composition. Under favourable conditions over 90% of the catch is *Champsocephalus gunnari* although often this species only makes up 50% of the total, probably because directed fishing on *Champsocephalus gunnari* did not take place throughout the reporting period.

71. Fishing for *Champsocephalus gunnari* is undertaken using pelagic as well as bottom trawls. Pelagic trawls are often fished close to or even on the bottom. *Champsocephalus*

gunnari is known to migrate inshore to the fjords of South Georgia during April and May to spawn and large catches have been reported for those months (Table 5).

72. On a few occasions in the recent past, the fishery has been directed towards other species. When catches of *Notothenia guentheri* are present, it can safely be assumed to have been the target species, as it is rarely found in association with the other commercial species. During the 1978/79 and 1979/80 seasons, Polish vessels in the vicinity of Joinville Island (Subarea 48.1) were fishing for *Chaenodraco wilsoni*.

73. With the limited information on area of capture contained in the STATLANT B forms, this is probably as far as this review can be carried. With more detailed area breakdown, it might be seen that the situation in the South Atlantic is similar to that at Kerguelen, with considerable separation between the fisheries directed at different species.

Status of Stocks

South Georgia

74. In the 1985 Report, it was noted that the *N. rossii* stock was severely depleted, and that the stocks of *C. gunnari* and *N. gibberifrons* were also heavily fished. The more recent analysis reported on here confirms these conclusions. The stocks of *C. gunnari* and *N. gibberifrons* have been depleted well below their initial level, and the combined replacement yield of these species plus those of *C. aceratus* and *P. georgianus* is small - no more than a few thousand tonnes. Catches of *N. guentheri* are taken as a separate directed fishery around Shag Rocks, and there is no information on which to base an assessment of this stock.

Peninsula

75. The knowledge of the state of the stocks in this subarea is poor. Of the main species in the catch, the stock of *N. rossii* is probably well below its initial abundance, and that of *C. gunnari* dropped after heavy fishing in 1978/79, but there is little evidence that *N. gibberifrons* has been significantly affected by fishing.

South Orkney

76. The abundance of the main species in the catch, *C. gunnari*, is highly dependent on year-class strength. Current abundance is very much lower than that when fishing started in 1977. The other species, *N. gibberifrons* is moderately heavily fished.

Kerguelen

77. The management measures applied by the French authorities, including the additional protection given to the spawning stock of *N. rossii*, appear to have halted the decline in stocks that was occurring prior to 1979. There is some evidence of an increase in recovery of the most depleted stock, that of *N. rossii*, in 1986.

FUTURE ASSESSMENT WORK

78. Appendix III indicates the information relevant to stock assessment that is currently available for major stocks, and shows the annual catches from those stocks. Where there has been a significant fishery, much of the basic assessment information (i.e. catch, age and length data), has now been provided. There are still some gaps. For example, with the exception of Kerguelen, there is very little catch per unit effort data on a sufficiently fine scale to be of use for assessment purposes, and there are some stocks, e.g. *N. guentheri* and *D. eleginoides* for which very little data of any kind are available. The Working Group stressed the importance of filling these gaps. At the same time it recognised that filling gaps in historical data sets and adding data from one or two more fishing seasons was unlikely to lead to major improvements in the assessments that are already available, including those presented in this report.

79. There are a number of other stocks, some of which have supported catches, for which no data are so far available. These are listed in Table 4. Obviously no assessments can be done for these stocks.

80. The Working Group believed that it was timely to review the procedures being used to make assessments of the stocks, and to make proposals for how this work should be carried out in the future. In doing this, the Group recognised that what work was done had to be linked to the requirements of the Commission for advice on management, and the ways in which that advice would be provided in the future. It also recognised that within the

framework of the Commission, three stages could be distinguished – reporting of data by the countries to the Secretariat, routine processing of these data by the Secretariat, and the actual preparation of the assessment studies.

81. The Working Group noted that although a number of proposals have been made regarding submission of data (notably in the report of the Woods Hole meeting of the *Ad Hoc* Working Group on Data Collection and Handling) the only formal requirement on data submissions, including timing of reports, is that STATLANT A and B forms should be submitted to the Secretariat by 30 September following the fishing season. It believed that more formal commitments for the supply of other routine information should be made and that the Scientific Committee should set out in some detail the nature of these requirements, including standard methods for recording and reporting data. Such standards have already been set out elsewhere (e.g. for biological data in various BIOMASS documents) and standards for length reporting have been adopted by the Scientific Committee (see paragraph 4.7 of the 1985 Report). The Working Group recommended that the Scientific Committee consider recommending to the Commission formal requirements for routine submission of these data.

82. The Working Group noted that some of the difficulties experienced by the Commission in relation to data handling were now almost solved. It should therefore be possible for the Secretariat to assemble and circulate in advance the available data, in a standard format, along with the results of routine analyses requested by the Scientific Committee or by Working Groups. However, the production of full stock assessments including the integration of results from different types of data and analyses is likely to require expertise not immediately available within the Secretariat. At the same time, this type of work is not efficiently carried out by a large group, such as the present Working Group. Indeed it is unlikely that there would be a need for this group to meet again in the immediate future. A better arrangement might be for a small group (of perhaps three or four experts) to meet at some convenient place and time (not necessarily in Hobart), to prepare a report which could serve as the basis for the discussions of the Scientific Committee on stock assessment matters, including assessments of the current status of each major stock. The timing of such a meeting might be chosen late enough to assure a full reporting of data, but early enough to allow the report to be circulated to the members of the Scientific Committee in sufficient time for them to be able to digest it before the Committee's meeting.

83. The most useful data are likely to be survey results. These are particularly useful if they provide estimates of absolute numbers or biomass, but surveys giving relative numbers, e.g. indices of year-class strength from surveys of 0+ fish, are also of potential value. The

latter surveys need to be repeated at regular intervals using standard methods, if their potential is to be realised.

84. Surveys are expensive, and therefore need to be carefully planned if they are to provide the most information at the lowest cost. In particular, priorities and proposals for coordination need to be set by the Scientific Committee, taking account of the demands for advice by the Commission, and the degree to which individual stocks are depleted, moderately fished, or still unexploited.

85. The advice on stock assessment developed by the Scientific Committee should clearly focus on matters relevant to the Convention such as the ratios of current abundance to initial, unexploited, abundance; the current level of replacement or sustainable yield, or the degree to which recruitment has been affected by fishing.

86. Unfortunately, these matters cannot always be determined with certainty. For example, after there has been a clear decline in recruitment, there may still be doubt as to the role of fishing in causing this decline. The Working Group therefore believes that the Commission might wish to consider introducing some relatively easily measurable criteria for bringing into effect different management measures. For example, it might be decided to close a fishery for one season whenever the abundance of the adult stock was estimated to have fallen below some specified level and or to re-open a directed fishery when survey information indicated increased biomass and/or recruitment. The group suggests that this matter be discussed in more detail in the Scientific Committee.

87. Where the Commission is considering introducing specific measures, e.g. an increase in mesh size, or the closure for some specific period of a particular fishery, it would be desirable to determine the expected effects of such measures, and compare them with the effects of not acting. Bearing in mind the uncertainties of many assessments, such comparison might be made under different assumptions concerning the present state of the stocks, so that it can be seen to what extent the advantages of one or other management action is dependent on the precise state of the stocks. If such a procedure is to be followed, and the necessary calculations made, it would be essential for the Commission to give an early indication of the kind of measures it might wish to consider.

88. In any case, the priorities for future assessment work need to be matched to the requirements by the Commission for management advice. Thus, the more detailed the proposed measures, and the more detailed the advice needed, the more detailed should be the analysis performed and the greater will be the need for comprehensive reporting of data.

89. The Working Group noted that the analyses conducted at this meeting (e.g. VPA's) have been useful for an initial reconstruction of the stock trajectories up to the present time. However, additional information will be essential for developing on-going management advice for the Commission.

Table 1: Catches of fish in Convention Area, by year and subarea, 1970 – 1986 (in tonnes)

Year	Statistical Area 48					Statistical Area 58					Statistical Area 88	
	Sub Area					Sub Area					Sub Area	
	48.1	48.2	48.3	Unspecified	Total	58.4	58.5	58.6	Unspecified	Total	Unspecified	Total
1970	–		399704		399704		–	–	–	–	–	–
1971	–	–	113713	–	113713	–	–	–	99091	99091	–	–
1972	–	–	3351	–	3351	–	–	–	219552	219552	–	–
1973	–	–	2995	–	2995	–	–	–	32685	32685	–	–
1974	–	–	747	–	747	–	–	–	50034	50034	–	–
1975	–	–	4053	–	4053	–	–	–	68805	68805	–	–
1976	–	–	28732	–	28732	–	–	–	29233	29233	–	–
1977	–	–	124611	–	124611	–	–	–	10866	10866	–	–
1978	–	140311	37626	26185	204122	–	–	–	151503	151503	23	23
1979	52195	29105	24705	16257	122262	–	–	–	2629	2629	200	200
1980	26151	14808	56664	–	97623	4679	14827	–	–	19506	–	–
1981	6106	5086	91557	–	102749	3534	15348	–	–	18882	2100	2100
1982	–	3674	89036	–	92710	1519	30061	–	–	31580	105	105
1983	2620	18412	146482	–	167514	332	29658	18	–	30008	–	–
1984	–	15762	104742	–	120504	254	12436	–	–	12690	131	131
1985	–	8866	38517	–	47383	1325	24040		–	25365	–	–

Table 2: Estimates of recruitment (thousands of fish at age 2) for two notothenid stocks.

Year class	*N. rossii* S. Georgia		*N. gibberifrons* S. Orkney	
1959	10077	(11 years old in 1970)		
1960	15670	(10 years old in 1970)		
1961	19853	(9 years old in 1970)		
1962	21671	(8 years old in 1970)		
1963	20097	(7 years old in 1970)		
1964	20306	(6 years old in 1970)		
1965	16223	(5 years old in 1970)		
1966	10685	(4 years old in 1970)		
1967	5603	(3 years old in 1970)	167.2	(12 years old in 1979)
1968	3870	(2 years old in 1970)	398.8	(11 years old in 1979)
1969	4526	(2 years old in 1971)	816.9	(10 years old in 1979)
1970	6410	(2 years old in 1972)	1748.0	(9 years old in 1979)
1971	8094	(2 years old in 1973)	3091.3	(8 years old in 1979)
1972	8357	(2 years old in 1974)	4763.7	(7 years old in 1979)
1973	8568	(2 years old in 1975)	10513.0	(6 years old in 1979)
1974	8424	(2 years old in 1976)	19958.7	(5 years old in 1979)
1975	8221	(2 years old in 1977)	28083.5	(4 years old in 1979)
1976	7074	(2 years old in 1978)	38137.9	(3 years old in 1979)
1977	6272	(2 years old in 1979)	45940.7	(2 years old in 1979)
1978	6587	(2 years old in 1980)	39807.9	(2 years old in 1980)
1979	5797	(2 years old in 1981)	52217.0	(2 years old in 1981)
1980	3302	(2 years old in 1982)	47166.1	(2 years old in 1982)
1981	1474	(2 years old in 1983)	77123.6	(2 years old in 1983)
1982	inadequate data		74066.1	(2 years old in 1984)

Table 3: Catches, by species, from South Georgia (subarea 48.3) (tonnes)

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Pisces n.e.i.	–	1454	27	–	493	1407	190	13840	270	331	5166	7313	4849	11753	4227	3775
Nototheniidae n.e.i.	–	–	–	–	–	–	–	–	129	2407	486	210	51	–	40	365
Notothenia gibberifrons	–	–	–	–	–	–	4999	3727	11758	2540	8143	7971	2605	–	3304	2081
Notothenia guentheri	–	–	–	–	–	–	–	–	–	15011	7381	36758	31351	5029	10586	11923
Notothenia rossii	399704	101558	2738	–	–	–	10753	8365	2192	2137	24897	1651	1100	866	3022	1891
Notothenia squamifrons	–	–	35	765	–	1900	500	2937	–	–	272	544	812	–	–	1289
Dissostichus eleginoides	–	–	–	–	–	–	–	441	635	70	255	239	324	116	109	285
Channichthyidae n.e.i.	–	–	–	–	–	–	–	–	–	–	–	4554	–	–	–	54
Chaenocephalus aceratus	–	–	–	–	–	–	–	293	2066	464	1084	1272	676	–	161	1042
Champsocephalus gunnari	–	10701	551	1830	254	746	12290	93400	7557	641	7592	29384	46311	128194	79997	14148
Pseudochaenichthys georgianus	–	–	–	–	–	–	–	1608	13015	1104	665	1661	956	–	888	1097
Myctophidae	–	–	–	–	–	–	–	–	–	–	505	–	–	524	2401	523
Rajiformes	–	–	–	–	–	–	–	–	4	–	218	120	1	–	7	28

Table 4: Cumulative catches, by subarea, of species or species groups) for which no assessment data have been provided.

Species	TOTAL CATCH (tonnes)						
	SOUTH ATLANTIC OCEAN			INDIAN OCEAN			PACIFIC OCEAN
	Subarea			Subarea			Subarea
	48.1	48.2	48.3	58.4.2	58.4.4	Unspecified	88
Notothenia rossii					538		
Notothenia squamifrons	36	239	9054		8406		
Dissostichus eleginoides	102	254	2474		168		
Pleuragramma antarcticum		110		1245			1628
Nototheniidae n.e.i.	21	1494	3688				
Champsocephalus gunnari				293*			15**
Channicthyidae n.e.i.	26	1911	4608				
Myctophidae	48	350	3953				129
Rajiformes	1	10	378				
Pisces n.e.i.	4876	20163	55095			993	202

* Probably *Chaenodraco wilsonii*

** Unlikely to be this species

Table 5: Monthly reported catches of *Champsocephalus gunnari* using midwater otter trawls (OTM) and bottom trawls (OTB) in the South Georgia region during the 1982/83 season.

	Month							
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
(OTM)	6551	15029	20752	10346	16741	6162	6191	3393
(OTB)			9235	2130	8234	12085	8998	51
TOTAL	6551	15029	29987	12476	24975	18247	15189	3444

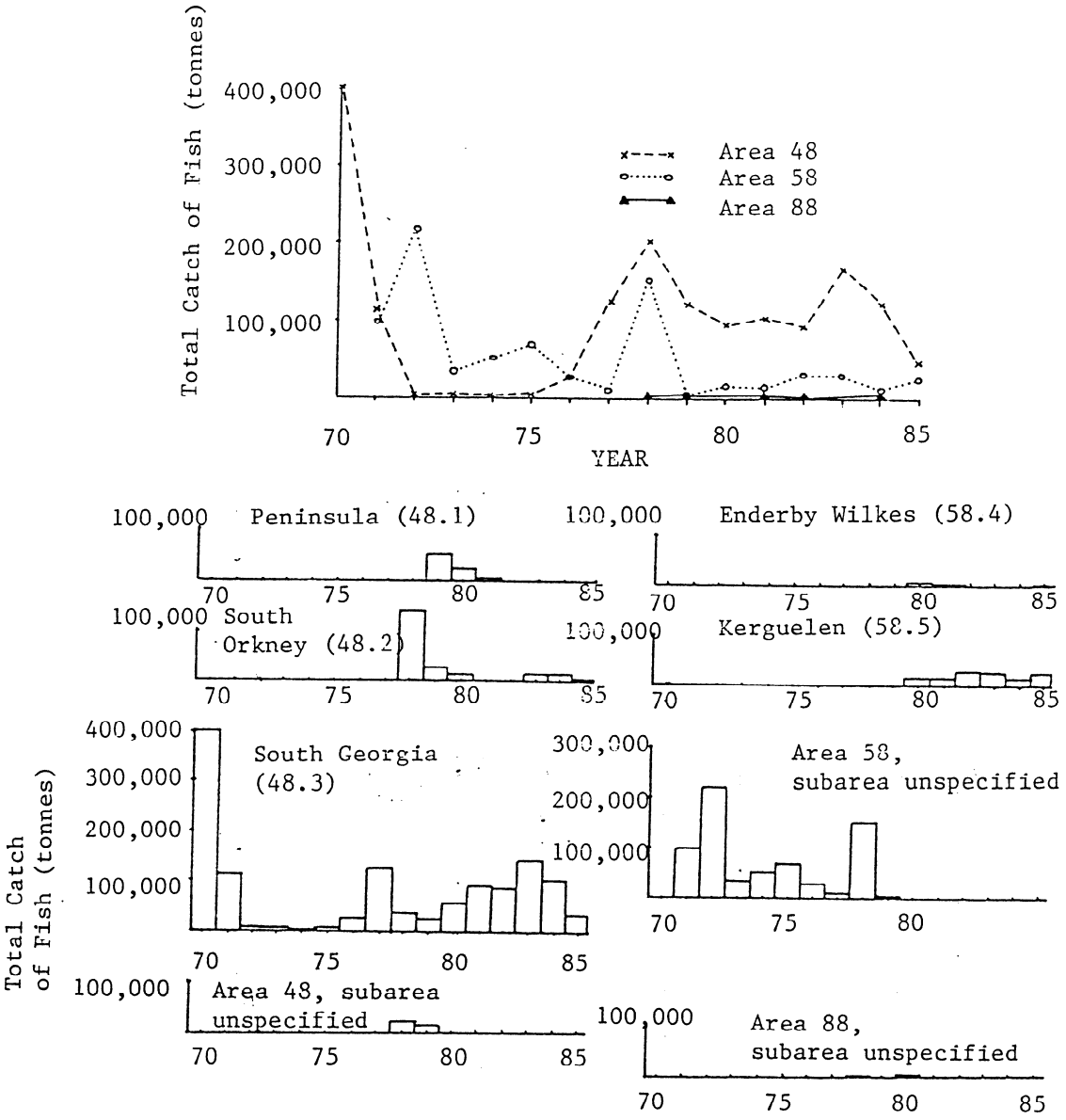

Figure 1: Annual total catches of all fin-fish species combined from each subarea of the Antarctic.

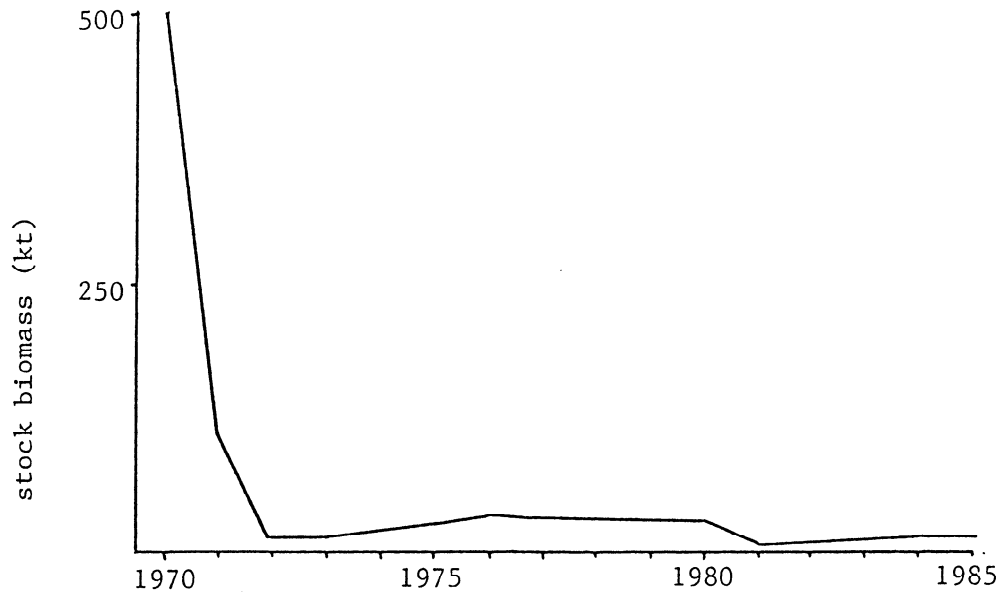

Figure 2: Estimated trends, from VPA, of biomass of *Notothenia rossii* at South Georgia.

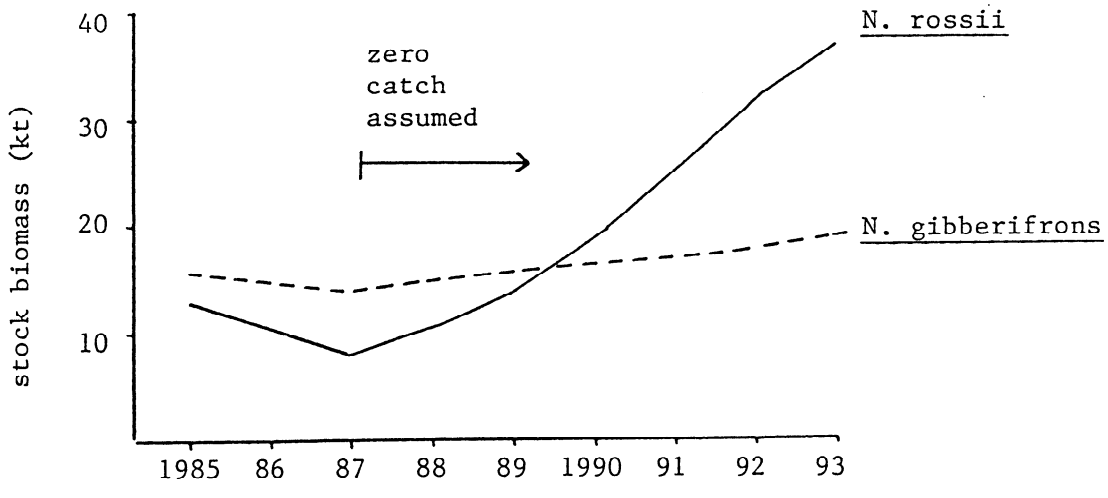

Figure 3: Estimated expected stock projections for *N. rossii* and *N. gibberifrons* in Area 48.3 assuming (i) catch in 85/86 same as 84/85 (ii) zero catch 86/87 onwards (iii) recruitment equal to average value of previous years.

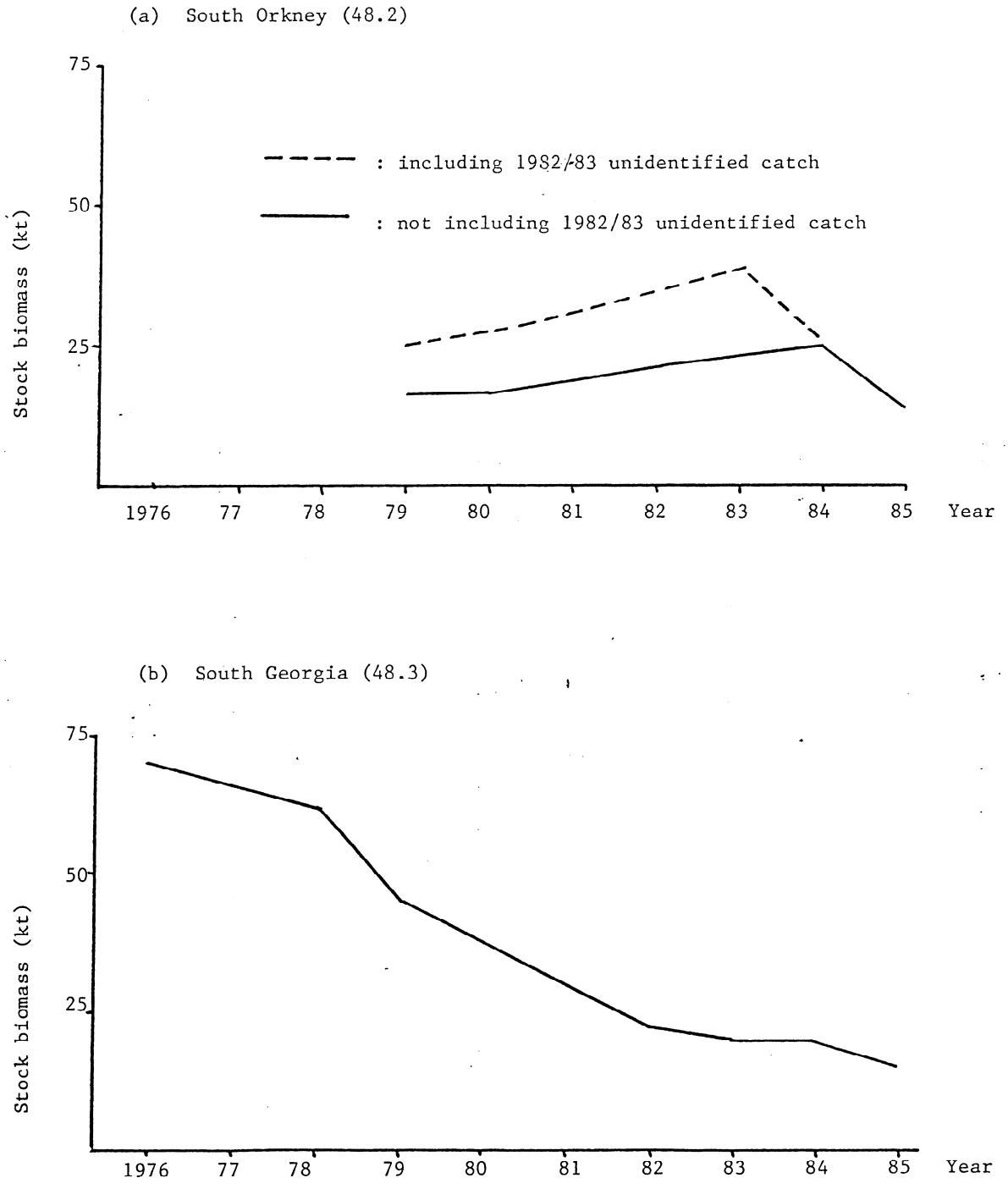

Figure 4: Estimated trends, from VPA, of biomass of *Notothenia gibberifrons*.

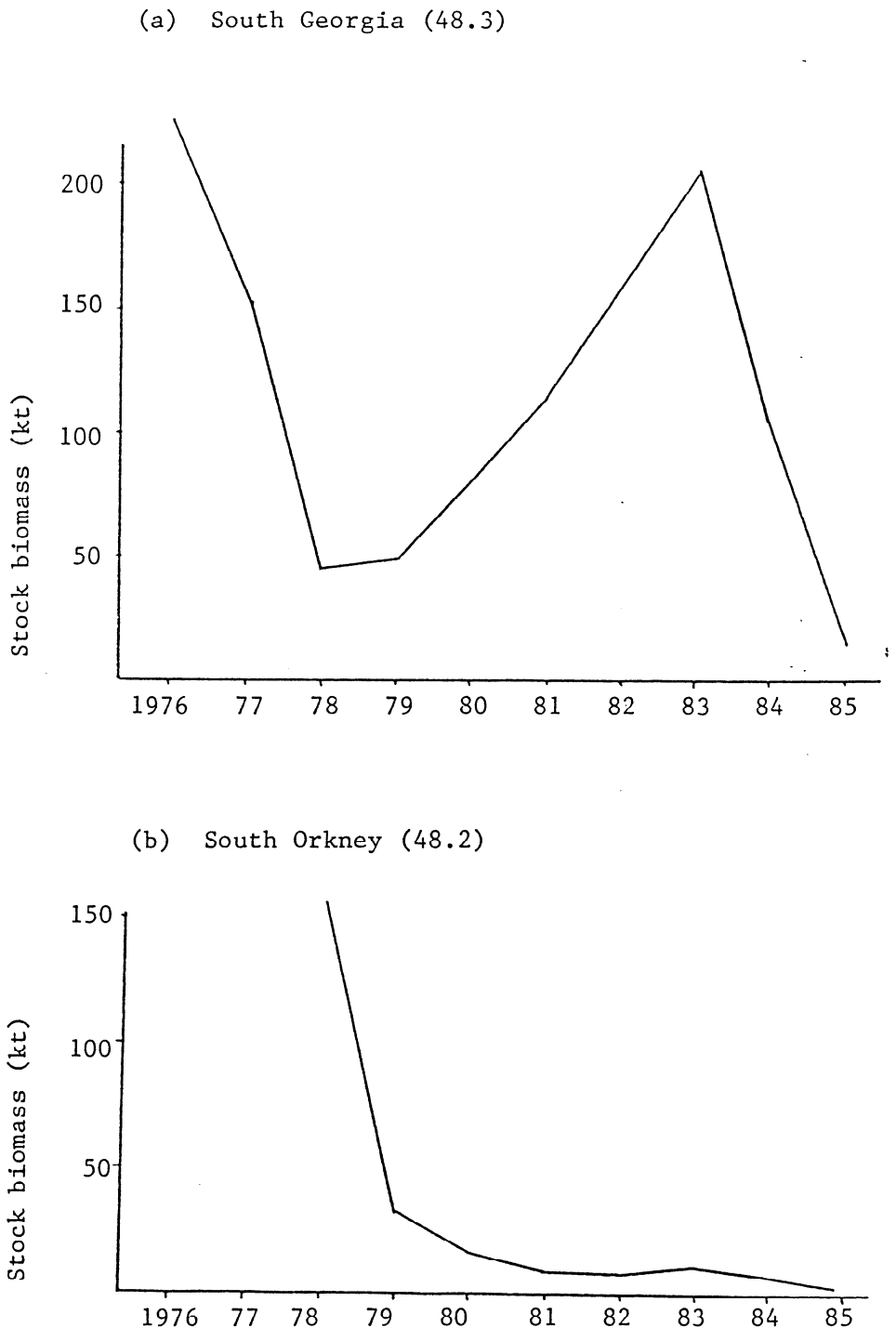

Figure 5: Estimated trends, from VPA, of biomass of *Champsocephalus gunnari*.

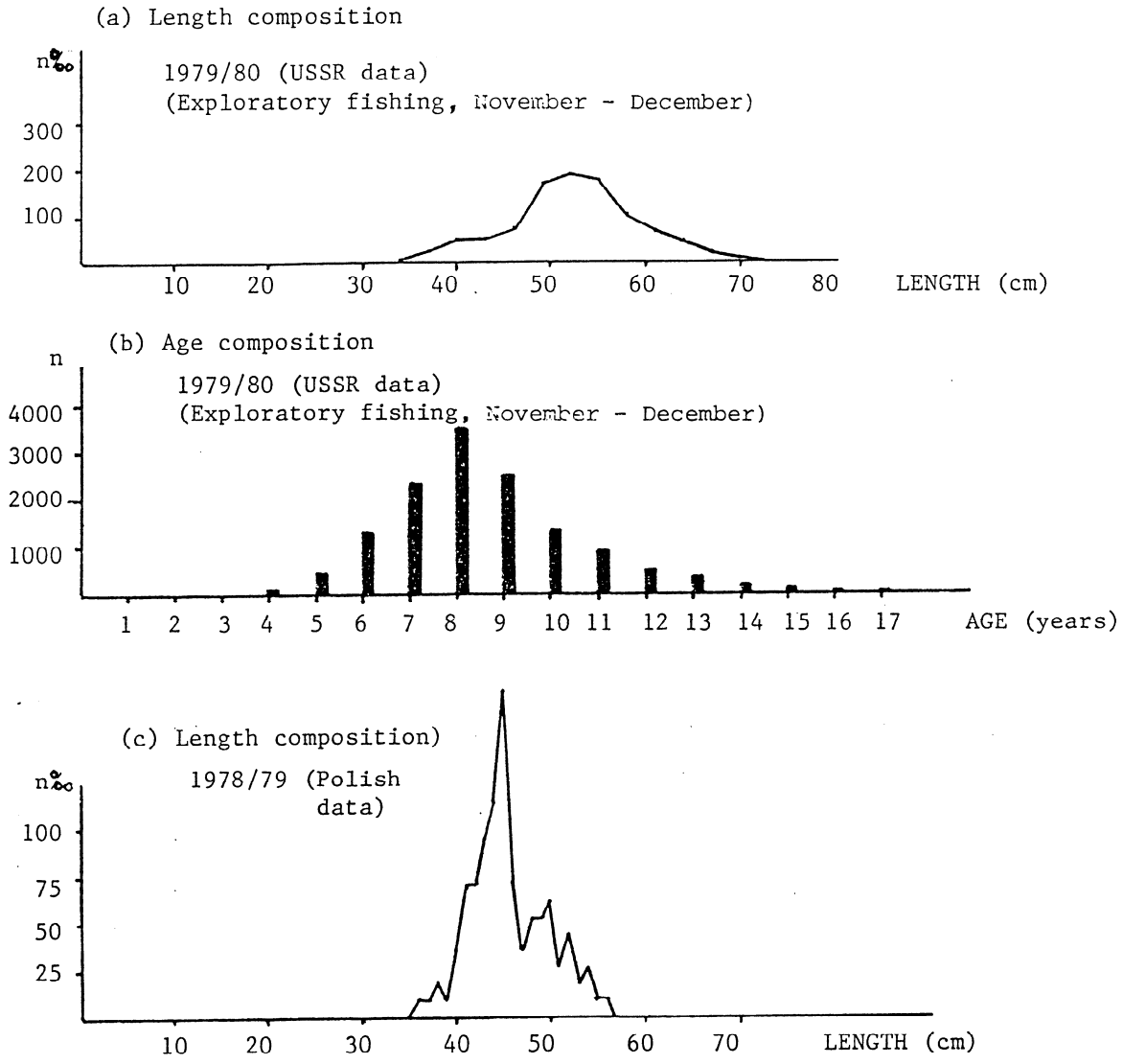

Figure 6: Length and age composition of *Notothenia rossii* in the Peninsula area.

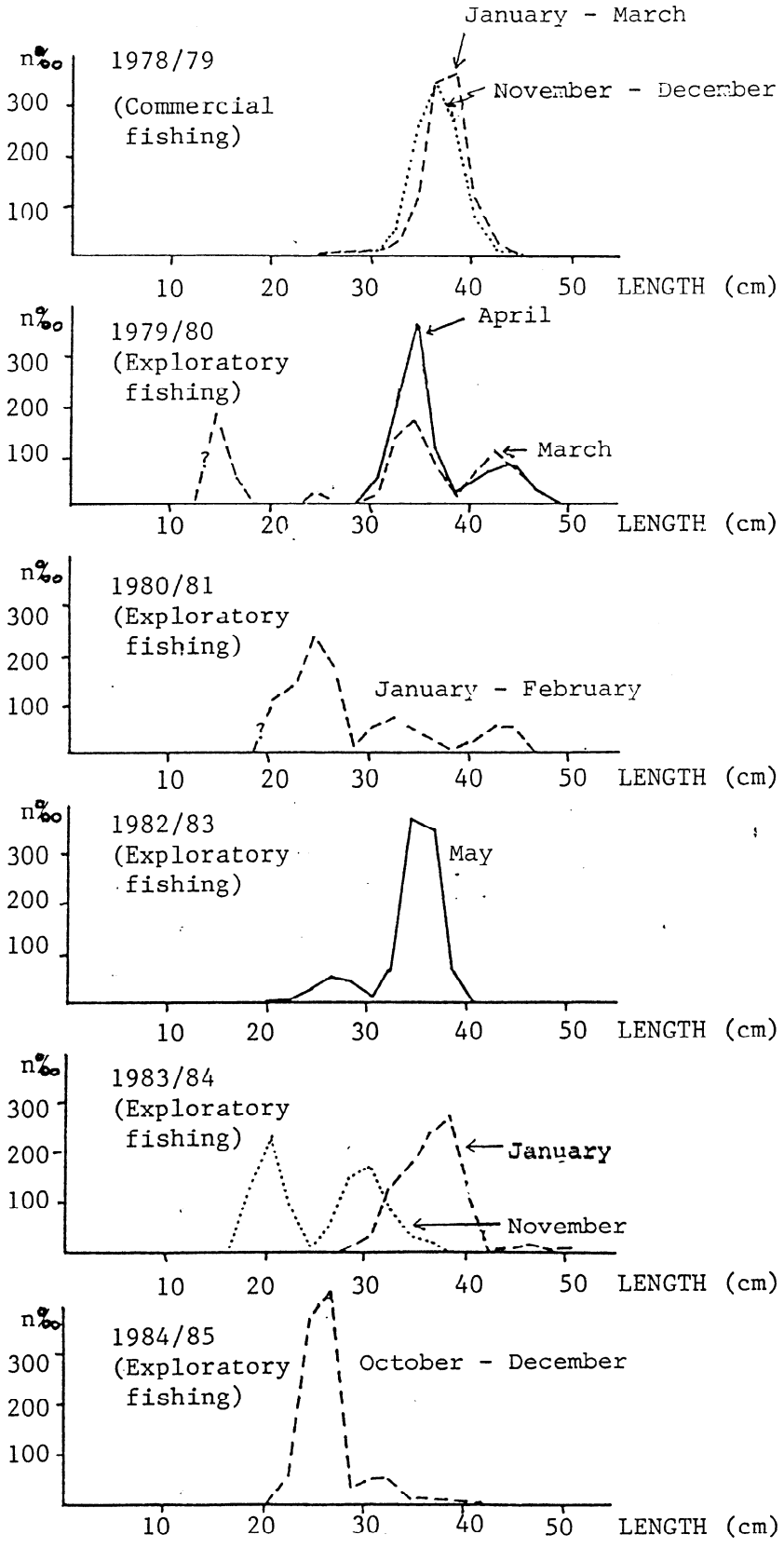

Figure 7a: *Champsocephalus gunnari* length frequency (USSR data) in the Peninsula area.

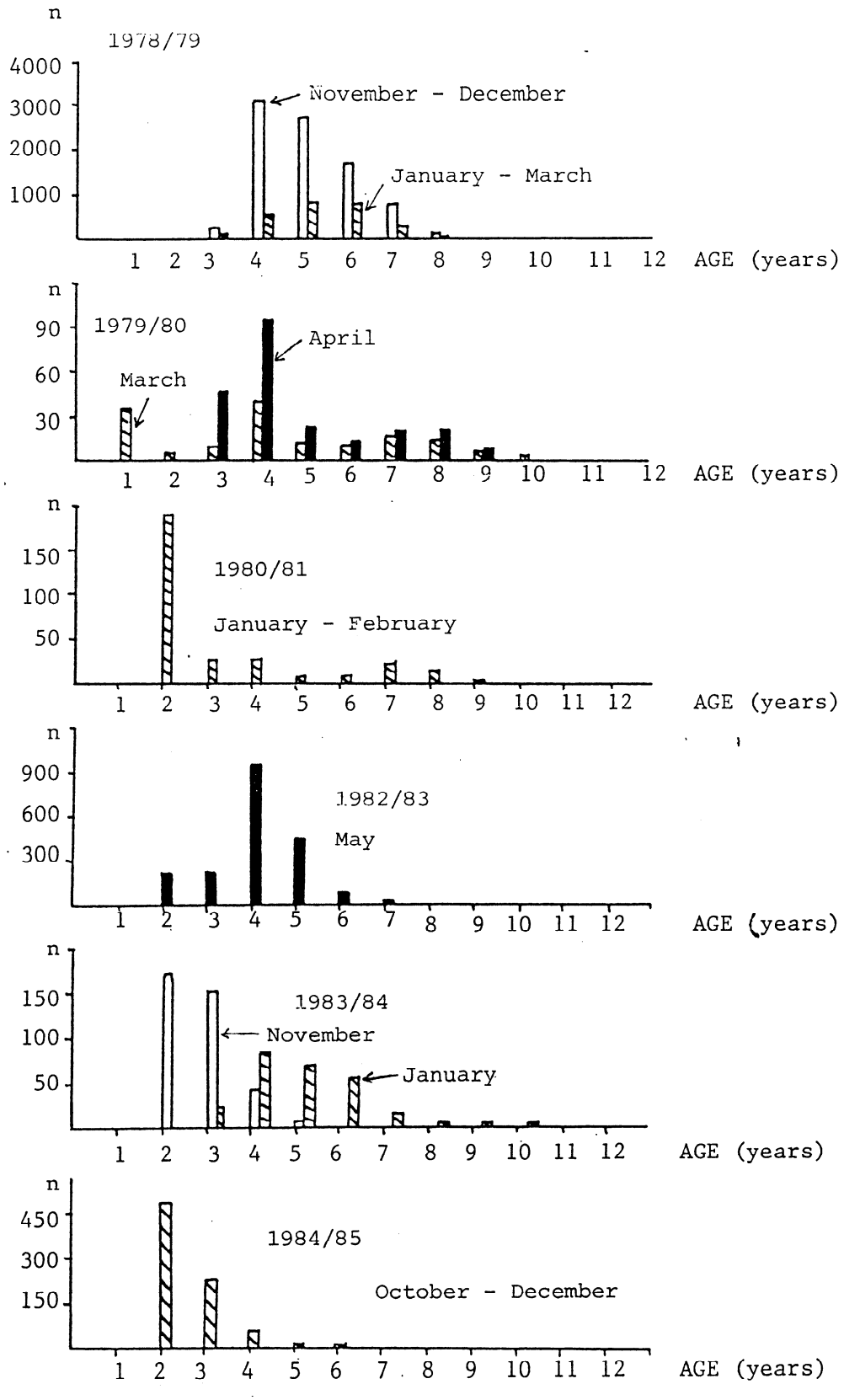

Figure 7b: *Champsocephalus gunnari* age composition (USSR data) in the Peninsula area.

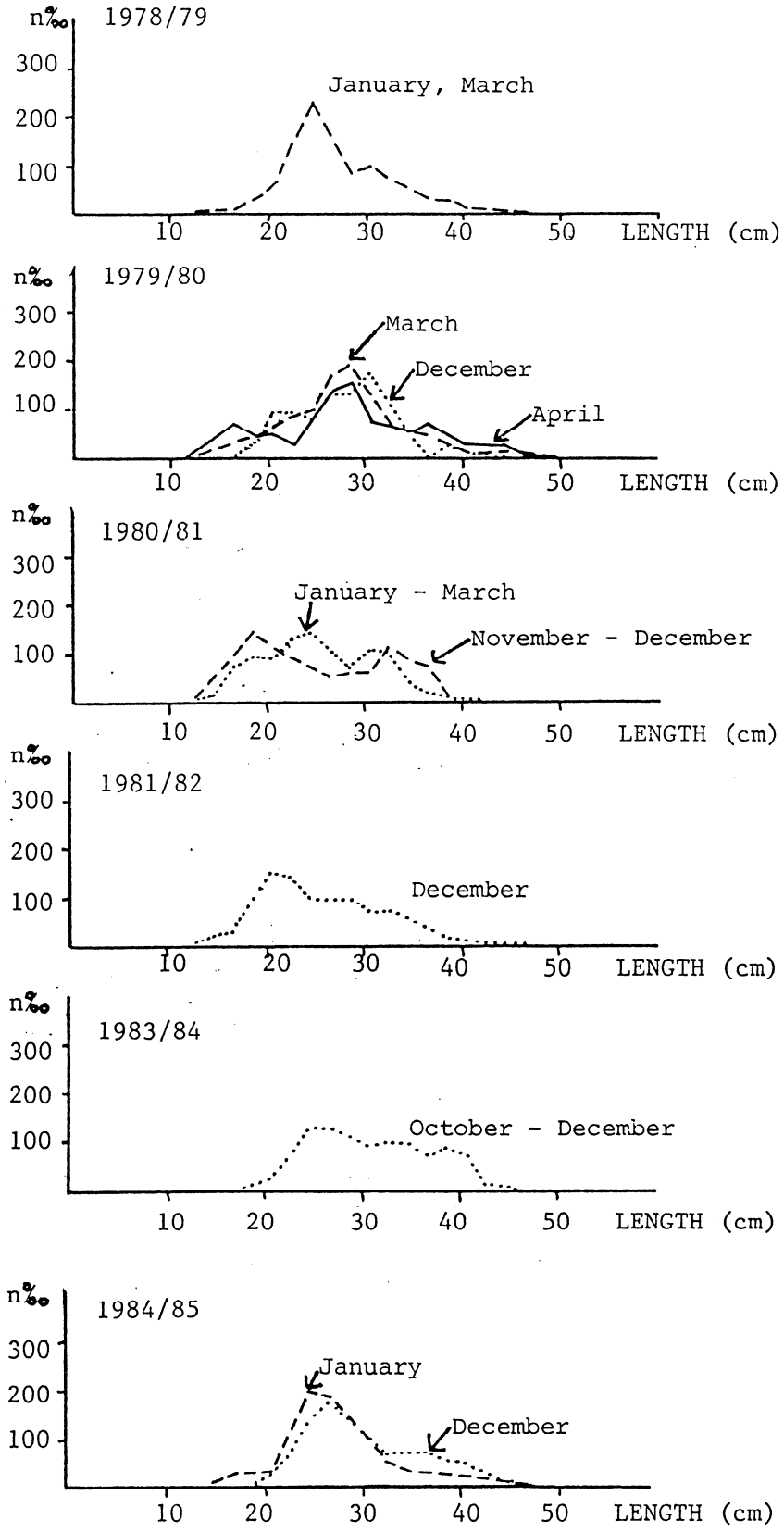

Figure 8: Length composition of *Notothenia gibberifrons* (USSR data) in the Peninsula area.

APPENDIX I

LIST OF PARTICIPANTS OF FISH STOCK ASSESSMENT WORKING GROUP

(1–4 September 1986, Hobart)

AUSTRALIA	Mr W. de la Mare Mr P. Heyward Dr K. Kerry Dr G.P. Kirkwood Dr R. Williams
CHILE	Dr A. Mazzei
EEC	Dr G. Duhamel Dr K.-H. Kock
NEW ZEALAND	Dr D. Robertson
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SOUTH AFRICA	Mr. D. Miller
USSR	Dr R. Borodin Miss N. Prusova
UK	Dr J. Beddington Dr I. Everson
USA	Dr R. Hennemuth
IUCN	Dr J. Cooke
INVITED EXPERTS	Dr W. Gabriel Dr J. Gulland
SECRETARIAT	Dr D. Powell Dr E. Sabourenkov

APPENDIX II

LIST OF DOCUMENTS OF FISH STOCK ASSESSMENT WORKING GROUP

(1–4 September 1986, Hobart)

Fish WG/1986/Doc.1	Preliminary Results of a Bottom Trawl Survey Around Elephant Island in May/June 1986 (K.-H. Kock, FRG)
Doc.2	Assessments of the Stocks of *Notothenia rossii marmorata* and *Chamsocephalus gunnari* in the South Georgia Area (J. Cooke, IUCN)
Doc.3	The Kerguelen Database (G. Duhamel, France)
Doc.4	Preliminary Report on Biological Observations and Exploratory Fishing Data Collected in the South Georgia Area During the 1985/1986 Cruise of MT *Carina* (W. Slosarczyk, Poland)
Doc.5	Preliminary Appraisal of Antarctic Fish Selection by the 32/36 Bottom Trawl Combined with Various Codends (W. Slosarczyk, Poland)
Doc.6	Program of Work
Doc.7	Data Availability for Fish Stock Assessment in Subareas 48.1–48.3, 1986
Doc.8	Draft Summary of Recent Published Instantaneous Mortality Rates, Area 48
Doc.9	Results of VPA Runs for Subareas 48.1–48.3

Doc.10 Distribution and Relative Abundance of Juvenile Pike Glassfish (*Champsocephalus gunnari*) from the Trawl Survey Results on the South Georgi Shelf in June–July 1985
(V.A. Boronin, G.P. Zakharov, V.P. Shopov, USSR)

Doc.11 Informal Summary of Results of the Antarctic Fish Age Determination Workshop

Doc.12 Mesh Size Measurement
(Secretariat)

Doc.13 Management and Uncertainty; the Example of South Georgia
(J.A. Gulland)

APPENDIX III

PENINSULA SUBAREA 48.1

Notothenia rossii

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Catch (tonnes)	0	0	0	–	–	–	0	0	0	470	18,763	0	0	0	0	0	–
Length composition	–	–	–	–	–	–	FRG*	–	FRG*	GDR POL	USSR	FRG*	–	–	ARG	JAP FRG*	ARG
Age composition	–	–	–	–	–	–	FRG	–	FRG	–	–	–	–	–	–	FRG	FRG
Age/length Key	–	–	–	–	–	*	* FRG	–	* FRG	–	USSR	–	–	–	–	FRG	FRG
Length at age	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Weight at age	–	–	–	–	–	–	–	–	–	–	USSR	–	–	–	–	FRG	–
Maturity at age	–	–	–	–	–	–	–	–	–	–	USSR	–	–	–	–	–	–
Mortality	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Partial Recruitment	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Biomass	–	–	–	–	–	–	FRG	–	FRG	–	POL	POL	–	–	ARG	FRG	–

§ CATCH REPORTED BUT NO BIOLOGICAL DATA

* AVAILABLE IN PUBLISHED PAPERS

SOUTH ORKNEY SUBAREA 48.2

Notothenia rossii

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Catch (tonnes)	0	0	0	–	–	–	0	0	85	237	1722	72	0	0	714	58	–
Length composition	–	–	–	–	–	–	–	–	§	POL	POL	POL	–	–	§	§	–
Age composition	–	–	–	–	–	–	–	–	§	§	§	§	–	–	§	§	–
Age/length Key	–	–	–	–	–	–	–	–	§	§	§	§	–	–	§	§	–
Length at age	–	–	–	–	–	–	–	–	§	§	§	§	–	–	§	§	–
Weight at age	–	–	–	–	–	–	–	–	§	§	§	§	–	–	§	§	–
Maturity at age	–	–	–	–	–	–	–	–	§	§	§	§	–	–	§	§	–
Mortality	–	–	–	–	–	–	–	–	§	§	§	§	–	–	§	§	–
Partial Recruitment	–	–	–	–	–	–	–	–	§	§	§	§	–	–	§	§	–
Biomass	–	–	–	–	–	–	–	–	POL	POL	POL	POL	–	–	§	§	–

SOUTH GEORGIA SUBAREA 48.3

Notothenia rossii

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Catch (tonnes)	399,704	101,558	2,738	–	–	–	10,753	8,365	2,192	2,137	24,897	1,651	1,100	866	3,022	1,891	–
Length composition	USSR	USSR	USSR	USSR	–	USSR	FRG	USSR GDR POL	FRG USSR GDR POL	POL	GDR	USSR GDR POL	USSR POL	USSR	POL	USSR FRG POL	–
Age composition	§	§	§	–	–	–	FRG*	§	§	§	§	§	§	§	§	§	–
Age/length Key	USSR	USSR	USSR	USSR	–	USSR	§	USSR	USSR	§	§	USSR	USSR	USSR	§	USSR FRG	USSR
Length at age	§	§	§	–	–	–	§	§	§	§	§	§	§	§	§	USSR	USSR
Weight at age	USSR	§	§	–	–	–	§	§	§	§	§	§	§	§	§	USSR FRG	–
Maturity at age	USSR	§	§	–	–	–	§	§	§	§	§	§	§	§	§	USSR	–
Mortality	§	§	§	–	–	–	§	§	§	§	§	§	§	§	§	§	–
Partial Recruitment	§	§	§	–	–	–	§	§	§	§	§	§	§	§	§	§	–
Biomass	§	§	§	–	–	–	§	POL	POL	POL	POL	POL	POL	POL	POL	FRG*	–

PENINSULA SUBAREA 48.1

Notothenia gibberifrons

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Catch (tonnes)	–	–	–	–	–	–	0	0	0	3,280	765	50	0	0	0	0	–
Length composition	–	–	–	–	–	–	FRG	–	FRG	GDR USSR POL	GDR USSR	JAP USSR FRG	JAP USSR	–	FRG USSR USSR	JAP FRG USSR	ARG
Age composition	–	–	–	–	–	–	–	–	–	§	§	§	§	–	–	–	–
Age/length Key	–	–	–	–	–	–	–	–	–	USSR POL	USSR	USSR	§	–	USSR	USSR	–
Length at age	–	–	–	–	–	–	–	–	–	POL	USSR POL	POL	USSR POL	–	–	USSR	–
Weight at age	–	–	–	–	–	–	–	–	–	§	§	§	§	–	–	USSR	–
Maturity at age	–	–	–	–	–	–	–	–	–	§	§	§	§	–	–	USSR	–
Mortality	–	–	–	–	–	–	–	–	–	§	§	§	§	–	–	–	–
Partial Recruitment	–	–	–	–	–	–	–	–	–	§	§	§	§	–	–	–	–
Biomass	–	–	–	–	–	–	–	–	FRG	POL	POL	§	§	–	–	FRG	ARG

SOUTH ORKNEY SUBAREA 48.2

Notothenia gibberifrons

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Catch (tonnes)	–	–	–	–	–	–	0	0	75	2,598	1,398	196	589	1	9,160	5,722	–
Length composition	–	–	–	–	–	–	FRG	–	FRG	USSR POL	USSR POL	USSR	USSR	§	USSR	FRG USSR	–
Age composition	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	§	–
Age/length Key	–	–	–	–	–	–	–	–	§	USSR POL	POL	USSR	§	§	USSR	USSR	–
Length at age	–	–	–	–	–	–	–	–	§	POL	POL	POL	§	§	§	USSR	USSR
Weight at age	–	–	–	–	–	–	–	–	§	§	§	§	§	§	USSR	§	–
Maturity at age	–	–	–	–	–	–	–	–	§	§	§	§	§	§	USSR	USSR	–
Mortality	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	§	–
Partial Recruitment	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	§	–
Biomass	–	–	–	–	–	–	–	–	POL	POL	POL	POL	§	§	§	§	–

SOUTH GEORGIA SUBAREA 48.3

Notothenia gibberifrons

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Catch (tonnes)	–	–	–	–	–	–	4,999	3,727	11,758	2,540	8,143	7,971	2,605	0	3,304	2,081	–
Length composition	–	–	–	–	–	–	POL FRG	POL GDR	POL GDR FRG	POL	GDR	POL GDR	POL	–	§	FRG USSR	USSR
Age composition	–	–	–	–	–	–	POL	POL	POL	POL	§	POL	POL	–	§	§	–
Age/length Key	–	–	–	–	–	–	POL	POL	POL	POL	§	POL	POL	–	§	USSR	USSR
Length at age	–	–	–	–	–	–	§	§	§	§	§	§	USSR	–	§	§	–
Weight at age	–	–	–	–	–	–	§	§	§	§	§	§	USSR	–	§	§	–
Maturity at age	–	–	–	–	–	–	§	§	§	§	§	§	USSR	–	§	§	–
Mortality	–	–	–	–	–	–	§	§	§	§	§	§	§	–	§	§	–
Partial Recruitment	–	–	–	–	–	–	§	§	§	§	§	§	§	–	§	§	–
Biomass	–	–	–	–	–	–	FRG	POL	POL FRG	POL	POL	POL	POL	POL	POL	FRG	

SOUTH GEORGIA SUBAREA 48.3

Notothenia guntheri (THIS SPECIES IS NOT FOUND IN SUBAREAS 48.1 AND 48.2)

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Catch (tonnes)	–	–	–	–	–	–	–	–	–	15,011	7,381	36,758	31,351	5,029	10,586	11,923	–
Length composition	–	–	–	–	–	–	–	–	–	§	§	§	§	§	§	FRG	–
Age composition	–	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	–
Age/length Key	–	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	–
Length at age	–	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	–
Weight at age	–	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	–
Maturity at age	–	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	–
Mortality	–	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	–
Partial Recruitment	–	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	–
Biomass	–	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	

PENINSULA SUBAREA 48.1

Champsocephalus gunnari

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Catch (tonnes)	–	0	0	0	0	0	0	0	0	35,930	1,087	1,700	0	2,604	0	0	–
Length composition	–	–	–	–	–	–	FRG	–	FRG	GDR USSR POL	GDR USSR	JAP USSR FRG	JAP	USSR	USSR FRG	FRG JAP USSR	–
Age composition	–	–	–	–	–	–	–	–	–	§	§	§	–	§	–	–	–
Age/length Key	–	–	–	–	–	–	–	–	–	USSR POL	§	USSR	–	USSR	USSR	USSR	–
Length at age	–	–	–	–	–	–	–	–	–	POL	POL	§	–	§	–	–	–
Weight at age	–	–	–	–	–	–	–	–	–	§	USSR	§	–	§	–	–	–
Maturity at age	–	–	–	–	–	–	–	–	–	§	USSR	§	–	§	–	–	–
Mortality	–	–	–	–	–	–	–	–	–	§	§	§	–	§	–	–	–
Partial Recruitment	–	–	–	–	–	–	–	–	–	§	§	§	–	§	–	–	–
Biomass	–	–	–	–	–	–	–	–	POL FRG	POL	§	§	–	§	–	FRG	FRG

SOUTH ORKNEY SUBAREA 48.2

Champsocephalus gunnari

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Catch (tonnes)	–	0	0	0	0	0	0	0	138,895	21,439	5,231	1,861	557	5,948	4,499	2,361	–
Length composition	–	–	–	–	–	–	FRG	–	USSR POL FRG	USSR POL	USSR POL	USSR	USSR	USSR	USSR	FRG USSR	–
Age composition	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	§	–
Age/length Key	–	–	–	–	–	–	–	–	USSR POL	USSR POL	USSR POL	USSR	USSR	USSR	USSR	USSR	–
Length at age	–	–	–	–	–	–	–	–	§	USSR POL	POL	POL	§	§	§	§	–
Weight at age	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	§	–
Maturity at age	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	USSR	–
Mortality	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	§	–
Partial Recruitment	–	–	–	–	–	–	–	–	§	§	§	§	§	§	§	§	–
Biomass	–	–	–	–	–	–	FRG	–	POL FRG	POL	POL	POL	§	§	§	FRG	–

SOUTH GEORGIA SUBAREA 48.3

Champsocephalus gunnari

YEAR	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Catch (tonnes)	–	10,701	551	1,830	254	746	12,290	93,400	7,557	641	7,592	29,384	46,311	128,194	79,997	14,148	–
Length composition	–	§	USSR	USSR	USSR	USSR	USSR POL FRG	USSR POL GDR	USSR POL FRG GDR	USSR POL	USSR GDR	USSR POL	POL	USSR	USSR POL	USSR	USSR FRG
Age composition	–	§	§	§	§	POL	POL	POL	POL	POL	§	POL	POL	§	POL	§	§
Age/length Key	–	§	USSR	USSR	USSR	USSR	USSR POL FRG	USSR POL	USSR POL	USSR POL	USSR	USSR POL	POL	USSR	USSR POL	USSR	USSR
Length at age	–	§	§	§	§	§	§	§	§	§	§	§	§	§	§	USSR	USSR
Weight at age	–	§	§	§	§	§	§	§	USSR	§	§	§	§	§	§	USSR	§
Maturity at age	–	§	§	§	§	§	§	§	USSR	§	§	§	§	§	§	USSR	§
Mortality	–	§	§	§	§	§	FRG*	§	FRG*	§	§	§	§	§	§	§	§
Partial Recruitment	–	§	§	§	§	§	§	§	§	§	§	§	§	§	§	§	§
Biomass	–	§	§	§	§	–	FRG	POL	POL FRG	POL	POL	POL	POL	POL	POL	POL FRG	§