FISH RESOURCES

5.1 The Report of the Ad Hoc Working Group on Fish Stock Assessment, which had met in the CCAMLR Headquarters 19–23 October, was presented by the Convener, Dr K.-H. Kock (Federal Republic of Germany). The text of the report is given in Annex 5. The Chairman thanked the Group, and especially its convener, Dr K.-H. Kock (Federal Republic of Germany), and rapporteur, Dr J. Gulland (EEC), for their thorough work. He noted that the work of the Group had been considerably facilitated by the preparation and preliminary analyses of data carried out by the Secretariat.

Stock Assessment

General

5.2 Despite the progress made by the Secretariat in processing data in advance of the meeting, there is also much information that has been submitted to the Commission, e.g. effort data, length and/or age data (other than those aspects included in VPA) and survey data, that remains in other forms e.g. extensive data sheets existing in a limited number of copies. It is not easy for a large group to use data in these forms in an effective way. Partly because of time constraints, it was not possible to review these data as thoroughly as other data, and therefore the stocks to which these data apply may have been assessed with less accuracy than might, under other circumstances, have been possible. Ways in which the presentation of data, and other aspects of the Group's work, might be more effective are discussed later (paragraphs 5.70–5.74).

5.3 Some of the estimates had been derived from data collected on a Spanish survey during the 1986/87 season. While the Working Group had been able to obtain the relevant information through informal channels, no formal presentation of data had been made to the Working Group. This was an unsatisfactory procedure, but had probably arisen because Spain had only very recently joined the Commission and the invitation to participate had only been received two days before the start of the meeting. The information had now been formally deposited with the Secretariat, and relevant extracts from the report have been appended as an attachment to the Working Group's Report.

Notothenia rossii

South Georgia Subarea (48.3)

5.4 The total reported catch in the 1986/87 season was 216 tonnes mostly taken by the Soviet Union. This is approximately what would be expected from compliance with the Resolutions and Conservation Measures approved by the Commission at its 1985 and 1986 meetings concerning the cessation of a directed fishery, and the avoidance of by-catch, though as already noted, this is not consistent with the stated intention of not catching more than in 1985/86.

5.5 Information on biomass is available from surveys carried out in 1986/87, though not all the data from those surveys have been fully analysed and reported to the Commission. Each estimate for biomass is subject to considerable variance, and it is difficult to detect small changes in biomass. Thus while the observations are consistent with the recent restrictions having the expected effect, and beginning to allow the stock to rebuild, they are also consistent with there being no effect. It would be valuable to carry out some simulations or similar studies to determine how soon the effect of the restrictions could be detected, at different levels of survey effort.

5.6 The recent studies confirm that the stock abundance is now very much lower that in 1969, with the biomass being around 5% of the catches in that period. However, there are elements in the records of catches, age-composition etc. that are not wholly consistent.

5.7 These inconsistencies do not alter the immediate need to rebuild the stock, but could alter the expectations of the extent to which the stock could be rebuilt, and therefore decisions on when to re-open the fishery.

Other Atlantic Areas

5.8 No fisheries had been carried out in Subareas 48.1 or 48.2 in the 1985/86 or 1986/87 seasons, and there is no new information on which to modify the conclusions in last year's report, that the stock abundance was well below the levels at the time when fishing began.

Kerguelen Subarea (58.5)

5.9 Directed fishing on the spawning concentration has been prohibited since 1984, and since the 1985/86 season, catches have been limited to by-catch. Catches were 801 tonnes in 1985/86 and 482 tonnes in 1986/87. Both VPAs and catches per unit effort indicate a clear decline in abundance from 1980 to 1984. Since 1984 there seems to have been some recovery of the stock though the catch statistics for the most recent seasons have not been fully analysed.

Notothenia squamifrons and *Patagonotothen brevicauda guntheri*

5.10 The Group noted that extensive biological data from the Soviet fishery for *Notothenia squamifrons* on the Ob and Lena Seamounts (Division 58.4.4) and for *Patagonotothen brevicauda guntheri* in Area 48, as requested last year by the Scientific Committee (SC-CAMLR-V, paragraph 4.41), had recently been received by the Secretariat. However, it had not been possible in the time available to the Group to make any assessment of these resources.

Champsocephalus gunnari

South Georgia Subarea (48.3)

5.11 Catches in 1986/87 were 71 247 tonnes, the highest since 1983/84. The Soviet scientists reported that their fishing fleets had been advised to restrict their catches, and that their catches could have been larger. It appears that this highly variable stock is at a peak. There were previous peak catches around 1977 and 1983.

5.12 Though trawl surveys have been made in the area in several recent years, the catches of this species during surveys are highly dependent on the type of the gear and its rigging, so that it is difficult to use the available results to estimate recent trends in abundance. It might be possible to derive better indices from commercial catch and effort data in future, because a distinction has been made in the most recent reports between fishing targeted on krill and on fish. Such biomass indices were obtained from Polish commercial data (SC-CAMLR-VI/BG/40), collected in the past ten years by scientific observers, who could assign precisely fishing effort to target species.

5.13 Because of the large natural fluctuations in abundance it is not easy to use the level of abundance as a simple indicator of the effect of exploitation. It is now clear that abundance was high at the beginning of the 1986/87 season, but the available information is inadequate to estimate the current (October 1987) abundance with any precision. Biomass estimates during the 1986/87 season were some 80 000 tonnes (from the Polish commercial data), and 150 000 tonnes (from the Spanish survey in December 1986).. Bearing in mind that many fish could be mid-water and missed by the commercial bottom trawl, and that the Polish estimate covered only part of the area, the Group believed that the true figure at the time of the surveys was nearer to 150 000 tonnes.

5.14 The impact of fishing is better indicated by the mortality rates. When fishing started in 1976, all ages from 3 to 10 appeared in significant quantities in the catch. Current mortality appears to be high, with only one or two age-groups contributing to the fishery. This is adding to the year-to-year variability in the stock (and hence in the catches). The number of year-classes in the spawning stock has also been reduced.

Peninsula Subarea (48.1)

5.15 A very small catch, 76 tonnes, was reported in 1986/87; this is the first reported catch since 1983. Surveys in the Elephant Island area gave low estimates of abundance – 934 tonnes, Federal Republic of Germany in 1985, about 1 000 t Federal Republic of Germany in 1986 and 1 962 t Spain in December 1986.

South Orkney Subarea (48.2)

5.16 Reported catches were only 29 tonnes in 1986/87, compared with a few thousand tonnes in previous years. An estimate of biomass of 1 179 tonnes was obtained from the Spanish survey in 1987. This is similar but rather lower than the estimate from the 1985 Federal Republic of Germany survey (3 669 tonnes). Although commercial catches could be strongly affected by changes in the distribution and availability of the fish, well-designed surveys should be less affected by these factors.

5.17 Current abundance is clearly low, and it appears from the length and age data that the present stock is composed largely of the survivors of a relatively strong year-class (or year-classes) that recruited to the fishery in 1982.

Kerguelen Subarea (58.5)

5.18 Catches in 1986/87 were only 2 625 tonnes, compared with 17 137 tonnes in 1985/86. The major part of the 1986/87 catches was taken outside the Kerguelen continental shelf (on the Skiff Bank), largely from the 1984 cohort. The 1982 cohort on the shelf, which provided the good catches in the 1985 and 1986 seasons on the main shelf is now passing out of the fishery, and the catch rates in numbers of this cohort have fallen from 5.76 in 1984/85 and 3.81 in 1985/86 to only 0.4–0.5 in 1986/87 (the exact figures are not available, pending full analysis of the log-books). As in other areas, the stock is dependent of the recruitment of the occasional good year-class.

5.19 The 1985 cohort, which is currently protected by the 25 cm size limit regulation, should enter the fishery soon, and may be of reasonable strength. The abundance of this cohort will be evaluated by a joint Soviet/French survey during the 1987/88 season prior to exploitation.

5.20 The Committee noted that data concerning the fisheries before 1979 still have not been reported to the Commission. These data are most valuable for studying past trends in the fishery and should be reported as soon as possible.

McDonald and Heard Islands

5.21 A joint Soviet-Australian survey was made in this area, and the results reported in SC-CAMLR-VI/BG/16. Most of the catches were of *C. gunnari*. The fish were taken in two small areas (130.4 km^2 and 205.8 km^2) of relatively high density. The estimated abundances in these areas were 16 580 (±6 913) and 2 079 (±1 558) tonnes respectively.

5.22 It was suggested that these figures, and corresponding estimates of potential yield should be treated with caution because of the non-random distribution of trawl hauls (see Annex 5, Figure 1). There are also strong reasons to believe there is a close relationship between the populations of the Heard and McDonald Islands and those of Kerguelen Island.

Notothenia gibberifrons

South Georgia Subarea (48.3)

5.23 Catches in 1986/87 were 2 842 tonnes. This continues a picture apparent in previous years of relatively stable catches, in contrast to high fluctuations in other species.

5.24 VPA calculations were carried out, but because recruitment appears to occur over a wide range of ages (not being complete until ages 10–12), the results are highly dependent on the assumptions made about recruitment patterns. In particular, the assumption of constant mortality with age can lead to a serious under-estimate of the abundance of the younger fish in the most recent years. It is clear that abundance decreased in the first few years of exploitation, as might be expected with a long-lived fish, but the trends since 1981 are less clear, although they indicate a relatively stable biomass.

5.25 The age-composition and length composition data showed a decrease in the proportion of larger fish when exploitation began, indicating an increase in total mortality and a relatively high fishing rate, but in the most recent years the mean size has increased.

5.26 Biomass estimates are available from the 1984/85 Federal Republic of Germany survey, and the 1986/87 US/Polish survey, which gave 15 762 and 13 394 tonnes respectively. These agree well, and given the variance in both figures, the difference cannot be taken as evidence of any decrease. An estimate of 11 356 tonnes for part of the area is also available from data of Polish commercial vessels.

Peninsula Subarea (48.1)

5.27 Catches in 1986/87 were only 56 tonnes, after several years of zero catch. The Federal Republic of Germany survey in 1985 gave a biomass estimate of 25 000 tonnes around Elephant Island. It appears that this stock remains lightly exploited because it is only taken as a by-catch in the *C. gunnari* fishery.

South Orkney Subarea (48.2)

5.28 Catches in 1986/87 were only 2 tonnes, compared with several thousand tonnes in 1983/84 and 1984/85. The 1984/85 Federal Republic of Germany survey gave a biomass estimate of 12 000 tonnes.

Other Species

5.29 An analysis of information collected by observers on board Polish commercial trawlers fishing around South Georgia (SC-CAMLR-VI/BG/40) enabled the trends in abundance of several species to be followed in the period 1976/77–1986/87. It appears that there has been some increase recently in the abundance of *Chaenocephalus aceratus*. Trends in the biomass density index of *Pseudochaenichthys georgianus* and *Notothenia rossii* are not clear (Annex 5, Figure 2). It is difficult to determine the role of fishing in these changes. In the interpretation of the trends in some seasons, the influence of targeted fishing for *C. gunnari* should also be considered. When this species is abundant, fishing effort on other species is reduced, which might result in low biomass density estimates derived from 'swept-area' methods. The Committee noted the catches of *C. aceratus* and *P. georgianus* as reported in the STALANT forms may understate the true catches of these species because appreciable quantities may be included in the figures for unidentified fish.

Additional Comments by the Scientific Committee

5.30 In thanking the Group for the work that it had managed to do in the time available, the Committee noted that there were other questions which it would be desirable for the Working Group to address. In particular, the Group should examine the impact of decisions taken by the Commission at its previous meetings. It was noted at the 1986 meeting 'Members carrying out fisheries in this area (Subarea 48.3) took the position that any such limitations of catch for the 1986/87 season should be fixed at the level of catch for the 1985/86 season and indicated that they did not intend to exceed these limits' (CCAMLR-V, paragraph 51).

5.31 Despite that statement, catches of several fish species in 1986/87 had greatly exceeded those in 1985/86, as indicated in the following table:

Table 5.1: Fish catches (in tonnes) in Subarea 48.3 (South Georgia)

	1985/86	1986/87	Ratio 86/87:85/86
D. eleginoides	564	1 199	2.1 : 1
N. gibberifrons	1 678	2 842	1.7 : 1
N. rossii	70	216	3.1 : 1
N. squamifrons	41	183	4.5 : 1
C. gunnari	11 107	71 146	6.4 : 1
Unidentified fish	356	1 906	5.3 : 1

This table also shows a significant and increasing quantity of unidentified fish being reported. Recognising that this could include species from stocks that extend beyond the Convention Area, the Committee urged that every effort should be made to provide identification to species in future reports.

5.32 In relation to the high catches of *Champsocephalus gunnari*, the Soviet delegation pointed out that they had informed the Committee at its 1986 session that recruitment to this stock was likely to be high.

5.33 The Committee recognised that in its work, the Group had made extensive use of research vessel trawl surveys to estimate biomass. While such surveys, if carried out in standard fashion, provide reliable measures of relative abundance and changes from year to year, they are less reliable for estimating absolute abundance. Trawl catch data used in abundance estimation are considered to be representative of the abundance of fish in a particular area. The area swept by a trawl is calculated as the product of the distance towed times the distance between the tips of the wings of the trawl. The actual catches also include fish originally outside the path of the net, but herded into the path by the bridles and trawl doors. Conversely, some fish in the path may not be caught because they pass above the headline or escape in other ways. The estimates of biomass obtained from trawl surveys could therefore differ appreciably from the true value, depending on the rigging of the gear, and the figure could be in error in either direction.

Management Policy

5.34 The Commission requires management advice from the Committee on several specific measures e.g. on catch limits to implement Conservation Measure 7/V regarding catch limits for fishing around South Georgia in 1987/88. However, the Committee has difficulty in providing that advice because the Commission has not made a clear decision over the policy it wishes to pursue, which could be expressed as a quantitative measure such as the fishing mortality, or minimum stock biomass.

5.35 The decision on such a policy would normally be part of a hierarchy of decision, proceeding from the broad principles set out in the Convention to specific tactical decisions for the measures to be recommended in the forthcoming season; an example is set out below.

Possible Decision

General Policies
- Reactive management: act only when problems arise, and something is clearly needed
- Anticipatory management: act before problems arise
- Experimental management: set measures that will enable more to be learnt about the system
- Other

Specific Policies
- Ensure that fishing mortality is not more than that giving the maximum yield per recruit
- Ensure that spawning stock biomass does not fall below some specified level
- Ensure that fishing mortality does not exceed replacement level

Strategies
- Set the TAC (for current, and all future years until corrected) equal to 90% of the estimated MSY
- Set a sequence of TACs, to be modified from year to year according to predetermined rules
- Set a limit on fishing effort in terms of numbers and size of vessels
- Other

Tactics
- Set 1988 TAC
- Other (according to strategy adopted).

5.36 The strategy that might be adopted could be more or less complex, according to the situation being faced. For example, for a severely depleted stock, the strategy might be merely to hold catches at the minimum possible level (preferably zero) until research has shown clearly that recovery has occurred. In the case of hitherto unexploited stock, the first step may be to conduct a survey to estimate the stock biomass and distribution, along with the age-structure and age-weight relationship. From these data an appropriate target level of fishing mortality could be estimated. An appropriate fraction of the stock's area could then be opened to fishing, the size of the area being chosen to keep the level of fishing mortality around or below the target level.

5.37 There is bound to be considerable recycling within this hierarchy, with policies or strategies being modified in the light of, for example, changing knowledge of the resource. At the same time, the stages need to be distinguished, and decisions at one stage clearly determined (if only temporarily) before moving on to the next. Often the arguments that arise, especially over tactics (e.g. the level of next year's TAC) have proved difficult or impossible to resolve because there has been no prior decision on the policy or strategy to be followed.

5.38 The decisions at each stage have to be taken by the Commission, but these decisions will be easier if there is appropriate scientific advice.

5.39 If the Commission wishes to adopt a policy in terms of a target fishing mortality there are a variety of targets it might choose. For example, it might choose that fishing mortality rate that could result in the maximum sustained yield. This can be difficult to calculate because the relation between the abundance of the adult stock and subsequent recruitment is often unclear. An alternative might be to aim at achieving the maximum yield per recruit. Often it would be desirable to aim at rather lower fishing mortality rates. They have the advantages of leading to higher catch rates (and hence the likelihood of more profitable operations) and the presence of more age-classes in the stock, and hence increased stability and less risk of stock collapses. Other values of target fishing mortality, such as the $F_{0.1}$, as explained in the Working Group's Report, might also be chosen.

5.40 The actual value of target F would be expected to vary from stock to stock, taking into account differences in growth rates, potential life-span, variability in recruitment, the age-structure of the catch, etc. It is possible that for stocks with highly variable recruitment, a constant F might not be appropriate.

5.41 Policy targets might also be expressed in terms of spawning stock biomass. Often it might be desirable to combine the two types of target i.e. the fishing mortality could be set at some target F provided the spawning stock was not reduced below a given minimum level.

5.42 In achieving policy targets, the Commission has potentially two types of controls - on the amount of fishing (through catch and effort controls), or on the ages caught. Controls aimed at protecting small fish (e.g. through mesh regulation) were likely to be particularly useful when there were practical problems in implementing controls on the amount of fishing.

5.43 Problems in using catch limits are likely to be particularly serious for fisheries that depend on only a few year classes as occurs when mortality rates are high and recruitment variable. If a catch limit is to come close to achieving the desired level of fishing mortality there must be good estimates of current biomass and of the strength of the incoming recruitment. For example it is now clear that because the recruitment to the *C. gunnari* stock at South Georgia during 1986/87 was very good, the replacement yield of that stock at the time of the 1986 meeting was greater than the few thousand tonnes mentioned in last year's report. If the Commission wishes to use the approach as a general method of controlling the amount of fishing, the Committee will need to examine the research (e.g. pre-recruit surveys) needed to give adequate advice on the catch levels required to achieve the specific target.

Simulations

5.44 The use of simulations, such as those illustrated in Annex 5, Figures 3a, b and c, are very useful in many different situations of interest to the Commission, e.g. in examining the probable impact of developing krill fisheries on associated and dependent species under various assumptions about the food requirements. Members of the Committee, and especially the members of the Fish Stock Assessment Working Group, were therefore encouraged to use and develop simulation models in their work.

Management Policies for Specific Stocks

Notothenia rossii

South Georgia Subarea (48.3)

5.45 The immediate objective for this stock should be to rebuild the spawning stock as quickly as possible. Preferably no catches should be taken at all, but it was recognised that this would be impracticable if commercial fishing for the other species continues. The measures already taken by the Commission have clearly resulted in a decrease in the reported catch. The available data are not adequate to prove that they are also having the desired effect of rebuilding the stock.

5.46 It would be desirable to have better information on the incidence of by-catch and its variation in space and time. This could lead to modification in the management measures that would further reduce the by-catch. Some of this information should be available on data

forms already received, but there has not been time to examine these in detail. For the present, the Committee agreed with the Working Group in seeing no reason to modify the Conservation Measures already in force.

Other Atlantic Areas

5.47 In the absence of new information, the Committee had no new advice to make about these stocks.

Kerguelen Subarea (58.5)

5.48 The immediate objective should be to rebuild the spawning stock. The Conservation Measures currently in force appear to be having this effect, and should be continued.

Champsocephalus gunnari

South Georgia Subarea (48.3)

(a) Protection of Small Fish

5.49 At present, the fishery starts catching the fish when they are relatively young, at 2–3 years old (the onset of sexual maturity). If the fish were afforded protection until they were 3 or 4 years old, there would be some benefits in terms of increased yield per recruit (Y/R) and a greater spawning stock biomass per recruit (SSB/R). This is shown in the following table, for different values of fishing mortality.

Table 5.2: Yield and spawning stock biomass per recruit for *C. gunnari* at different levels of fishing mortality and age at first capture.

Fishing Mortality	Fished From Age 2		Fished From Age 3		Fished From Age 4	
	Y/R	SSB/R	Y/R	SSB/R	Y/R	SSB/R
0.2	.096	.335	.099	.409	.096	.488
0.4	.105	.158	.116	.236	.118	.326
0.6	.103	.089	.118	.162	.124	.251
0.8	.100	.056	.118	.125	.126	.211
1.0	.098	.038	.118	.103	.127	.186

5.50 The benefits are particularly marked in terms of spawning stock biomass and at higher levels of fishing mortality. For example if F = 0.8 (and in peak years the fishing mortality has been well in excess of this value), changing the age at first capture form 2 to 4 would increase the yield per recruit by 25%, and the spawning stock biomass per recruit by four-fold.

5.51 Traditionally an increased age at first capture has been achieved by the use of a larger mesh size. This technique would be useful for *C. gunnari*, but the relation between mesh size of the codend netting used by the commercial trawlers and age at first capture is not clear. Dr Slosarczyk reported that the Polish scientists have made further net selectivity studies. Due to limited ship time available for fishing with 80 mm meshes, these studies were not completed and will be continued in the 1987/88 season.

5.52 Further studies under commercial conditions, and the full reporting of experiments that have already been carried out are needed. In the meantime the Committee was not in a position to advise on the precise consequences of the present 80 mm mesh regulation. However, the Committee noted that Table 5.2 shows that there would be significant benefits in terms of spawning stock, and (except at very low fishing rates) yield per recruit, from increasing the size of first capture above the present (age 2–3 years), and therefore from increasing mesh size.

5.53 The Committee noted that there were other methods that could protect the small fish. These include the use of regulations governing the minimum sizes of fish that can be landed. Another possibility, not examined in detail by the Working Group, might be to reduce catches at a time when young fish predominate in the population. For example, rough calculations of the balance between growth and natural mortality, suggest that the 70 000 tonnes, mainly of 2–3 year of fish caught during the last season, could have contributed even more to the catches in the 1987/88 and subsequent seasons if they had not been caught in 1986/87.

5.54 The Committee believed it would be useful to give particular attention to determining the effects of changing the mesh size for *C. gunnari*.. This has implications for the Committee's future work, including studies by the Working Group of the immediate and long-term effects of mesh changes and the priorities that should be set for this work. There was in any case desire for further work on mesh selectivity as discussed later (see paragraph 5.79).

(a) Control of the Amount of Fishing

5.55 At present the fishery is characterised by the presence of only a limited number of age-groups, a high year-to-year variability in catches, and a relatively low spawning stock biomass. Reducing the level of fishing would tend to reverse these undesirable features. In any case, Table 5.2 shows that, at the present age at first capture (2 to 3 years), there is little or no gain in yield per recruit at high fishing rates. As noted earlier (paragraph 5.39) and in more detail in paragraph 44 of the Report of the Fish Stock Assessment Working Group, the Committee believes that there are some advantages in lower levels of target fishing mortality, such as $F_{0.1}$. These would result in a level of fishing that would be consistent with objectives such as increasing stability, or increasing spawning stock biomass.

5.56 In the case of *C. gunnari*, $F_{0.1}$ was estimated to correspond to an actual value of fishing mortality of F = 0.21. So that the Commission can contrast the consequences of fishing at various rates, including $F_{0.1}$, simulations were run to compare possible future catches and spawning stock biomass under different policies. Three values of F (0.21, 0.3 and 0.5) were used, and three assumptions made about the current biomass (75 000, 150 000 or 225 000 tonnes) centred about the current estimate (see Annex 5, paragraph 20). To make the projections, a pattern of future recruitment was obtained by drawing a random sequence of recruitments form the values observed in the past. The same sequence was used for all the simulations at different values of F and current biomass. The simulations therefore illustrate the differences to be expected between policies, but are <u>not</u> predictions of the future. The chosen sequence implies good recruitment around years 3 and 12 and poor recruitment between, but it is unlikely that this precise sequence will occur. What will occur will be a sequence of good and bad years, though their timing is likely to be different from that of the simulation.

5.57 Some results of the simulation concerning catch an spawning stock biomass are shown in Annex 5, Figure 3, a, b, c. For spawning biomass the picture is clear. The curves for the three levels of F are well separated, the spawning biomass being lower and relatively more variable at higher values of F. For all levels of initial biomass, in the last year of simulation the spawning biomass at F = 0.5 is only some 40% of that of F = 0.3. For F = 0.3, the spawning biomass is 75% of that at F = 0.21.

5.58 As regards catch, in the first year the higher the F, the greater the catch. After the initial period, the differences in yield between the three levels of fishing mortality chosen are not large. The ranking is not the same in all years. In years of poor recruitment there are, at the higher levels of F, few survivors from earlier good recruitment to support the fishery. Thus, for example, the predicted catches in year 8 from the population simulated at F = 0.5 are very much less than those from the simulated populations for F = 0.21 of F = 0.3. (It may

be noted here that no allowance was made for any influence of spawning stock biomass on subsequent recruitment. If there were any such effect, the catches at lower Fs would be expected to be relatively greater from perhaps year 6 onwards).

5.59 Figure 4 of Annex 5 shows the estimated biomass-at-age at the beginning and end of the simulation period, and indicates that the level of fishing mortality affects the age structure of the population.

5.60 In the absence of more clearly specified goals, the Working Group could not conclude on the basis of this simulation that one or other policy was better than the rest. However, the long-term interests (such as increasing spawning stock biomass) seem to point to the lower levels of F as being more desirable.

5.61 If $F_{0.1}$ were adopted as the target, then the corresponding catch limit for the 1987/88 season can be calculated as 0.21 x mean biomass in 1987/88. This biomass is not known, and for the present purposes (and for similar calculations in respect of other possible target fishing mortalities or for other stocks) a figure based on an estimate for some recent period has to be used.

5.62 The recent biomass is believed to be around 150 000 tonnes, including fish of age class one not taken by the commercial fishery, and the Working Group used this figure in its calculations of catch levels as set out in paragraph 67 of its Report. Strictly this figure of biomass refers to the period of the Spanish survey, which ended on 18 December 1986. Between the end of December and the end of June some 50 000 tonnes were removed (see Table 5.3 below).

Table 5.3: Monthly catches (in tonnes) of *C. gunnari* in Subarea 48.3 during the 1986/87 season.

1986	Catch	1987	Catch
July	1 756	Jan	17 504
Aug	6 509	Feb	16 104
Sept	229	March	10 272
Oct	1 328	April	2 459
Nov	663	May	1 800
Dec	10 419	June	2 099

The committee believed that the figure for the biomass should be adjusted to correct for these catches, giving a value of some 10 000 tonnes for the biomass at the beginning of the 1987/88 season. Further adjustments should be made to correct for losses due to natural mortality, and gains due to growth and recruitment, but the necessary information on recruitment strength was not available.

5.63 Using these figures of 100 000 tonnes (derived as described above) and 150 000 tonnes (used by the Working Group), and using the simple approximation of catch = F x biomass, the landings corresponding to any desired target F can be readily calculated (see Table 5.4).

Table 5.4: Calculations of landings corresponding to various F values

	Biomass estimates used	
	100 000 tonnes	150 000 tonnes
F values	Landings	
$F_{0.1}$ (= 0.21)	21 000 tonnes	31 500 tonnes
F = 0.3	30 000 tonnes	45 000 tonnes
F = 0.5	50 000 tonnes	75 000 tonnes

5.64 The Committee believed it would have been very useful in providing the Commission with advice on the consequences of different action if the Working Group had calculated how future catches would have been affected if Member countries had in fact complied with their expressed intention of keeping catches at their 1985/86 level. In particular, it would have been interesting to see the extent to which the catch levels for different target Fs for the 1987/88 seasons given above would have been increased. The yield per recruit calculations indicate that such increases summed over the life span of the cohorts involved, would have exceeded the 1986/87 catches.

Other Atlantic Subareas

5.65 The standing stock in these areas is very low, and cannot sustain significant fishing.

Kerguelen Subarea (58.5)

5.66 The objectives of the Conservations Measures in force are to increase the spawning stock biomass. Because only one age-group is present in the catches, the stocks are very sensitive to exploitation, and depend on the level of recruitment. Surveys of the incoming cohorts are planned for 1987/88. Simulations similar to those done for the South Georgia Subarea could be made for Kerguelen, using estimates of current biomass. Regulations have been set on the size of fish and on the level of catches for the 1987/88 season. The level of catches is based on the mean index of abundance for the two preceding cohorts. These regulations should reduce the impact of fishing on future spawning biomass.

Notothenia gibberifrons

South Georgia (48.3)

5.67 Catches in the last four years have averaged around 2 500 tonnes, and the stock appears to be stable. Replacement yield is probably also at about the same level.

Other Matters

Age Determination

5.68 It was noted that the report of the Age-Determination Workshop held in Moscow in 1986 was not yet available. This was due to delays in communications between Cambridge and Moscow. The Committee was informed that the final corrections had been sent to the rapporteur, and the report should be available soon. The program for exchange of otoliths and scales was in operation (SC-CAMLR-VI/BG/26).

Early Life History

5.69 A key to the identification, and a catalogue of fish larvae was being prepared by Mr A.W. North and Dr A. Kellermann. This represented a considerable expansion on the existing publication by BIOMASS, covering more species and developmental stages as well as information in ecology. Printing this booklet (500 copies in one language) would cost some US$6 000–7 000. The Committee believed it would be appropriate for the Commission to make a contribution to these costs. This contribution might be shared with BIOMASS and the Alfred Wegener Institute of Polar and Marine Research, Bremerhaven, Federal Republic of Germany.

Future Work

Organisation of the Working Group

5.70 The Committee agreed that, following the ideas expressed at its 1987 session, the Ad Hoc Working Group on Fish Stock Assessment should be established as a formal standing Working Group.

5.71 The terms of reference of the Working Group of Fish Stock Assessment should be:

(a) Apply and develop methodologies for fish stock assessment, including:

(i) procedures for monitoring fish stock abundance and population structure

(ii) protocols for the collection and analysis of fishery-related data including the relevant operations of the CCAMLR data base

(iii) analytical procedures for the estimation and projection of fish stock population trajectories;

(b) review and conduct assessments of the status and potential yield of fish stocks in the Convention Area;

(c) evaluate the actual and potential impact on fish stocks and fisheries of past, present and possible future management actions.

5.72 Dr K.-H. Kock (Federal Republic of Germany) was appointed Convener of the Working Group.

5.73 The Group should meet immediately preceding the next session of the Scientific Committee. In accordance with the pattern of work suggested in the Ad Hoc Working Group's report (Annex 5, paragraphs 73–78), the Group should start work on Wednesday, 12 October, probably within small groups, to carry out the work of review and refinement of preliminary analyses ('phase one' of the Working Group's suggestions for the meeting). Starting on Monday, 17 October, it should meet to review the assessments and formulate advice ('phase two' of the Working Group's suggestions).

5.74 Reduction of data and preliminary analyses should be carried out by the Secretariat before the meeting commences. This intersessional work, largely by the Data Manager, should be carried out under the guidance and advice of the Convener of the Working Group and the Chairman of the Scientific Committee. They would be assisted by receiving comments and suggestions from other members of the Working Group.

Data

5.75 The Committee endorsed the proposals made by the Working Group regarding the submission and publication of data. Specifically it recommended:

(a) The following changes should be made in the draft forms for submitting detailed catch and effort data:

- calendar months should be divided into three parts: day 1 to day 10, day 11 to day 20 and the remaining days. It was recognised that the third period would vary depending on the number of days in the month but this could be allowed for in any computations;

- an explanation should be added to the instructions to the effect that searching time has not been requested as a measure of fishing effort for finfish;

- nominal mesh size should be specified, but where available, measured mesh size should also be included;

- to assist in completing the forms, the species list should be included on the back of the form together with species codes. (The species list should be amended to include the following categories: commercially important species; blank spaces for the listing of other species, families, and catches NEI);

- instructions should be included to the effect that catches converted to fish meal should be reported by species if possible.

(b) All Members of the Commission should report the size of ships using the system described in the instructions for the STALANT and fine-scale data forms.

(c) The instructions for completing the forms should be expanded to include a map of the Convention Area and perhaps illustrations of commercially important species. These instructions should be distributed as a bound manual.

(d) The following changes should be made to the draft Statistical Bulletins (SC-CAMLR-VI/6):

- Tables 5 and 6 of SC-CAMLR-VI/6 should be combined in one table;

- a complete bound version should be issued each year rather than pages to be inserted in a loose bound volume;

- the taxonomic listing of species should be retained.

5.76 Potential fishing grounds around Heard and McDonald Islands are in the same statistical subarea as Kerguelen (58.5), and it is important that catches from the two regions should be distinguished in future statistical reports. The Committee therefore recommended the establishment of two new statistical division - Kerguelen Division (58.5.1), and Heard-McDonald Division (58.5.2). (Refer to Figure 2.)

5.77 The Committee recommended that the divisions be defined as described in the Agreement on Maritime Delimitation between France and Australia, signed in Melbourne, Australia on 4 January 1982. Specifically, Subarea 58.5 should be divided by a line drawn from 53°14'S latitude, 60°00'E longitude to 53°14'S latitude, 67°03'E longitude thence to 49°24'S latitude, 76°42'E longitude and thence to 49°24'S latitude, 80°00'E longitude. The northern division would be designated Division 58.5.1 and the southern division would be designated Division 58.5.2. The actual boundaries of the two proposed new divisions would be defined by the rhumb lines joining the above co-ordinates.

5.78 The Committee requested that the Secretariat contact FAO regarding the changes to Subarea 58.5.

Mesh Selectivity

5.79 Better information on mesh selectivity is needed, particularly for *C. gunnari* around South Georgia (see paragraph 5.51). A number of countries including Poland, Japan and USSR reported that they were implementing or planning mesh experiments. Countries were

urged to continue this work, especially under commercial conditions, and to report the results to the 1988 session of the Working Group.

Management Advice

5.80 The Committee's report to the Commission relevant to management is set out in paragraphs 5.34 to 5.68. The Commission's attention is drawn in particular to the following points:

(a) General Matters

- The Committee has difficulty in providing advice in the absence of clear decisions over the policy by the Commission wishs to pursue (paragraph 5.34)

- the policy of the Commission may range from reactive to predictive. In order to achieve its policy (or policies) the Commission will need to control fishing mortality and the age at which fish are first captured. In general, by reducing fishing mortality (to $F_{0.1}$, for example) and by increasing age at first capture, variability in yield and biomass can be reduced, there would be a lower risk of recruitment overfishing, with some potential sacrifice in yield.

- because of problems in setting catch limits, especially for fisheries dependent on relatively few year classes, the use of catch limits will require that the Committee carefully evaluate the research (e.g. pre-recruit surveys) necessary for the formulation of adequate advice (paragraph 5.43).

(b) Specific Matters

- The existing measures for *Notothenia rossii* should be maintained (paragraphs 5.47 and 5.49)

- the replacement catch for *Notothenia gibberifrons* at South Georgia is probably at the level of recent catches (2 500 t) (paragraph 5.68)

- the abundance of *Chaenocephalus aceratus* around South Georgia appears to have increased recently (paragraph 5.33), while trends in biomass density indexes of *Pseudochaenichthys georgianus* are not clear (paragraph 5.33)

- high catches of 2–3 year old *Champsocephalus gunnari* taken at South Georgia in 1986/87 have reduced potential long-term yield (paragraphs 5.54 and 5.65) and an increase in size at first capture of *Champsocephalus gunnari* at South Georgia would be beneficial (paragraphs 5.53 and 5.54)

- the catch limits of *Champsocephalus gunnari* corresponding to different target values of F and two levels of biomass are set out in Table 5.4 (paragraph 5.64).