

HARVESTED SPECIES

Krill

Report of WG-EMM

Distribution and Standing Stock

5.1 The Scientific Committee noted that results of various local krill surveys in Subareas 48.1 and 48.3 had been reported to WG-EMM (Annex 4, paragraphs 3.1 to 3.8).

Estimates of Global Krill Abundance

5.2 The Scientific Committee noted that new estimates of the global krill biomass had been presented to WG-EMM (Annex 4, paragraphs 3.9 to 3.14). These estimates were based on the distribution of krill and recent stratified acoustic density measurements, and ranged from 62 to 137 million tonnes. This range is lower than earlier estimates using a variety of methodologies and is considerably lower than the figure of 500 million tonnes which is often quoted as the global krill biomass.

5.3 Possible reasons for these differences include: underestimation of the range of krill, underestimates of krill density by acoustics and overestimate of krill demand by predators. The Scientific Committee noted that research into these areas had already improved knowledge in the field of krill acoustics and into the krill requirements of predators, but encouraged further research to determine which of these factors contributes most to the uncertainties in krill biomass and production estimates (Annex 4, paragraph 3.10).

CCAMLR 2000 Krill Synoptic Survey of Area 48

5.4 The Scientific Committee agreed with WG-EMM that the key results of the CCAMLR-2000 Survey will be an estimate of krill biomass (B_0) that will be used in the krill yield model (KYM) to set a precautionary catch limit in Area 48.

5.5 These results of the CCAMLR-2000 Survey could be viewed in the context of the results of the other, smaller, acoustic surveys that have been carried out in the South Atlantic. Consequently, it may be apparent whether the survey has been conducted in an anomalous year.

5.6 The Scientific Committee agreed that an urgent task was the development of mechanisms for the subdivision of this catch limit into smaller management areas to prevent the fishery from concentrating its effort in a relatively small area at one time. This subdivision may have to include temporal as well as spatial elements because of the seasonal movements of the fishery and because of its focus on the South Georgia area in winter.

Regional, Vertical and Seasonal Distribution of Krill

5.7 The Scientific Committee noted WG-EMM's discussion on studies concerning regional, vertical and seasonal distribution of krill (Annex 4, paragraphs 3.15 to 3.19) and population structure, recruitment, growth and production (Annex 4, paragraphs 3.20 to 3.22), and agreed that these were topics requiring further research.

Indices of Abundance Distribution and Recruitment

5.8 WG-EMM had discussed indices of krill abundance distribution and recruitment (Annex 4, paragraphs 3.23 to 3.41). The Scientific Committee encouraged further research on potential errors involved in sampling krill populations, including the non-random structure of krill aggregations, potential flux into and out of the sampling areas and the provision of independent estimates of mortality (Annex 4, paragraph 3.40).

5.9 The Scientific Committee recognised the need for long time series of data on krill population parameters from the Indian and Pacific Ocean sectors of the Antarctic to improve general understanding of krill population dynamics (Annex 4, paragraph 3.41).

Future Work

5.10 It was noted that a time series of krill surveys in the area north of the South Shetland Islands in 1999/2000 (in conjunction with the CCAMLR-2000 Survey) was planned by Japan, USA and Republic of Korea (Annex 4, paragraphs 3.42 and 3.43) and the results of this survey will complement those of the CCAMLR-2000 Survey.

Data Requirements

5.11 The Secretariat had been requested to approach Peru for details of recent surveys in the Bransfield Strait (Annex 4, paragraph 3.43).

5.12 WG-EMM had highlighted the need for data from the commercial fishery during the 1999/2000 season (Annex 4, paragraph 2.15). The Scientific Committee endorsed the priorities for data collection by scientific observers on krill fishing vessels operating during the CCAMLR-2000 Survey which are set out in section 3.

Advice to the Commission

5.13 The purpose of the CCAMLR-2000 Survey is to provide an estimate of biomass (B_0) that will be used in the KYM to set a precautionary catch limit for krill in Area 48.

5.14 The setting of a new precautionary catch limit is merely the beginning of the process of developing a management procedure for krill in the South Atlantic. This procedure will need to include a consideration of the subdivision of the catch limit into smaller management units. The size of these management units and the trigger level at which the catch limit would be subdivided need to be determined by WG-EMM at its next meeting.

Fish Resources

Review of Available Information

Data Inventory and Developments in the CCAMLR Database

5.15 The majority of the data from the 1998/99 split-year (1 July 1998 to 30 June 1999) and the 1998/99 fishing season (various periods) were available to WG-FSA. STATLANT data

were summarised in SC-CAMLR-XVIII/BG/1. Some STATLANT data remain to be submitted. For assessments at WG-FSA-99, missing data were temporarily constructed from catch and effort and fine-scale data. Catch and effort data reports for the 1998/99 fishing season were summarised in CCAMLR-XVIII/BG/9. Dr S. Kawaguchi (Japan) reported that fine-scale data for the krill fishery in Area 48, referred to in paragraph 3.5 of WG-FSA's report (Annex 5), have now been submitted.

5.16 The Scientific Committee welcomed developments in the CCAMLR research survey database during 1999, and looked forward to further developments in 2000. The Scientific Committee endorsed the comments of WG-FSA regarding submission of research survey data for inclusion in this database.

5.17 Appendix B of SC-CAMLR-XVIII/BG/1 summarised data on the trade of *D. eleginoides* in 1998 and 1999, which had been reported to the Secretariat by Australia, Chile, USA and FAO. These data quantify imports and exports of *Dissostichus* products such as frozen fillets and headed, gutted and tailed (HAT) fish.

Data Entry and Validation

5.18 All the available fishery, observer and survey data from the 1998/99 split-year and from the 1998/99 fishing season had been entered into the CCAMLR database and validated. As in previous years, some datasets were submitted only a short time before the meeting and were processed during the meeting. Annex 5, paragraph 3.14 listed fine-scale data which were overdue at the start of the WG-FSA meeting. The Scientific Committee noted that these data had either now been received or were expected to be received very soon, but requested the Commission to remind Members of the importance of timely submission of data to facilitate the activities of WG-FSA.

5.19 The Scientific Committee noted the problems identified in the database from validation of fine-scale data and endorsed the comments of WG-FSA regarding resolution of these problems.

5.20 The Scientific Committee welcomed developments in the use of electronic data forms for reporting STATLANT data, catch and effort reports, fine-scale data (catch, effort and biological) and observer data, as well as the creation of a prototype Microsoft Access database for use by observers.

Estimates of Seabed Area

5.21 The Scientific Committee noted the revised estimates of seabed areas within the 500 m isobath of the South Orkney Islands presented to WG-FSA. The revision of seabed areas requested at WG-FSA-98 had not been undertaken in 1999 due to a delay in the release of a new dataset, at a spatial resolution of 1 x 1 minute, from Sandwell and Smith.

Catch, Effort, Length and Age Data Reported to CCAMLR

5.22 Table 2 of WG-FSA's report (Annex 5) summarised catches reported from the Convention Area during the 1998/99 split-year (1 July 1998 to 30 June 1999). Table 3 summarised fisheries carried out under conservation measures in force during the 1998/99 fishing year (5 November 1998 to 30 November 1999). The main fisheries in this case were:

- (i) trawl fishery for *C. gunnari* in Subarea 48.3; catch limit 4 840 tonnes, reported catch 265 tonnes;
- (ii) trawl fishery for *C. gunnari* in Division 58.5.2; catch limit 1 160 tonnes, reported catch 2 tonnes;
- (iii) trawl fishery for *D. eleginoides* in Division 58.5.2; catch limit 3 690 tonnes, reported catch 3 480 tonnes;
- (iv) longline fishery for *D. eleginoides* in Subarea 48.3; catch limit 3 500 tonnes, reported catch 3 652 tonnes;
- (v) exploratory longline fishery for *Dissostichus* spp. in Subarea 88.1; catch limit 271 tonnes north of 65°S, 2 010 tonnes south of 65°S, reported catch 0 tonnes north of 65°S, 298 tonnes south of 65°S;
- (vi) pot fishery for crabs in Subarea 48.3; catch limit 1 600 tonnes, reported catch 4 tonnes; and
- (vii) other fisheries allowable as new or exploratory fisheries in the 1998/99 season were either not carried out or caught less than 1 tonne of the target species.

5.23 The Scientific Committee noted an overshoot of the catch limit in the longline fishery for *D. eleginoides* in Subarea 48.3 amounting to 152 tonnes (4%), which resulted from high catch rates during the final 10 days of the fishing season. The issue of conversion factors is discussed in more detail in paragraphs 5.41 to 5.51.

Estimates of *Dissostichus* spp. Catches from Illegal, Unregulated and Unreported Fishing

5.24 The Scientific Committee noted the deliberations of WG-FSA regarding IUU catches of *Dissostichus* spp. in the Convention Area, set out in Annex 5, paragraphs 3.29 to 3.44. Information for the 1998/99 season was compiled intersessionally by a small task group and further reviewed during the WG-FSA meeting.

Catches by Members and Acceding States in the Convention Area and EEZs

5.25 Reported catches of *Dissostichus* spp. by Members and Acceding States, from inside the Convention Area and EEZs outside the Convention Area, along with estimated unreported catches by Members and Acceding States from inside the Convention Area, are presented in Table 5. The total estimated catch by Members and Acceding States for all areas was similar in the 1998/99 split-year (41 201 tonnes) to that in 1997/98 (42 508 tonnes). The total reported catch from EEZs outside the Convention Area and from within the Convention Area during the 1998/99 split-year (37 165 tonnes) was more than during the 1997/98 split-year (27 908 tonnes). The estimates of total unreported catches during the 1998/99 split-year (4 080 tonnes) was much less than during the 1997/98 split-year (14 600 tonnes).

5.26 The Scientific Committee noted that estimates of unreported catches by Members and Acceding States (Table 5) were only available for Argentina and Chile, and that these numbers should be treated with caution because they are derived from crude estimates of potential catch and effort in the Indian Ocean. It was noted that the caution is in regard to the possible upper level of the estimates rather than the lower level. The real level of IUU catch is likely to be

greater than that estimated by WG-FSA, but it is uncertain how much higher.

IUU Landings by all Countries

5.27 WG-FSA had estimated landings of IUU-caught *D. eleginoides* by all countries (CCAMLR Members and non-Members) in Cape Town/Durban (South Africa), Walvis Bay (Namibia), Port Louis (Mauritius) and Montevideo (Uruguay) for the 1997/98 and 1998/99 split-years and the period July to September 1999 (Annex 5, Table 5). The total green-weight landings for the 1998/99 split-year were estimated as 16 636 tonnes. The Scientific Committee noted that this was a decrease compared to the previous split-year (26 829 tonnes), but that WG-FSA had been unable to determine the reasons for this decline. Mauritius remains the primary site for the landing of IUU-caught fish.

IUU Effort and Catches in the Convention Area for the 1998/99 Split-year

5.28 WG-FSA used the approach adopted at its 1998 meeting (SC-CAMLR-XVII, Annex 5, paragraph 3.24) to estimate the magnitude of IUU fishing effort and catches in various subareas and divisions of the Convention Area during the 1998/99 split-year. The results of this analysis are presented in Tables 6 and 7 of WG-FSA's report (Annex 5). The estimated total catch for all subareas and divisions in the Convention Area in the 1998/99 split-year was 24 211 tonnes, comprising 17 588 tonnes of reported catch and 6 653 of estimated unreported catch (Annex 5, Table 7). The total estimated landings of catches in Walvis Bay and Mauritius (16 425 tonnes) in 1998/99 accounted for some 86% of the estimated 18 983 tonnes total catch in the Indian Ocean.

Estimated Trade in *Dissostichus* spp. in the 1998/99 Split-year

5.29 Trade statistics for *D. eleginoides* in 1998/99 were received from FAO, Japan, USA, Chile and Australia. These figures were presented in Annex 5, Tables 9 to 11. Product imports into Japan and the USA totalled an estimated equivalent of 44 796 tonnes of whole *D. eleginoides* during the 1998 calendar year, with Chile, Argentina, Mauritius, France and Australia being the major sources of supply. In the first half of 1999, imports into Japan and the USA totalled 23 207 tonnes equivalent whole weight, with China emerging as a more important source. The equivalent estimate of imports in the 1997 calendar year was 69 978 tonnes (SC-CAMLR-XVII, Annex 5, Table 9).

5.30 Although there was a decrease in the volume of imports into Japan and the USA, the Scientific Committee noted that the price of headed and gutted product on the US market has nearly trebled since July 1998 (Annex 5, Figure 1). The increasing trend has continued despite obvious fluctuations in supply, and will increase the incentive for IUU fishing.

5.31 The Scientific Committee reiterated its warning of previous years that trade statistics should be treated with caution since the export sources of product are not necessarily responsible for the catching of fish. In this context, the emergence of China as an export source was noted and the fact that China could contribute to increased fishing effort in the future.

Overall Estimates of IUU Catch

5.32 Table 12 of WG-FSA's report (Annex 5) provides overall estimates of the catch from IUU fishing operations. The total estimate for the 1998/99 split-year was 10 733 tonnes. This compares to 33 583 tonnes in the 1997/98 split-year and 38 000 to 42 800 tonnes in 1996/97. Although the estimates of IUU catches have decreased, the Scientific Committee noted WG-FSA's concern that the difficulties in estimating IUU catches have increased. For example, information received by WG-FSA indicates that the transshipment of catches at sea is increasing and that as much as 6 000 tonnes of fish may have been moved in this way during 1998/99. The information available for 1998/99 is therefore more uncertain than that for 1997/98. The Scientific Committee agreed that estimates of IUU catches of *Dissostichus* spp. are only minimum estimates and that the values for 1998/99 should be compared with previous years only with caution.

5.33 There is, however, some indication that the potential number of vessels involved in IUU fishing has decreased. Information presented to WG-FSA in the report of the intersessional subgroup on IUU fisheries indicated that four vessels engaged in IUU fishing in Area 58 had been arrested and were no longer taking part in IUU fisheries. Prof. Moreno noted that although the problem of IUU fishing continues and is very serious, there have been some positive developments. In particular, Chile has implemented new measures (e.g. requirement for VMS on all fishing vessels and revision of the national authorisation for fishing) which has resulted in the reduction of the Chilean fleet authorised to conduct longlining operations from 36 to nine vessels.

5.34 The Scientific Committee also noted that whilst the overall picture of IUU fishing is bleak, the problem is not uniformly distributed throughout the Convention Area. As in the past, most IUU fishing for *Dissostichus* spp. during 1998/99 occurred in the Indian Ocean sector (Area 58). Concern was expressed over the emergence of Division 58.4.4 (Ob and Lena Banks) as a focus of IUU fishing, particularly in view of the remoteness of this region and the high degree of uncertainty regarding real levels of effort occurring there. In other areas, estimates of IUU catches are lower and there is more information on likely levels of effort by IUU vessels.

Use of IUU Catch Estimates in Stock Assessments and Implications for Management

5.35 Estimates of IUU catches for Subareas 48.3, 58.6 and 58.7, and Divisions 58.5.1, 58.5.2 and 58.4.4 were used to calculate estimates of total removals for the 1998/99 fishing season, for use in updated assessments using the GYM (Annex 5, Table 8). As in past years, WG-FSA took into account unreported catches of *D. eleginoides* in its assessment of yields on the assumption that IUU catches can be brought under control.

5.36 The Scientific Committee again stressed that continued illegal fishing holds serious implications for the long-term yield and that total catches, in some areas at least, may seriously compromise the status of the spawning stock in the shorter term. For example, there are indications that catches of *D. eleginoides* in the South African EEZ around the Prince Edward Islands (Subareas 58.6 and 58.7) have fallen to about 10% of their initial levels and biomass estimates around the Crozet Islands have declined to between 25 and 30% of their original levels. Dr Constable further pointed out that assessments of stock status and future projections using the GYM as done in the past, do not presently include a stock–recruitment relationship. Thus the possible direct effects of large reductions in spawning biomass on future recruitment are not taken into account.

5.37 The Scientific Committee recalled that there are lessons to be learned in this respect from former fisheries for *Notothenia rossii* in the Convention Area. More than 20 years after the end

of large-scale commercial fishing for this species in Subareas 48.1 and 48.3, there is little sign of recovery to former levels of biomass. The impact on these stocks, although it resulted from fishing prior to the establishment of CCAMLR, is therefore at a level which is contrary to the requirements of Article II.3(c).

5.38 Based on monitoring studies on inshore demersal fish carried out over a 16-year period in the lower South Shetland Islands area (Subarea 48.1) (Annex 5, paragraph 3.135), Dr E. Barrera-Oro (Argentina) established a parallel between the decline in the abundance of *N. rossii*, and that of *Gobionotothen gibberifrons* which was also caught in the commercial fishery in the late 1970s. He noted that although *G. gibberifrons* is still the dominant offshore fish species of the area, it has virtually disappeared from the catches taken from inshore waters, in conjunction with the decline of *N. rossii*.

Research Surveys

5.39 Several research cruises to study harvested stocks were conducted in the Convention Area during the 1998/99 season, and these are detailed in Annex 5, paragraphs 3.78 to 3.81. These included trawl surveys by Australia in Divisions 58.4.1, 58.4.3 and 58.5.2, and by the USA in Subarea 48.2. Longline-weighting trials were conducted by the UK in Subarea 48.3. Other research surveys notified for 1998/99 and summarised in CCAMLR-XVIII/BG/9 had either been postponed or were not aimed to acquire data in support of the assessment of fish stocks.

5.40 Surveys proposed for the 1999/2000 season are described in Annex 5, paragraphs 6.6 to 6.12. These include survey activities by Australia in Division 58.5.2; UK, Russia, and Argentina in Subarea 48.3; New Zealand in Subarea 88.1 and the USA in Subarea 48.1.

Conversion Factors

5.41 As last year, scientific observers' reports included independent estimates of CFs used to convert measurements of processed weights to estimates of whole weight of catches. 1998/99 was the first year that observers had made consistent observations of CFs using a standard protocol established at last year's meeting. The results are presented in Table 18 of WG-FSA's report (Annex 5).

5.42 The Scientific Committee noted that differences between the CFs calculated by observers and those used by the fishing vessels to report their catches suggest that there might be errors in reported catches. Table 19 of WG-FSA's report presents mean CFs from observers and vessels.

5.43 The Scientific Committee noted with concern that catches from some fisheries, particularly in Subarea 48.3, may be underestimated because inappropriate CFs are being used by most vessels when reporting their catches. Observer-derived CFs were 15% higher than CFs used by vessels in Subarea 48.3, 7% higher in Subarea 58.7 and 3% higher in Division 58.5.2 (Annex 5, Table 19). Consequently, catches reported for the past three seasons in Subarea 48.3, calculated using the vessels' CFs, are lower than those that would result from using the observers' CFs by 351, 399 and 545 tonnes respectively.

5.44 The Scientific Committee noted that these calculations make the assumption that the observers' estimates of CFs are correct and those used by the vessels are incorrect. The large differences observed in Subarea 48.3 might still result from differences between products considered by vessel skippers and those considered by scientific observers. It is not always clear from observer reports whether CFs have been calculated using different product forms and

how the factors relate to standard product cuts such as illustrated in the *Scientific Observers Manual*.

5.45 There are two issues to be considered in relation to inconsistencies in CFs:

- (i) the within-season reporting of catches required to implement catch limits and establish fishery closure dates; and
- (ii) WG-FSA requires accurate estimates of total removals of fish in order to undertake its assessments.

5.46 With respect to the latter point, it is possible for WG-FSA to make adjustments after the season based on the best estimates of CFs. However, with respect to within-season reporting, some action is needed to ensure that appropriate CFs are used in the calculation of total catches to be reported to the Commission.

5.47 The Scientific Committee stressed the need to avoid the potential for catches to routinely exceed catch limits. The possible use of a standard CF throughout the fishery was discussed, but it was noted that CFs vary between vessels and also depend on the size of fish being processed. WG-FSA's report had noted the possibility that the exploitation patterns in the longline fishery in Subarea 48.3 may be changing, hence it would be problematic to adopt a single factor in a particular year.

5.48 An alternative approach is to directly record the whole weight of whole fish in the catch. This would avoid the use of CFs in the estimation of total weight of catches. The Scientific Committee recognised that direct weighing of catch was probably not a practical option in the short term, but should be kept under consideration for the future.

5.49 The Scientific Committee agreed that observers should continue to use the current protocol for determining CFs set out in the *Scientific Observers Manual*, and that the fish being sampled should be subject to exactly the same processing methods as used during commercial processing of the catch.

5.50 Prof. Moreno noted that CFs used by commercial vessels are often based on historical records and that there are no specific instructions to masters on how CFs should be measured and updated from year to year. The Scientific Committee recommended that the procedure set out in the *Scientific Observers Manual* be adopted as a standard method for measuring CFs, not only by observers, but also by vessel masters. The protocol could be circulated to Members in the form of a Commission circular and passed on to vessel masters by Flag States, or possibly set out in a technical conservation measure in a similar way to the regulation on mesh size measurement (Conservation Measure 4/V). The Scientific Committee encouraged vessel masters and observers to cooperate in the establishment of CFs to avoid duplication of work and possible inconsistencies in results.

5.51 CFs estimated at the start of each fishing trip using the standard procedure should then be used in the calculation of total catches to be reported to the Commission during the season.

Fish Biology, Demography and Ecology

5.52 The Scientific Committee welcomed a number of important contributions on *D. eleginoides* and *D. mawsoni* which had been presented to WG-FSA (Annex 5, paragraphs 3.94 to 3.112). These included information on age determination and genetic techniques to separate stocks and to identify fish products to species level.

5.53 A considerable amount of new information was presented on the biology of *C. gunnari*

(Annex 5, paragraphs 3.113 to 3.129). This includes length-to-mass relationships and size distributions for the Atlantic sector, diurnal migrations, standing stock, reproduction, feeding, condition factor and parasites.

Developments in Assessment Methods

5.54 The Scientific Committee noted the deliberations of WG-FSA regarding development of assessment methods (Annex 5, paragraphs 3.139 to 3.145). Intersessional activities included a workshop held at the Renewable Resources Assessment Group, Imperial College, UK, in March 1999 to further develop the mixture analyses for estimating recruitments at South Georgia and to examine ways of integrating CPUE analyses and the yield assessments of the GYM.

5.55 Dr P. Gasiukov (Russia) had presented a paper to WG-FSA (WG-FSA-99/60) reporting on the implementation of an approach for processing outputs from the GYM when CPUE or some other index of abundance is available. This approach results in a subset of possible projections being used in the final assessment of long-term annual yield according to the CCAMLR decision rules.

5.56 The Scientific Committee welcomed this development, particularly as it had been indicated last year as an area of priority research. The Scientific Committee noted the discussion by WG-FSA of another approach to the same problem, which is to use a Sampling/Importance Resampling (SIR) algorithm (McAllister et al., 1994). This approach avoids the problem of rejecting large numbers of projections, by assigning probabilities to individual projections according to the compatibility of the observed CPUE with projected abundances.

5.57 Recalling comments from previous years on the need for information required to develop direct estimates of recruitment for areas subject to new and exploratory fisheries (SC-CAMLR-XVII, paragraph 7.6), the Scientific Committee noted that apart from a recent survey by Australia at Heard Island and BANZARE Bank, no new information had become available. The Scientific Committee expressed great concern at the continuing lack of information on stocks of *Dissostichus* spp. subject to applications for new and exploratory fisheries, especially given that many of these stocks appear to have been targeted already by IUU vessels. It was agreed that in the absence of research voyages into these areas, there is a need for longliners entering these fisheries to contribute to some form of research program to help develop assessments of stock status and long-term yield. This is discussed further in section 9.

Assessments and Management Advice

Assessed Fisheries

Methods Applied to the Assessment of *D. eleginoides*

5.58 The assessment of *D. eleginoides* undertaken by WG-FSA again focused on three main analyses:

- (i) standardisation of CPUE data using GLMs;
- (ii) analysis of catch-weighted length frequencies; and
- (iii) determination of long-term annual yields using the GYM.

5.59 Analysis of the CPUE data was only undertaken for Subarea 48.3 where new data were

available for the latter part of the 1997/98 season and the whole of the 1998/99 season. The basic approach used to fit the GLMs was the same as that used last year (SC-CAMLR-XIV, Annex 5, Appendix G). However, changes were made to the CPUE data transformation and the particular type of GLM analysis used, in order to improve the distribution of residuals (Annex 5, paragraph 4.105).

5.60 Catch-weighted length frequencies were generated using a database application developed by the Secretariat during the intersessional period (WG-FSA-99/15). This analysis also focused on Subarea 48.3.

5.61 Long-term annual yields were reassessed for Subarea 48.3 and Division 58.5.2, based on revised input parameters for the GYM. Revised inputs included new growth parameters, a new exploitation pattern for longlines, a range of natural mortality (M) rather than a single value and new estimates of recruitment. Details of the assessment methods are found in paragraphs 4.104 to 4.135 of Annex 5 for Subarea 48.3, and in paragraphs 4.151 to 4.156 for Division 58.5.2.

5.62 Considerable time was spent during the WG-FSA meeting on refining inputs into the GYM. It was therefore not possible at this year's meeting to examine the use of depletion-based methods and methods for combining the GYM with abundance indices such as CPUE (see paragraph 5.55). The Scientific Committee recommended that further examination of the use of these methods should be undertaken at next year's meeting.

5.63 The Scientific Committee endorsed the methods used by WG-FSA for the assessment of *D. eleginoides* this year, and noted the common approaches being used to assess the longline fishery in Subarea 48.3 and the trawl fishery in Division 58.5.2. In both these areas, fisheries for *D. eleginoides* have been undertaken for several years and time series of recruitments are available, based on the results of fisheries-independent trawl surveys.

D. eleginoides at South Georgia (Subarea 48.3)

Standardisation of CPUE

5.64 Details of the analysis of CPUE are provided in Annex 5, paragraphs 4.104 to 4.114. The Scientific Committee endorsed the CPUE analysis undertaken by WG-FSA this year, including the following modifications:

- (i) the use of a square root transformation for the CPUE data; and
- (ii) the use of a robust form of GLM.

5.65 These modifications resulted in a more satisfactory distribution of residuals, but little change in the pattern of standardised CPUE up to the 1997/98 season.

5.66 The Scientific Committee noted that the adjusted, standardised catch rates decreased between the 1993/94 and 1997/98 seasons, but increased in the 1998/99 season (Annex 5, paragraph 4.109). This was consistent with expectations based on estimates of recruitment from fishery-independent surveys (Annex 5, paragraph 4.141).

Distribution of Fishing and Size at Capture

5.67 The Scientific Committee noted the investigation by WG-FSA of recent changes in the distribution of fishing by depth in Subarea 48.3 and the possible effect on the exploitation pattern (Annex 5, paragraphs 4.110 to 4.112). It appears that the longline fishery is starting to

concentrate more in shallower water where the fish are generally smaller. The Scientific Committee recommended that this development be reviewed again at next year's meeting.

Determination of Long-term Annual Yield using the GYM

5.68 The Scientific Committee endorsed the analysis undertaken at this year's meeting of WG-FSA to revise the estimate of long-term annual yield using the GYM. In particular, the Scientific Committee noted and endorsed the following revisions of input data and parameters for Subarea 48.3:

- (i) Revised growth parameters were estimated, based on length–age data from readings of scales taken from the commercial longline fishery in the period February to May 1991, and otoliths collected during the UK survey around South Georgia in January and February 1991. A priority task for next year should be to re-estimate the growth parameters based on new information of length at age from material collected as part of the CCAMLR Scheme of International Scientific Observation.
- (ii) A range of estimates of M ($0.13\text{--}0.2\text{ yr}^{-1}$), equivalent to the range 2 k to 3 k, rather than a single value was used.
- (iii) A revised selectivity pattern was developed, based on the assumption that fish in excess of 79 cm in length are likely to be fully selected by the fishery. In conjunction with the apparent shift towards the catching of smaller fish in shallower water in some parts of Subarea 48.3 (paragraph 5.67), the Scientific Committee recommended that next year's meeting of WG-FSA undertake a more detailed analysis of the effect of changing selectivity on long-term annual yield.
- (iv) A comprehensive review of the recruitment time series was undertaken based on bottom trawl surveys undertaken in Subarea 48.3 between 1987/88 and 1996/97.

Management Advice for *D. eleginoides* (Subarea 48.3)

5.69 The estimate of yield from the GYM was 5 310 tonnes. This was higher than the result obtained at last year's meeting (3 550 tonnes) for two main reasons:

- (i) the increase in the estimate of mean recruitment; and
- (ii) the revision of the selectivity pattern to include all fish >79 cm.

5.70 The Scientific Committee welcomed the considerable progress made at this year's meeting of WG-FSA in refining the data inputs into the GYM.

5.71 According to the analysis of available data for the most recent season, the standardised CPUE has increased since the 1997/98 season. This may be partially explained by the recruitment to the fishery of the strong 1989 year class (age 4 in 1992/93 – Annex 5, Table 38).

5.72 The Scientific Committee agreed that the estimate of yield from the GYM analysis undertaken by WG-FSA should be used to set the catch limit for the 1999/2000 season. Other management measures for *D. eleginoides* in Subarea 48.3 in the 1999/2000 season should remain as for the 1998/99 season.

5.73 The Scientific Committee noted the small overshoot of the catch limit in the 1998/99 season, resulting from higher than average CPUE at the end of the season (Annex 5, paragraph 3.25) and the occurrence of some illegal fishing in Subarea 48.3 (Annex 5, paragraph 3.33). However, it was noted that these additional catches were taken into account by WG-FSA in the calculation of long-term yield using the GYM, and that therefore it would not be necessary for the amount of this additional catch to be subtracted from the catch limit set for the 1999/2000 season.

5.74 Dr E. Marschoff (Argentina) noted that the analysis of CPUE discussed in paragraphs 5.55 and 5.56 produced an estimate of yield which was lower than the 3 550 tonnes agreed by the Commission last year. Dr Marschoff indicated that the catch in 1999/2000 should be less than 5 310 tonnes in order to maintain a degree of caution appropriate to the uncertainty indicated by the results of this analysis.

5.75 Other Members noted that, whilst this analysis was a useful contribution to the development of procedures for the refinement of the outputs of the GYM, the results did not include CPUE and catch data available at this year's meeting of WG-FSA, and used input data and parameters for the GYM from last year's meeting which have since been revised. These results could therefore not be used to infer the outcome of such a procedure in this year's analysis.

5.76 The Scientific Committee noted that any catch of *D. eleginoides* taken as part of research fishing in Subarea 48.3 should contribute towards the catch limit.

5.77 The Scientific Committee recommended the development of methods to integrate different indicators of stock status into assessments.

D. eleginoides at South Sandwich Islands (Subarea 48.4)

5.78 Despite a catch limit of 28 tonnes for *D. eleginoides*, no fishing in this subarea was reported to the Commission during the 1998/99 season. No new information was made available to WG-FSA on which to base an update of the assessment.

Management Advice for *D. eleginoides* and *D. mawsoni* (Subarea 48.4)

5.79 The Scientific Committee noted that there had been no longline fishing reported in this subarea since the 1992/93 season, but that the existing catch limit was a precautionary harvest level which was based on the results of an exploratory fishing trip (SC-CAMLR-XII, Annex 5, paragraphs 6.1 to 6.4). The Scientific Committee recommended that 28 tonnes be adopted as an appropriate catch limit for a precautionary harvest strategy for *D. eleginoides* and *D. mawsoni* in Subarea 48.4 and that WG-FSA consider what would be an appropriate precautionary harvest strategy and data collection plan at its next meeting (section 7).

D. eleginoides at Kerguelen Islands (Division 58.5.1)

5.80 The total catch in the longline fishery in Division 58.5.1 during the 1998/99 season was 5 402 tonnes. The Scientific Committee noted that the recent catch was less than the long-term annual yield derived from assessments last year. France has reported all catch and effort data to the Commission, but no new assessments were undertaken this year.

Management Advice for *D. eleginoides*
(Division 58.5.1)

5.81 The French authorities will allow trawling and longlining in their EEZ within this division in the 1999/2000 season (1 September 1999 to 31 August 2000). The French authorities have advised that there will be no increase in total catch of *D. eleginoides* over that taken last season, and that catch for the trawl fishery will be reduced.

D. eleginoides at Heard and McDonald Islands
(Division 58.5.2)

5.82 The catch limit of *D. eleginoides* in Division 58.5.2 for the 1998/99 season was 3 690 tonnes for the period 7 November 1998 to the end of the Commission meeting in 1999 (Conservation Measure 158/XVII). The catch reported for this division at the time of the WG-FSA meeting was 3 480 tonnes.

Determination of Long-term
Annual Yields using the GYM

5.83 The analysis of long-term annual yield was updated with the recent catches taken from Division 58.5.2. With the exception of natural mortality, revised data and parameters have all been estimated directly for Heard Island fish, in contrast to previous years when estimates from South Georgia have been used.

5.84 The Scientific Committee endorsed the analysis undertaken at this year's meeting of WG-FSA to revise the estimate of long-term annual yield using the GYM. In particular, the Scientific Committee noted and endorsed the following revisions of input data and parameters for Division 58.5.2:

- (i) Estimates of von Bertalanffy growth parameters were revised by WG-FSA at this year's meeting. A difficulty with estimating the parameters for Heard Island is that the samples comprise mostly small fish. In the absence of other information on L_{∞} , WG-FSA agreed to use the L_{∞} estimated for South Georgia (194.6 cm).
- (ii) A range of M was used rather than a single value. The range adopted was 0.0828 to 0.1242 yr⁻¹.
- (iii) A new series of recruitments was used based on a new mixture analysis presented in WG-FSA-99/68.

Management Advice for *D. eleginoides*
(Division 58.5.2)

5.85 The estimate of yield from the GYM was 3 585 tonnes. This is similar to the previous estimates of yield despite the application of many new parameters derived from the Heard Island region. The combined effects of slower growth rates, lower mortality and revised fishing selectivity have been balanced by observations of very strong recruitments in recent years.

5.86 The Scientific Committee recommended that the catch limit for Division 58.5.2 in the 1999/2000 season should be revised to 3 585 tonnes. Other management measures for *D. eleginoides* in Division 58.5.2 in the 1999/2000 season should be similar to the 1998/99 season.

C. gunnari at South Georgia (Subarea 48.3)

5.87 One Russian vessel took part in the commercial fishery for *C. gunnari* around South Georgia (Subarea 48.3) during the 1998/99 season which was open from the end of the Commission meeting in November 1998 until 1 April 1999. The catch limit was 4 840 tonnes. The total reported catch was 265 tonnes, taken in 23 days between 16 February and 10 March 1999. The Scientific Committee noted that 86% of this catch was taken in the four days between 28 February and 3 March on the northwestern slope of South Georgia, where *C. gunnari* formed dense concentrations which were feeding on krill.

Assessment at this Year's Meeting

5.88 The Scientific Committee noted WG-FSA's discussions regarding variability in M between years in relation to the availability of krill and predation by fur seals, and the need to consider appropriate decision rules for application of the GYM to assessing precautionary yield for this fishery (e.g. SC-CAMLR-XVI, paragraphs 4.171 to 4.178).

5.89 An assessment of *C. gunnari* in Subarea 48.3 was made using the same short-term annual yield method adopted during the 1997 meeting. This method is also used for this species in Division 58.5.2. The resulting fishing mortality for 1999/2000 and 2000/2001 was 0.14. This resulted in a combined catch over two years of 6 810 tonnes, comprising 4 036 tonnes in the first year (1 December 1999 to 30 November 2000) and 2 774 tonnes in the second year (1 December 2000 to 30 November 2001). The 2000/2001 catch level will be subject to revision if a new survey is conducted in 1999/2000.

5.90 The Scientific Committee noted that it was now two years since the time of the last survey and there is a large degree of uncertainty in the current state of the stock. The yields estimated from the short-term projections were based on the lower 95% confidence bound of the 1997 UK trawl survey and most participants considered that this constituted a conservative estimate of yield.

5.91 Dr Marschoff noted that given the time lapsed since the last survey and events in the past causing high mortality which have yet to be explained, this assessment might be invalid and a survey was needed before setting any catch limit. He stated that his view is reinforced by the failure of the fishery in the last two seasons. In the 1997/98 season, the explanation offered was that the master of the fishing vessel did not have experience in the fishery, while this year the fishing company's headquarters had abruptly decided to move the ship (after a week of low catch rates) to the squid fishery.

5.92 Dr K. Shust (Russia) pointed out that the decision to move the *Zakhar Sorokin* away from Subarea 48.3 was unrelated to the conditions in the *C. gunnari* fishery. The vessel achieved catches of 2 to 5 tonnes shortly before leaving Subarea 48.3 to fish elsewhere for squid.

5.93 In relation to the probability of events of high mortality in the stock of *C. gunnari*, Dr Marschoff indicated that these events have been associated with years of low krill availability (WG-FSA-99/50). WG-EMM has indicated that 1998/99 has been a year of low krill abundance in Subarea 48.3 while the 1999/2000 season is expected to continue the trend of

low-abundance years (Annex 4, paragraphs 3.1 to 3.3).

5.94 Dr Shust noted that a report of the fishing cruise of the *Zakhar Sorokin* presented at the meeting of WG-FSA reported that the *C. gunnari* caught by the vessel were feeding on krill as their main prey item. The fish found in the largest concentration to the northwest of South Georgia were in an area of high krill concentration and had stomachs full of krill (Annex 5, paragraphs 4.163 and 5.12).

5.95 The Scientific Committee welcomed the news that three new scientific surveys on *C. gunnari* in Subarea 48.3 by the UK, Russia and Argentina were planned for the 1999/2000 season. The results of these surveys should be available for the next meeting to update the assessment (paragraph 5.40).

Protection of Young Fish and Spawning Aggregations

5.96 The Scientific Committee noted the discussion in the report of WG-FSA regarding the merits of various approaches to protection of young fish and spawning aggregations, including the closure of coastal spawning grounds and the establishment of refuge areas for young fish (Annex 5, paragraphs 4.174 to 4.184).

5.97 The Scientific Committee agreed that the present closed season from 1 April to the end of the Commission meeting was not necessary for the protection of spawning and that a closed season of 1 March to 31 May would be more appropriate. It was also agreed that the priority for the protection of spawning was to apply this closed season to areas where spawning is known to take place.

5.98 There was considerable discussion in the Scientific Committee regarding the extent of the area to which the closure should apply. The debate centred on whether there was sufficient information on the location of spawning aggregations to identify a subsection of Subarea 48.3 to which the closure should apply, or whether the closure should apply to the whole subarea.

5.99 Information regarding the location of spawning was discussed by WG-FSA (Annex 5, paragraph 4.177). Existing information indicates that peak spawning of *C. gunnari* at South Georgia occurs in the fjords and coastal areas between March and May (Annex 5, Figure 27).

5.100 Some Members felt that the information available on the location of spawning concentrations indicated that it was not necessary to close the whole subarea to protect spawning. The required level of protection could be achieved by creating a refuge area covering the coastal areas of South Georgia, out to a set distance from the island. This would allow spawning to take place in the fjords all around the island of South Georgia without disturbance from the commercial fishery. There is precedent for such an approach within the conservation measures of the Commission. Conservation Measure 1/III, in force from 1984 to 1989, closed to fishing the waters within 12 n miles of South Georgia.

5.101 Other Members of the Scientific Committee felt that knowledge on spawning of *C. gunnari* at South Georgia and around Shag Rocks is still too limited to justify that only certain areas of the shelf, such as waters immediate to the coast, be closed to fishing during the spawning season. A survey conducted in late March 1978 found aggregations of *C. gunnari* immediately prior to spawning in Cumberland West Bay, Fortuna Bay and Royal Bay. Males start their migration to the spawning grounds earlier than females (Kock, 1981, 1989). Other areas were not investigated. It is thus still unknown to what extent the species spawns in other fjords along the east coast of the island, at the more exposed west coast and around Shag Rocks. A survey of these coastal areas in March and April is urgently needed to further identify spawning grounds and to better understand spawning activities of *C. gunnari* at South Georgia.

The Scientific Committee also noted that information from the commercial fishery could provide useful insights into spawning seasons, migrations and aggregations.

5.102 Both options were forwarded to the Commission for consideration.

5.103 Since there will be nine months to take any catch limit that the Commission wishes to establish, Dr Marschoff questioned whether a restriction to the protection of spawning should occur, given the paucity of the information available on the geographical distribution of the spawning grounds.

5.104 Dr Parkes pointed out that the protection of spawning concentrations and the setting of catch limits are separate management issues. Measures to protect spawning are associated with the life cycle of the fish and therefore tend to perpetuate from year to year. Catch limits change more frequently according to the status of the stock.

5.105 The Scientific Committee also noted the discussion by WG-FSA regarding the application of closed areas to the protection of young fish and the analysis of length data from bottom trawl surveys around South Georgia. The Scientific Committee recommended that a more detailed analysis be undertaken to provide advice on the possible benefits of the use of refuges for protecting young fish as part of the management procedure for *C. gunnari*. The Scientific Committee agreed that this issue was relevant for all areas where there are fisheries for *C. gunnari* and should be a priority task for the intersessional subgroup of WG-FSA working on the assessment of this species.

5.106 The Scientific Committee endorsed the decision of WG-FSA to again postpone the Workshop on the Development of a Long-term Management Strategy for *C. gunnari* as first recommended in 1997. The requirement for the types of analyses listed in the provisional terms of reference for this workshop remain high, but WG-FSA's intersessional subgroup on *C. gunnari* fisheries and WG-EMM participants will aim to make progress on these issues along the lines of paragraph 9.10 of Annex 5. The requirement for a dedicated workshop should be considered again at next year's meeting.

Management Advice for *C. gunnari* (Subarea 48.3)

5.107 Most Members agreed that the total catch limit for *C. gunnari* in Subarea 48.3 should be revised to 4 036 tonnes for the period 1 December 1999 to 30 November 2000. The catch limit for the 2000/2001 season of 2 774 tonnes will be subject to revision if one or more surveys are conducted in 1999/2000.

5.108 Dr Marschoff noted that the low catch in this fishery indicates that the stock remains at a low level and that a survey is needed before setting any catch limit.

5.109 The Scientific Committee agreed that in order to protect spawning concentrations, there should be a closed season in the fishery for *C. gunnari* in Subarea 48.3 between 1 March and 31 May.

5.110 The Scientific Committee noted that WG-FSA had agreed that the closed season should apply to the areas where spawning is known to take place, but was not in a position at this stage to provide unequivocal advice on the extent of the area within Subarea 48.3 which needed to be protected. The Scientific Committee offered two alternatives for consideration by the Commission. The first alternative is to close certain areas of the shelf for fishing from 1 March to 31 May 2000. This is detailed in paragraph 5.100. The other alternative is to close the whole of Subarea 48.3 for the same period. This option is further detailed in paragraph 5.101.

5.111 Other management measures for *C. gunnari* in Subarea 48.3 set for the 1998/99 season should remain in force.

C. gunnari at Kerguelen Islands (Division 58.5.1)

5.112 No commercial fishing for *C. gunnari* took place in this division during the 1998/99 season. A survey during the 1998/99 season indicated that the current biomass on the traditional northeastern fishing ground is very low. The French authorities have indicated that a resumption of fishing is not being contemplated at this time but that the survey will be repeated in the 1999/2000 season.

Management Advice for *C. gunnari*
(Division 58.5.1)

5.113 The Scientific Committee is looking forward to seeing the full analysis of the results of the survey conducted in 1998/99 and welcomed the reported intention to undertake a survey in 1999/2000.

C. gunnari at Heard and McDonald Islands
(Division 58.5.2)

5.114 The catch in the commercial fishery for *C. gunnari* in Division 58.5.2 during the 1998/99 fishing season up to the time of the current meeting was 2 tonnes. This was a result of the fishing vessels concentrating on the *D. eleginoides* fishery. The only aggregations of *C. gunnari* detected were of young fish. No survey for *C. gunnari* was undertaken in 1998/99.

5.115 An assessment of *C. gunnari* in the Heard Island Plateau area was made using the same short-term annual yield method adopted during the 1997 meeting and used for this species in Subarea 48.3. The results of a trawl survey conducted in 1998 were used as input to this assessment. The resulting fishing mortality for 1999/2000 and 2000/2001 was 0.139. This resulted in a combined catch over two years of 1 518 tonnes, comprising 916 tonnes in the first year and 603 tonnes in the second year.

Management Advice for *C. gunnari*
(Division 58.5.2)

5.116 The Scientific Committee agreed that the management of the fishery for *C. gunnari* on the Heard Island Plateau part of Division 58.5.2 during the 1999/2000 season should be similar to that in force last season, as detailed in Conservation Measure 159/XVII.

5.117 The total catch limit should be revised to 916 tonnes in accordance with this year's short-term yield calculations. The fishery on Shell Bank should be closed, as last year.

Other Fisheries

Antarctic Peninsula (Subarea 48.1)

5.118 Finfish stocks in the Antarctic Peninsula region (Subarea 48.1) have been exploited from 1978/79 to 1988/89, with most of the commercial harvesting taking place in the first two years of the fishery. Given the substantial decline in biomass of the target species in the fishery, *C. gunnari* and *N. rossii*, by the mid-1980s, Subarea 48.1 was closed for finfishing from the 1989/90 season onwards.

5.119 New data pertaining to the biological characteristics of Antarctic fish stocks taken in a random stratified bottom trawl survey around Elephant Island and the lower South Shetland Islands during 1998/99 were presented to WG-FSA. However, this new information was not sufficient to undertake any assessment on the stocks in this subarea (Annex 5, paragraphs 4.199 to 4.201).

Management Advice

5.120 There appears to be little prospect for a substantial fishery given the low biomass estimates for the 1997/98 season (SC-CAMLR-XVII, paragraph 5.107) and the absence of sufficient new information. WG-FSA therefore recommended that Conservation Measure 72/XVII should remain in force.

South Orkney Islands (Subarea 48.2)

5.121 A random stratified bottom trawl survey within the 500 m isobath was carried out by the US AMLR Program around the South Orkney Islands in 1999 and the biomass of eight species of finfish were estimated. Biomass levels for only two species increased in 1999 over the 1991 survey, and there was an apparent decrease in biomass for all other species in 1999, particularly *C. gunnari*. The upper 95% confidence limit of the 1999 biomass level of *C. gunnari* is roughly at 4% of pre-exploitation levels around the South Orkney Islands (Annex 5, paragraphs 4.203 to 4.210). Given the current low abundance of *C. gunnari* and the other species, no attempt was made to calculate precautionary catch limits using the GYM.

Management Advice

5.122 There appears to be little prospect for a substantial fishery given the low biomass estimates for the 1998/99 season. The Scientific Committee therefore recommended that Conservation Measure 73/XVII should remain in force until future surveys indicate an increase in fish biomass in the subarea.

Pacific Ocean Sector (Subarea 88.3)

5.123 No fishing occurred in Subarea 88.3 during the 1998/99 season and no Member has notified their intention to conduct fishing operations in this area during the 1999/2000 season.

Management Advice

5.124 In view of the low catch rates encountered by a feasibility study during the 1997/98

season, the Scientific Committee recommended that fishing for *Dissostichus* spp. should be prohibited in the 1999/2000 season.

Crab Resources

5.125 The Scientific Committee noted a UK report that between 7 and 20 September 1999, a single vessel had caught 30 512 individuals of *Paralomis formosa* and 4 602 of *P. spinosissima* (Annex 5, paragraphs 4.215 to 4.219). This catch comprised 7 184 and 1 900 kg respectively by weight of the two species. However, the percentages of retained crabs were very small (14 and 9%). This resulted in only 4 129 individuals and 1 861 kg of *P. formosa* and 402 individuals and 317 kg of *P. spinosissima* being retained. Concern was expressed regarding the large proportion of undersized crabs and the uncertainty regarding the survival of discards.

5.126 The problem of discards was recognised by the 1993 CCAMLR Workshop on the Long-Term Management of the Antarctic Crab Fishery (SC-CAMLR-XII, Annex 5, Appendix E, paragraphs 4.7 and 6.10) and the Scientific Committee accepted the workshop's advice that long-term studies should be conducted on discard mortality from the crab fishery.

5.127 The UK and the USA indicated that one vessel from each country expects to participate in the crab fishery during the 1999/2000 season.

Management Advice for Crabs (*Paralomis* spp.)

5.128 The Scientific Committee recognised the great utility of the experimental harvest regime set out in Conservation Measure 150/XVII and recommended that the measure should remain in force. However, if new vessels were to enter the fishery, the Commission might wish to revise Phase 2 in the light of the comments made in paragraph 4.183 of the 1996 report (SC-CAMLR-XV, Annex 5).

5.129 The Scientific Committee agreed that, since no need had been identified at this time requiring vessels to conduct activities under Phase 2, then this requirement could be eliminated from Conservation Measure 150/XVII.

5.130 The Scientific Committee also agreed that since crab stocks have not been fully assessed, the conservative management scheme contained in Conservation Measure 151/XVII is still appropriate for this fishery.

Squid Resources

Squid (*Martialia hyadesi*) in Subarea 48.3 (South Georgia)

5.131 No new information on this species was presented to WG-FSA at this year's meeting. The scientific basis on which the current conservation measure was based has not changed.

5.132 In addition, there was no notification of intention to conduct a fishery for the 1999/2000 season.

Management Advice

5.133 The Scientific Committee recommended that the existing management regime, as set out in Conservation Measure 165/XVII, be maintained for the 1999/2000 fishing season.