HARVESTED SPECIES

Krill Resources

Krill Status in 1999/2000

5.1 The Scientific Committee noted with pleasure the progress towards publication of the results of the CCAMLR-2000 Survey in *Deep Sea Research*. Workshops had been held on the CCAMLR-2000 Survey and on the associated surveys which had taken place in the same season, and the intention to include papers resulting from the complementary 1999/2000 surveys by Japan, Republic of Korea, Peru and the USA in the *Deep Sea Research* volume was welcomed (Annex 4, paragraphs 3.9 to 3.14).

5.2 The collaboration between CCAMLR and the IWC on the CCAMLR-2000 Survey had been very productive and the Scientific Committee encouraged further such collaborative research (see also Section 11).

Krill Status in 2000/01

5.3 Results from the 2000/01 season indicated above-average krill abundance and recruitment in the Elephant Island area, resulting from successful spawning during 1999/2000. A second year of high recruitment is also predicted for the 2001/02 season (Annex 4, paragraph 3.30).

5.4 The Scientific Committee noted WG-EMM's consideration of a paper examining the level of escapement (75%) used in the GYM which is the culmination of research begun in 1992 (Annex 4, paragraphs 3.76 to 3.79). Further developments of this type of approach were encouraged.

Small-scale Management Units

5.5 The Scientific Committee noted that discussion of appropriate management units for fisheries in the Convention Area has a long history. WG-EMM had examined two types of management units:

- small-scale 'predator units', based on local predator demand, local krill distribution and fishing fleet patterns (Annex 4, paragraphs 4.4 to 4.11); and

- larger-scale 'harvesting units' which were formed by subdividing the large existing statistical areas (Annex 4, paragraphs 4.12 to 4.15).

Discussion on predator units is presented in paragraphs 6.15 to 6.19.

Harvesting Units

5.6 WG-EMM had drawn attention to the size of several of the large CCAMLR statistical areas and had suggested that they might be able to be subdivided into 'harvesting units' on ecological grounds. The rationale for establishing such harvesting units was that these large

areas are currently too large to survey with ease, some boundaries may artificially divide populations, and many existing areas contain large areas where krill are generally thought to be absent (Annex 4, paragraphs 4.10 to 4.15).

5.7 In response to a request from WG-EMM (Annex 4, paragraph 4.14), a paper was provided to the Scientific Committee highlighting an approach to the subdivision of these large areas using historical data on krill distribution and abundance (SC-CAMLR-XX/BG/24). The paper adopted several general principles:

- areas where krill were abundant were separated from areas where krill were scarce;
- boundaries were located between 'stocks' of krill; and
- consistency with Conservation Measure 200/XIX was aimed for.

The overall aim was to produce a series of harvesting units of <400 000 km^2, which could be surveyed by a single ship in a summer season.

5.8 This approach was welcomed by the Scientific Committee and it was suggested that additional data should be taken into account in further developing this proposal. These could include: satellite information, bathymetry, the position of the Polar Front, oceanographic data and additional data on krill distribution and abundance, particularly further evidence of the existence of sub-populations of krill.

5.9 The Scientific Committee recommended that an intersessional group, co-convened by Drs M. Naganobu (Japan) and Constable, should develop this approach to harvesting units, and report to the 2002 meeting of WG-EMM.

5.10 The Scientific Committee noted that requests for altering management units from existing statistical boundaries to ones more related to ecological or physical boundaries have arisen a number of times. The Scientific Committee requests the Commission to advise whether it would wish to receive advice on appropriate ecological or physical units, and whether it would prefer the boundaries for different species be harmonised where possible, or whether there might be a need for separate schemes for different species.

5.11 The Scientific Committee recommended that this work on harvesting units should proceed, noting, however, that WG-EMM's highest priority had been to the smaller predator units, which were to be the focus of a workshop at the 2002 meeting of WG-EMM.

Consideration of Existing Conservation Measures

Submission of Catch and Effort Data

5.12 The Scientific Committee noted WG-EMM's advice that the future work identified during the workshop on the future agenda of WG-EMM would require catch and effort data on the finest space and time scales practicable, and in a consistent format across all krill fleets (Annex 4, paragraph 4.44).

5.13 Historically, fine-scale data for the krill fishery has referred to aggregated data from fine-scale rectangles (0.5° latitude x 1.0° longitude). However, the Scientific Committee noted that there was no consistency in the reporting of data from the krill fishery. In the past, data have been provided by fine-scale rectangles, or by finer-scale rectangles (10 n miles x 10 n miles), or as haul-by-haul data. In many instances, no data have been submitted at all.

5.14 The Scientific Committee noted that none of the specific conservation measures adopted for krill to date specified the submission of catch and effort data on any scale. In order to further the work of the Scientific Committee, it was essential that consistent submission of data on the krill fishery be provided by all operators on the finest standardised scale practicable.

5.15 The Scientific Committee noted that for all fisheries other than krill in the Convention Area, the Commission had specified the appropriate level of fine-scale data submission (Conservation Measure 122/XIX).

5.16 Dr Kawaguchi indicated that although Japan supported the concept of consistent reporting of catch and effort data from the krill fishery from all operators, he indicated that his view was that the submission of such data should be on a voluntary basis, and guidelines on data submission rather than a conservation measure would suffice. Japan would have great difficulty supplying haul-by-haul data from the point of view of commercial confidentiality.

5.17 The Scientific Committee reiterated the urgent need for these data to be reported, and to be reported in a consistent format, as they were critical for the development of smaller management units which will need to take into account the behaviour of the fishing fleets. Most Members felt that a requirement to report haul-by-haul data in a consistent format would be the appropriate form of data submission from the krill fishery.

5.18 Dr Goubanov indicated that haul-by-haul data on krill fisheries carried out by the Ukrainian vessel from May to October 2001 will be submitted once the vessel returns and the data have been processed.

Method of Forecasting Closure Dates

5.19 The Scientific Committee noted WG-EMM's caution on the potential for overshooting the catch limit because of the current method of forecasting the closing date based on catch rates. The Secretariat was requested to review mechanisms that could be used for managing the krill fishery based on periodic reports from the fishery that would be able to ensure that overshoot of the catch limit was unlikely to occur. Although the potential to overshoot currently might not appear critical given the low level of overall catch compared to the precautionary catch limits, it would be important when considering catches in relation to smaller management units.

Catch Limits in Subareas 48.5 and 48.6

5.20 WG-EMM had sought clarification on catch limits for krill in Subareas 48.5 and 48.6 since these had not been surveyed as part of the CCAMLR-2000 Survey. The Scientific Committee indicated that the wording of Conservation Measure 32/XIX specified that the total catch of krill in Area 48 should be limited to 4 million tonnes. Furthermore, all of that

catch had been allocated to Subareas 48.1, 48.2, 48.3 and 48.4. Thus, there was no catch allocated to Subareas 48.5 and 48.6.

5.21 Catch limits for Subareas 48.5 and 48.6 could be established either through new synoptic surveys or through analysis of existing data from previous krill biomass surveys, and the Scientific Committee encouraged the investigation of both these approaches. Without the analysis of such survey data, any proposals for krill fisheries in these areas would have to provide notification under the rules established for new fisheries (Conservation Measure 31/X).

Conservation Measure 45/XIV

5.22 The Scientific Committee recommended that the Commission revise the fishing season in Conservation Measure 45/XIV (precautionary catch limit on krill in Division 58.4.2) to bring it into line with the fishing seasons adopted by the Commission in Area 48 and Division 58.4.1.

Advice to the Commission

5.23 The Scientific Committee's advice to the Commission is contained in paragraphs 5.10 and 5.22.

Fish Resources

Fish, Squid and Crab Biology/Demography/Ecology

5.24 The Scientific Committee welcomed a number of important contributions on the biology, demography, and ecology of finfish and crab resources which had been presented to WG-FSA (Annex 5, paragraphs 3.92 to 3.142):

(i) The results of an intersessional Workshop on Estimating Age in Patagonian Toothfish are discussed in Annex 5, paragraphs 3.92 to 3.102.

(ii) Other results on the biology of *D. eleginoides*, including tagging studies, are presented in Annex 5, paragraphs 3.103 to 3.107. The Scientific Committee recognised the value of tagging experiments, and encouraged further tagging of *D. eleginoides*. The Scientific Committee emphasised the need for all scientific observers to be aware of the possibility that tagged fish may be in catches.

(iii) Aspects of the biology, including new information on reproduction and population structure of *D. mawsoni* are discussed in Annex 5, paragraphs 3.108 to 3.111.

(iv) New information on aspects of *C. gunnari* biology, demography and ecology were presented by WAMI in Annex 5, paragraphs 3.112 to 3.127. The entire WAMI report is contained in Appendix D of Annex 5.

(v) Information on growth parameters of *C. gunnari* is presented in Annex 5, paragraphs 4.196 to 4.199. The Scientific Committee endorsed the recommendations of WG-FSA that an otolith exchange system be established and a reference collection of otoliths be prepared similar to what has been established for the CCAMLR Otolith Network for *Dissostichus* spp.

(vi) Information on the distribution, sizes and survival after discarding of crabs from the experimental pot fishery for *D. eleginoides* in Subarea 48.3 is given in Annex 5, paragraphs 3.128 to 3.131.

(vii) New biological information on skates and rays is summarised in Annex 5, paragraphs 3.133 to 3.136.

(viii) New information on macrourids is summarised in Annex 5, paragraphs 3.137 to 3.140.

5.25 Dr Goubanov stated that Ukraine possesses data on several scientific surveys in Subarea 48.3 targeting *C. gunnari* and other fish species. Submission of these data will contribute to the better understanding of the biology, demography and interannual variability of *C. gunnari* in the area. Ukraine has a problem with submission of haul-by-haul data from scientific research trawl surveys for the period from 1970 to 1995, because of lack of financing.

Developments in Assessment Methods

5.26 The Scientific Committee welcomed a number of papers dealing with new assessment methods, which are described in Annex 5, paragraphs 3.143 to 3.150. Several new methods addressed the estimation of selectivity or 'fishing vulnerability', a term that includes both availability of fish to the fishery and selectivity by the fishery, and its effect on calculating growth parameters. The GYM had been revised to make the estimate of natural mortality and recruitment internally consistent in computations (Annex 5, paragraph 3.145). In addition, an age-structured production model was applied to the *D. eleginoides* fishery at Prince Edward Island (Annex 5, paragraph 3.148).

Assessment and Management Advice

Assessed Fisheries

Dissostichus spp.

5.27 Assessments of long-term annual yield for *Dissostichus* spp. were reviewed for Subarea 48.3 and Division 58.5.2. Several input parameters to the GYM were reassessed, the recruitment series updated, and catches updated for both Subarea 48.3 and Division 58.5.2. These assessments are detailed in Annex 5, paragraphs 4.84 to 4.155.

D. eleginoides at South Georgia (Subarea 48.3)

5.28 The catch limit for the fishery for *D. eleginoides* in Subarea 48.3 in the 2000/01 season was 4 500 tonnes (Conservation Measure 196/XIX). The total catch of *D. eleginoides* from this fishery, as reported by 7 October 2001 in the catch and effort reporting system, was 4 050 tonnes, of which 3 991 tonnes were taken by longline and 59 tonnes were taken by pot. The longline fishing season closed on 31 August 2001, and the pot fishing season will remain open until 30 November 2001 or until the catch limit is reached, whichever is the sooner.

Standardisation of CPUE

5.29 Analysis of CPUE data was undertaken for Subarea 48.3 using a GLM. New longline haul-by-haul data from most vessels were available from the 2000/01 season for vessels operating in Subarea 48.3. Details of the standardisation of the CPUE at South Georgia are described in Annex 5, paragraphs 4.87 to 4.91. The Scientific Committee endorsed the CPUE analysis undertaken by WG-FSA this year.

5.30 The Scientific Committee noted that the standardised catch rates were relatively constant from 1986/87 to 1994/95, decreased substantially between 1994/95 and 1996/97, and that there has been very little change since the 1996/97 season. The Scientific Committee observed that the trend in recent seasons towards increased longline fishing effort at shallow depths (300–700 m) was not observed in the 2000/01 season.

Determination of Long-term Annual Yield using the GYM

5.31 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. The Scientific Committee further endorsed the refinements to the assessment procedures, including the use of the final parameters in Annex 5, Table 28 in this year's assessment. The Scientific Committee agreed to include three changes toward the final calculation of long-term yield compared to last year:

- the estimation of the different fishing vulnerabilities (selectivity);
- refinements to the recruitment estimates; and
- an updated time series of catches and standardised CPUE estimates.

5.32 Methods used in the assessment of long-term yield in Subarea 48.3 are described in Annex 5, paragraphs 4.94 to 4.114. The Scientific Committee endorsed the recommendation that a new selectivity curve was more appropriate for the fishery for 1998 onwards, whereas the previously used curve was still appropriate for 1997 and earlier.

5.33 A revised recruitment series was used in the GYM which produced similar estimates of yield to the 1999 assessment and a greater estimated yield than last year's assessment. The increase in yield also resulted from using the cohort densities directly so as to vary the recruitment series whenever the value of M is changed in the projection, rather than estimating the recruitment series using a mean value of M prior to the assessments. The outcome was that the estimated yield of *D. eleginoides* in Subarea 48.3 was 5 820 tonnes. As in previous years, the decision rule concerning the probability of depletion was binding.

5.34 The Scientific Committee welcomed the progress made at this year's meeting in refining the data inputs into the GYM, particularly with respect to progress made in estimating fishing vulnerability and incorporating internal consistency between parameters in the GYM. The Scientific Committee encouraged the continued development and testing of methods to integrate different indicators of stock status into assessments.

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

5.35 The Scientific Committee recommended that the catch limit for the 2001/02 season should be 5 820 tonnes. Other management measures for *D. eleginoides* in Subarea 48.3 in the 2001/02 season should remain as for the 2000/01 season.

5.36 Any catch of *D. eleginoides* taken in other fisheries (such as the pot fishery) in Subarea 48.3 should be counted against this catch limit.

D. eleginoides at South Sandwich Islands (Subarea 48.4)

5.37 No new information was made available to WG-FSA for *D. eleginoides* in Subarea 48.4 (South Sandwich Islands) on which to base an update of the assessment.

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

5.38 The Scientific Committee recommended that Conservation Measure 180/XVIII be carried forward for 2001/02. As with last year, the Scientific Committee recommended that the situation in this subarea be reviewed with a view to considering the period of validity of the existing assessment. However, the Scientific Committee reviewed the advice of WG-FSA and concluded that given the high workload at its meetings, it was unlikely to be able to review this measure in the near future.

D. eleginoides at Kerguelen (Division 58.5.1)

5.39 The Scientific Committee was not able to consider any updated assessments or give advice on *D. eleginoides* population status or exploitation in Division 58.5.1 (Kerguelen) because recent haul-by-haul data have not been provided. The Scientific Committee endorsed the recommendation of WG-FSA that these data should be made available for assessment purposes, as well as any other information that would help determine the current stock status.

5.40 The Scientific Committee agreed that the presence of a French scientist and comprehensive information from the fishery at WG-FSA is essential for undertaking an

assessment of the state of *Dissostichus* spp. stocks in Division 58.5.1 and adjacent areas such as the Crozet Island region (see also Annex 5, paragraph 4.126).

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

5.41 The catch limit of *D. eleginoides* in Division 58.5.2 for the 2000/01 season was 2 995 tonnes (Conservation Measure 197/XIX) for the period from 1 December 2000 to the end of the Commission meeting in 2001. The catch reported for this division at the time of the WG-FSA-01 meeting was 2 490 tonnes. Two Australian vessels are participating in the fishery.

5.42 The Scientific Committee welcomed new data from the *D. eleginoides* fishery in Division 58.5.2, the details of which are described in Annex 5, paragraphs 4.129 to 4.144. New information included a revision of growth parameters. The mixture analyses used to determine cohort densities were therefore reassessed, providing a revised set of cohort densities.

5.43 Similar to the Subarea 48.3 assessment, the new method for estimating age-based fishing vulnerability was applied to the available catch data for Division 58.5.2, using revised growth and mortality parameters. The Scientific Committee encouraged the further development of this method to take account of fishing mortality, but noted that the results for this year are an improvement on the function used previously. The function used this year takes better account of the presence of large fish in the catch.

5.44 Based on the revisions of the inputs to the GYM, the yield estimate for Division 58.5.2 was 2 815 tonnes. The decision rule concerning the 50% escapement of median pre-exploitation biomass was binding.

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

5.45 The Scientific Committee recommended that the catch limit by trawling for Division 58.5.2 in the 2001/02 season be revised to 2 815 tonnes. The remaining provisions of Conservation Measure 197/XIX should be carried forward for the 2001/02 season.

D. eleginoides at Prince Edward Islands (Subarea 58.7)

5.46 The Scientific Committee welcomed the assessment of *D. eleginoides* in the South African EEZ around the Prince Edward Islands described in Annex 5, paragraph 3.120. The Scientific Committee noted that this assessment indicated that *D. eleginoides* stocks in the EEZ since 1996 have been subject to high levels of illegal catch leading to a sharp decline in the longline CPUE. It also showed that spawning stock biomass has been depleted to only a few percent of the pre-exploitation level. The Scientific Committee further noted that

projections suggest that the annual allowable catch in the Prince Edward Islands EEZ should be reduced to about 400 tonnes.

Management Advice for *D. eleginoides* (Subarea 58.7)

5.47 The Scientific Committee acknowledged the high levels of uncertainty associated with estimates of *D. eleginoides* stocks in this area, especially in the light of IUU fishing. The Scientific Committee recommended that annual allowable catches in the Prince Edward Islands EEZ should be reduced to 400 tonnes.

D. eleginoides at Crozet Islands (Subarea 58.6)

5.48 WG-FSA did not undertake an assessment of *D. eleginoides* in the French EEZ around the Crozet Islands. France was encouraged to undertake such an assessment and inform WG-FSA of the results.

General Management Advice for *D. eleginoides* (Subareas 58.6 and 58.7)

5.49 Following advice of recent years, the Commission's attention is again drawn to the high levels of uncertainty associated with estimates of *D. eleginoides* stock levels in Subareas 58.6 and 58.7 in general. The negative role of IUU fishing in increasing such uncertainty is also re-emphasised.

5.50 Given the prevailing uncertainties, the Scientific Committee recommended a continuation of the prohibition of directed fishing for *D. eleginoides* in Subarea 58.7 outside the EEZ of South Africa (Conservation Measure 160/XVII).

General Advice on *D. eleginoides* Assessments

5.51 The Scientific Committee was encouraged by the progress made this year on methods for reducing uncertainty in important assessment parameters. It endorsed the priority work on estimating growth and natural mortality (Annex 5, paragraph 4.142; SC-CAMLR-XIX, Annex 5, paragraphs 4.143 to 4.146) and consideration of the consequences of different growth rates between males and females on the assessment of yield (SC-CAMLR-XIX, Annex 5, paragraphs 4.122 and 4.123).

5.52 The Scientific Committee noted that the application of new methods in these fisheries will cause some variation from time to time in the estimates of parameters and, consequently, estimates of yield, and agreed that the inter-dependence of estimates of recruitment, growth, selectivity and natural mortality means that, if possible, estimation of these parameters should not be undertaken in isolation.

Champsocephalus gunnari

Workshop on Approaches to the Management of Icefish

5.53 The Scientific Committee noted the conclusions of WAMI, reported by WG-FSA (Annex 5, paragraphs 4.159 to 4.189). In particular, the Scientific Committee noted that fisheries for *C. gunnari* in Subarea 48.3 and Divisions 58.5.1 and 58.5.2 share many characteristics, including:

(i) large fluctuations in catch;

(ii) periods of low or zero commercial catches;

(iii) a recent resurgence in interest in the fishery in the mid- to late 1990s with modest levels of fishing effort and catches in Subarea 48.3 and Division 58.5.2;

(iv) reliance of the commercial fishery on a few age classes: mainly ages 3 and 4; and

(v) age 5+ fish are poorly represented in survey and commercial catches, suggesting an age-specific increase in natural mortality (M).

5.54 The Scientific Committee endorsed the recommendations of WG-FSA on issues relating to current management measures (Annex 5, paragraph 4.165), ecological interactions (Annex 5, paragraph 4.175), surveys (Annex 5, paragraphs 4.176 to 4.183) and alternative approaches to management (Annex 5, paragraph 4.189).

5.55 The Scientific Committee noted that changes in the ecosystem in the recent past may be affecting the dynamics of *C. gunnari* stocks. The Scientific Committee advised the Commission that for the first time a CCAMLR working group had concluded that, in the context of Article II, it is possible that changes have occurred in the ecosystem, which may not be reversible over two or three decades. In particular, the Scientific Committee noted:

(i) increases in populations of fur seals and some penguin species at South Georgia;
(ii) increases in populations of fur seals and king penguins in the Indian Ocean;
(iii) increases in mean annual air temperature at the Antarctic Peninsula; and
(iv) decreases in the mean annual extent of sea-ice in the southern Scotia Arc.

5.56 Dr Marschoff noted that the past history of heavy fishing in the 1970s and 1980s was not discussed by WG-FSA in this context as a possible contributing factor to these changes.

5.57 The Scientific Committee recognised that high short-term variability in the size of *C. gunnari* stocks exists, and that there is potential for recovery following an event of high recruitment.

5.58 Dr Constable noted similarities between the program of work proposed by WG-FSA on ecological interactions between the *C. gunnari* fishery, *C. gunnari* and its predators and prey and other elements of the ecosystem (Annex 5, paragraph 4.175), and future work proposed by WG-EMM (paragraph 6.20). In particular, simulation studies are needed to examine plausible scenarios which could explain observed abundances of

C. gunnari, krill and the predators. For example, a simulation study of the impact of seal predation may help determine what future work is required. Members of WG-FSA and WG-EMM were encouraged to work together on these issues to better understand the dynamics of *C. gunnari* and its fisheries in the Convention Area in the context of the ecosystem approach.

5.59 Dr Everson noted the information on by-catch of *C. gunnari* in krill trawls reported to WG-FSA from the fishery by Ukraine in Subarea 48.2 (Annex 5, paragraph 4.173). He noted that this report appeared to refer to catches of krill taken over the shelf to the south of the South Orkney Islands. The bulk of krill fishing in this subarea takes place to the north and west of the South Orkneys over deeper water. The Scientific Committee noted that it is rare to find *C. gunnari* in plankton hauls over deeper water.

5.60 Dr Kawaguchi noted that Japan has been continuing to deploy fish by-catch observers on krill trawlers around the South Shetland Islands area for nearly 10 years. The results of these analyses, presented in WG-EMM every year, show a low fish by-catch rate.

5.61 Dr Shust drew the Scientific Committee's attention to WG-FSA's discussion of survey methodology including the acoustic methods to better estimate the abundance of *C. gunnari* (Annex 5, paragraphs 4.176 to 4.180). The Scientific Committee agreed that research surveys need to be as representative as possible of the true status of the stock as they are now the primary means of measuring the current status of the stock and form the starting point for the subsequent calculation of catch limits using the short-term projection method. The Scientific Committee recognised the value of combined acoustic and bottom trawl surveys to assess the abundance of fish in the water column both in the near-bottom layer sampled by the bottom trawl, and in the layers above the trawl. WG-FSA had agreed, however, that there were many issues that would need to be resolved before quantitative estimates of *C. gunnari* biomass could be derived from acoustic data (listed in Annex 5, Appendix D, paragraph 7.23), and discussion would be necessary at next year's meeting of WG-FSA to determine ways in which abundance estimates from the bottom trawl and acoustic surveys might be combined. Although there are limitations to the bottom trawl method, it is important to continue these surveys as they provide a continuous time series conducted using similar techniques.

5.62 Methods of setting catch limits were reviewed in paragraphs 4.184 to 4.189 of WG-FSA's report (Annex 5). The Scientific Committee endorsed the continued use of the current short-term projection method to provide advice on catch limits for *C. gunnari*, pending the development of alternative methods. It also noted that with the fishery based mainly on two age classes, the currency of assessments is two years. If there is no survey information from the most recent two seasons, the advice on catch limits becomes unreliable.

5.63 Dr Marschoff noted that the short-term projection will always result in a catch limit even if it is applied to a very low estimate of biomass from a survey.

5.64 The Scientific Committee agreed that the types of assessment methods and decision rules that could be used for *C. gunnari* should be evaluated in a simulation framework to test the performance of the procedures before suggesting modifications to the current management system. Proposals for the evaluation of alternative approaches to management, as set out in Annex 5, paragraph 4.189, were endorsed by the Scientific Committee.

C. gunnari at South Georgia (Subarea 48.3)

5.65 The Scientific Committee noted the details of the 2000/01 fishing season for *C. gunnari* in Subarea 48.3 (Annex 5, paragraphs 4.190 and 4.191). The season was split into two periods: the first from 1 December 2000 to 28 February 2001 and the second from 1 June 2001 to 30 November 2001. There was a closed season from 1 March to 31 May to protect spawning concentrations. The catch limit was 6 760 tonnes. The reported catch during the first part of the season was 1 427 tonnes, taken by four trawlers: one from France, one from Chile and two from the UK. There was negligible catch taken during the second part of the season.

5.66 The assessment of *C. gunnari* in Subarea 48.3 undertaken by WG-FSA in 2001 is described in Annex 5, paragraphs 4.190 to 4.242. The short-term projection method first used in 1997 was used to estimate yield in 2001/02. No new survey was undertaken in Subarea 48.3 during the 2000/01 season, however, WG-FSA decided to update the advice on catch limits in 2001/02 based on new information on growth parameters, mortality and survey catchability. The decision criteria agreed previously by the Working Group were used (Annex 5, paragraphs 4.194 to 4.217).

5.67 As last year, WG-FSA had combined the data from two surveys in January–February 2000 to generate a single stock size estimate from which to project yield for the 2001/02 season. At last year's meeting, the surveys had been combined assuming they had the same catchability. At this year's meeting, a GLM approach had been used to estimate relative differences in catchability between the two surveys.

5.68 The Scientific Committee welcomed the advice that two surveys would be undertaken in Subarea 48.3 during the forthcoming season; one by the UK and one by Russia. These surveys will overlap in January 2002, providing a valuable opportunity to compare the results of the two survey vessels fishing in the same small area at the same time. This could provide very useful additional information on relative catchability to reconcile data from different surveys. The Scientific Committee encouraged scientists from Russia and the UK to cooperate on the planning of their respective surveys.

5.69 The Scientific Committee noted discrepancies between age data derived from otolith readings by different readers reported by WG-FSA (Annex 5, paragraphs 4.196 to 4.199). The Scientific Committee endorsed the decision by the Working Group to use the results of age determinations by Russian scientists of otolith material collected during the Russian survey in February 2000. The Scientific Committee also noted the importance of obtaining reliable age determinations for *C. gunnari*. In this regard, the Scientific Committee endorsed the recommendation of WG-FSA that an otolith exchange program should be started among interested scientists as a first step in 2002 (see paragraph 5.24(v)). The exchange program will be prepared by Russian scientists supported by Dr Kock. The program will be based on otoliths collected during cruises in January–February 2002 at South Georgia and will start in late spring 2002. An interim report will be submitted to the 2002 meeting of WG-FSA. No financial support is needed from CCAMLR for the exchange program. However in 2003, a workshop was planned in Kaliningrad, Russia, which will require CCAMLR support (see paragraph 14.1).

5.70 The Scientific Committee endorsed the reassessment of catch limits for the 2001/02 season by WG-FSA. The yield projected for 2001/02, satisfying the previously agreed criteria and using the data inputs agreed this year, was 5 557 tonnes.

5.71 The Scientific Committee recalled that an important aspect of the short-term projection approach is that the yield estimate is conditional on the maintenance of the spawning biomass and on the escapement of a certain percentage of the population. In line with the management of krill, an escapement level of 75% has been used to leave a notional amount for predators. However, as for krill, the predator requirements for this species need to be reviewed as data become available in order to determine the appropriate level of escapement that takes account of ecosystem interactions (Annex 5, paragraphs 4.165 to 4.175).

5.72 The Scientific Committee endorsed WG-FSA's plan with respect to the evaluation of alternative approaches to management of *C. gunnari* (Annex 5, paragraph 4.189). In particular, the Scientific Committee requested that the Working Group continue to investigate appropriate reference points and the development of decision rules that take account of changes in the relative status of the stock.

5.73 WG-FSA had discussed again the use of closed seasons for the *C. gunnari* fishery in Subarea 48.3 for the protection of spawning concentrations (Annex 5, paragraphs 4.232 to 4.242). New information provided strong evidence that spawning is concentrated mainly in the inshore areas and bays of South Georgia. The Scientific Committee agreed that a complete closure of Subarea 48.3 during the spawning season is therefore unnecessary. Substantial protection of spawning concentrations is provided by preventing fishing from taking place in the bays and near-shore areas.

5.74 However, the Scientific Committee further agreed that in order to collect information on the condition of fish offshore during the spawning season, each vessel intending to undertake fishing in Subarea 48.3 between 1 March and 31 May should conduct 20 research hauls in the manner described in Annex 5, paragraphs 4.236 to 4.240.

5.75 WG-FSA had also recommended that the level of catch that can be taken within the spawning season should be limited in some way so as to avoid a concentration of fishing on the shelf at that time of year. Mr Jones suggested that this could be achieved by limiting the catch in the period 1 March to 31 May to 25% of the total catch limit, representing an even spread of the catch limit over the year. This suggestion was accepted by the Scientific Committee.

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

5.76 The Scientific Committee endorsed the advice of WG-FSA regarding the management of the *C. gunnari* fishery in Subarea 48.3 during the 2001/02 season.

5.77 The total catch limit should be revised to 5 557 tonnes for the period from 1 December 2001 to 30 November 2002.

5.78 There should not be a closed season for *C. gunnari* in Subarea 48.3 during the 2001/02 season. Each vessel intending to undertake fishing in Subarea 48.3 between 1 March and 31 May should conduct 20 research hauls in the manner described in Annex 5, paragraphs 4.236 to 4.240.

5.79 The catch that can be taken in the period 1 March to 31 May should be limited to 25% of the total catch limit.

5.80 A closed area within 12 n miles of South Georgia should be established to protect spawning concentrations during the spawning season (1 March to 31 May).

5.81 The remaining provisions in Conservation Measure 194/XIX should be carried forward for the 2001/02 season.

C. gunnari at Kerguelen Islands (Division 58.5.1)

5.82 No commercial fishing for *C. gunnari* took place in Division 58.5.1 during the 2000/01 season and no surveys were reported.

5.83 WG-FSA had not undertaken a new assessment this year, and based its advice on information from a survey in the 1998/99 season that indicated very low biomass in the traditional northeastern fishing ground.

5.84 Prof. Duhamel reported to the Scientific Committee that fine-scale data reported to the Commission for November 2000 and April 2001 showed very low abundance. A new survey will be undertaken during the 2001/02 season.

5.85 The Scientific Committee thanked Prof. Duhamel, and expressed the hope that it will be possible for a French scientist to attend the next meeting of WG-FSA to present the results of the survey.

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

5.86 The Scientific Committee reiterated its advice from last year. Prior to any resumption of commercial fishing, a survey of *C. gunnari* abundance should be conducted and the results analysed by WG-FSA.

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

5.87 The Scientific Committee noted the details of the 2000/01 fishing season for *C. gunnari* in Division 58.5.2 (Annex 5, paragraphs 4.251 and 4.252). The season was open from 1 December 2000 to 30 November 2001 with a catch limit of 1 150 tonnes. The reported catch up to 7 October was 938 tonnes, taken by two trawlers from Australia.

5.88 The assessment by WG-FSA of *C. gunnari* yield in Division 58.5.2 used the same methods as used for this species in Subarea 48.3, and is described in Annex 5, paragraphs 4.253 and 4.254. Biomass was estimated from a survey conducted by Australia in 2001. New growth parameters reported to the Working Group in a background paper were used in the projection.

5.89 With a projected fishing mortality of 0.14 for 2001/02 and 2002/03, the catch limit satisfying the agreed criteria is 1 600 tonnes over two years. This is made up of 885 tonnes in the first year and 715 tonnes in the second year.

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

5.90 The total catch limit should be revised to 885 tonnes for the period from 1 December 2001 to 30 November 2002.

5.91 The remaining provisions in Conservation Measure 195/XIX should be carried forward to the 2001/02 season.

Other Finfish Fisheries

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

5.92 The Scientific Committee noted that WG-FSA considered other finfish fisheries in Subareas 48.1 (Antarctic Peninsula) and 48.2 (South Orkney Islands). There appears to be little scope to reopen the fisheries in the two subareas in the near future given the comparatively low biomass of the abundant fish species.

Management Advice

5.93 The Scientific Committee endorsed the advice of WG-FSA that Conservation Measures 72/XVII and 73/XVII should remain in force.

Fish By-catch

By-catch Levels and Species Identification

5.94 The Scientific Committee noted the discussion by WG-FSA of by-catch in longline and trawl fisheries in the Convention Area (Annex 5, paragraphs 4.277 to 4.286). Data were available from three different sources: STATLANT data, observer reports and fine-scale catch and effort data. However, difficulties were encountered in compiling accurate figures on by-catch due to inconsistent reporting from commercial fisheries and differences in the way in which by-catch data have been recorded by different observers.

5.95 Table 13 of the WG-FSA report (Annex 5) records the total biological records for all species recorded by scientific observers during the 2000/01 season. This provides an indication of the presence/absence of a by-catch species in a given area, however, the observer data could not be used to estimate by-catch quantities, due to insufficient information on sampling fractions.

5.96 Current information on by-catch levels for longline fisheries and trawl fisheries from 1986 to the present, based on fine-scale catch and effort data, is provided in Annex 5, Tables 45 and 46. The Scientific Committee agreed that these should be regarded as minimum estimates of by-catch due to inconsistent reporting from some commercial fisheries. As such, it recommended that masters of vessels give special attention to the reporting of by-catch in their catch and effort data.

5.97 The Scientific Committee endorsed the recommendations of WG-FSA to improve the quality and usefulness of by-catch data submitted to CCAMLR through the Scheme of International Scientific Observation. Specifically, the Scientific Committee recommended that:

(i) observers be asked to indicate the number of longline sets and trawl hauls actually observed for by-catch;

(ii) observers be asked to indicate the proportion of each longline set actually observed for by-catch;

(iii) observer reports should clearly indicate the type of observation being made at a particular time;

(iv) by-catch sampling should be according to the same regime as that applied to target species;

(v) revised species identification sheets be prepared to assist observers in making accurate identification of species; and

(vi) a revision of the *Scientific Observers Manual* and the electronic observer logbook be undertaken intersessionally to improve the information collected on fish and invertebrate by-catch in all fisheries.

5.98 Dr Goubanov reminded the Scientific Committee that some species that are presently regarded as by-catch may eventually become target species. As for target species, the Commission sets by-catch limits based on assessments of yield wherever possible. Consequently, the collection of data to facilitate assessments is a priority for both by-catch and target species. These data would also facilitate the transition of a species from by-catch to target status if considered appropriate.

5.99 In response to requests from observers, identification sheets of common by-catch species in the longline fisheries have been developed. WG-FSA recommended some revisions to these sheets and revised versions will be prepared and copies sent to technical coordinators. The Scientific Committee agreed that sufficient funds should be included in the budget for the sheets to be laminated in waterproof material. Copies of the species identification sheets should be included in the *Scientific Observers Manual.*

5.100 The Scientific Committee endorsed the advice of WG-FSA regarding revised species identification sheets and the standard measure of length for macrourids (Annex 5, paragraphs 4.299 to 4.301).

By-catch Limits for *Macrourus* spp. and Skates and Rays

5.101 The Commission has identified measures to ensure the long-term status of by-catch species as an issue for urgent attention by the Scientific Committee (CCAMLR-XIX, paragraph 9.39).

5.102 In reviewing existing measures to limit by-catch in the Convention Area, the Scientific Committee noted that for certain by-catch species, there are catch limits based on stock assessments. These include finfish by-catch in the trawl fishery for *C. gunnari* in Subarea 48.3 (Conservation Measure 95/XIV), crab by-catch in the pot fishery for toothfish in Subarea 48.3 which counts towards the catch limit (Conservation Measure 215/XIX), and two species caught as by-catch in trawl fisheries in Division 58.5.2 (Conservation Measure 198/XIX). For by-catch species without a formal assessment, there are interim precautionary measures in place. These are the limitation on by-catch in Division 58.5.2 (Conservation Measure 198/XIX) and the limitations on by-catch incorporated into the general measures for exploratory fisheries for *Dissostichus* spp. (Conservation Measure 200/XIX). The Scientific Committee noted that these precautionary measures included examples of overall catch limits as well as 'move-on' rules to reduce the likelihood of localised depletion, as proposed in the mixed strategy recommended by the Scientific Committee as a general policy in 1998 (SC-CAMLR-XVI, paragraph 4.139).

5.103 In considering fisheries for which there are no precautionary limits at present, the Scientific Committee noted that there are no specific limits for the finfish by-catch in the longline fishery for *Dissostichus* spp. in Subarea 48.3, which comprises *Macrourus* spp. and skates and rays (Annex 5, Table 45). Whilst there is a move-on rule addressing the concern of localised depletion of *Macrourus* spp. in exploratory fisheries for *Dissostichus* spp. (Conservation Measure 200/XIX), this measure does not include an upper limit on the catch of this species.

5.104 The Scientific Committee further noted the request from the Commission for advice on the by-catch of skates and rays in longline fisheries to provide the foundation for conservation measures on this species (CCAMLR-XIX, paragraph 9.33).

5.105 WG-FSA attempted an assessment of the precautionary yield of skate and ray species in Subarea 48.3 based on information from several sources, including observer data from South Georgia and recent research from the Falkland/Malvinas Islands (Annex 5, paragraphs 4.302 to 4.307). A figure for the precautionary pre-exploitation harvest level (γ) as a proportion of a survey estimate of biomass (B_0) was estimated on the basis of a target median escapement of the spawning stock at the end of 20 years of exploitation of 75%, and the probability of depletion below 20% of the pre-exploitation spawning stock biomass being no greater than 0.1 over a 20-year period. The resulting estimate of γ for skates and rays in Subarea 48.3 is 0.026, which under a B_0 CV of 1.003 results in a median escapement of 0.749 and a probability of depletion of 0.094.

5.106 There are currently no estimates of biomass (B_0) for skates and rays at South Georgia and WG-FSA had insufficient time to adapt information from other areas to use as a proxy. It is therefore not possible to calculate a value of precautionary yield at present. It was also not possible to undertake an assessment of *Macrourus* spp. in Subarea 48.3 due to insufficient information.

5.107 The Scientific Committee noted these attempts by WG-FSA to provide the information requested by the Commission and endorsed the list of key topics for further investigation provided in the WG-FSA report (Annex 5, paragraphs 4.311 and 4.315). Assessments of catch limits for these species should be given a high priority for the next meeting of WG-FSA.

5.108 The Scientific Committee agreed that interim precautionary measures should be adopted for the forthcoming year to place upper limits on the by-catch of *Macrourus* spp. and skates and rays and reduce the potential for local depletion of these species groups.

5.109 In this regard, the Scientific Committee endorsed the advice of WG-FSA that any such measures will of necessity be somewhat arbitrary but should take account of the following criteria:

(i) the fishery should not adversely impact the by-catch species;

(ii) measures should not constrain fishing on the target species without due cause; and

(iii) data and samples from the by-catch should be used in support of future assessments.

5.110 To address the possibility of local depletion, the Scientific Committee endorsed the recommendation of WG-FSA for *Macrourus* spp. and skates and rays caught as by-catch in any fishery in the Convention Area:

> If any vessel catches more than 1 tonne of a by-catch species in a longline set or haul, it must move its fishing position (defined as the midpoint of the set or haul) by at least 5 n miles. It may not return to the position of the high by-catch to fish within five days.

5.111 For the purposes of this measure, '*Macrourus* spp.' and 'skates and rays', should each be counted as a single species.

By-catch Limits in Assessed Fisheries

5.112 Regarding an overall by-catch limit, the Scientific Committee agreed that for each assessed fishery, an interim precautionary by-catch limit for each species group could be set at a percentage of the total allowable catch of the target species. WG-FSA had suggested that the information in Tables 45 and 46 of its report could be used to set these percentages for longline fisheries (Annex 5, paragraph 4.332). However, the Scientific Committee noted that there was some concern over the accuracy of these figures due to inconsistent reporting of by-catch from the commercial fishery. The Scientific Committee agreed that in the absence

of a clear scientific basis on which to set a percentage level, a figure of 5% would be a reasonable interim measure for longline fisheries for the forthcoming year. In addition, to avoid undue constraints on fisheries with small catch limits of target species, the by-catch limit should have a minimum level of 50 tonnes.

By-catch of *Macrourus* spp. in Exploratory Fisheries

5.113 Regarding the overall catch limits for *Macrourus* spp. in exploratory fisheries, the Scientific Committee recognised that imposition of the interim measure proposed for longline fisheries in Subarea 48.3 might unduly constrain exploration in these fisheries. Due to their exploratory nature there is a greater risk of a vessel inadvertently taking a large by-catch in a few hauls that would lead to the closure of the fishery in the area where the by-catch was taken.

5.114 In considering an alternative approach, the Scientific Committee noted the existing limits on all species other than *Macrourus* spp. set out in Conservation Measure 200/XIX. In SSRUs in Subarea 48.6, Division 58.4.2 and Subarea 88.1 south of 65°S, and on BANZARE Bank, the by-catch of any species other than *Macrourus* spp. is limited to 50 tonnes. In all other SSRUs, the per species by-catch limit for species other than *Macrourus* spp. is 20 tonnes.

5.115 Recognising the likely higher productivity of *Macrourus* spp. compared to some other by-catch species, such as skates and rays, the Scientific Committee recommended that precautionary limits be adopted for this species group at levels double those existing for other species. The proposed levels are therefore 100 tonnes in SSRUs in Subarea 48.6, Division 58.4.2 and Subarea 88.1 south of 65°S, and on BANZARE Bank, and 40 tonnes in all other SSRUs.

5.116 The Scientific Committee reiterated that the precautionary by-catch limits proposed for this year are interim measures designed to encourage avoidance of excessive by-catch, and stressed the importance of undertaking assessments to develop scientifically based measures for by-catch species as a matter of urgency.

5.117 Dr Kock noted that differences in levels of by-catch of skates and rays on longlines occur, depending on the rigging of the longline. Lines with the hooks set on the bottom tend to catch more skates and rays than those with hooks set several metres above the bottom. Effects of gear configuration on species composition should be investigated further to determine optimal approaches to minimising by-catch.

Advice to the Commission

5.118 The Scientific Committee made several recommendations regarding methods to improve the quality and usefulness of by-catch data submitted to CCAMLR as set out in paragraph 5.97.

5.119 New species identification sheets have been developed to assist scientific observers. The Scientific Committee agreed that sufficient funds should be included in the budget for the sheets to be laminated in waterproof material.

5.120 The Scientific Committee recommended that interim precautionary measures should be adopted for the forthcoming year to place upper limits on the by-catch of *Macrourus* spp. and skates and rays and reduce the potential for local depletion of these species groups.

5.121 With respect to *Macrourus* spp. and skates and rays, the Scientific Committee recommended that if any vessel catches more than 1 tonne of a by-catch species in a longline set or haul, it should be required to move its fishing position (defined as the midpoint of the set or haul) by at least 5 n miles. It should not return to the position of the high by-catch to fish within five days. For the purposes of this recommendation, 'by-catch' refers to *Macrourus* spp. and skates and rays. '*Macrourus* spp.' and 'skates and rays' should each be counted as a single species.

5.122 For the longline fishery in Subarea 48.3, an interim precautionary by-catch limit for *Macrourus* spp. and skates and rays should be set at 5% for each by-catch species group of the catch limit of the target species, or 50 tonnes, whichever is the greater.

5.123 The upper limit on by-catch of *Macrourus* spp. in exploratory fisheries is recommended to be 100 tonnes in SSRUs (as defined in Table 1 and Figure 1 of Annex 200/B to Conservation Measure 200/XIX) in Subarea 48.6, Division 58.4.2 and Subarea 88.1 south of 65°S, and on BANZARE Bank, and 40 tonnes in all other SSRUs.

5.124 Existing by-catch measures for species other than *Macrourus* spp. and skates and rays should remain in force.

Crab Resources

5.125 The Scientific Committee noted that while Conservation Measures 214/XIX and 215/XIX were in force during 2000/01, no direct fishing was conducted on crab species, although 14 tonnes were caught as by-catch in the pot fishery for *D. eleginoides*.

5.126 Japan and the USA had notified their intention to conduct a fishery for crabs in the coming season (paragraph 2.17). The Scientific Committee acknowledged that the Japanese vessel involved should conduct an experimental harvest regime in accordance with Conservation Measure 214/XIX.

5.127 The Scientific Committee noted WG-FSA's deliberations contained in Annex 5, paragraphs 3.128 to 3.131 dealing with crabs caught as by-catch in the *D. eleginoides* pot fishery, covering their distribution, sizes and survivorship, and endorsed the assessment and management advice provided in Annex 5, paragraphs 4.264 to 4.274.

5.128 The Scientific Committee recalled the large discard of undersized crabs in the pot fishery (SC-CAMLR-XIX, paragraph 5.111). Only crabs retained on board count towards the catch limit. Regarding the survival of discarded crabs, the Scientific Committee noted new information reported by WG-FSA this year. Most crabs were lively on arrival on deck after pot hauling (99% *P. spinosissima*, 97% *P. formosa* and >90% of *P. anamerae*). Mortality

rates estimated from reimmersion experiments indicated that on the vessel which emptied pots directly onto the factory conveyor belt, 85–90% of crabs would survive discarding, whereas survival was reduced on the vessel where crabs were emptied down a vertical chute prior to sorting (39–58% survivorship).

Management Advice

5.129 The Scientific Committee reiterated its advice (SC-CAMLR-XIX, paragraph 5.113) that since crab stocks have not been fully assessed, the conservative management scheme contained in Conservation Measures 214/XIX and 215/XIX is still appropriate. It recommended that the minimum legal size be revised to 94 mm (Annex 5, Table 44).

5.130 The Scientific Committee also recommended that all vessels participating in the crab fishery, which had not done so, should conduct Phase 1 of the experimental harvest regime specified in Conservation Measure 214/XIX, and that a CCAMLR international observer should be carried on board every vessel participating in the fishery. To date, only a US vessel has fulfilled these requirements (SC-CAMLR-XIX, paragraph 5.114).

5.131 The Scientific Committee agreed that crabs caught as by-catch in other fisheries should be counted against the catch limit set for the directed fishery.

Squid Resources

5.132 A limited fishery that took place in the 2000/01 season (catching 2 tonnes) was considered by WG-FSA (Annex 5, paragraph 3.132). The fishery for *M. hyadesi* in Subarea 48.3 remains at an exploratory stage and there is little indication of significant commercial interest in the fishery.

Management Advice

5.133 Conservation Measure 213/XIX is currently in force to regulate this fishery. There was no notification of intention to conduct a fishery for the coming season. The Scientific Committee agreed that all conservation measures are to be retained.