

HARVESTED SPECIES

Krill

Methods for Krill Assessment

4.1 The Scientific Committee noted the discussions of WG-EMM on various methods for the assessment of krill biomass (B_0) and demography (Annex 4, paragraphs 4.2 to 4.14).

4.2 These discussions focussed on estimating krill distribution and standing stock, krill recruitment and production, survey design, the quantification of errors from such surveys, multifrequency acoustic techniques and a variety of problems associated with echosounder systems.

4.3 The Scientific Committee endorsed WG-EMM's recommendation that submissions on survey designs to be implemented in Area 48 should be prepared during the intersessional period and discussed at the next meeting of WG-EMM (Annex 4, paragraph 4.8).

4.4 The Scientific Committee noted that Russia (in Subareas 48.1 and 48.2) (CCAMLR-XIV/MA/4), India (Division 58.4.2), Japan (Division 58.4.1), Argentina (Subareas 48.2 and 48.3) and the USA (Subarea 48.1) all planned krill surveys during the forthcoming season covering parts of the indicated subareas. Most notably, Australia planned to carry out a survey in Division 58.4.1 to estimate B_0 (see paragraph 4.18 below).

4.5 Dr Shust welcomed a discussion on survey design which might be incorporated into the Russian research plan. Therefore, a subgroup met to review past WG-EMM and Working Group on Krill (WG-Krill) advice on this subject (SC-CAMLR-X, Annex 5, Appendix D and WG-EMM-95/71). Dr Shust indicated he would prepare a research plan intersessionally and forward it to the Secretariat for circulation to Members.

4.6 Dr S. Abidi (India) stated that India proposes to send a scientific research expedition to Area 58 by the end of 1995 to assess krill and other fishery resources in relation to oceanographic parameters. India is committed to the development and conservation of Antarctic marine living resources. As requested by Conservation Measure 64/XII, India will soon provide details of the planned research to the CCAMLR Secretariat, for circulation to Members for comment.

4.7 The Scientific Committee urged all the nations concerned, especially Russia and India, to make the details of their proposed surveys available as soon as possible as the experience and

advice from other Members could be used to enhance the effectiveness of the survey designs, which would in turn assist in the work of WG-EMM.

4.8 The Scientific Committee noted that systematic and random errors may arise from acoustic surveys of krill, particularly with regard to system calibration, the estimation of acoustic target strength, diurnal migration and the effective identification of acoustic targets. It also noted that these components of uncertainty in the estimation of krill biomass may vary from survey to survey. Such uncertainty may be as large as (or larger than) sampling error (see Annex 4, paragraph 4.12). The Scientific Committee urged Members with information on the above topics to submit papers and data to the next meeting of WG-EMM.

4.9 The Scientific Committee endorsed WG-EMM's conclusion regarding the importance of developing multifrequency acoustic techniques for the survey of krill abundance/distribution. It supported WG-EMM's recommendation that future acoustic surveys of krill abundance and distribution should be undertaken using at least two frequencies in order to facilitate the discrimination of acoustic targets (Annex 4, paragraph 4.13).

Krill Distribution and Abundance (Annex 4, paragraphs 4.15 to 4.49)

4.10 In accordance with WG-EMM's views, the Scientific Committee encouraged further research on the effects of krill flux (i.e., movement) and aggregation, as well on other issues associated with krill spatial distribution (Annex 4, paragraphs 4.15 to 4.25).

4.11 The Scientific Committee noted that recent studies have confirmed a local decline of krill abundance in both Subareas 48.3 (South Georgia) and 48.2 (South Orkneys) during 1994. The possibility of a general decline in krill abundance in Area 48 between the periods 1977-83 and 1985-94 was also discussed by WG-EMM, and the Scientific Committee noted the importance of this in terms of possible variations in krill recruitment.

4.12 WG-EMM indicated that there may have been changes in the pattern of krill recruitment in Area 48 in recent years. The Scientific Committee endorsed WG-EMM's recommendation that the examination of information relevant to this subject should be assigned a high priority and that a steering committee (to be convened by Dr Agnew) should complete the required analyses by correspondence during the forthcoming intersessional period. The planned approach set out in Appendix D of WG-EMM's report was accepted by the Scientific Committee as offering the most useful course to be followed.

4.13 Given uncertainties regarding krill recruitment in recent years, the Scientific Committee agreed that the provision of further advice concerning a precautionary catch limit for krill in Area 48 should be deferred until further information on variability in krill recruitment, including the analysis described in paragraph 4.12, becomes available.

4.14 With respect to the estimation of B_0 , the Scientific Committee noted WG-EMM's discussions on the low priority to be given to the recalculations of the coefficient of variation (CV) in the FIBEX survey to estimate B_0 (as used in the current krill yield model) since this would little affect the Scientific Committee's advice on the precautionary krill catch limit (Annex 4, paragraphs 4.51 to 4.56).

4.15 The Scientific Committee concurred with WG-EMM's conclusion that it was not necessary at this time to re-analyse the FIBEX data in order to improve the current estimate of B_0 for krill in Area 48 (35.4 million tonnes) and in Division 58.4.2 (3.9 million tonnes).

4.16 The Scientific Committee endorsed WG-EMM's conclusion, however, that a new survey of krill in Area 48 is desirable (Annex 4, paragraph 4.61) since:

- there are technological and methodological problems associated with the collection and analysis of the FIBEX data;
- the survey coverage of Subarea 48.3 during FIBEX was inadequate;
- there may have been biotic and abiotic changes in the marine environment of the South Atlantic since the FIBEX survey in 1981;
- both acoustic survey technology and the survey design methodology have improved since FIBEX; and
- any new survey could be designed in such a way as to take specific account of the krill yield model currently employed by CCAMLR in the estimation of krill yield and in the subsequent derivation of precautionary catch limits.

4.17 The Scientific Committee therefore supported WG-EMM's conclusion that a new survey of krill biomass in Area 48 should be carried out and that Members should be encouraged to develop plans for such a survey (Annex 4, paragraph 4.67). The Scientific Committee recommended that

papers on potential survey designs to be implemented in Area 48 should be submitted to the next meeting of WG-EMM.

4.18 With respect to Division 58.4.1, the Scientific Committee again noted Australia's intention to undertake an acoustic survey in this division during the forthcoming austral summer (1995/96) and supported implementation of the survey (Annex 4, paragraph 4.9).

Harvesting Mortality

4.19 The Scientific Committee noted that in accordance with concerns expressed over the past couple of years (SC-CAMLR-XII, paragraph 2.25) there is still uncertainty as regards the potential mortality of krill passing through meshes of trawl nets (Annex 4, paragraph 3.18). While the matter remains a concern of both the Scientific Committee and Commission, the Scientific Committee noted that initial modelling efforts by Russian scientists cannot be continued.

4.20 The Scientific Committee therefore urged Members to submit information on the mortality caused by fishing operations which is additional to reported catches.

Krill Fisheries in Other Areas

4.21 The Scientific Committee noted that WG-EMM-95/48 had been tabled in response to a request by WG-Krill for information on krill fisheries outside the Convention Area.

4.22 The Scientific Committee welcomed this paper and recognised that important information on the Japanese *Euphausia pacifica* fishery contained therein is of particular interest to CCAMLR since it describes various management approaches and the ancillary use of environmental information in their formulation.

Future Euphausiid Symposium

4.23 The Scientific Committee noted WG-EMM's views on the desirability of conducting an international symposium on Euphausiid biology and ecology in the near future (Annex 4, paragraphs 9.1 to 9.5).

4.24 Although preparations for this symposium are at an early stage, the Scientific Committee agreed that CCAMLR has a strong interest in its proceedings. Therefore, it encouraged Dr Miller and Dr J. Watkins (UK) to continue with plans for the symposium's implementation and suggested that CCAMLR should support these by making a financial contribution in the next year or two. The Scientific Committee therefore proposed that a sum of around A\$11 500 should be included within the Scientific Committee's budget for 1996 and 1997 for this purpose as detailed in Annex 6.

Data Requirements

4.25 The Scientific Committee noted that there are a number of continuing requirements for data on krill and the krill fishery. In brief these include:

- examination of the precision of estimates of krill length/weight relationships;
- demographic data (especially as parameters for the krill yield model);
- krill flux data;
- length frequency data from the fishery;
- haul-by-haul data from the fishery;
- submission of fine-scale data from the fishery (e.g., as per the Japanese 10 x 10 n mile data reporting);
- estimates of biomass within the Integrated Study Regions (ISRs);
- monthly reporting of krill catches;
- data on the quantity and viability of krill passing through trawl meshes;
- historical fine-scale data from the fishery (especially from the ex-Soviet fishery);
- information on proposed acoustic surveys of krill biomass in Area 48 (including possible survey designs and minimum data requirements);
- examination and assessment of variability in krill recruitment; and
- data on the by-catch of fish in krill trawls.

Advice to the Commission

4.26 The Scientific Committee drew the Commission's attention to the need for a survey of krill biomass in Area 48 (paragraphs 4.15 and 4.16 above) and encouraged the development of plans for such a survey.

4.27 The Scientific Committee re-affirmed both WG-Krill's (in 1994) and WG-EMM's advice that the current best estimate of B_0 for krill is 35.4 million tonnes in Area 48 and 3.9 million tonnes in Division 58.4.2.

4.28 The Commission's attention is drawn to the extensive discussions conducted by the Scientific Committee at its 1994 meeting on the calculation of the precautionary limit for Area 48 (SC-CAMLR-XIII, paragraphs 5.31 to 5.45). Based on acceptance of the value of $\gamma = 0.116$ (in the equation $\text{Yield} = \gamma B_0$), a precautionary limit of 4.1 million tonnes is obtained for Area 48 (i.e., an estimate of 35.4 million tonnes for B_0). An alternative view is that there is no need to revise the precautionary limit of 1.5 million tonnes set out in Conservation Measure 32/X until various refinements in the krill yield calculation (as in paragraphs 4.12 and 4.13) have been completed (Annex 4, paragraph 7.102).

4.29 For Division 58.4.2, no further data are available to refine the value of γ . The Scientific Committee therefore advises that the current best estimate of a precautionary krill catch limit in this division is 450 000 tonnes (B_0 of 3.9 million tonnes combined with γ of 0.116) as opposed to the 390 000 tonnes contained in Conservation Measure 45/XI.

4.30 The Scientific Committee agreed that further advice concerning the revision of the precautionary krill catch limit for Area 48 should be deferred until more information on variability in krill recruitment becomes available (paragraphs 4.12 and 4.13).

4.31 Concerning the subdivision of precautionary catch limits within Area 48, the Scientific Committee concurred with WG-EMM's conclusion that no further advice can be given until the analyses described in Annex 4, paragraphs 4.46 to 4.48 and 7.80, have been completed and evaluated by WG-EMM at its next meeting.

Fish Resources

Data Requirements Endorsed by the Commission in 1994

4.32 At its last meeting WG-FSA identified specific data that were required for its future work (SC-CAMLR-XIII, Annex 6, Appendix D). Some of the requested information on *D. eleginoides* has been acquired through scientific observers, the completion of new data reporting forms, and catch data from *D. eleginoides* fisheries in areas adjacent to the CCAMLR Convention Area (see Annex 5, Appendix D). Little of the information requested from other fisheries, however, has been forthcoming, and the Scientific Committee endorsed the new approach of specific requests for data in section 11 of the WG-FSA report (Annex 5).

Fisheries and Observer Information

4.33 The Scientific Committee endorsed the Working Group's comments in Annex 5, paragraphs 3.3 to 3.14, and requested WG-FSA and the Secretariat to take the necessary steps to improve the quality of catch, effort and length-at-age and other biological data (Annex 5, section 12).

Research Surveys

4.34 The results of several research surveys and exploratory fisheries were reported. These were an Argentinian survey in Subarea 48.3 (paragraph 4.63), French exploratory trawling in Subarea 58.6 (Crozet Archipelago), a French survey of myctophids in Division 58.5.1 (Kerguelen Islands), an Italian survey of ichthyoplankton in the Ross Sea (Subarea 88.1) and Australian exploratory fishing for *D. eleginoides* around Macquarie Island, just outside the Convention Area. Results of these activities are detailed in Annex 5, paragraphs 3.15 to 3.21.

Fish Biology/Demography/Ecology

4.35 A number of observations on fish biology, demography and ecology were detailed in Annex 5, paragraphs 3.26 to 3.38. Of particular concern was the need for a better standardisation of the technique for determining gonad maturity stages of *D. eleginoides*, and the need to improve methods for ageing *D. eleginoides* before the extensive collections of otoliths and scales can be analysed.

Developments in Assessment Methods

4.36 The Scientific Committee endorsed the advice of WG-FSA (Annex 5, paragraphs 3.39 to 3.47). In particular, it noted with approval the development of the generalised yield model which extends the analysis method developed for krill to deal with uncertainty in the assessment of other resources such as finfish. This new model was used to great effect in assessments.

Report of the Workshop on Methods for the Assessment of *Dissostichus eleginoides* (WS-MAD)

4.37 The Workshop on Methods for the Assessment of *Dissostichus eleginoides* (WS-MAD) was held at CCAMLR Headquarters, Hobart, Australia from 5 to 9 October 1995. The main aim of the Workshop was to develop methods for assessing the biomass and status of *D. eleginoides* stocks. The full terms of reference of the Workshop are given in SC-CAMLR-XIII, paragraph 2.17.

4.38 The Workshop first reviewed the approaches taken in previous CCAMLR assessments of *D. eleginoides*, taking account of similar assessments of longline fisheries for *D. eleginoides* in Chile and the relationship between trawl and longline catches in the experimental longline fishery for hake off South Africa. Key problem areas in CCAMLR assessments were identified and potential solutions were discussed. A brief summary of key sections of the Workshop report is given in Annex 5, paragraphs 4.5 to 4.19, and the full proceedings are in Annex 5, Appendix E.

4.39 The Scientific Committee endorsed the Workshop recommendations relating to the accuracy of estimates of total catches, the need for the development of new assessment methods, and the need for a research program directed to cover the full bathymetric range of all size classes of fish in the stocks being investigated. It emphasised that given the perceived inadequacies in the reporting of total removals (Annex 5, paragraph 4.15), it is not sufficient to rely solely on fishery-dependent data to estimate stock yields (Annex 5, paragraph 4.21).

Assessments and Management Advice

Statistical Area 48 (South Atlantic)

Dissostichus eleginoides (Subarea 48.3)

4.40 The Scientific Committee noted that the Working Group had to address the problem of substantial unreported catches of *D. eleginoides* in Subarea 48.3. Information from a number of sources was used by the Working Group to estimate the total removals of fish from Subarea 48.3 and adjacent banks. The best estimates of these catches are given in Table 3 (Annex 5, paragraphs 5.10 to 5.12). The Commission's attention is drawn to the problems of estimating total removals from this fishery and the difficulties that imprecise catch data pose in assessments.

Table 3: Estimated catches of *D. eleginoides* in Subarea 48.3 and adjacent Rhine and North Banks and TACs agreed by the Commission for Subarea 48.3.

| Split-year | TAC (tonnes) | CCAMLR Catch (tonnes) | Estimate of Additional Catch | Best Estimate of Real Catches ¹ |
|------------|--------------|-----------------------|------------------------------|--|
| 1990 | - | 8156.0 | 345 | 8501.0 |
| 1991 | 2500 | 3639.0 | 565 | 4206.0 |
| 1992 | 3500 | 3841.6 | 3470 | 6309.6 |
| 1993 | 3350 | 3088.5 ⁴ | 2500 | 5588.5 |
| 1994 | 1300 | 459.5 ³ | 6145 | 6604.5 |
| 1995 | 2800 | 3301.1 ² | 2870 | 6171.1 |

¹ Includes the adjacent banks.

² Includes 180 tonnes taken by Bulgaria in August 1994, and 59 tonnes taken outside Subarea 48.3 on Rhine and North Banks and reported to CCAMLR. The total catch reported from Subarea 48.3 for the 1994/95 season (1 March to 16 May) was therefore 3 062 tonnes.

³ 180 tonnes of this TAC was taken after 1 July and appears below, under 1995.

⁴ Fishery closed early due to non-reporting of zero catches. Closure date was projected from previous non-zero catch rates. In all other cases, the difference between TAC and actual catch is due to differences between 5-day reports and final reports from the fishery.

4.41 The Scientific Committee welcomed the Working Group's considerable progress in developing new assessment techniques which take account of uncertainty in available data. Details of these analyses are in Annex 5, paragraphs 5.22 to 5.49. The Scientific Committee recognised that further testing of the new methods was required, and encouraged this work.

4.42 The Scientific Committee considered that the assessment of *D. eleginoides* in Subarea 48.3 using the generalised yield model is far superior to any that has been conducted previously for this species. In particular, it noted that:

- (i) previous assessments have used abundance estimates based on analysis of short to medium term trends in CPUE. At best, this technique produces indirect estimates of density, and in practice the failure to observe consistent depletion (Annex 5, paragraphs 5.17 and 5.18) has often meant that no such estimates can be calculated;
- (ii) a current WG-FSA assessment, however, uses direct estimates of absolute recruitment obtained from fishery-independent scientific surveys. This is not only likely to be much more reliable than those based on CPUE analyses, but it has also been possible to quantify both estimation uncertainty and interannual variability in recruitment; and
- (iii) the generalised yield model has allowed specific account to be taken of various sources of uncertainty and variability and has the flexibility to be modified to allow for new data which may alter some of the important assumptions made in the current assessment (Annex 5, paragraph 5.74).

4.43 The Working Group compared the results of projections of population size over a 35-year period using the yield model to the decision rule for γ_1 adopted for krill and for *D. eleginoides* in Division 58.5.2 (Heard Island) at last year's meeting of the Scientific Committee. This decision rule requires that the probability during the projection period of the spawning stock biomass falling below 20% of its initial level should not exceed 10% (SC-CAMLR-XIII, paragraphs 5.18 to 5.26 and 2.70). Twenty per cent of the initial level of the spawning stock biomass has become a standard biological reference point used in fisheries management, based on Beddington and Cooke (1983)², in which the probability of stock depletion influencing recruitment was found to increase once the spawning stock declines below 20% of its equilibrium level.

4.44 The Scientific Committee noted that the Working Group had tested this model against other stock assessment models used in the past. However when the $F_{0.1}$ strategy previously applied in assessments of stocks in the Convention Area was used, there is a 60 to 80% chance of the spawning stock biomass falling below 20% of its initial level over the 35-year period. This violates the γ_1 decision rule by a considerable margin. In addition, at the end of the projection period, the spawning stock biomass would be reduced to only 20 to 30% of the pre-exploitation level.

4.45 The Scientific Committee also noted that the generalised yield model had revealed that an $F_{0.1}$ harvesting strategy was not appropriate for this fishery due to the uncertainty and variability in recruitment. Harvesting at $F_{0.1}$ over the period of the projection would, in fact, result in considerable depletion of the spawning stock.

² Beddington, J.R. and J.G. Cooke. 1983. The potential yield of fish stocks. *FAO Fisheries Technical Paper*, 242: 47 pp.

4.46 Projections carried out to identify the catch level at which γ_1 was satisfied, taking into account uncertainty surrounding the estimate of mean recruitment, interannual variability in recruitment and the fixed estimate of natural mortality, indicate that an annual yield of 4 000 tonnes would satisfy the γ_1 criterion. At this level of catch the median spawning stock at the end of the projection period is likely to be approximately 74% of the pre-exploitation level.

4.47 The Scientific Committee noted that the Working Group considered that the γ_1 decision rule, as it had been applied at this year's meeting, was a reasonable basis for setting guidelines for the limits on total removals of *D. eleginoides* in Subarea 48.3 during the 1995/96 season. The Scientific Committee also noted that the application of the γ_1 decision rule would be kept under review by the Working Group.

4.48 It was also noted that the appropriateness of the probability level (10%) used in the γ_1 decision rule was not purely a scientific question and that the Commission may wish to consider this matter further. Before this could be done, however, the Scientific Committee recognised that the Commission would require more information and advice from the Scientific Committee. The Scientific Committee noted that the Working Group would give this detailed consideration at its next meeting. This may involve presentation of a wider range of options corresponding to different levels of risk.

4.49 Lic. E. Marschoff (Argentina) considered that, bearing in mind the different biological parameters of *D. eleginoides* and krill (where $P = 10\%$ was also used), the probability level should be selected from the lower end of the range in Table 14 of the Working Group report (Annex 5).

4.50 Other Members stated that at this year's meeting the Working Group had not considered probability levels other than the 10% adopted by the Scientific Committee for krill and *D. eleginoides* in Division 58.5.2 (Heard Island) at last year's meeting (SC-CAMLR-XIII, paragraphs 2.70, and 5.18 to 5.26) and that the results shown in Table 14 of the Working Group report (Annex 5) did not constitute a range of options.

4.51 The Scientific Committee recognised the importance of further work aimed at reducing uncertainties about the assumptions made in this assessment or in the estimates used as inputs to the generalised yield model. It endorsed the recommendations of WG-FSA on the subjects requiring attention (Annex 5, paragraphs 5.75 and 5.76).

Management Advice

4.52 The results of the projections over a period of 35 years using the generalised yield model indicated that to have a probability of no greater than 10% that the spawning stock biomass will fall to below 20% of its unexploited level, the annual catch should not exceed 4 000 tonnes. At this level of catch the ratio of median spawning stock biomass at the end of the projection period to the pre-exploitation level was about 74%. These criteria have been used in the past as a basis for setting catch limits, and 20% of unexploited spawning stock biomass has become a standard biological reference point used in fisheries management (paragraph 4.43). The Scientific Committee noted, however, that this assumed that the actual removals of fish would be no greater than the catch limit (i.e., no unreported catch). Total annual removals exceeding 4 000 tonnes would increase the probability of stock depletion.

4.53 The Scientific Committee stressed, however, that this assessment may change in future as more data become available and the analysis can be refined.

4.54 Lic. Marschoff, referring to paragraphs 4.49 and 4.50, stated that the appropriate catch level is 3 000 tonnes, the level associated with a probability of 7% that the spawning stock biomass will fall below 20% of its unexploited level over a period of 35 years (Annex 5, Table 14).

4.55 The Scientific Committee noted that the assessment of yield was based on the expectation that future catches will be taken only by longline vessels. Use of other types of fishing gear would change the age structure of the catch. The Scientific Committee made no assessment of the effects of such catches at this meeting. It therefore recommended that the directed fishery for *D. eleginoides* in Subarea 48.3 during the 1995/96 season should be restricted to longliners.

4.56 The Scientific Committee recalled that in previous years it had been agreed that fishing effort should be distributed in such a way as to ensure that catch and effort data are able to contribute to assessments of the stock (SC-CAMLR-XIII, paragraph 2.20). It also recalled that in 1994 some Members had suggested that it would be beneficial to distribute effort throughout the subarea and over a period longer than a single reporting period, but consistent with periods fished in previous seasons (SC-CAMLR-XIII, paragraph 2.21). In particular, effort should not be concentrated in too short a time period in one area.

4.57 The Scientific Committee noted that Conservation Measure 80/XIII restricted the 1994/95 fishing season to the period 1 March to 31 August in order to assist other measures adopted by the Commission to reduce incidental mortality of seabirds in the longline fishery. However it also noted:

- the argument advanced in Annex 5, paragraphs 8.70 and 8.71, based on avoiding the period of maximum potential incidental mortality of wandering albatrosses breeding at South Georgia, for delaying the start of fishing until 1 May; and
- the concerns that such a delay might result in the fishery operating during the spawning season of *D. eleginoides* (July to August) (Annex 5, paragraph 8.71).

4.58 On the understanding that there would be full compliance with Conservation Measure 29/XIII (thereby protecting albatrosses), the Scientific Committee recommended the retention of the fishing season of 1 March to 31 August for 1995/96. It requested Members, however, to collect and/or provide data for assessing the consequences of delaying the start of a fishing season for *D. eleginoides* until 1 May.

4.59 The Scientific Committee noted with concern the apparent high level of unreported catches of *D. eleginoides* in Subarea 48.3. At this year's meeting of WG-FSA an attempt was made to estimate total removals and to take these into account in the assessment. However the Scientific Committee noted that future illegal catches would continue to hinder severely attempts to make reliable stock assessments and requested that the problem be addressed by the Commission as a high priority.

4.60 The Scientific Committee also noted that since catches of *D. eleginoides* are taken both inside and outside the Convention Area in waters adjacent to Subarea 48.3, this species constituted a straddling stock. This further complicated the assessments of total removals from the stock. Issues relating to conservation and management of straddling stocks are also discussed in paragraph 9.9 and Annex 5, paragraphs 10.10 to 10.14.

4.61 The need for regular re-assessment of the stock using the generalised yield and CPUE models highlights the importance of collecting catch and effort information on as fine a scale as possible. The Scientific Committee recommended the continuation of the current procedures for reporting haul-by-haul and biological information from the fishery, and strongly encouraged the reporting of historical haul-by-haul data from the longline fishery prior to 1992. It also recognised the importance for the assessment work of the biological data and information collected by scientific observers. The Scientific Committee recommended that the 100% observer coverage applied to this fishery over the past two seasons be continued.

Champscephalus gunnari (Subarea 48.3)

Commercial Catch

4.62 The fishery for *C. gunnari* was closed for the 1994/95 fishing season in accordance with Conservation Measure 86/XIII. There has now been no substantial reported commercial catch of *C. gunnari* in Subarea 48.3 since March 1990.

4.63 A research survey conducted by Argentina on this species provided some qualitative evidence that the stock has increased compared to 1994, but did not provide sufficient information for the Working Group to carry out a quantitative assessment (Annex 5, paragraphs 5.90 to 5.97).

4.64 In the absence of recent data on the population status of *C. gunnari*, some proposals were made concerning the determination of population status in order to assess the dynamics of this stock (Annex 5, paragraphs 5.98 to 5.100).

4.65 To assess the stock dynamics most effectively, it is necessary to review as many historical research and commercial trawl data as possible. This will also help define the optimum design and timing of trawl surveys in Subarea 48.3 and to standardise the research survey results. The Scientific Committee endorsed the Working Group's recommendation that these data be submitted to the Secretariat in the appropriate format and be reviewed by an intersessional group convened by Dr Holt.

4.66 The Working Group was unable to make further progress in the development of a long-term management plan for the *C. gunnari* fishery as requested by the Commission last year (CCAMLR-XIII, paragraph 8.38). The Scientific Committee reiterated the need for such a plan, especially in the light of the high interannual recruitment variability, uncertainty in biomass estimates and potential variability in natural mortality with age and between years. Any estimates of yield will need to incorporate the possibility of major mortality occurring every few years. Members were encouraged to address these topics.

Management Advice

4.67 The Scientific Committee recommended that bottom trawling should continue to be prohibited in the directed fishery for *C. gunnari* in Subarea 48.3.

4.68 The Scientific Committee endorsed the Working Group's advice that the most reliable estimate of abundance for *C. gunnari* around South Georgia and Shag Rocks was still that from the 1994 UK survey (see SC-CAMLR XIII, Annex 4, Table 3). Given the uncertainty associated with the state of this stock, the Working Group further recommended that the lower confidence interval of that estimate be used if TACs are considered. The lower 95% confidence limit was 13 295 tonnes.

4.69 The Working Group considered two options for setting a TAC for *C. gunnari*:

- (i) no TAC should be set until a new research survey to assess the status of the stock has been conducted. This new estimate would then be considered by WG-FSA as a basis for providing new management advice; and
- (ii) a TAC should be set (at some proportion of the lower confidence limit of the 1994 UK survey estimate), but this TAC would be dependent on two things; a research survey being carried out before the commercial operation, and an international scientific observer being on board each vessel fishing commercially.

4.70 The Scientific Committee preferred option (i) but some Members stated that option (ii) was also acceptable. If the Commission decides to re-open the fishery (option (ii)), it is recommended that a TAC be set at a level which is considerably below 13 295 tonnes, that a research survey be carried out prior to the commercial fishery in accordance with the design recommended by WG-FSA in 1992, and that an international scientific observer be on board any commercial fishing vessel.

4.71 The Scientific Committee recommends that a high priority should be given to the development of a long-term management plan for this fishery.

Chaenocephalus aceratus, *Gobionotothen gibberifrons*³,
Notothenia rossii, *Pseudochaenichthys georgianus*,
*Lepidonotothen squamifrons*⁴ and *Patagonotothen guntheri*
(Subarea 48.3) - Management Advice

4.72 The Scientific Committee endorsed the previous advice of the Working Group concerning these species (SC-CAMLR XIII, Annex 4, paragraphs 4.98, 4.102 and 4.103). In the absence of any substantive new information, a directed fishery on these species should remain prohibited (Conservation Measures 2/III, 3/IV, 76/XIII and 85/XIII).

³ Formerly known as *Notothenia gibberifrons*

⁴ Formerly known as *Notothenia squamifrons*

Electrona carlsbergi (Subarea 48.3)

4.73 The Scientific Committee endorsed the view of the Working Group that, given the limited new information on this stock (Annex 5, paragraphs 5.114 and 5.115), the precautionary yields based on the revised krill yield model are appropriate estimates of yield for this species, pending a revision of the biological parameters. The estimate of yield will be smaller with greater uncertainty in the estimates of these parameters (SC-CAMLR-XIII, paragraphs 5.18 to 5.26).

Management Advice

4.74 The Scientific Committee recommended that TACs for *E. carlsbergi* should be 14 500 tonnes for the region around Shag Rocks and 109 000 tonnes for all of Subarea 48.3, as recommended last year (SC-CAMLR-XIII, Annex 4, paragraphs 4.91 to 4.93). A consequence of this recommendation is that any potential by-catch of other pelagic species taken in the *E. carlsbergi* fishery is likely to be reduced proportionately to the reduction of the precautionary limit from the 200 000 tonnes set by Conservation Measure 84/XIII.

4.75 In addition, the Scientific Committee agreed that the implementation of the conservation measure pertaining to the collection of biological information on *E. carlsbergi* from the commercial fishery (Conservation Measure 54/XI) should follow the format of the reporting of this information from other fisheries, including monthly reporting of by-catch and biological information on all species found in the catch. The Scientific Committee also noted that this fishery may take other pelagic species. If Conservation Measure 84/XIII is continued, then it should contain a reference to Conservation Measure 52/XI rather than Conservation Measure 54/XI, with the following provisions for setting a TAC and reporting conditions on this fishery:

- the target species is designated as *E. carlsbergi*;
- by-catch species are all other species caught during fishing operations;
- the relative densities of each species of fish in catches from each fishing ground should be reported; and
- length composition data of 500 specimens of each species taken randomly from catches in this fishery from each fishing ground should be reported.

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

4.76 In the absence of new information on stocks in these areas, the Scientific Committee reiterated its advice of last year (SC-CAMLR-XIII, Annex 4, paragraph 4.116) that fisheries in Subareas 48.1 and 48.2 should remain closed until a survey is conducted to provide more accurate estimates of the status of these stocks.

South Sandwich Islands (Subarea 48.4)

4.77 Although a small fishery for *D. eleginoides* was open in this area, no catches were reported. In the absence of further information, the Scientific Committee could not update its advice from 1993 (SC-CAMLR-XII, Annex 5, paragraph 6.4) when a TAC of 28 tonnes was recommended.

Statistical Area 58

Notothenia rossii and *Lepidonotothen squamifrons*
(Division 58.5.1) - Management Advice

4.78 Given that no new data are available this year for either of these species, the Scientific Committee recommended that the fisheries for *N. rossii* and *L. squamifrons* remain closed until new data are available which indicate that a fishery can be supported (Annex 5, paragraphs 5.136 and 5.139 respectively).

Champscephalus gunnari (Division 58.5.1)

4.79 New information provided in WG-FSA-95/15 Rev. 1 on the Soviet fishery for *C. gunnari* will necessitate a considerable revision of the catch data in Subarea 58.5 between 1970 and 1978. In addition, the Scientific Committee noted that there was heavy fishing of young age classes, which may have affected cohort strength in subsequent years (Annex 5, paragraphs 5.140 to 5.145).

4.80 The Scientific Committee recommended that the Data Manager verify the accuracy and completeness of the data reported in WG-FSA-95/15 Rev. 1, and if appropriate check with Russian authorities to see if additional catch data from this fishery are stored with them. If he is satisfied that the new data are correct, the *Statistical Bulletin* should be updated.

4.81 *C. gunnari* was fished for the first time since the 1991 season. The 1991 cohort, now at age 3+, was exploited and the catch was low compared to other seasons when a strong year class has been predicted (Annex 5, paragraphs 5.146 to 5.150). The abundance index for this cohort was much lower than for the three previous cohorts at the same age, and CPUE also declined markedly through the season. This continues the trend of decline in cohort strength over the last 12 years, even though no fishing had taken place since the present cohort was born in 1991. The previous strong cohort had been heavily fished when the fish were 2+ years old and before most of them had spawned.

Management Advice

4.82 The Scientific Committee advised in its 1993 and 1994 reports that because of the consistent decline in abundance of the strong cohorts which appear every three years, it would be appropriate to delay fishing of the present strong cohort until it has had at least one chance to reproduce. Thereafter fishing should be kept to a low level to allow sufficient escapement of fish to spawn a second time. This is in fact what has applied up to 1994/95.

4.83 Given the continuation of the decline in cohort strength, the Scientific Committee endorsed the Working Group's recommendation that this policy be continued. Therefore the fishery for *C. gunnari* in Division 58.5.1 should be closed until at least the 1997/98 season, when the cohort born in 1994 will have had an opportunity to spawn. Before this cohort is fished, it is recommended that a pre-recruit biomass survey be conducted in the 1996/97 season to evaluate the strength of the cohort at age 2+. The data obtained should be evaluated at the 1997 meeting of WG-FSA, and an appropriate level of catch recommended.

Dissostichus eleginoides (Division 58.5.1)

4.84 Fishing for this species continued in the 1994/95 season as a longline fishery on the western slope and a trawl fishery on the northern shelf. Trawling also commenced on a recently discovered ground on the eastern part of the shelf.

4.85 Standardisation of CPUE data for the *D. eleginoides* fishery was also conducted for Division 58.5.1 (Annex 5, paragraphs 5.157 to 5.168). For the trawl fishery, although depth, year and vessel factors were significant components of the variance, there are probably other variables contributing to variation in CPUE that were not considered in the analysis. The Scientific Committee

recommended that during the intersessional period the haul-by-haul data from the trawl fishery be analysed to identify additional predictor variables.

4.86 For the longline fishery, data were not available on a genuinely haul-by-haul basis, and factors that are known to be significant for the fishery in Subarea 48.3 (i.e., month, soak time and depth) were not found to be significant here. The Scientific Committee noted that haul-by-haul data are critical for proper standardisation of CPUE data and recommended that every effort should be given to providing these data to future meetings of WG-FSA.

Management Advice

4.87 The Scientific Committee felt that the analysis of factors affecting CPUE in longline and trawl fisheries is a potentially useful technique to improve its interpretation. However the analyses described in Annex 5, paragraphs 5.157 to 5.168, were limited by the lack of data on a genuinely haul-by-haul basis for the longline fishery, and by lack of data prior to 1994 for the trawl fisheries. The Scientific Committee recommended that in future, catch and effort data be collected and reported to CCAMLR on a haul-by-haul basis for the longline fishery. In addition, the Secretariat should acquire haul-by-haul data from Ukrainian authorities for the fisheries in previous years.

4.88 French authorities have already set TACs for the three sectors fished for the 1995/96 season. These are: 2 800 tonnes for the trawl fishery in the northern sector, 1 000 tonnes for the trawl fishery in the eastern sector, and 500 tonnes until the end of 1995 for the longline fishery in the western sector. These TACs were supported by the assessments of WG-FSA (Annex 5, paragraphs 5.169 to 5.172) and those made in previous years (SC-CAMLR-XIII, Annex 4, paragraph 4.134). Therefore the Scientific Committee endorsed these TACs. It further recommended that for the western sector longline fishery, as a 500-tonne catch has already been authorised for the first half of the split-year, this would imply a catch limit for the January to June 1996 period of 900 tonnes.

4.89 The Scientific Committee recommended, however, that further analysis of the *D. eleginoides* stocks exploited by the longline and trawl fisheries should be undertaken at the next meeting using the improved techniques recently established by WG-FSA.

Ob and Lena Banks (Division 58.4.4)

4.90 At CCAMLR-XIII, a conservation measure to allow a commercial catch of 1 150 tonnes of *L. squamifrons* to be taken over a two-year period (Conservation Measure 87/XIII) was approved at

the request of Ukraine, provided a biomass survey was undertaken. Despite this, no fishing took place during the 1994/95 season, and so no new data are available.

4.91 Revised catch figures for both banks submitted to last year's meeting (SC-CAMLR-XIII/BG/13⁵) differ little from the previously accepted data set (Annex 5, Table 24), and did not warrant a re-assessment of the stocks.

Management Advice

4.92 The Scientific Committee reiterates its opinion held for the past few years that a biomass survey is necessary to provide a valid assessment of the fish stocks on the two banks.

4.93 As Conservation Measure 87/XIII, allowing a catch of 1 150 tonnes of *L. squamifrons* on the two banks provided an approved biomass survey is undertaken, is still valid until the end of the 1995/96 season, the Scientific Committee encourages this option to be taken up. This should provide data on which a new assessment can be based.

4.94 As the revised catch data now describe catches for Ob and Lena Banks separately, it is recommended that separate statistical subdivisions be made for each bank and that in future catch and effort data be continued to be reported separately for each bank.

Heard and McDonald Islands (Division 58.5.2)

4.95 No fishery has been reported since 1978, but Conservation Measure 78/XIII set precautionary TACs of 311 tonnes and 297 tonnes for *C. gunnari* and *D. eleginoides* respectively on the basis of results from Australian biomass surveys.

4.96 Assessments carried out by WG-FSA at this year's meeting (Annex 5, paragraphs 5.180 and 5.181) indicated that these TACs remained valid.

⁵ Ukraine. 1994. Ob and Lena Banks: Report of Observer. Document SC-CAMLR-XIII/BG/13. CCAMLR, Hobart, Australia.

Management Advice

4.97 The Scientific Committee recommended that Conservation Measure 78/XIII, establishing a TAC of 311 tonnes for *C. gunnari* and 297 tonnes for *D. eleginoides* in Division 58.5.2, should remain in force. In the light of experience in the *C. gunnari* fishery in Division 58.5.1 (Annex 5, paragraphs 5.146 to 5.153), it is recommended that the fishery for *C. gunnari* in Division 58.5.2 delay catching these fish until they have had an opportunity to spawn (about 28 cm total length).

4.98 Additional advice on by-catches is given in paragraph 8.4.

Pacific Ocean Sector (Area 88)

4.99 There was no fishing reported in the area, and no information was available to make any assessment of stocks in this area.

Crab Resources

4.100 The Scientific Committee noted that a single US fishing vessel (*American Champion*) has started fishing for crabs in Subarea 48.3 under the experimental harvest regime set forth in Conservation Measure 75/XII (Annex 5, paragraph 5.119). Preliminary catch and effort data for the period 1 September to 10 October 1995 have been submitted to the Secretariat (Annex 5, Table 18) and, to date, the total reported catch of crabs is about 79 tonnes.

4.101 The Scientific Committee recognised that there were not enough data available to make an assessment of the crab stock at the 1995 meeting of WG-FSA (Annex 5, paragraph 5.128). The Scientific Committee further noted WG-FSA's observation that crabs may not be abundant off the southern and eastern coasts of South Georgia (Annex 5, paragraph 5.122) and supported the Working Group's concern that future assessments may need to take account of geographic differences in crab density (Annex 5, paragraph 5.123).

4.102 The pots used on board the *American Champion* are different from those used during the 1991/92 crab fishing season (Annex 5, paragraph 5.125). The Scientific Committee shared WG-FSA's concern that there is a large by-catch of small *D. eleginoides* in the pots currently used by the *American Champion* (Annex 5, paragraph 5.126 and Table 19).

4.103 The Scientific Committee noted the slow development of the crab fishery and endorsed WG-FSA's opinion that Conservation Measure 75/XII should be extended to remain in force through the 1997/98 crab fishing season (Annex 5, paragraph 5.130).

4.104 Dr Holt identified the need for a minor revision to Phase 2 of the experimental harvest regime set forth in Conservation Measure 75/XII. Information obtained from the fishery after the 1995 meeting of WG-FSA indicates that the boundaries of the small squares delineated in Conservation Measure 75/XII (Annex 75/A, Table 2) bisect the normal crab fishing grounds. The *American Champion* fishes in a narrow depth range, and the square boundaries currently set for Phase 2 will severely limit the vessel's ability to collect experimental data from the normal fishing grounds. If experimental data are not collected from the normal fishing grounds, WG-FSA may have difficulty interpreting results from the experimental harvest regime.

4.105 Adjusting the square boundaries of Phase 2 to include the normal fishing grounds is consistent with the WG-FSA's opinion that during this phase it would be better for the vessel to occupy three squares in an area of high crab density (Annex 5, paragraph 5.124).

4.106 The Scientific Committee agreed that Conservation Measure 75/XII, paragraph 5, should be redrafted so that fishing vessels could conduct the Phase 2 experimental operations in the preferred depth range. This redrafting would not compromise the scientific objectives of Phase 2. In general, a redrafted paragraph would eliminate the need for Table 2 of Annex 75/A and allow vessel captains to determine (subject to various limitations) the locations of square boundaries. Such a redraft would also preserve the current limitations on the size of experimental squares, the amount and distribution of fishing effort to be expended in each square and the minimum distance between squares.

4.107 The Scientific Committee endorsed WG-FSA's recommendation that additional data be collected to determine an appropriate size limit for male *P. formosa* (Annex 5, paragraph 5.127).

4.108 The Scientific Committee agreed that studies of technological methods (Annex 5, paragraph 5.126) to reduce the by-catch of *D. eleginoides* in crab pots should receive a high priority and urged this work to be undertaken as soon as possible.

Management Advice

4.109 Since the crab stock could not be re-assessed, the Scientific Committee endorsed WG-FSA's opinion that the fishery should be controlled by direct limitations on catch and effort as well as by limitations on the size and sex of crabs that can be retained in the catch (Annex 5, paragraph 5.128). In this regard, the Scientific Committee recommended that Conservation Measure 79/XIII should be applied to the 1995/96 crab fishing season.

4.110 The Scientific Committee noted that the experimental harvest regime can provide valuable information about the crab stock (Annex 5, paragraph 5.129) and recommended that Conservation Measure 75/XII should be revised in light of the issues presented in paragraphs 4.104 to 4.106.

4.111 The Scientific Committee further recommended that Conservation Measure 75/XII be extended to remain in force through the 1997/98 crab fishing season.

Squid Resources

4.112 Dr Croxall introduced this topic by recollecting that in previous years the UK had presented data and reports indicating that the ommastrephid squid, *Martialia hyadesi*, has significant potential for commercial exploitation in the waters of the Convention Area and adjacent areas and is also an important prey of several species of seabirds and marine mammals breeding in the Convention Area.

4.113 This year, the UK reports in SC-CAMLR-XIV/BG/22 Rev. 1:

- (i) a catch of about 18 000 tonnes of *M. hyadesi* in waters adjacent to Subarea 48.3 in 1995;
- (ii) advances in technical processing that may enhance the commercial value of this species; and
- (iii) continuing interest from fishing agencies, including those of non-members of the Commission, in fishing for this species of squid.

4.114 The paper suggests that given the increasing likelihood of commercial exploitation of stocks of this squid which occur in or near the Convention Area there needs to be enhanced acquisition of biological data relevant to developing appropriate management measures. Paper SC-CAMLR-XIV/BG/22 Rev. 1 also draws attention to a recent review by UK and Spanish scientists of stock

assessment methods used for cephalopod fisheries. Current data on distribution and demography of *M. hyadesi*, however, would be inadequate for the development of effective regulatory measures, such as exist for some species in waters adjacent to the Convention Area.

4.115 Prof. Duhamel reported the first substantial incidental catch of squid, similar to *M. hyadesi*, in the French trawl fisheries around Kerguelen (Division 58.5.1). Given the potential commercial significance of this discovery, full information will be reported to the Scientific Committee in due course.

4.116 The Scientific Committee agreed that the evidence of increased interest in fishing for squid in the Convention Area (or on stocks of species that straddle the Convention Area and adjacent waters) warranted greater attention and research than hitherto.

4.117 The Scientific Committee encouraged Members to acquire relevant biological data for such squid species/stocks so that appropriate management measures might be developed as soon as possible.

4.118 Last year the UK had planned to test a longlining system developed by Japanese scientists for catching squid in the Convention Area (SC-CAMLR-XIII, paragraph 4.5). Paper SC-CAMLR-XIV/BG/22 Rev. 1 reports that this trial has been postponed until 1996. The UK indicated that it would ensure that measures mitigating potential seabird mortality (as far as they could be envisaged for this new and specialised type of fishing), would be available for use during the trial, and that the trial would be conducted in accordance with Conservation Measure 64/XII.

4.119 Paper SC-CAMLR-XIV/BG/21 summarised recent data indicating that the trophic system involving squid as predators of myctophid fish is particularly well developed in the vicinity of the Antarctic Polar Frontal Zone (at least in Subarea 48.3) and concluded that this system has much greater ecological importance than hitherto envisaged.