

## ECOSYSTEM MONITORING AND MANAGEMENT

6.1 The fifth meeting of WG-EMM was held at the Instituto Español de Oceanografía, Santa Cruz de Tenerife, Spain, from 19 to 29 July 1999, the second time a SC-CAMLR working group had met at the institute. The Scientific Committee thanked the hosts of the meeting, Mr L. López Abellán and Dr E. Balguerías, for an efficient and friendly meeting, and the convener, Dr Everson, for chairing the meeting.

### Environmental Variables

6.2 The Scientific Committee endorsed the recommendation of WG-EMM (Annex 4, paragraph 5.9) that monitoring of the key environmental variables identified in the CEMP standard methods should continue.

6.3 Recent research results presented to WG-EMM indicate that increased UV-B in Antarctica may have the potential to adversely affect krill and other key populations (Annex 4, paragraphs 5.6, 5.7 and 5.10). The Scientific Committee noted that effects such as these warrant further directed research (detailed in Annex 4, paragraph 5.10) to identify how such effects may affect the overall productivity of krill populations and the ecosystem as a whole.

6.4 The Scientific Committee noted how the long-term study of the US AMLR Program had indicated the presence of an oceanic front to the northwest of Livingston Island and King George Island which was known to vary in its location by approximately 10 to 20 km. The Scientific Committee encouraged Dr Holt to provide more information to WG-EMM at its next meeting (Annex 4, paragraphs 5.2 and 12.3).

### Ecosystem Analysis

6.5 The Scientific Committee noted further progress in the development of multivariate analyses of CEMP indices (Annex 4, paragraphs 6.1 to 6.7). It welcomed the direction that WG-EMM was taking in working towards identifying how composite standardised indices (CSIs) might be used in a management context. In particular, the Scientific Committee endorsed the following important questions for future work (Annex 4, paragraphs 6.5 and 6.6):

- (i) How to formulate reference points for decision rules that incorporate CSIs or other information on predators?
- (ii) How to select parameters to derive indices and interpret these indices in relation to demography and abundance of indexed species and the identification of ecologically important values and trends (SC-CAMLR-XVII, Annex 4, paragraph 8.17 and endorsed by SC-CAMLR-XVII, paragraph 6.17)?
- (iii) What functional relationships can be developed relating CSIs to krill abundance (such as the one described in WG-EMM-99/40)?
- (iv) How can CSIs be used for identifying a critical level of krill abundance (reference points) for use in estimating precautionary yields or for adjusting catch limits in the short term?
- (v) How sensitive are CSIs to changes in key environmental or other parameters compared to krill abundance?
- (vi) What developments are required to facilitate the use of CSIs in feedback

management processes or for evaluating the success of conservation measures?

- (vii) What analytical and assessment methods are required to test the utility of CSIs as a basis for management decisions?

6.6 The Scientific Committee agreed that this program of work should help identify how data arising from CEMP might be used in predictive models to assess the possible impacts of krill harvesting as well as how these monitoring activities may be used in providing feedbacks to help with adjusting catch controls.

6.7 Some progress had been made with archiving the KYM in the past year (Annex 4, paragraph 6.8). The Scientific Committee endorsed the continued archiving of this model and asked the Secretariat, in consultation with Dr Constable, to continue preparing documentation on the model.

6.8 Methods for estimating the overlap between fisheries and predator foraging areas have been under consideration for several years and some progress had been made during the intersessional period (Annex 4, paragraphs 6.9 and 6.10). The Scientific Committee endorsed the recommendation of WG-EMM for further work on these models as detailed in Annex 4, paragraph 6.11. The Scientific Committee encouraged Members to involve statistical experts to assist the Secretariat with the development of indices (Annex 4, paragraph 6.12).

#### Krill-centred Interactions

6.9 The Scientific Committee noted the work on the diet of krill predators (Annex 4, paragraphs 6.16 to 6.21), the effect of diet on individual predators (Annex 4, paragraphs 6.22 to 6.24), the effect of diet on predator populations (Annex 4, paragraphs 6.25 to 6.28), the distribution of predators relative to krill (Annex 4, paragraphs 6.29 to 6.33) and the overlap in foraging of predators with fisheries (Annex 4, paragraphs 6.34 and 6.35). In particular, revised estimates of krill consumption for Adélie, chinstrap and gentoo penguins and female Antarctic fur seals in the South Shetland Islands cannot be met from the current estimates of krill density (Annex 4, paragraphs 6.20 and 6.21). Part of this problem may arise from uncertainty in the demographic parameters used in the KYM. This problem is common for other areas where krill consumption appears to far exceed the estimate of krill biomass (Annex 4, paragraphs 3.9 and 3.10).

#### Ecological Processes and Interactions

6.10 WG-EMM reported on a number of studies examining interactions of the ecosystem with the environment (Annex 4, paragraphs 6.36 to 6.39). The Scientific Committee noted the need to develop appropriate ecosystem models for underpinning management decisions in CCAMLR and work to reduce uncertainties in these ecosystem models was encouraged. It was also noted that the international workshop 'Large-scale Variability in the Southern Ocean – Patterns, Mechanisms and Impacts' provided some directions for study in this area (paragraph 11.29).

6.11 The Scientific Committee noted that considerable progress has been made in refining acoustic estimates of krill abundance. It agreed that attention needs to be given to refining estimates of predator abundance in order to improve the estimates of the demand for krill by predators.

## Fish- and Squid-based Interactions

6.12 The Scientific Committee noted the discussions concerning squid-based interactions (Annex 4, paragraphs 6.40 to 6.42).

## Ecosystem Assessment

6.13 An ecosystem assessment involves two components:

- (i) an analysis of the status of key biotic components of the ecosystem; and
- (ii) a prediction of the likely consequences of alternative management action (SC-CAMLR-XIV, Annex 4, paragraphs 2.13 to 2.21).

6.14 The Scientific Committee noted the progress in developing assessment methods since 1995 (Annex 4, paragraphs 7.1 to 7.13). It was noted that almost all initiatives so far had been associated with krill-centred systems and that assessments of ecosystem interactions involving fish and squid may be considered in the near future. In this regard, the Scientific Committee noted that it would be useful to consider whether, and in what form, action is necessary to improve assessments of these interactions.

6.15 The Scientific Committee also noted that there was a need to complement existing management advice for catch limits at large scales with advice on management at local scales (Annex 4, paragraph 7.11).

6.16 The Scientific Committee endorsed the request by WG-EMM to have the Secretariat review the items listed under the agenda item on future work at and after 1995 to provide some indication of the current status of the various tasks (Annex 4, paragraph 7.12). It noted that the assistance of Members will be important for this work.

## Estimates of Potential Yield

6.17 In 1997 WG-EMM had recommended that revision of estimates of potential yield of krill should be postponed until the results of the CCAMLR-2000 Survey became available. The Scientific Committee endorsed this recommendation, noting that such estimates are expected next year and that advice will also be provided on a subdivision of the area-wide precautionary catch limit. This subdivision is considered necessary in order to ensure the interaction between fisheries and krill predators remains at appropriate levels.

## Precautionary Catch limits

6.18 Precautionary catch limits for krill are currently enacted in Conservation Measures 32/X (Area 48), 45/XIV (Division 58.4.2) and 106/XV (Division 58.4.1). The Scientific Committee recommended that these conservation measures should remain in force as they stand, until the results of the CCAMLR-2000 Survey are available.

6.19 The survey will include revised estimates of stock biomass which will contribute to the revision of precautionary catch limits at least for Area 48. It was understood that unless relevant new data with which to revise are developed intersessionally, the only changes to the KYM will be the new estimates of stock biomass in Area 48 (Annex 4, paragraphs 7.16 and 8.50).

## Assessment of the Status of the Ecosystem

6.20 An extensive review of the status of the ecosystem in Area 48 was undertaken last year, particularly arising from the results of the Workshop on Area 48 (SC-CAMLR-XVII, Annex 4, Appendix D). Also, it is expected that a report on the status of bird populations will be available from SCAR to WG-EMM next year. Consequently, WG-EMM provided an assessment of the status of the ecosystem only for 1999. These assessments are summarised for Area 48 (Annex 4, paragraphs 7.21 to 7.25), Division 58.4.2 (Annex 4, paragraph 7.26), Subareas 58.7 (Annex 4, paragraph 7.27) and 88.1 (Annex 4, paragraph 7.28).

6.21 The Scientific Committee endorsed the approach to these assessments to be taken by WG-EMM next year in which the following areas will be evaluated:

- (i) status and trends of resources;
- (ii) status and trends of dependent species;
- (iii) status and trends of environmental variables;
- (iv) status and trends of fisheries; and
- (v) interactions between environment, resources, dependent species and fisheries.

6.22 The Scientific Committee agreed that fishery-derived data should be included in this topic and Members were asked to consider intersessionally which indices might be relevant and to prepare suggestions and/or data on these to facilitate discussion at the next meeting of WG-EMM.

6.23 The Scientific Committee noted the opportunities being developed in WG-EMM for using composite standardised indices for detecting trends in the ecosystem (Annex 4, paragraphs 7.31 to 7.38). It was noted that the krill fishery is considered to be at a low level but may expand in the near future. Consequently further elaboration of how to incorporate predator information in a management framework is required quickly in order that the effects of krill fishing on predators can be appropriately monitored. This might be achieved through a consultancy, but not in the immediate future (Annex 4, paragraph 7.39).

6.24 The Scientific Committee endorsed the development and testing of models which offer the ability to ensure precautionary management approaches that are robust and effective (Annex 4, paragraphs 7.40 to 7.42).

## Considerations with respect to Precautionary Approaches

6.25 The Scientific Committee noted the considerations with respect to precautionary approaches (Annex 4, paragraphs 7.43 to 7.45).

6.26 The Scientific Committee noted that a succinct summary of the key components of the GYM is given in Annex 4, paragraphs 7.47 and 7.48. The Scientific Committee agreed that the potential for incorporating age-structured krill mortality into the GYM should be investigated by Prof. I. Boyd (UK), Dr Constable and Prof. D. Butterworth (South Africa) (Annex 4, paragraph 7.49). Other considerations of the KYM and GYM are given in Annex 4, paragraphs 7.46 to 7.54. In addition, existing work and new proposals on estimating krill yield based on estimation of krill consumption by dependent species would be considered by Prof. Boyd, and Drs Everson, Constable and Nicol (Annex 4, paragraphs 7.51 and 7.52).

6.27 The Scientific Committee noted the issues associated with ecosystem variability (Annex 4, paragraphs 7.55 to 7.62), including:

- (i) the problems involved in scaling up (extrapolating) to larger scales using data collected at smaller scales;
- (ii) the allocation of catch limits at scales smaller than statistical areas (i.e. how limits estimated at or for large areas are divided for application to smaller areas); and
- (iii) avoidance of localised effects of krill fishing, especially in relation to potential adverse effects on dependent species.

6.28 It was concluded that much useful information might accrue from a dialogue with fishers.

6.29 In order to establish a feedback management regime, as intended by the Commission, it is essential to have good information about the way in which the fishery might develop (Annex 4, paragraphs 7.63 to 7.73). Of particular interest is the use of scientific observers on krill fishing vessels. The Scientific Committee recommended that this is a matter of general importance. It endorses the request of WG-EMM for these to be operational during the CCAMLR-2000 Survey either through the CCAMLR scheme or by bilateral arrangements because such information would be useful for comparing the fishing activities with the observed distribution from the survey (Annex 4, paragraphs 7.72 and 7.73).

6.30 The Scientific Committee noted that the IUCN global review of threatened species was discussed by WG-EMM (Annex 4, paragraphs 7.74 to 7.78). It noted that the Commission may need to take action on some species to afford protection to them under Article II.3(c). The Secretariat was requested to contact IUCN in order to obtain details on the criteria used and the process applied in the preparation for publication in 2000 of the new list of globally threatened species. The Scientific Committee asked Mr Cooper, representative from IUCN, to convey to the SCAR-BBS that WG-EMM would like the report on the status and trends of Antarctic seabirds arising from the Montana, USA, meeting in 1999 to be made available to the 2000 meeting of WG-EMM if at all possible. This will facilitate the assessment of the ecosystem as well as providing important data for use in estimating consumption of krill by predators.

#### The Ecosystem Approach as Applied in other Parts of the World

6.31 The Scientific Committee noted the discussion of WG-EMM concerning similar ecosystem management initiatives elsewhere in the world (Annex 4, paragraphs 9.1 to 9.9) and that there is value in examining the experiences of other groups that may have encountered similar management problems to those faced by CCAMLR. Such approaches and meetings include the South African BENEFIT Programme (Annex 4, paragraphs 9.2 and 9.3) and the recent SCOR/ICES Symposium on the Ecosystem Effects of Fishing in Montpellier, France, during March 1999.

6.32 At the latter meeting, CCAMLR was represented by Dr Constable, whose presentation was well received at the meeting and the subsequent paper presented to the Scientific Committee in SC-CAMLR-XVIII/BG/26 (Annex 4, paragraphs 9.4 to 9.7). From that meeting, it was clear that the work of CCAMLR is well ahead of other management organisations in terms of developing a precautionary approach to the ecosystem management of fisheries. The Scientific Committee considered that some aspects of the work of CCAMLR, especially in the areas of by-catch of elasmobranchs or the effects of trawling on the seabed, may merit greater attention in future. The results of the Montpellier meeting would help to provide guidance about operational objectives and definitions for ecosystem management. Some of these results, particularly in relation to the definitions of the precautionary approach to fisheries management, had been developed at the Lysekil, Sweden, meeting in 1995 (SC-CAMLR-XIV, Annex 5, paragraphs 10.1 to 10.8).

6.33 Mr A. Dommasnes (Norway) indicated to the Scientific Committee that multispecies models have been developed for the Barents Sea and the waters around Iceland, using the long history of data and research programs from these fisheries. Norway is also planning to include marine mammals and plankton in these models. The Scientific Committee welcomed this input and encouraged further input to CCAMLR regarding these models. It was noted that these models are far more detailed than is possible for Antarctica. It was recognised that ecosystem models for the Southern Ocean need to concentrate at this stage on the important linkages of dependent species to the target species of fisheries, as well as taking account of uncertainty in knowledge of these systems.

6.34 The Scientific Committee noted the discussion of WG-EMM on the proposal of Mr R. Shotton at last year's meeting (SC-CAMLR-XVII, paragraph 6.20) regarding a FAO initiative to host a meeting on the ecosystem approach to management. The Scientific Committee welcomed this initiative and recommended that if CCAMLR is to participate, then it should take a lead in developing the terms of reference of such a meeting and that it should ensure that it is strongly represented. The Chairman of the Scientific Committee agreed to correspond with FAO with regard to this request.

#### CCAMLR-2000 Survey

6.35 The plans for this survey are very well advanced following a meeting in March 1999 in Cambridge, UK, and subsequent correspondence leading to further refinement of the procedures during the WG-EMM meeting in Tenerife, Spain. The details of the plans can be found in Annex 4, paragraphs 8.1 to 8.36.

6.36 The Scientific Committee welcomed the participation of the USA, UK, and Japan in the survey in January and February 2000. It also welcomed the announcement by Russia of their participation in the survey and their contribution for covering the large area in Subarea 48.4 (SC-CAMLR-XVIII/BG/22).

6.37 The objective of the survey is to provide an estimate of  $B_0$  for calculating a precautionary yield. Accordingly, a two-week workshop meeting is planned for May–June 2000 to be held in La Jolla, USA. Plans for this are set out in Annex 4, paragraphs 8.37 to 8.39.

6.38 The Scientific Committee agreed that key papers arising from the survey might be published in *CCAMLR Science* in 2001.

6.39 The Scientific Committee agreed the terms of reference for the workshop should be:

- (i) estimate  $B_0$  for Area 48;
- (ii) identify and parameterise survey measurement and sampling variance; and
- (iii) report the results of (i) and (ii) to WG-EMM-2000.

6.40 The Scientific Committee agreed that in estimating potential yield it was recognised that a number of processes should be undertaken (Annex 4, paragraph 8.50):

- (i) estimate  $B_0$  for Area 48;
- (ii) update to incorporate the variance estimate of the  $B_0$  survey;
- (iii) estimate sustainable potential yield; and
- (iv) derive the precautionary catch limit for Area 48 and subdivide this precautionary catch limit for smaller management areas as appropriate.

6.41 The Scientific Committee endorsed the approach of WG-EMM for subdividing the estimate of yield for Area 48 into smaller areas. This will be done by subdividing the precautionary catch limit (see Annex 4, paragraph 8.52) by prorating the overall yield by the

proportion of the CCAMLR-2000 Survey in each statistical subarea (estimated from the lengths of survey tracks associated with the large-scale component of the survey) (Annex 4, paragraph 8.61). Other options that may be developed in future by individual members are considered in Annex 4, paragraphs 8.55 to 8.62.

6.42 The Scientific Committee agreed that the Data Manager should participate in the workshop and that the datasets should be archived at the Secretariat. One of the key roles of the Data Manager at the workshop is to begin the process of archiving data. The Scientific Committee also agreed that a member of the Secretariat should accompany the Data Manager in order that a high-quality report can be produced in time for WG-EMM that year.

6.43 The Scientific Committee noted that WG-EMM will consider at its next meeting how the data from regional krill surveys can be used in conjunction with the CCAMLR-2000 Survey.

6.44 The Scientific Committee thanked Drs J. Watkins (UK), R. Hewitt (USA) and M. Naganobu (Japan) for their leadership and organisation of the survey.

6.45 The Scientific Committee also thanked the IWC for its contribution in the planning and future conduct of the survey and noted that this collaboration is similar to the SOWER workshop. This is described in Annex 4, paragraphs 8.69 to 8.74. The Scientific Committee noted that the collaboration will need to continue beyond the survey and that there may be an opportunity for a joint IWC–CCAMLR workshop to examine the relationships between the cetacean dataset and the synoptic survey dataset to be obtained from the CCAMLR-2000 Survey.

#### Convenership of WG-EMM

6.46 The Scientific Committee thanked Dr Everson for steering WG-EMM for its first five years. It recognised his significant contribution for laying solid foundations for the integration of WG-Krill and WG-CEMP. The Scientific Committee also thanked Dr Everson for his extensive involvement through the history of CCAMLR.

6.47 The Scientific Committee thanked Dr Hewitt for agreeing to become the next convener of WG-EMM, taking it into the next millennium.