

ECOSYSTEM MONITORING AND MANAGEMENT

Advice from WG-EMM

General comments

3.1 Dr Reid, Convener of WG-EMM, reported on the 2006 meeting of WG-EMM which was held from 17 to 28 July 2006 in Walvis Bay, Namibia. Other intersessional activities included the second meeting of SG-ASAM and work by correspondence groups on the design of land-based krill predator surveys and on the subdivision of CCAMLR statistical areas into ecologically based harvesting units. During the meeting the following groups met:

- (i) the Second Workshop on Management Procedures
- (ii) Subgroup on CEMP Methods
- (iii) ad hoc Group on Fishery Dynamics
- (iv) subset of the Steering Group for the CCAMLR-IPY-2008 Survey
- (v) Steering Committee on the Review of the Structure of the Working Groups of the Scientific Committee.

3.2 These activities were summarised in three documents for consideration by the Scientific Committee:

- (i) report of WG-EMM-06 (Annex 4) containing a listing of 'Key points for consideration by the Scientific Committee' at the end of each major agenda item, as well as the report of the Second Workshop on Management Procedures (Annex 4, Appendix D);
- (ii) synopses of working papers (SC-CAMLR-XXV/BG/8) considered at the meeting, each containing an abstract and a summary of the findings and/or conclusions as they relate to a particular agenda item;
- (iii) report of the Convener of WG-EMM to SC-CAMLR-XXV (SC-CAMLR-XXV/BG/7) containing appropriate references to paragraphs in the report of WG-EMM-06.

3.3 As in recent years, the agenda of WG-EMM-06 was structured to consider the status and trends in the krill fishery (Annex 4, section 3), the status and trends in the krill-centric ecosystem (section 4), the status of management advice arising from these considerations (section 5) and future work (section 6).

3.4 In particular, the Working Group drew the attention of the Scientific Committee to:

- (i) the analysis of long-term population data from both the South Shetland Islands and South Orkney Islands that has revealed consistent declines in both Adélie and chinstrap penguin numbers over the last 20 to 30 years (Agenda Item 3);
- (ii) the substantial progress in the use of ecosystem models for evaluating management procedures which indicate that a spatially restricted krill fishery (if fishing only occurred in Subarea 48.1, or following the distribution of historical catches) would have considerable negative impacts for regional ecosystems (Agenda Item 3);

- (iii) concern about the lack of necessary ship-time to conduct the CCAMLR-IPY-2008 Survey (Agenda Item 13(v));
- (iv) development of planning for the CCAMLR-IWC Workshop in 2008 (Agenda Item 13(vi));
- (v) the work of the steering committee for the CCAMLR Workshop on Bioregionalisation of the Convention Area (Agenda Item 3);
- (vi) the breadth and scope of the potential future work identified by WG-EMM (Agenda Item 3);
- (vii) the need for information on fishing methodologies, technology and fishing operations as well as broader observer coverage on all types of krill fishing vessels to provide operational data on fishing selectivity and total mortality, reiterating previous advice to the Scientific Committee (Agenda Item 4);
- (viii) the recommendation from the Steering Committee on the Review of the Structure of the Working Groups of the Scientific Committee that, while recognising that present needs are being met, there is a need for the Scientific Committee to undertake a long-term review of its work plans in order for the working groups to appropriately prioritise their meeting schedules (Agenda Item 13).

Status and trends in the krill-centric ecosystem

3.5 The Scientific Committee noted that the analysis of long-term penguin population data from both the South Shetland Islands and South Orkney Islands had revealed consistent declines in both Adélie and chinstrap penguin numbers over the past 20 to 30 years.

3.6 The Scientific Committee recalled that historical analyses had previously indicated that differences in winter sea-ice conditions had opposite effects on these two species; specifically that years of extensive winter sea-ice favoured Adélie penguins, whereas years of reduced winter sea-ice favoured chinstrap penguins. This had led to the expectation that changing regional sea-ice conditions would differentially impact populations of the two species. These new analyses indicated that, as both species now showed population declines, this may reflect the influence of reduction in prey availability linked to large-scale climate forcing.

3.7 The Scientific Committee therefore requested that Members consider what the potential effects of climate change on the Antarctic marine ecosystems might be, and how this knowledge could be used to advise the Commission on management of the krill fishery. It also requested that Members consider how the effects of fishing might be distinguished from the effects of climate change. For example, could a program of experimental fishing be used to help quantify these effects and/or how might simulation studies using ecosystem models be used to understand what the potential effects might be. The Scientific Committee requested that Members provide submissions on this item to the next meeting of WG-EMM.

Status of management advice

Second Workshop on Management Procedures

3.8 This was the sixth in a series of workshops held by WG-EMM designed to develop a management procedure for krill (Annex 4, Appendix D). The aim of this workshop was to examine how well six candidate methods for subdividing the krill catch limit in Area 48 among SSMUs would meet the objectives of CCAMLR.

3.9 The Scientific Committee recognised that there had been a considerable amount of work undertaken since WG-EMM-05 that had helped develop existing models (KPFM2, EPOC and SMOM), and helped build parameter sets on which the provision of management advice could be based. As with the previous workshop in 2005, the Second Workshop on Management Procedures had focused on the output of KPFM2, and also explored structural uncertainty about allocation options using both KPFM2 and SMOM (Annex 4, paragraph 2.2).

3.10 In simulation trials conducted using KPFM2 it was apparent that, should the fishery take the existing precautionary catch limit entirely from within Subarea 48.1, there would be considerable negative impacts on the ecosystem in that region and, under the assumptions of flux, negative consequences for the ecosystem in the downstream SSMUs in Subareas 48.2 and 48.3 (Annex 4, paragraph 2.4).

3.11 Furthermore, simulation trials using both KPFM2 and SMOM indicated that Fishing Option 1 (following the distribution of the historical fishery) would have greater negative impacts on the ecosystem compared to the other fishing options.

3.12 The Scientific Committee noted that further evaluation of Fishing Options 2, 3 and 4 would require additional work on the development and interpretation of performance measures. It further noted that simulations carried out during the workshop indicated that the performance of these fishing options would be improved if monitoring data were used to regularly review and update the allocation of catches among SSMUs; that is, in a manner analogous to Fishing Option 5 (Annex 4, paragraph 2.6).

3.13 It was recognised that further discussions on performance measures and the means for providing integrated advice to the Commission on the relative merits of different strategies with respect to Article II would help progress this work.

3.14 Some Members expressed their concern that, although substantial progress had been achieved, the Scientific Committee was still unable to provide conclusive advice concerning the six candidate procedures for subdividing the catch limit for krill among SSMUs in Area 48. The Scientific Committee recognised that while evaluating these candidate management options remained a high priority, this presented a very complex task.

3.15 The Scientific Committee agreed that it may be beneficial if a review of the technical modelling issues be added to the agenda of WG-SAM for consideration at its next meeting in order to maintain the momentum that has been developed in this area of work. The Scientific Committee also recommended that an integrated assessment approach for krill, similar to that used by WG-FSA for other species, should be explored by WG-SAM.

3.16 ASOC drew Members' attention to its paper CCAMLR-XXV/BG/26 which supported a flexible approach to the allocation of catch among SSMUs and which emphasised the value of including new data and the importance of incorporating uncertainty.

Existing conservation measures

3.17 The Scientific Committee requested that the requirement to review CEMP site protection under Conservation Measure 91-01 (2004) in respect of Conservation Measures 91-02 and 91-03 (protection of Cape Shirreff and Seal Island respectively) should be clarified and, if required, reviewed at the earliest opportunity.

3.18 The Scientific Committee agreed that results from the Australian krill biomass survey conducted in Division 58.4.2 (SC-CAMLR-XXIV, paragraph 3.8) provided information necessary to update the precautionary catch limit in Conservation Measure 51-03 to 1.49 million tonnes (Annex 4, paragraph 5.35 and SC-CAMLR-XXV/8).

Future work of WG-EMM

Operating models

3.19 The Scientific Committee noted the change of name of the Subgroup on the Development of Operating Models, to Operating Models Subgroup. It also endorsed the list of tasks identified by the subgroup and the development of a newsgroup (Annex 4, paragraphs 6.19 to 6.23).

Workshops outside CCAMLR relevant to the work of WG-EMM

3.20 The Scientific Committee noted the following scientific initiatives that were of relevance to the work of WG-EMM.

3.21 Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) is a multidisciplinary international initiative (under IMBER) to develop a coordinated circumpolar approach to understand climate interactions in the Southern Ocean, the implications for ecosystem dynamics, the impacts on biogeochemical cycles, and the development of management procedures. WG-EMM recognised that a number of CCAMLR scientists have been closely involved with the planning of ICED and encouraged continued close cooperation between the two groups. ICED proposed to hold a workshop on circumpolar ecosystem modelling during the latter part of 2007, the outcomes of which will be of considerable relevance to CCAMLR (Annex 4, paragraph 7.8). The ICED website is www.antarctica.ac.uk/Resources/BSD/ICED/index.htm.

3.22 The Lenfest Ocean Program, a non-profit private organisation that supports scientific research, is considering sponsoring a scientific/technical workshop on krill-based ecosystem dynamics in the southwest Atlantic between April and June 2007. The theme of the workshop will be designed so as to provide outcomes of use to the work of CCAMLR.

3.23 FAO will be conducting a Workshop on Modelling Ecosystem Interactions for Informing an Ecosystem Approach to Fisheries during the second or third quarter of 2007. The FAO workshop is via invitation only, and expressions of interest from Members are welcome (Annex 4, paragraphs 7.14 and 7.16).

3.24 The Scientific Committee looked forward to the outcomes of all these initiatives.

Long-term work plan of WG-EMM

3.25 The Scientific Committee endorsed the long-term work plan of WG-EMM (Annex 4, paragraph 6.41) and noted that the following three actions should have priority status:

- (i) facilitate the continued evaluation of management procedures to allocate the precautionary krill catch limit in Area 48 among SSMUs;
- (ii) develop SSMU-specific estimates of predator abundance and demand in Area 48;
- (iii) consider revising estimates of B_0 and γ in all areas where harvesting occurs, taking account of recent developments in estimating parameters used in assessments, and considering revising estimates of precautionary yield where appropriate.

3.26 The Scientific Committee agreed that a workshop to review estimates of B_0 and precautionary catch limits for krill should be held in conjunction with the WG-EMM meeting in 2007 (Annex 4, paragraph 6.49). The workshop will be convened by Dr Nicol and should consider the following points:

- (i) review of parameters used in the assessment, including growth and recruitment variability;
- (ii) examine whether integrated approaches could be used to estimate recruitment variability and M from long-term datasets;
- (iii) consider the level of krill escapement to provide for predators in the decision rule;
- (iv) consider alternative methods for estimating catch limits for krill according to the CCAMLR decision rules and how the different methods might be compared and evaluated for providing advice;
- (v) consider sources of uncertainty that may not be able to be included specifically in the estimation of B_0 or the assessment process generally.

3.27 With respect to the workshop in 2007, the Scientific Committee noted the requests from WG-EMM for advice from WG-SAM and SG-ASAM on the most appropriate method for estimating B_0 and associated CV from survey data (Annex 4, paragraph 6.50). This involvement may be facilitated by the establishment of the electronic newsgroup of the Operating Models Subgroup (Annex 4, paragraphs 6.19 to 6.23).

Advice to the Commission

3.28 The Scientific Committee called to the attention of the Commission the following items arising from WG-EMM:

- (i) The Australian BROKE-West acoustic krill biomass survey of Division 58.4.2 carried out from January to March 2006 provided an updated estimate for the catch limit of 1.49 million tonnes for Division 58.4.2 (SC-CAMLR-XXV/8).
- (ii) Simulation trials using both KPFM2 and SMOM indicated that Fishing Option 1 (following the distribution of the historical fishery) would have greater negative impacts on the ecosystem compared to the other fishing options (Annex 4, paragraph 2.4).
- (iii) Although substantial progress had been achieved, the Scientific Committee was still unable to provide further conclusive advice concerning the six candidate procedures for subdividing the catch limit for krill among SSMUs in Area 48 and further work was necessary (Annex 4, paragraph 6.57(xv)).
- (iv) A workshop to be held in 2007 and convened by Dr Nicol will review estimates of B_0 and γ and suggest appropriate revision for the precautionary catch limits for krill in Areas 48 and 58 (Annex 4, paragraph 6.57(xv)).
- (v) A proposed workshop should be held no later than 2008 to examine data requirements and existing data that provide abundance estimates and associated uncertainty of land-based predator populations (Annex 4, paragraph 6.57(i)).
- (vi) The Scientific Committee highlighted its concern regarding the lack of commitment for ship-time for the CCAMLR-IPY-2008 Survey (SC-CAMLR-XXV/BG/5 Rev. 1). It noted that the current situation could be embarrassing to CCAMLR and its Members if the survey were to be cancelled.
- (vii) The Scientific Committee noted the advances in planning for the CCAMLR-IWC Workshop in 2008 (SC-CAMLR-XXV/6).

Management of protected areas

3.29 In respect of ATCM Decision 9 (2005), the Scientific Committee recommended that, at least in the near future, all ATCM protected area proposals with marine components should continue to be provided to CCAMLR for review, unless they are clearly not required according to ATCM Decision 9 (Annex 4, paragraphs 5.11 and 5.12). In addition, to avoid potential confusion in the future, the Scientific Committee also recommended that standard terminology be adopted within CCAMLR to distinguish between 'ATCM draft management plans with marine components' and 'marine protected areas (MPAs)' *per se* (Annex 4, paragraph 5.8).

3.30 Co-conveners of the Bioregionalisation Workshop Steering Committee, Drs Penhale and Grant, presented an update on progress towards the 2007 CCAMLR Workshop on Bioregionalisation (SC-CAMLR-XXV/BG/24).

3.31 The Scientific Committee endorsed the Steering Committee's recommendation that its membership be expanded to include the conveners of the four Scientific Committee working groups and Dr W. Dinter (Germany), an additional member nominated by CEP.

3.32 Progress leading to the 2007 Bioregionalisation Workshop included several years of discussion on MPAs at WG-EMM, followed by the 2005 CCAMLR Workshop on MPAs, held in Silver Spring, USA (SC-CAMLR-XXIV, Annex 7). In 2006, the Bioregionalisation Workshop Steering Committee was formed. The 2007 workshop is viewed as a next step in the progression of endeavours leading to the establishment of a system of MPAs harmonised for the protection of the Antarctic marine environment across the Antarctic Treaty System.

3.33 Two separate components of work to be undertaken towards the development of a system of MPAs for the Convention Area were identified:

- (i) technical development of methods for bioregionalisation of the Southern Ocean
- (ii) consideration of methods for selection and designation of MPAs.

3.34 The focus of the 2007 Bioregionalisation Workshop will be on component (i). The aim of the workshop is to advise on a bioregionalisation of the Southern Ocean, including, where possible, advice on fine-scale subdivision of biogeographic provinces. Work on component (ii) should proceed in parallel, with submission of papers to either the Scientific Committee or its working groups. It is anticipated that further work towards the development of methods for the selection and designation of MPAs will be progressed by the Scientific Committee.

3.35 The Scientific Committee was invited to consider how individuals might contribute in advising on, and undertaking, the tasks outlined in SC-CAMLR-XXV/BG/24 in preparation for the 2007 workshop. These tasks include:

- (i) identification and collation of relevant datasets which will be of use in the workshop analysis;
- (ii) further development of a program of work to be undertaken during the workshop;
- (iii) review of existing bioregionalisation methods and approaches;
- (iv) undertaking fine-scale bioregionalisation analysis for areas of interest, particularly areas for which data are available.

3.36 Members were also encouraged to identify experts who might participate in the 2007 Bioregionalisation Workshop.

3.37 Papers addressing the topics identified in paragraph 3.35 should be submitted to the 2007 Bioregionalisation Workshop, in particular to provide reviews and background information on existing bioregionalisation methods and potential data sources.

3.38 Prof. J. Beddington (UK) noted that a bioregionalisation analysis may need to consider the effects of climate change, and that the results may need to be updated if and when new information becomes available.

3.39 Dr Constable noted that the methods adopted to undertake the bioregionalisation should be able to be used in the future to update the bioregionalisation if and when new information becomes available. He also noted that, with respect to climate change, the data from scenarios used by the Intergovernmental Panel on Climate Change could be used to explore how robust the bioregionalisation might be to changes arising from climate change.

3.40 Dr K. Shust (Russia) noted that Russia had considerable expertise in bioregionalisation based on analysis of data on the composition of fish fauna. This work resulted in the identification of eight ichthyo-geographic zones. He noted that other Members might contribute review papers based on biological, oceanographic and climatic data which would provide a basis for bioregionalisation.

3.41 Dr Constable noted that digital maps of existing bioregionalisations would be of particular value to the workshop, to allow comparison of the results of different approaches. Datasets used in the development of existing bioregionalisation work should also be made available to the workshop, in synoptic form where possible, to allow comparison with other datasets.

3.42 Prof. Moreno noted the importance of including data on the distribution of fishing effort, in order to identify areas that might be considered in the development of a system of MPAs.

3.43 The Scientific Committee congratulated the Bioregionalisation Workshop Steering Committee on its progress to date, noting its contribution to the aim to establish a harmonised regime for the protection of the Antarctic marine environment across the Antarctic Treaty System (CCAMLR-XXIV, paragraph 4.12).

3.44 Dr Constable presented SC-CAMLR-XXV/BG/7 on the outcomes of an independent Experts Workshop on Bioregionalisation of the Southern Ocean, held in Hobart, Australia, in September 2006. This workshop was hosted by WWF-Australia and the Antarctic Climate and Ecosystems Cooperative Research Centre (Hobart), and supported by Peregrine Adventures. The workshop was attended by 23 experts in their independent capacity. Members of the Bioregionalisation Workshop Steering Committee were invited to participate in the workshop, however only a few members were able to attend.

3.45 The aim of the Experts Workshop was to develop a proof of concept for a bioregionalisation of the Southern Ocean, to assist the Scientific Committee in its work on this topic.

3.46 The workshop addressed three main areas:

- (i) data to be incorporated in a bioregionalisation (using physical and environmental data, including sea-ice, oceanographic characteristics and surface chlorophyll, as the primary input);
- (ii) development of a statistical method for bioregionalisation, based on an approach previously presented at WG-EMM (Annex 4, paragraph 5.17), work by CEP (Environmental Domains analysis), and work by Australia and New Zealand for their respective EEZs;

- (iii) expert review of the bioregionalisation outcomes based on existing knowledge of the Southern Ocean.

3.47 A method was agreed which incorporated aspects of the four approaches listed in paragraph 3.46(ii). This method integrates a statistical approach with expert knowledge, and was successful in bringing together appropriate datasets. The ease with which additional data can be included using this method was also noted.

3.48 The primary regionalisation results corresponded with existing knowledge of frontal systems in the Southern Ocean, and also identified other features, such as the Weddell Gyre, the Scotia Arc and the Kerguelen Plateau. A secondary regionalisation introduced data on sea-ice and chlorophyll, and highlighted the heterogeneity of the coastal, shelf and seasonal sea-ice areas.

3.49 The workshop made substantial progress towards a method that could be used to undertake a bioregionalisation of the Convention Area, and established a proof of concept. Further work should focus on the introduction of other (particularly biological) datasets, and finer-scale analysis for particular areas of interest.

3.50 Dr Naganobu noted that the results of the Experts Workshop were important not only for fisheries management but also for Southern Ocean science.

3.51 The Scientific Committee congratulated the experts' group on its efforts, and welcomed the outcomes of the Experts Workshop. It was noted that this type of review has relevance not only for the work of the Scientific Committee, but also in a wider context.

3.52 Dr H.-C. Shin (Republic of Korea) enquired how temporal variation could be incorporated into a bioregionalisation. Dr Constable responded that the use of average values over long time series (e.g. for synoptic satellite data) was the approach used at the Experts Workshop for incorporating a temporal component into the analysis, but that variation over both short and longer time-scales should be considered further. He noted that temporal characteristics can be incorporated into a bioregionalisation in other forms such as through measures of variability or as proportions of time that particular conditions might be met.

3.53 Dr Grant introduced SC-CAMLR-XXV/BG/19 on the potential for the achievement of MPAs using CCAMLR conservation measures. This paper noted that it is important for the Scientific Committee to identify the most appropriate tools for the achievement of MPA objectives. These could include existing area-based conservation and management tools such as closed areas, as well as other geographically defined regulations. It was further noted that ongoing efforts to define appropriate tools for the development of protected areas will contribute to component (ii) of the work identified in paragraph 3.33, which should proceed in parallel to the bioregionalisation work.

3.54 ASOC introduced SC-CAMLR-XXV/BG/30 on achieving a network of MPAs in the Convention Area. ASOC welcomed the discussions on MPAs and bioregionalisation, and expressed its desire to continue participating in work on this topic.

3.55 Belgium expressed its keen interest in supporting the efforts of CCAMLR towards the creation of a network of MPAs and noted that bioregionalisation is a crucial step in the

process. In this regard, Belgium offered to host the 2007 Bioregionalisation Workshop in Brussels during the first or second week in August. The Scientific Committee welcomed and endorsed Belgium's offer and looked forward to a productive workshop.

Advice to the Commission

3.56 The Scientific Committee endorsed the Steering Committee's recommendation that its membership be expanded to include the conveners of the Scientific Committee working groups and Dr Dinter, an additional member nominated by CEP.

3.57 The Scientific Committee welcomed and endorsed Belgium's offer to host the Bioregionalisation Workshop in Brussels, in August 2007.

Interactions between WG-EMM and WG-FSA

3.58 In order to address some of the issues regarding interactions between WG-EMM and WG-FSA identified by the working groups, the conveners of those working groups proposed a one-day workshop in 2007 (to coincide with the meetings of WG-SAM and WG-EMM). The aim of this workshop would be to consider the development of ecosystem models to examine the effects of fisheries in fish-based ecosystems. The Scientific Committee agreed that, in the spirit of encouraging interactions between the working groups, this workshop would be co-convened by the two working group conveners.

3.59 It was recognised that information about fish-dependent predators, such as Antarctic shags (*Phalacrocorax bransfieldensis*), would be extremely useful. For example, shags have declined in numbers in the South Shetland Islands over the past 17 years, this is thought to be related to changes in the availability of their main prey, demersal fish (Casaux and Barrera-Oro, 2006). Dr E. Barrera-Oro (Argentina) suggested that these changes are likely to be related to the effects of the commercial fishery in the late 1970s.