

ECOSYSTEM MONITORING AND MANAGEMENT

WG-EMM advice

3.1 The Scientific Committee considered advice from WG-EMM relating to the staged approach to subdivide the precautionary catch limit for krill in Area 48 among SSMUs under the following five headings:

- (i) Stage 1 allocation of the precautionary krill catch limit among SSMUs in Subareas 48.1 to 48.3;
- (ii) validation and access to models advising on SSMU allocations;
- (iii) allocation subsequent to Stage 1;
- (iv) SSMUs in Subarea 48.4;
- (v) concerns beyond the competency of the Scientific Committee.

3.2 The Scientific Committee asked Dr Watters, as Convener of WG-EMM, to express its gratitude to WG-EMM for its work relating to the staged approach to subdivide the precautionary catch limit for krill in Area 48. The Scientific Committee endorsed its commitment to this work and looked forward to further advice on this subject in 2009.

Stage 1 allocation of the precautionary krill catch limit among SSMUs in Subareas 48.1 to 4.83

3.3 The Scientific Committee noted that in order to estimate an SSMU allocation for Stage 1, a number of tasks were necessary (Annex 4, paragraph 2.31).

- (i) Use of the best available data to estimate SSMU allocation proportions for:
 - (a) Option 2: estimates of predator demand in each SSMU from available predator abundance data and consumption rates;
 - (b) Option 3: estimates of the proportion of krill in each SSMU derived from the CCAMLR-2000 Survey;
 - (c) Option 4: the difference between estimates of krill standing stock and predator demand.
- (ii) Assessment of the relative risks under the different options using the modelling tools available (FOOSA, SMOM, EPOC). The risk assessments were based on yield multipliers that scaled the yield from zero, through the current trigger level, to $1.25 \times$ the precautionary catch limit.
- (iii) Calculation of the SSMU allocations using the proportions determined in (i) above, multiplied by the yield multiplier determined in (ii) above, multiplied by the yield (from the GYM).

3.4 The Scientific Committee agreed that considerable progress had been made in assessing the relative risks of the different allocation options, and noted that WG-EMM now considered that this was sufficient for Task 2 (paragraph 3.3(ii)) of the Stage 1 SSMU allocation (Annex 4, paragraph 2.101).

3.5 The Scientific Committee noted that WG-EMM had advised (Annex 4, paragraph 2.95) that the overall conclusions drawn from the risk assessment were:

- (i) Option 4 performs significantly worse than Options 2 and 3 across all (fishery, predator and krill) performance indicators;
- (ii) Options 2 and 3 appeared to perform equally well under a number of scenarios, with differences in performance of Options 2 and 3 between models being due to differences in model structure;
- (iii) under Options 2 and 3 the risk of negative impacts on predators was negligible at yield multipliers of 0.15 (the harvest rate consistent with the trigger level);
- (iv) under Options 2 and 3 the risk of negative impacts on predators increased at yield multipliers greater than 0.25 to 0.5 with penguins and fish being most significantly affected, seals affected to a minor degree and whales unaffected;
- (v) evaluation of Options 2 and 3 with the available models included allocations of 70 and 62% respectively of the total catch to pelagic SSMUs, where fishery performance will be significantly negatively impacted.

3.6 The Scientific Committee noted that WG-EMM advised that the risk assessment was drawn from results that:

- (i) predicted that the krill fishery (Annex 4, paragraphs 2.70 to 2.74) –
 - (a) may be forced to change its behaviour in pelagic areas where total krill biomasses are relatively high but where average densities are relatively low;
 - (b) may not be able to catch its allocated catch limit in some SSMUs due to the assumed nature of competition between itself and krill predators;
 - (c) may be prohibited from fishing in some SSMUs because the model simulates the estimation of krill biomass or predator demand to represent the process that would be undertaken in reality (but may provide results that are different to those that would be obtained in reality);
- (ii) may be negatively biased and lead to advice on SSMU allocations that was not as precautionary as intended, in which case the risk assessment should be considered as indicating minimum risks to the ecosystem for any given harvest rate (Annex 4, paragraphs 2.54 and 2.55);

- (iii) were conditioned on a calendar of events which specifies a step-change in krill abundance that was likely to have occurred with an uncertain magnitude and does not describe the dynamics of fish populations whose role in the ecosystem is an important source of uncertainty (Annex 4, paragraphs 2.76 to 2.83);
- (iv) were initialised by extrapolating results from the CCAMLR-2000 Survey (Annex 4, paragraphs 2.84 and 2.85).

3.7 The Scientific Committee also noted that there were a number of uncertainties in the risk assessment (Annex 4, paragraphs 2.54 and 2.102).

3.8 The Scientific Committee noted WG-EMM's advice that:

- (i) should the allocations appropriate to Options 2 to 4 be applied to the current fishery, the present catch in a number of SSMUs would be constrained even though the total annual catch is only 17% of the trigger level (Annex 4, paragraph 2.92);
- (ii) decisions regarding the current trigger level are matters for the Commission (Annex 4, paragraph 2.93).

3.9 The Scientific Committee noted that the current spatial distribution of catches more closely reflects that under Option 1, the historical fishing distribution. The Scientific Committee noted that WG-EMM could not provide explicit advice on the risks associated with distributions of catches under Option 1, which may apply as the total catch approaches the trigger level. However, the Scientific Committee noted that previous advice (SC-CAMLR-XXV, paragraph 3.11) had suggested that allocations based on historical fishing distribution would have greater negative impacts on the ecosystem than other options (Annex 4, paragraph 2.99).

3.10 Dr V. Bizikov (Russia) noted that the modelling work completed during WG-EMM this year was a significant step forward. However, he noted that the results should be considered as intermediate and not final. He explained that the work was extremely promising, but needed additional effort in two areas as these constituted areas of considerable uncertainty:

- (i) The numerical calendar used for modelling does not include fish. Fish are known to be of considerable importance in the marine ecosystem and this was therefore an area of considerable uncertainty.
- (ii) The CCAMLR-2000 Survey covered approximately 50% of the combined aerial extent of Subareas 48.1, 48.2, 48.3 and 48.4. In the WG-EMM modelling exercise, the CCAMLR-2000 Survey results had been scaled to cover the whole of this combined aerial extent. However, as krill is not likely to occur over the whole of this combined area, some attendant uncertainty was present.

3.11 Dr L. Pshenichnov (Ukraine) noted the recent progress made in the assessment of krill predators (Annex 4, paragraphs 5.1 to 5.40). Taking into account that the convener of WG-EMM mentioned in his report several times the word 'risk', Dr Pshenichnov thought it

would be important to summarise existing data concerning the spatial concentration of krill predators in coastal areas for each SSMU for modelling and/or for the future implementation of interim measures, to protect predators from the direct impacts of krill fishing.

3.12 Mr H. Matsushima (Japan) noted that there were still a number of problems with the models as they were currently formulated. Dr H.-C. Shin (Republic of Korea) also noted that the developed modelling scheme apparently fails to simulate the current krill fishery and its minimal impacts, which has been in stable operation for well over a decade without detectable problems. He indicated that this is contrary to reasonable expectation, and questioned where the further improvement could come from.

3.13 Dr Shin considered that there are considerable uncertainties with the estimates used in the models, and if they were underestimated for krill and overestimated for predators, the similar outcomes from Options 2 and 3 are not surprising but to be expected. This puts him in doubt of the extent of the risks attached to Options 2 and 3 and hence the utilities.

3.14 In response to the concerns raised by some Members, Dr Constable, as Convener of WG-SAM, emphasised that all models are approximations of reality and that all models have attendant uncertainties. He reminded the Scientific Committee that WG-SAM had scrutinised the three models (FOOSA, SMOM, EPOC) and that WG-SAM had considered that the models adequately dealt with uncertainty for the purposes of Stage 1 advice.

3.15 As Convener of WG-SAM, Dr Constable further noted that the advice provided by WG-EMM was well rounded and included a number of caveats, and he considered that the advice was the best possible, given the available data and resources. Dr Constable also noted that the review process had been undertaken according to the expectations of the Scientific Committee.

3.16 The Scientific Committee recalled that the Commission had previously endorsed past advice to follow a staged approach to subdivide the precautionary catch limit for krill in Area 48 among SSMUs (CCAMLR-XXVI, paragraph 4.18). Also, that the subdivision for Stage 1 advice should be based primarily on one of Options 2 (based on the spatial distribution of predator demand), 3 (based on the spatial distribution of krill biomass) and 4 (based on the spatial distribution of krill biomass minus predator demand) (CCAMLR-XXVI, paragraph 4.18).

3.17 The Scientific Committee also noted that the Commission was expecting such advice on Stage 1 in 2008 (CCAMLR-XXVI, paragraph 4.19). The Scientific Committee noted that WG-EMM had advised that Option 4 performs significantly worse than Options 2 and 3 across all (fishery, predator and krill) performance indicators; also that Options 2 and 3 appeared to perform equally well under a number of scenarios, with differences in performance of Options 2 and 3 between models being due to differences in model structure.

3.18 Dr Constable noted that advice from WG-EMM (Annex 4, paragraph 2.90) indicated that failure to choose an allocation option for subdividing the catch of krill amongst the SSMUs would have attendant risks for the ecosystem. He reminded the Scientific Committee that if CCAMLR did not follow the advice from WG-EMM, then it was *de facto* following an allocation strategy equivalent to Option 1, and that this had previously (SC-CAMLR-XXV, paragraph 3.11) been shown as likely to be harmful to the ecosystem. Dr Agnew commented

that, should CCAMLR not follow advice from WG-EMM, it would be essential to undertake risk assessments for Option 1, as had been comprehensively undertaken for Options 2, 3 and 4.

3.19 Following detailed discussion of the advice from WG-EMM (paragraphs 3.3 to 3.9) and discussion of the concerns raised about the advice (paragraphs 3.10 to 3.18), the Scientific Committee was unable to reach consensus.

3.20 Although the majority of Members endorsed the advice from WG-EMM, Mr Matsushima and Dr Shin considered that considerable uncertainty still remained in the Stage 1 risk analysis.

3.21 The Scientific Committee noted the generic nature of the concerns raised by Mr Matsushima and Dr Shin and asked that they provide explicit details to the next meetings of WG-SAM and WG-EMM.

Validation and access to models advising on SSMU allocations

3.22 Dr Bizikov noted that the models used for formulating Stage 1 advice were extremely complex as they were trying to capture very complex ecological processes. Consequently, he considered that it was critical that the CCAMLR community had the opportunity to examine the models in detail and to examine the model code.

3.23 Dr Holt reminded the Scientific Committee that the models had been scrutinised over many years and that they had been modified on an annual basis to take into account a number of concerns raised by WG-EMM. Dr Holt reminded the Scientific Committee that no model was able to capture perfectly the operation of an ecosystem and that all models had attendant caveats and assumptions. He noted that the advice from WG-EMM made very explicit a number of such caveats and assumptions, but that WG-EMM had nevertheless concluded that the models were suitable for providing Stage 1 advice. Dr Holt also reminded the Scientific Committee that the code for FOOSA had been available, via the Secretariat, for some time.

3.24 Dr Constable noted that all fisheries models were becoming increasingly complex. As Convener of WG-SAM he asked for advice from the Scientific Committee on what was needed to gain the trust and conviction of the wider community who were not experts in modelling. The Scientific Committee recognised that this was a real concern for CCAMLR as well as for the wider fisheries community.

3.25 At present, there are three models being developed to provide advice on SSMU allocations in Area 48. However, except for the model authors, few people in either the Scientific Committee or WG-EMM are sufficiently familiar with the complex operation of the models, including the preparation of input data, parameterisation of the models, calculations provided by the models and analysis of the results. The Scientific Committee noted that WG-EMM had advised that:

- (i) for models to be used in providing advice, they should be sufficiently developed for use by individuals other than the model developers. This would enable wider participation by Members, as needed, in the development, validation and review of results of assessments with respect to SSMU allocation.

- (ii) participation by Members in the assessment work is highly desirable and recommended that:
 - (a) sufficient documentation is provided with a model to guide its use by others;
 - (b) software, example input files, and test cases are submitted to the Secretariat for access by Members.

3.26 The Scientific Committee noted that all models applied for krill management are complex and their effective implementation requires that an independent and critical approach be taken. The Scientific Committee recognised that this would be ensured through the continuing considerations of WG-SAM in accordance with procedures in SC-CAMLR-XXVI, Annex 7, paragraph 6.3. The Scientific Committee therefore agreed that WG-SAM should continue to review the methodological implementation of models used for SSMU allocation.

Allocation subsequent to Stage 1

3.27 The Scientific Committee noted that:

- (i) the development of the models leading to the provision of advice for Stage 1 SSMU allocation had been technically challenging and developing models for advice in subsequent stages would be equally challenging, if not more so. Thus, for allocations subsequent to Stage 1, the Scientific Committee recognised that it would be necessary to allow sufficient time in order to develop models so that they were formulated appropriately (Annex 4, paragraph 2.100);
- (ii) a range of alternative climate-change scenarios would need to be considered as part of a broader- and longer-term risk assessment for subsequent stages (Annex 4, paragraph 2.30).

SSMUs in Subarea 48.4

3.28 The Scientific Committee noted that WG-EMM had reviewed information on land-based predators that could be used for subdividing Subarea 48.4 into SSMUs appropriately (Annex 4, paragraph 7.5). The Scientific Committee endorsed the partitioning of Subarea 48.4 with one coastal and one pelagic SSMU (Figure 1). The Scientific Committee noted that such a partitioning was consistent with the approach used for separating pelagic and coastal SSMUs in Subareas 48.1, 48.2 and 48.3.

3.29 The Scientific Committee recognised that future analyses of foraging density and species composition may indicate the need for further subdivision of the coastal SSMU into northern (encompassing the six northern-most islands) and southern (encompassing the remaining islands) areas when additional data become available.

Concerns beyond the competency of the Scientific Committee

3.30 Dr Agnew noted that the advice provided by WG-EMM included a number of associated caveats and that these could be characterised into two categories. Firstly, those that reflected scientific concerns, such as described by paragraphs 3.6(ii), (iii) and (iv); and secondly, other caveats that could be characterised as reflecting issues relating to the behaviour of the krill fishery and therefore of more direct concern to the Commission; these included those described in paragraphs 3.6(i) and 3.8.

3.31 Mr Matsushima stated that the current harvest level of krill was approximately 100 000 tonnes and that this is not impacting the ecosystem. He added that it was therefore not yet necessary to spatially apportion the precautionary catch limit and he would like to wait for the completion of the EPOC and SMOM models so that these models could be compared with FOOSA. Mr Matsushima noted that the current trigger level of 620 000 tonnes was therefore an adequate management tool for the present.

3.32 Dr Agnew noted the possibility that it followed from paragraph 3.9 that the current trigger may not be as precautionary as previously assumed if the distribution of catches continues to follow the historical pattern. He reminded the Scientific Committee of WG-EMM's deliberations on this matter (Annex 4, paragraph 2.90).

3.33 Dr Nicol reminded the Scientific Committee that the existing trigger level of 620 000 tonnes is an aggregate of the highest annual commercial catches from each of the subareas in Area 48. At no point in the history of the krill fishery has a catch as high as 620 000 tonnes ever been taken. Dr Nicol reminded the Scientific Committee that the subdivision process was to ensure that such a large catch could not be taken from a restricted area.

3.34 The Scientific Committee noted that these issues were more appropriately the concern of the Commission rather than the Scientific Committee. The Scientific Committee therefore agreed that it should advise the Commission of these issues.

Advice to Commission

3.35 The Scientific Committee advised the Commission that:

- (i) the Scientific Committee maintained its commitment to the staged approach for subdividing the precautionary catch limit for krill in Area 48 (paragraph 3.2);
- (ii) detailed advice had been received from WG-EMM about the risk analysis for Stage 1 (paragraphs 3.3 to 3.9), and that considerable progress has been made in assessing the relative risks of the different allocation options. However, the Scientific Committee had been unable to reach consensus over this advice (paragraphs 3.19 and 3.20) and further work was still necessary before calculation of the SSMU allocations could be made (paragraphs 3.3 and 3.4);
- (iii) subdividing the precautionary catch limit for krill in Area 48 among SSMUs would affect the behaviour of the krill fishery under the scenarios examined by

WG-EMM (paragraphs 3.6(i), 3.8 and 3.30). This would potentially become more pronounced as catches increased such that it would not be feasible for the fishery to take the full catch limit from the current fishing grounds.

3.36 The Scientific Committee wished to bring to the attention of the Commission that some Members considered that it was not yet necessary to spatially apportion the precautionary catch limit and that the current trigger level of 620 000 tonnes was an adequate management tool for the present (paragraph 3.31), while most Members considered the current trigger level of 620 000 tonnes may not be as precautionary as previously assumed (paragraphs 3.32 and 3.33; Annex 4, paragraph 2.90).

3.37 The Scientific Committee asked the Commission to endorse the partitioning of Subarea 48.4 as proposed, with one coastal and one pelagic SSMU (paragraphs 3.28 and 3.29).

Report of WG-EMM-STAPP (Status and Trend Assessment of Predator Populations)

3.38 The Predator Survey Workshop was held at CCAMLR Headquarters, Hobart, Australia, from 16 to 20 June 2008, and was reported in WG-EMM-08/8. The workshop was convened by Dr Southwell. Participants at the workshop included two experts from SCAR (Ms Patterson-Fraser and Dr Raymond) and an independent invited expert (Dr Fewster). A report from Dr Fewster on the workshop was reviewed in Annex 4, paragraph 5.1.

3.39 The workshop provided the following recommendations and advice (Annex 4, paragraph 5.7) at different time scales:

- (i) Immediate –
 - (a) recent survey work in Area 48 provides major improvements in the state of knowledge about the abundance of crabeater seals, fur seal pup production in the South Shetland Islands, macaroni penguins at South Georgia and white-chinned petrels at South Georgia;
 - (b) aerial surveys of Antarctic fur seals at South Georgia are scheduled for completion in the 2008/09 season;
 - (c) the continued development of a new database containing existing penguin count data from a number of sources that can serve as a basis for the production of large-scale abundance estimates;
 - (d) the development of two new methods to account for bias and uncertainty in raw count data when estimating total abundance that provide complimentary utility for estimating SSMU-specific abundance;
 - (e) a major gap in abundance data for priority species is for flying seabirds throughout Area 48, except for white-chinned petrels at South Georgia. Given the lack of land-based data for this group, the workshop recommended that WG-EMM invite submissions on at-sea data for flying

seabirds in Area 48 for consideration at WG-EMM-09. The workshop identified US AMLR summer cruise data, US-LTER summer and winter cruise data, and BAS data at South Georgia and across the Scotia Sea as potential datasets for analysis.

(ii) Short-term (intersessional work for submission to WG-EMM-08) –

The development of SSMU-scale estimates of penguin abundance as an illustration of the compiled database were provided in a document submitted to WG-EMM.

(iii) Medium-term (intersessional work for WG-EMM-09) –

- (a) if feasible, production of SSMU-specific crabeater seal abundance estimates based on habitat modelling;
- (b) the anticipated completion of the Antarctic fur seal survey at South Georgia in early 2009 will provide an important update to the existing abundance estimates from 1991;
- (c) further development and testing of the new estimation procedures for penguins, and implementation of those procedures to quantify bias and uncertainty in adjusting raw counts.

(iv) Long-term work –

- (a) recent count data for penguins in the western South Shetland Islands and eastern Antarctic peninsula;
- (b) count data for flying seabirds throughout Area 48;
- (c) adjustment data for most species in most areas, particularly strategic collection of adjustment data to improve estimation of penguin abundance;
- (d) development of alternate survey methods for large penguin colonies.

3.40 The Scientific Committee noted that the work of WG-EMM-STAPP represents a substantial contribution to the work of CCAMLR and for quantifying predator abundance within SSMUs (Annex 4, paragraph 5.8). Notable features of this contribution include:

- (i) the combined database of penguin count data, comprising data collected under CEMP, data from the ASI and historical data from the literature (this database will eventually be made available to CCAMLR, and access will then be governed by the Rules for Access and Use of CCAMLR Data) (Annex 4, paragraphs 5.9 and 5.10);
- (ii) the analysis of APIS data, by BAS, on crabeater seal distribution and abundance (Annex 4, paragraph 5.11);

- (iii) identification of geographic areas with poor coverage, where future survey work can be focused (e.g. the Antarctic Peninsula East SSMU) (Annex 4, paragraph 5.12);
- (iv) attempts towards estimating uncertainty in predator abundance estimates that will be particularly useful for modelling (Annex 4, paragraph 5.13).

3.41 The Scientific Committee noted that the Predator Survey Workshop was the first stage of a multi-stage process with the ultimate goal of regional-scale estimates of predator abundance and consumption, and agreed that future work should also include fish predators.

Advice on estimates of krill B_0

3.42 The Scientific Committee noted the importance of estimating uncertainties and providing measures, such as probability density functions, of confidence in estimates of B_0 (Annex 4, paragraph 5.112). The Scientific Committee considered the implication this may have on the estimate of B_0 and recalled paragraph 2.20(i) of WG-EMM-07 (SC-CAMLR-XXVI, Annex 4) in relation to estimation of B_0 , which states:

‘A consistent set of protocols should be maintained for a period of five years. At the end of this period, any improvements to these protocols should be agreed on and implemented. This would include the reanalysis of existing datasets. However, it was also recognised that mid-period improvements in acoustic protocols will likely be in the peer-reviewed literature where appropriate.’

3.43 The Scientific Committee reaffirmed its agreement to this position. The Scientific Committee also noted that this paragraph refers specifically to the use of protocols in setting the precautionary catch limit and indicated that it would welcome submissions on revisions and updates to acoustic protocols so that these could be assessed by SG-ASAM at the earliest opportunity (Annex 4, paragraph 5.113). In doing so the Scientific Committee recognised that protocols for estimating B_0 will continue to be refined and improved into the future.

Climate-change impacts

3.44 Discussion of climate-change impacts was taken under Agenda Item 7.

Revised agenda and long-term work plan for WG-EMM

3.45 The Scientific Committee reviewed a proposal by WG-EMM for revising and structuring WG-EMM’s future agenda (Annex 4, paragraphs 8.7 to 8.12). The proposal was recommended to facilitate the achievement of long-term objectives while simultaneously maintaining the flexibility needed to address the annual requirements for scientific review and advice that will be expected by the Scientific Committee and the Commission.

3.46 The Scientific Committee reaffirmed that at least four topics require work over the long term, all of which have previously been endorsed by the Scientific Committee or have been identified as a topic of interest to the Commission:

- (i) The development and evaluation of feedback management strategies for the krill fishery, including work to estimate predator abundance and demand and to support the staged development of the krill fishery in Area 48 (e.g. SC-CAMLR-XXVI, paragraph 3.36(vii)).
- (ii) The development and application of methods to facilitate the conservation of marine biodiversity in the Convention Area, including work to identify VMEs (e.g. SC-CAMLR-XXVI, paragraph 14.9) and define candidate MPAs (e.g. SC-CAMLR-XXVI, paragraph 3.87) and to achieve a harmonised approach (e.g. SC-CAMLR-XXV, paragraph 3.32) within the Antarctic Treaty System and within CCAMLR.
- (iii) Consideration of the ecosystem effects of fishing for finfish (e.g. SC-CAMLR-XXVI, paragraph 3.99), including further collaboration with WG-FSA.
- (iv) Consideration of the impacts of climate change on the Antarctic marine ecosystem (e.g. CCAMLR-XXVI, paragraph 15.36).

3.47 The Scientific Committee agreed that focus topics (like those included in WG-EMM's agenda for 2008) provided a mechanism to facilitate requirements for short-term advice, and that long-term work objectives should form the primary items of WG-EMM's future agenda. The Scientific Committee also noted that the topic of climate change was a cross-cutting issue that could be considered under multiple agenda items.

3.48 The Scientific Committee endorsed the proposed structure for the future agenda of the Working Group as follows:

- (i) Introduction (opening of the meeting, adoption of the agenda and appointment of rapporteurs, review requirements for advice and interaction with other working groups);
- (ii) Focus topic (to be determined on an annual basis with priority given to topics that relate to needs for short-term advice);
- (iii) Ecosystem effects of fishing for krill (krill, dependent predators, the fishery and scientific observation, surveys and monitoring, climate impacts and feedback management strategies);
- (iv) Ecosystem effects of fishing for finfish (fish, dependent predators, fisheries and scientific observation, surveys and monitoring, climate impacts and collaboration with WG-FSA);
- (v) Spatial management to facilitate the conservation of marine biodiversity (VMEs, protected areas, and harmonisation of approaches, both within CCAMLR and across the Antarctic Treaty System);
- (vi) Advice to the Scientific Committee and its working groups;

- (vii) Future work;
- (viii) Other business;
- (ix) Adoption of the report and close of the meeting.

3.49 The Scientific Committee noted that a focus topic might not be required every year and that, generally, focus topics should not occupy more than two to three days of WG-EMM's annual meeting. The Scientific Committee also indicated that focus topics should be agreed at the preceding meeting of SC-CAMLR where the conveners of the working groups and the Chair of the Scientific Committee can consult with Members. This would also provide an opportunity for considering the time required for, and timing of, the focus topics.

Management of protected areas

3.50 The WG-EMM Convener summarised the discussion and advice derived from the focus topic 'to progress the implementation of spatial management measures that aim to facilitate the conservation of marine biodiversity' (Annex 4, paragraphs 3.1 to 3.78).

3.51 Some Members expressed concern about the priority areas identified by WG-EMM for further work on the development of MPAs (Annex 4, Figure 12), since the process of secondary bioregionalisation has not been completed (SC-CAMLR-XXVI, Annex 9, Figure 4).

3.52 Dr X. Zhao (China) stated that China is a new Member of the Commission, and was not involved in Scientific Committee's previous work on bioregionalisation; he expressed his sincere appreciation of all the inputs made by those Members actively involved. He further noted that, since there are still some concerns and different views from the floor, he encouraged further work by WG-EMM to consolidate different views on this issue.

3.53 It was noted that Figure 12 in Annex 4 was based on an analysis which had previously been recognised to demonstrate heterogeneity in marine ecosystems (SC-CAMLR-XXV, paragraph 3.48). Figure 12 simply identifies areas which show a high level of heterogeneity and are therefore likely to contain complex biological and environmental characteristics. In order to better utilise limited resources available to CCAMLR, these complex areas were considered by WG-EMM to be appropriate regions in which to focus further work on the development of MPAs.

3.54 It was further noted that focused work on the topic of MPAs began in 2000 and that progress to date has included scientific research and modelling activities, several workshops and discussions within the Scientific Committee and its working groups and the Commission (e.g. CCAMLR-XXVI, paragraph 7.18). The reports of these meetings and workshops were noted as information resources.

3.55 The Scientific Committee:

- (i) recalled that recent discussions by CCAMLR and the CEP have concluded that the issues of where and how to establish a system of marine areas for the

conservation of biodiversity in the Southern Ocean should be addressed as a matter of priority (CCAMLR-XXIII, paragraph 4.13; CEP IX Final Report, paragraphs 94 to 101) (Annex 4, paragraph 3.71);

- (ii) agreed that the existing benthic and pelagic bioregionalisations developed by the 2007 Bioregionalisation Workshop were adequate for use in such work, although further refinement may be undertaken, and encouraged work to further develop the BRT method (Annex 4, paragraph 3.72);
- (iii) noted that a number of methods could be used for designing a representative system of MPAs, including, *inter alia*, bioregionalisation and/or systematic conservation planning, and endorsed using MARXAN as one feasible method for undertaking the latter (Annex 4, paragraph 3.76);
- (iv) agreed that it should, as a priority, continue the process of consolidating scientific views to maintain a common basis for the development of representative systems of MPAs, as agreed by the Commission (CCAMLR-XXVI, paragraph 7.18). The development of representative systems of MPAs should focus on, but not be limited to, the priority areas identified by WG-EMM in Figure 12 of Annex 4. Therefore, Members were encouraged to use appropriate methodologies to further this work (Annex 4, paragraph 3.77).

Interactions between WG-EMM and WG-FSA

3.56 The Scientific Committee endorsed the commitment to further collaboration between WG-EMM and WG-FSA that is implied by the new agenda agreed for WG-EMM which includes an item entitled 'Ecosystem effects of fishing for finfish' (paragraph 3.48).

3.57 Following this endorsement, the Scientific Committee reviewed the background to, and proposed topics for, the Second Workshop on Fisheries and Ecosystem Models in the Antarctic (FEMA2).

3.58 The Scientific Committee endorsed the proposal made by the Conveners of WG-EMM and WG-FSA that FEMA2 be structured in a manner that treats fisheries for toothfish in the Ross Sea as a case study of how ecosystem considerations can be used to advise on the management of fisheries that target finfish.

3.59 The Scientific Committee reviewed four topics that the conveners proposed for consideration during FEMA2, and endorsed the view, expressed by both working groups, that FEMA2 should aim to evaluate whether the level of escapement currently espoused in the existing decision rules for toothfish in the Ross Sea is sufficiently precautionary when these fish are viewed as important prey as well as predators (Annex 4, paragraphs 8.3 and 8.5; Annex 5, paragraph 13.15).

3.60 The Scientific Committee agreed to the following terms of reference for FEMA2:

- (i) Review existing information on predator species (Weddell seals, toothed whales etc.) in the Ross Sea known to consume *Dissostichus* spp. This may be aided

through a comparative analysis of the importance of *Dissostichus* spp. as prey in different regions throughout the Southern Ocean. The review should include:

- (a) abundance of predator species
 - (b) temporal and spatial extent of predation foraging ranges
 - (c) degree of overlap in vertical distribution with toothfish fishery
 - (d) size composition of *Dissostichus* spp. consumed by other predators
 - (e) daily consumption of predators
 - (f) proportion of predator population eating *Dissostichus* spp.
- (ii) Consider the current estimates of biomass, distribution and productivity of *Dissostichus* spp. in the Ross Sea, as well as annual removals by the fishery.
- (iii) Review rationale for existing escapement level of 0.5 for *Dissostichus* spp., and determine if 0.5 is an appropriately precautionary level of escapement in the Ross Sea, given the predator requirements, foraging ranges, toothfish stock biomass, distribution and productivity.
- (iv) Review other methods or options for mitigating risks in the Ross Sea toothfish fishery, including:
- (a) area closures
 - (b) season closures.
- (v) Development of methods to monitor changes in predators in the Ross Sea including:
- (a) Weddell seals
 - (b) toothed whales
 - (c) others?

3.61 The Scientific Committee agreed that, in considering the agreed topic of FEMA2, it would be useful for the workshop to conduct a general discussion about appropriate escapement levels when the age (or size) at which fish recruit to a fishery is contrasted with the age (or size) at which the fish are vulnerable to predation by other predators. It was also suggested that the workshop might benefit from considering previous work conducted by Thomson et al. (2000).

3.62 The Scientific Committee agreed that the Conveners of WG-EMM and WG-FSA should co-convene FEMA2 and that the workshop should be conducted as a focus topic (Annex 4, paragraph 8.11) within the agenda of WG-EMM.

3.63 In preparing for the workshop, the Conveners of WG-EMM and WG-FSA should consider whether technical review of quantitative methods could usefully be provided by WG-SAM. In cases where such review is appropriate and required, discussions with the Convener of WG-SAM will be required to fit such work into the agenda of WG-SAM.

3.64 The Scientific Committee noted that interactions between WG-EMM and WG-FSA are likely to occur on topics related to the by-catch of fish in the krill fishery and the depredation of toothfish by marine mammals.

3.65 With respect to this latter topic, the Scientific Committee noted that an experimental trial using trotlines fitted with a ‘cachalotera’ yielded mixed results. Although there was some evidence of a successful reduction in cetacean predation, this was offset by the poorer condition of skates and toothfish coming off the line, which may potentially make them unsuitable for tag and release (Annex 5, paragraphs 3.81 to 3.83). The Scientific Committee encouraged further studies using this system.