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Report of the Joint CEP / SC-CAMLR Workshop on Climate Change and Monitoring, Punta Arenas, Chile, 19-20 May 2016.

Report of the Joint CEP/SC-CAMLR Workshop on Climate Change and Monitoring

Punta Arenas, Chile 19-20 May 2016

1. Introduction

1.1 The second Joint Workshop of the Committee on Environmental Protection (CEP) and the CCAMLR Scientific Committee (SC-CAMLR) was held at the Dreams Hotel, Punta Arenas, Chile, from 19 to 20 May 2016. The workshop was co-convened by Dr Susie Grant (United Kingdom) and Dr Polly Penhale (United States).

1.2 The co-conveners thanked Chile for hosting the workshop, and expressed their particular gratitude to Ambassador Francisco Berguño, Macarena Quezada Borel and Ángel Garcia Fernandez (Ministerio de Relaciones Exteriores), the Instituto Antárctico Chileno (INACH), and the technical support team for their assistance. The Antarctic Treaty Secretariat and the CCAMLR Secretariat were also thanked for their support before and during the workshop.

1.3 The workshop was attended by 43 participants (listed in Appendix 1).

1.4 The workshop report was prepared by the co-conveners, with assistance from Dr Ewan McIvor, Prof Eugene Murphy, Dr Marta Soffker, Dr Keith Reid, Dr Mercedes Santos, Dr Christopher Jones, Dr Andrew Constable, Ms Birgit Njåstad and Dr Aleks Terauds.

2. Background and Terms of Reference

2.1 At their respective annual meetings in 2014, CEP (CEP XVII Report, paragraph 52) and SC-CAMLR (SC-CAMLR-XXXIII Report, paragraph 10.3) endorsed the proposal to hold a second Joint CEP/SC-CAMLR Workshop in 2016. The agreed general scope of the workshop was to identify the effects of climate change that are considered most likely to impact the conservation of the Antarctic, and to identify existing and potential sources of research and monitoring data relevant to the CEP and SC-CAMLR.

2.2 The 2016 joint workshop aimed to focus further attention on two of the five areas of common interest identified by the first joint CEP/SC-CAMLR workshop held in 2009. Climate change and related research and monitoring are key elements of the current agendas and work plans of the SC-CAMLR and the CEP, where the development of joint approaches and understanding is particularly pertinent.

2.3 The general scope of the workshop was to identify the effects of climate change that are considered most likely to impact the conservation of the Antarctic, and to identify existing and potential sources of research and monitoring data relevant to the CEP and SC-CAMLR.

2.4 The workshop terms of reference were to:

i. Identify those drivers or effects for which measurable responses are required to support the goals of the CEP and SC-CAMLR;

ii. Consider existing monitoring programs to determine whether the data is sufficient to assess climate change impacts or whether new approaches are needed; and

iii. Define mechanisms for practical cooperation, including the sharing of data and information.

2.5 The workshop programme is provided in Appendix 2, and a complete list of workshop papers is in Appendix 3.

2.6 The workshop included a series of presentations which provided background information and set the scene for discussion of each of the Terms of Reference. Summaries of each presentation were submitted as workshop papers, and are reproduced in Appendix 4. Additional background papers relevant to the Terms of Reference were submitted to the workshop, and are referred to in the following sections.

3. Update on CEP and SC-CAMLR activities of mutual interest

3.1 The CEP Chair, Mr Ewan McIvor (Australia) presented the outcomes from the first joint CEP / SC-CAMLR workshop held in Baltimore in April 2009 (*Workshop Paper XP003 – presentation summary; see Appendix 4*). He noted that both committees had agreed that the first workshop was successful in enhancing the shared understanding of roles and responsibilities, and in identifying several opportunities for improved cooperation.

3.2 The CEP Chair also presented an update on CEP activities on the five matters of mutual interest discussed at the first joint workshop (*Workshop Paper XP002 – presentation summary; see Appendix 4*). He noted that the CEP has welcomed the annual exchange of observers and reports with SC-CAMLR, and has moved its consideration of reports from other organizations to earlier in its agenda to ensure relevant developments can be considered throughout the meeting.

3.3 The former SC-CAMLR Chair, Dr Christopher Jones (United States) presented an update on SC-CAMLR activities since 2009 on the five matters of mutual interest (*Workshop Paper XP006 – presentation summary; see Appendix 4).* He noted that SC-CAMLR has also welcomed the continuing exchange of observers and reports with the CEP.

Discussion

3.4 The workshop thanked Mr McIvor and Dr Jones for their presentations, which provided a valuable opportunity for the CEP and SC-CAMLR to exchange information on their activities since the 2009 joint workshop, and to consider progress made on matters of mutual interest.

3.5 With regard to ecosystem and environmental monitoring, it was noted that the CCAMLR Ecosystem Monitoring Program (CEMP) focused on the krill centric ecosystem and krill predators. The question was asked whether CEMP could be broadened to toothfish dependent indicators. Dr. Jones responded that this was possible should a good rationale and solid research plan including standard methods be proposed to members.

3.6 The workshop noted that species diversity was very important in developing a system of ecosystem indicators, but that functional diversity was another critical aspect to consider when assessing the status of the ecosystem. Knowledge on the evolution of species and phylogenetics also were seen as critical in understanding the ecosystem, including knowledge on species that spend part of their life cycle north of the Convention Area.

3.7 Research and monitoring were seen to be critical to progress an understanding of climate change impacts in both the CEP and SC-CAMLR. While Research and Monitoring Plans are required elements in the CCAMLR development of MPAs, the role of for monitoring with regard to ASPAs is less well-defined. The workshop noted that understanding the role of climate change impacts in MPAs and ASPAs would require research and monitoring, best conducted by the broader scientific community, and not left to member(s) that proposed the designation.

3.8 The workshop recognized that considerations of climate change and related ecosystem and environmental monitoring are relevant to all of the other three topics of mutual interest (biodiversity and non-native species, specially protected species, and spatial management and protected areas). Further discussion on spatial management and protected areas in the context of climate change are reported in Section 9.

3.9 Table 1 provides a summary of progress on the five topics of mutual interest to both Committees, including recent achievements and plans for future actions. The workshop suggested that this table could be updated prior to future joint meetings, in order to provide an organized means to communicate progress, and to assist both Committees in sharing information and planning future work.

3.10 It was agreed that the identification of a ‘lead body’ for each of the topics of mutual interest had proved to be a useful mechanism for clarifying responsibilities and organizing work.

3.11 The workshop also noted that while there is no formal geographic demarcation between the marine areas of interest to SC-CAMLR and the CEP (and there is some overlap), the separation of activities between the two bodies on a nearshore/offshore basis has generally worked well. This has been very effective for example in the management of land-based predator colonies, with SC-CAMLR considering the effects of fishing on these colonies, and the CEP considering other, land-based human activities. However, it was agreed that communication on such issues of joint interest could still be improved.

4. Existing CEP and SC-CAMLR work on climate change

4.1 Ms Birgit Njåstad (Norway) presented an outline of the CEP Climate Change Response Work Programme (CCRWP) and its relevance for joint CEP and SC-CAMLR efforts (*Workshop Paper XP007 – presentation summary; see Appendix 4).*

4.2 One of the key functions of the Committee for Environmental Protection (CEP) is to provide advice to the Antarctic Treaty Parties on the state of the Antarctic environment as a basis for sound and relevant management and governance. Climate and climate change is one of the most important and obvious factors influencing the state of the Antarctic environment and are consequently of key concern to the CEP. At its meeting in 2015 the CEP adopted a Climate Change Response Work Programme (CCRWP). The objective of this CCRWP is to:

> *"provide a dynamic mechanism for identifying and revising goals and specific actions by the CEP to support efforts within the Antarctic Treaty System to prepare for, and build resilience to, the environmental impacts of a changing climate and the associated implications for the governance and management of Antarctica."*

4.3 The CCRWP is focused around a number of priority issues and specifies gaps, needs and tasks related to these. It includes a large number of marine issues that are of relevance both to the CEP and SC-CAMLR, in particular issues related to:

i) change to marine near-shore abiotic and biotic environment,
ii) ecosystem change due to ocean acidification,
iii) marine species at risk due to climate change, and
iv) marine habitats at risk due to climate change.

4.4 The workshop agreed that the CEP and SC-CAMLR need to explore and consider manners to jointly tackle challenges within these broader themes that are of interest and importance to both committees.

4.5 Dr Andrew Constable (Australia) presented an outline of SC-CAMLR work on climate change (*Workshop Paper XP019 – presentation summary; see Appendix 4),* noting that the effects of climate change also include the effects of ocean acidification.

4.6 Dr Constable noted that Articles II and IX of the CCAMLR Convention provide the impetus for work in the Scientific Committee on the effects of climate change, in order to provide, in a timely manner, the 'best scientific evidence available' on three issues:

1. Risks of climate change threatening the conservation of species, changing the vulnerability of species and/or foodwebs to the effects of fishing, or increasing the risk of invasive marine species in the CCAMLR area;
2. Status of Antarctic marine living resources (AMLR) and the Antarctic marine ecosystem relative to the Reference State and whether actions may be required to conserve AMLR because the Reference State had changed;
3. Requirements for adapting harvest strategies in the future so as fishing does not increase the risk of failing to conserve AMLR in the long term.

4.7 The state of knowledge on impacts of climate change on Southern Ocean ecosystems was summarised. Climate change has been appearing regularly in discussions in SC-CAMLR since 2002 and came on to the agenda of SC-CAMLR in 2008. A constant theme since then has been to develop a risk assessment framework for identifying when climate change impacts may need attention from the Commission, along with developing a 'state of

environment' report. Most work in SC-CAMLR has been within the Working Group on Ecosystem Monitoring and Management (WG-EMM). In this regard, WG-EMM has focussed on the effects of climate change on Antarctic krill and its habitats, along with a proposal to manage ocean areas adjacent to the Antarctica Peninsula uncovered by ice shelf collapse. SC-CAMLR does not yet have an explicit strategy and timetable of work for (i) assessing climate change impacts on AMLR or (ii) providing advice to the Commission on how to deal with climate change. Nevertheless, many Members have engaged with developing approaches to address climate change impacts when developing strategies on at least three current issues in SC-CAMLR: (i) the design of krill feedback management strategies to accommodate the potential for changing ecosystem state in the absence of fishing, (ii) proposals for representative marine protected areas incorporate considerations of adaptation of the system to climate change as well as having reference areas for measuring climate change impacts, (iii) the development of food web and ecosystem models for evaluating management and conservation strategies.

4.8 Dr Constable also described how the work of the IMBER-SCAR program Integrated Climate and Ecosystem Dynamics of the Southern Ocean (ICED) and the SCAR-SCOR Southern Ocean Observing System (SOOS) can help both CCAMLR and CEP address the effects of climate change on their interests. They are complementary programs working on, respectively, (i) assessments and modelling of change in Southern Ocean ecosystems (an ICED conference is to be held in 2018) and (ii) the design and implementation of observing systems and the integration and facilitation of access to the observational data. Resolution 30/XXVIII (2009) encourages Members to become engaged in these two programs. The resolution refers to ICED and the Southern Ocean Sentinel, the latter of which has had its aims incorporated into both ICED and SOOS. SC-CAMLR and CEP would benefit from working with these two bodies to develop the capabilities necessary to deliver the advice on the three climate change issues of importance to them.

Discussion

4.9 The workshop thanked Ms Njåstad and Dr Constable for their presentations, noting that considerable progress has been made by both the CEP and SC-CAMLR on work related to climate change since the previous joint workshop. Climate change is now a well-established item on the agendas of both Committees, with a wide range of activities being conducted and reported each year.

4.10 It was agreed that the CCRWP is particularly useful in setting out priorities and identifying gaps and requirements, and that it presented a well-ordered set of priorities, highlighting areas in which joint cooperation between the Committees would progress work. The workshop noted that SC-CAMLR could benefit from undertaking a similar exercise, based initially on the overlapping priorities already identified in the CCRWP. It was suggested that this could be discussed during the SC-CAMLR Priority Setting Symposium being held in advance of its next meeting. The SC-CAMLR Chair hoped that SCAR would also attend this symposium.

4.11 The workshop discussed the issue of reference states and ecosystem baselines, noting the difficulty of addressing these topics during periods of environmental change. It agreed that it will be important to consider factors such as the potential movement of non-native species into the Antarctic, where ecosystem changes at the boundaries of the Convention Area may be viewed as an "early warning system". The recovery of whale populations may

also have a strong influence on current baselines, and the workshop agreed that ecosystem and foodweb modelling are likely to be important tools in addressing this topic.

5. Scientific activities relevant to the work of the CEP and SC-CAMLR on climate change

5.1 Dr Aleks Terauds (SCAR) presented a summary of SCAR activities on climate change and monitoring (*Workshop Paper XP004 – presentation summary; see Appendix 4).* SCAR also presented *Workshop Paper XP005* – Antarctic Climate Change and the Environment 2016 update.

5.2 SCAR undertakes a diverse range of activities on climate change and monitoring. These include the facilitation and coordination of research into the physical and biological manifestations of climate change, the dissemination of research findings at international meetings and the provision of climate related advice to a range of bodies, including the Committee for Environmental Protection (CEP) and the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). The mechanisms through which these activities are undertaken are diverse and include the Expert Group on Antarctic Climate Change and the Environment (ACCE), SCAR Scientific Research Programs, and other Expert and Action groups under the Standing Scientific Groups. From a monitoring perspective, SCAR supports the Southern Ocean Observing System (SOOS) and the Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) groups, and is also supporting the development of the Antarctic Nearshore and Terrestrial Observing System (ANTOS).

5.3 Prof Eugene Murphy (SCAR) presented an outline of the Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) programme (*Workshop Paper XP014 – presentation summary; see Appendix 4).* SCAR also presented *Workshop Paper XP015* – Report on the activities of the Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) programme.

5.3 ICED is a regional programme of the joint International Geosphere-Biosphere Programme (IGBP)-SCOR Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) Programme and is closely linked with SCAR. ICED is undertaking an integrated circumpolar approach to improve our understanding of change and the implications for Southern Ocean ecosystems and for management of human impacts. A diverse range of multidisciplinary research is underway through core activities such as historical data rescue and synthesis, fieldwork, and modelling. Considerable progress has been made in understanding the structure and functioning of ecosystems, modelling species and food webs, and with qualitative assessments of change. These studies have also identified an urgent requirement for the systematic development of quantified understanding of the life cycles of key species and of food web processes throughout the Southern Ocean. ICED current major focus is on the further development of assessments of the impacts of change and the generation of models and scenarios for projections of future change. ICED's research and associated activities have enabled the Southern Ocean scientific community to work more closely together to consider some of the key challenges and potential solutions. These activities are developing the basis for integrated approaches for analyses of climate-ecosystem interactions, which can inform decision making in ecosystem-based management.

5.4 Four additional workshop papers described climate change research being undertaken by national programmes:

- *Workshop Paper XP009* (Russian Federation) – Current Russian results of studies of climate variability at present and in the past
- *Workshop Paper XP012* (Chile) – Climate Change research conducted by the Chilean Antarctic Program: I. Identifying key species, factors and processes in marine ecosystems of the Antarctic Peninsula
- *Workshop Paper XP013* (Chile) – Climate Change research conducted by the Chilean Antarctic Program: II. The terrestrial realm, steady state and horizons.
- *Workshop Paper XP016* (Chile) – Population genetic structure of *Sanionia uncinata* moss: A focus to support conservation and management plans in Antarctica

Discussion

5.5 The workshop thanked Dr Terauds and Prof Murphy for their presentations, and expressed particular appreciation for this opportunity to learn more about the very wide range of relevant activities being undertaken by SCAR and its Scientific Groups and Standing Groups, as well as other associated programmes including ICED and SOOS.

5.6 It was agreed that this joint workshop had been very timely, given the maturity now being reached by programmes such as ICED and SOOS following a period of development in recent years. The representatives from SCAR, ICED and SOOS indicated their strong desire to contribute to the work of the CEP and SC-CAMLR wherever possible.

5.7 The workshop warmly welcomed the potential for further scientific contributions from SCAR, ICED and SOOS. It noted that the CEP and SC-CAMLR will need to articulate clear and specific questions to be addressed to scientific programmes in order for such interactions to be successful.

5.8 The workshop noted that the SCAR Horizon Scan had been an important priority setting activity, but that it did not result in much focus on marine ecosystems and applied research. Dr Terauds noted that SCAR is now undergoing a formal strategic planning exercise which involves stakeholder input, and that this is a good time to engage in the process with an aim of increasing cooperation between SCAR, CEP and SC-CAMLR. Ongoing and future targeted research programs such as ICED and SOOS provide opportunities for collaboration. One suggestion to increase collaboration could be to include further expertise in SC-CAMLR related research in the SCAR SCATS committee, which Dr. Terauds noted could be a consideration.

5.8 SC-CAMLR participants noted that the ability to predict where changes are most likely to take place, for example via modelling components within the ICED programme, would provide good input into decision rules set up to manage harvesting under climate change.

5.9 The workshop agreed that information on how the location of human activities might be expected to change over time (for example accessibility of fishing grounds or tourist

landing sites) would also be of significant value to the development of management advice by both the CEP and SC-CAMLR.

5.10 ICED modelling work on temperature and sea ice dynamics is of particular relevance. Although ICED has focused on pelagic systems, the program realizes the need to address benthic systems, which are now viewed as more important in terms of links between benthic organisms and the carbon biogeochemistry of the shelf and deep ocean.

5.11 While acknowledging that data will never be complete, the workshop noted that the identification of key species and key ecosystem processes is critical. Additionally, the need for representation of alternative species in the creation of realistic models for monitoring impacts of changes was acknowledged.

5.12 In order to effectively incorporate the results of climate change research into management decisions, the workshop noted the importance of:

i) Making data sources more visible and accessible where possible
ii) Engaging relevant expertise from the wider scientific community in the work of SC-CAMLR and the CEP
iii) Articulating uncertainty to decision makers
iv) Identifying climate change scenarios to progress understanding of the ecosystem
v) Using both regional and local models in programmes such as ICED

5.13 The workshop noted that there is a strong overlap between the priorities set out by the CCRWP and by ICED.

5.14 It was suggested that particular localities of interest (for example nearshore canyon structures) should be identified for focused joint work, including with SCAR programmes.

6. Identification of drivers or effects for which measurable responses are required to support the goals of CEP and SC-CAMLR

Discussion

6.1 The workshop agreed that the CCRWP and the components of SC-CAMLR work (as identified in *Workshop Paper XP019*) provided a good starting point in identifying the drivers or effects of climate change for which measurable responses are required. While many of these are specific to one of the respective bodies, several are of joint interest.

6.2 It was agreed that the climate change scenarios provided in the Antarctic Climate Change and the Environment (ACCE) report provide important baseline information for identifying drivers or effects of climate change. While recent ACCE updates provide an important summary of research progress, it would also be valuable to have a regular, high level summary update on the state of knowledge regarding climate change scenarios. Such summaries would also be a useful way to communicate the major outcomes of programmes such as ICED and SOOS. However, the workshop recognized the large amount of work involved in synthesizing the current state of knowledge in this way, and noted that it would be important for CEP and SC-CAMLR to make realistic and timely requests.

6.3 Table 2 sets out a process for identifying and conveying shared climate change research and monitoring needs. The workshop agreed that this process would best be initiated within the CEP and SC-CAMLR's Working Group on Ecosystem Monitoring and Management (WG-EMM) and could be developed further through iterative discussions between the relevant bodies and scientific programmes. The SCAR Open Science Meeting in Kuala Lumpur, Malaysia (August 2016) was also highlighted as a good opportunity for scientists involved in ICED, SOOS, and national Antarctic programmes to come together for a discussion on a preliminary set of shared CEP and SC-CAMLR research and monitoring requirements.

6.4 The workshop suggested that updates on the process described in Table 2 should be delivered via communications from the SC-CAMLR and CEP chairs. The use of e-groups (or similar) could also be considered as the process develops further.

Recommendation 1

Encourage SC-CAMLR and CEP to recognize, encourage and support wherever possible the contribution that programmes such as SCAR, ICED and SOOS can make to their work on climate change and related monitoring.

Recommendation 2

Encourage the articulation of clear questions to be addressed to scientific programmes in order to obtain the best scientific advice relevant to the goals of the CEP and SC-CAMLR.

Recommendation 3

Identify and convey shared climate change research and monitoring needs to SCAR, ICED and SOOS, and other similar programs, using the process outlined in Table 2.

Recommendation 4

Encourage the periodic production of high level summaries of outcomes and progress made in programmes such as ACCE, ICED, SOOS, etc. in order to aid the CEP and SC-CAMLR in the understanding of the current state of knowledge and in the formation of questions to help progress work on climate change.

7. Existing monitoring programmes

7.1 Dr Keith Reid (CCAMLR) and Dr Mercedes Santos (Argentina) presented a summary of SC-CAMLR monitoring activities (*Workshop Paper 017 – presentation summary; see Appendix 2).*

7.2 Monitoring undertaken by CCAMLR can be conveniently divided into two general classifications of monitoring; operational and surveillance monitoring. Operational monitoring is put in place in response to a specific management objective, for example fishery monitoring and closure forecasting. Whereas the emphasis in surveillance monitoring is on collecting basic observation data that provides data useful for management but not necessarily linked to a specific response. Examples of surveillance monitoring include

CCAMLR's marine debris monitoring and CCAMLR Ecosystem Monitoring Program (CEMP). The aims of CEMP, which was established in 1985 and has a focus on the krill-based foodweb, are to detect and record significant changes in critical components of the ecosystem, and to distinguish between those changes that are due to the harvesting of commercial species and changes due to environmental variability. Since its inception CEMP has evolved to include new data collection sites, providing broader geographic coverage, as well as the introduction of new methodologies (i.e. remote camera networks) to collect monitoring data. As it is a multinational programme, engagement in CEMP also provides a mechanism for collaboration to fill key information gaps that are crucial to the interpretation of the monitoring data. For example, in 2015 the CCAMLR CEMP Special Fund awarded a grant to undertake a coordinated multinational satellite tracking study on the year-round distribution of CEMP monitored penguin species in the Antarctic Peninsula region.

7.3 Dr Constable (Australia) presented an introduction to the Southern Ocean Observing System (SOOS) (*Workshop Paper 018 – presentation summary; see Appendix 2).*

7.4 SOOS aims to facilitate the collection and delivery of essential observations on dynamics and change of Southern Ocean systems to all international stakeholders (researchers, governments, industries). SOOS will be implemented regionally through Regional Working Groups, currently one for the West Antarctic Peninsula and one for the Indian Sector. A Ross Sea Working Group is in the process of being established. Apart from the regional working groups, which will be of direct interest to the implementation of monitoring programs in different regions of the CCAMLR and Antarctic Treaty areas, there are 5 main topics described here that SC-CAMLR and CEP may be interested in participating and/or developing a relationship with SOOS:

i) the development of priority variables ("ecosystem Essential Ocean Variables" – eEOVs) for observing dynamics and change in Southern Ocean ecosystems (Constable et al. 2016). These variables are intended to be defined biological or ecological quantities, which are derived from field observations, and which contributes significantly to assessments of Southern Ocean ecosystems - status and trends in ecosystem properties, attribution of trends to causes, and predicting future trajectories;

ii) the spatial and temporal design of a sustained circumpolar marine biological observing system in SOOS, which is intended to be completed in time for consideration at the ICED 2018 International Conference on Marine Ecosystem Assessment for the Southern Ocean (www.MEASO2018.aq);

iii) the SOOS Portal for linking metadata, accessing datasets and synthesis products, and coordinating field activities, which aims to resolve two important gaps in the Southern Ocean science community – better access to all the data relevant to the Southern Ocean, and better advance knowledge of field activities in order to facilitate better co-ordination and collaboration in research programs.

iv) assessments of the state of Southern Ocean ecosystems will be facilitated by SOOS through linking datasets through the SOOS Portal and in facilitating the collection of observations to support assessments.

v) circumpolar benchmarking of the state of Southern Ocean ecosystems in 2022, which will build on the work of GLOBEC, the Census of Antarctic Marine Life and the SCAR Biogeographic Atlas, to provide a comprehensive circumpolar ecological

assessment that will link different long-term biological datasets from throughout the Southern Ocean and to provide the baseline for sustained circumpolar biological observations and assessments of change in the future.

Discussion

7.5 The workshop thanked Drs Reid, Santos and Constable for their presentations, and noted the extensive range of monitoring activities now being undertaken across the Southern Ocean. Such monitoring activities have relevance to the full range of topics that are of mutual interest to the CEP and SC-CAMLR.

7.6 The workshop recognized that determining whether existing monitoring programmes are sufficient to assess climate change is a difficult task. As it is impossible to collect data on all aspects of marine ecosystems, the Committees will need to find ways to use what data is available now and to make strategic plans for future research and monitoring programs.

7.7 It was noted that CEMP was established 30 years ago, with refinement to standard methods and approaches made over time. Long-term data collection allows for an understanding not achievable through short-term. Recent technical developments in monitoring, such as satellite remote sensing, sophisticated bird and animal tags, UAVs, instruments placed on fishing lines, etc. can be applied to monitoring studies. It was recognized that fully integrating these approaches into climate change research is a priority and that it is critical to articulate now the new and specific questions to be addressed.

7.8 It was also noted that CEMP data could provide useful information to CEP work in the area of ASPA management plan development or reviews, in particular for ASPAs established for the protection of predators such as seabirds and marine mammals. CEMP research may be conducted in similar areas as current or potential ASPAs. CEMP data was also seen useful for SCAR in its provision of advice to the CEP.

7.9 The workshop recognized the value of programmes such as SOOS in providing monitoring information, and encouragement was given to engage with SOOS regarding specific questions of interest and what sort of data products would be most valuable to the Committees. This would allow for the development of discovery tools and could be built into future SOOS work plans.

7.10 Ms Amanda Lynnes (IAATO) reported that IAATO collects operational monitoring data such as ship tracks, spatial and temporal distribution of visitors in terms of population size, activities, and land use in order to distinguish changes due to tourism vs. environmental variability. These data sources could be useful to the Committees in their work relating to climate change and other topics.

7.11 Dr Rodolfo Werner (ASOC) referred the workshop to the 2nd Call for Proposals by the Antarctic Wildlife Research Fund (http://www.antarcticfund.org/) which provides support designed to fill critical gaps in research and monitoring to improve the management of the Antarctic krill fishery. The Fund was established in 2015 by representatives for ASOC WWF-Norway and Aker BioMarine, which manages the Fund. Peer review of proposals is conducted by a Science Advisory Group.

8. Mechanisms for practical cooperation, including sharing of data and information

Discussion

8.1 The workshop agreed that interaction between the CEP and SC-CAMLR could be extended beyond the current system of observers attending CEP and SC-CAMLR meetings, to facilitate better communication between the two bodies and engagement of scientists with expertise that is relevant to specific agenda items and discussions. Work plans such as the CEP 5-year work plan, and the priorities to be developed by SC-CAMLR at its forthcoming symposium, will assist with planning appropriate engagement.

8.2 Joint forums for discussion (such as the CEP Forum or CCAMLR e-groups) may be useful for discussion of climate-related matters of joint interest. The workshop encouraged ongoing intersessional contact between the two Committees, including the exchange of expertise at relevant meetings as far as possible.

8.3 The workshop discussed the accessibility and visibility of data sources, including data and other information held by the CCAMLR Secretariat. The workshop noted that summaries describing CEMP sites and associated metadata would be particularly valuable for the CEP. SCAR also noted its interest in having access to CEMP data.

8.4 The workshop noted that while it is desirable to make metadata available to improve data discoverability, it will be important to provide information on where and how the data were collected, and to facilitate collaboration with the data originators to ensure appropriate use.

8.5 Dr Neil Gilbert introduced *Workshop Paper 10* (New Zealand) which gives an outline of the aims and current content of the Antarctic Environments Portal. The workshop agreed that although it is currently aimed primarily at the CEP, the information contained in the Antarctic Environments Portal is also of significant value to SC-CAMLR. Summary articles provide an important synthesis of information that may be particularly useful in addressing topics not covered in detail by SC-CAMLR (such as marine non-native species), and in summarizing the state of scientific knowledge for policymakers.

8.6 The workshop agreed that standardized geographic information on the locations of protected and managed areas, as well as monitoring sites (including MPAs, ASPAs, ASMAs and CEMP sites) would be useful to both Committees. It suggested that such information could be made available through both the CCAMLR GIS and the Antarctic Protected Areas Database.

8.7 Dr Gilbert informed the workshop that the Portal provides an interactive and searchable map, displaying a range of information, including topography, place names (based on the SCAR Gazetteer) and coastline as well as environmental information of relevance to the CEP including on protected and managed areas and Antarctic conservation biogeographic regions. It would be possible to add spatial data on CEMP sites, as well as sites of ASPAs and ASMAs.

Recommendation 5

Encourage flexibility in the composition of national delegations according to relevant agenda items, to allow SC-CAMLR, CEP and SCAR to engage in discussions on specific topics.

Recommendation 6

Consider invitation of experts to CCAMLR Working Groups (particularly WG-EMM for discussions relating to climate change), including appropriate input from programmes such as SCAR, ICED and SOOS.

Recommendation 7

Promote the development of young scientists by encouraging participation in the CCAMLR Scholarship and SCAR Fellowship programmes, with the specific aim of contributing research relevant to climate change.

Recommendation 8

Encourage improved visibility of CCAMLR metadata to facilitate discoverability and exploration of data relevant to matters of mutual interest, particularly including CEMP data.

Recommendation 9

Recognize that data sharing is not just sharing the products of research already collected, but information is also needed on future plans to collect additional data, to facilitate combined efforts and avoid duplication of effort.

Recommendation 10

Encourage use of the Antarctic Environments Portal in providing policy-ready summaries on issues of mutual interest to members of both Committees. SC-CAMLR could be encouraged to request topics for inclusion, or to author summaries in due course.

Recommendation 11

Recognize the importance of using common baseline information, and recommend that summary information such as ACCE updates and are submitted under climate change agenda item in both Committees.

9. Spatial protection and management in the context of climate change

Discussion

9.1 The workshop recognized that considerations of climate change and monitoring have particular relevance to the work of the CEP and SC-CAMLR on marine spatial protection and management (one of the five topics of mutual interest).

9.2 Dr Santos introduced *Workshop Paper XP011* (Argentina and Chile) on the relevance of the MPA designation process in Domain 1 in the current climate change context, particularly noting the rapid changes being observed in this region. Over 180 data layers were produced from information provided by more than eight SC-CAMLR Members, demonstrating the utility of collaboration in the planning process. The authors of this paper encouraged the involvement of all Parties in the Domain 1 MPA planning process, to i)

enhance and increase joint research efforts, ii) improve analyses by filling knowledge gaps, and iii) add value to the process by including different perspectives and experiences through a multinational process. The compiled MPA dataset will have utility for broader purposes including long-term monitoring studies associated with different aspects of climate change.

9.3 The example of the Weddell Sea MPA planning process was also brought to the attention of the workshop. It was noted that both internal CCAMLR collaboration as well as external collaborations with SCAR, ICED, SOOS and other such programmes would be necessary in order to best include climate change impact into MPA planning activities in this region.

9.4 The workshop noted that research and monitoring undertaken within MPAs will generate a significant amount of new data on ecosystems and environments. It was also agreed that research and monitoring within protected areas (including MPAs and ASPAs) should be undertaken by all Parties as far as possible, and not just the proponent.

Recommendation 12

Consider further appropriate development of scientific reference areas with the objective of understanding impacts of climate change, using existing tools available to the CEP and SC-CAMLR.

Recommendation 13

Promote ongoing work led by Argentina, Chile, and including other Members, on the development of MPAs in planning Domain 1 (Antarctic Peninsula), acknowledging particular relevance to climate change research and the establishment of reference areas in this region of rapid change.

Recommendation 14

Acknowledge that data from MPA planning processes will integrate and make available a significant amount of information that will improve decision-making and be relevant to the work of the CEP and SC-CAMLR on a range of other topics.

Recommendation 15

Recognize that research and monitoring within CCAMLR and ATCM protected area systems will benefit from coordinated and integrated programmes within the respective regions, including the wider community of interested scientists (SCAR, ICED, SOOS, and/or national programmes).

10. Conclusions

10.1 Throughout the workshop, both Committees recognized the benefits of communication and collaboration, particularly through periodic joint workshops. It was

agreed that a 5-year period between joint workshops would fit with the existing 5-year work planning periods of the CEP.

10.2 The workshop encouraged sustained communication on high priority topics during interim periods between workshops, as appropriate. Such discussions could be facilitated through the formation of e-groups as needed.

10.3 The workshop particularly noted that the benefits of increased collaboration with SCAR, ICED, SOOS and other programmes of relevance to the goals of the Committees.

Recommendation 16

> Encourage further and regular meetings between SC-CAMLR and the CEP, at least once every 5 years. Also encourage more frequent communication on topics of mutual interest in the intervening period before the next joint meeting, including via online forums as appropriate.

10.4 The co-conveners thanked the CEP and SC-CAMLR chairs and all of the workshop participants for their very positive and constructive engagement during the meeting. They encouraged the CEP and SC-CAMLR to consider the workshop report and to adopt the recommendations contained therein.

Table 1: Summary of outcomes from 2009 Joint CEP/SC-CAMLR workshop and update on activities on matters of mutual interest

Issue	Outcomes from 2009 Workshop		Activities since 2009	
	Areas of common interest	**Mechanisms for practical cooperation**	**CEP**	**SC-CAMLR**
Climate change and the Antarctic marine environment	• need to understand the effects of climate change on the marine environment • advice to parent bodies on adapting or responding to such effects • understand how uncertainty could be incorporated into decision-making procedures	• complementary baselines, reference areas and appropriate indicators to inform an understanding of climate change effects • utilising global standards for collecting relevant environmental and ecological data • regular exchange of information periodic meetings to review and evaluate the risks of climate change and ancillary effects on the Antarctic marine environment	• Considered recommendations on environmental matters arising from the 2010 Antarctic Treaty Meeting of Experts (ATME) on Climate Change and Implications for Antarctic Management and Governance. • Adopted a Climate Change Response Work Programme (CCRWP), identifying goals and specific actions to support efforts within the Antarctic Treaty system to prepare for, and build resilience to, the environmental impacts of a changing climate and the associated implications for the governance and management of Antarctica. • Received annual updates from SCAR on its 2009 Antarctic Climate Change and the Environment (ACCE) report. • Supported a proposal (still in progress) to test the application of RACER (Rapid Assessment of Circum-Arctic Ecosystem Resilience) methodology to Antarctica, as a possible tool for identifying key features important for conferring resilience to climate	• Recognized that climate change has the potential to induce rapid change within ecosystems, and that aligning CEMP with a broader suite of parameters collected as part of multiple research programs would be beneficial to the detection of climate impacts. • Recognized that climate change: has implications for the development and implementation of an RSMPA within the Convention Area; may increase the vulnerability of different ecosystem components necessitating a more precautionary approach in the establishment of an RSMPA; and has potential to impact the objectives of the Commission. • Acknowledged that ocean warming, sea-ice decline, acidification, and ocean circulation patterns will impact on Antarctic krill and ecosystems. • Recognized that the effects of climate change on growth, mortality and recruitment of Antarctic krill, and endorsed work to develop decision rules for the krill fishery in light of the potential influence of climate change.

Issue	Outcomes from 2009 Workshop		Activities since 2009	
	Areas of common interest	**Mechanisms for practical cooperation**	**CEP**	**SC-CAMLR**
			change. • Undertook a review of the 2005 *Guidelines for Environmental Impact Assessment in Antarctica* (EIA Guidelines), including to highlight the importance of considering how climate change may affect proposed activities and their associated environmental impacts.	• Recognized that increased warming and acidification are highly likely to impact marine ecosystems during the current century. • The Commission adopted Resolution 30/XVIII which urged increased consideration of climate change impacts in the Southern Ocean to better inform CCAMLR's management decisions. The Scientific Committee prioritized climate change issues in their agenda. • Agreed that the development and progress of a feedback management strategy for the krill fishery offers the opportunity to adapt to the impacts of climate change. At WG-EMM 2015, one-third of all papers submitted to WG-EMM made reference to climate change.
Biodiversity and non-native species in the Antarctic marine environment	• potential for non-native species to considerably alter marine biodiversity	• CEP to keep SC-CAMLR informed of its work on this issue use the SCAR Alien Species database to share information	• Encouraged further collection of spatially explicit biodiversity data, and acknowledged the value of Antarctic Biodiversity Portal www.biodiversity.aq. • Informed the revision of Annex II to the Protocol (not yet in force), including to strengthen requirements for preventing and responding to the introduction of non-native species. • Adopted the CEP Non-Native Species Manual, containing key	• Noted that the CEP would be the lead-body on this issue, and would liaise with SC-CAMLR as appropriate. As such, little to no discussion on alien or non-native marine species has taken place explicitly on this topic. • Nevertheless, there is monitoring of by-catch species in fisheries though the Flag States and Scheme of International Observations, as well as some and protection of biodiversity

Issue	Outcomes from 2009 Workshop		Activities since 2009	
	Areas of common interest	**Mechanisms for practical cooperation**	**CEP**	**SC-CAMLR**
			principles, practical guidance and resources for prevention, monitoring and response. • Will consider a recent review of the Non-Native Species manual, including recommendations to address marine risks and to cooperate closely with SC-CAMLR in this regard. • Undertook a review the EIA Guidelines, including to highlight the importance of considering non-native species risks.	inherent within spatial planning and MPA initiatives.
Antarctic species requiring special protection	• maintaining / improving the conservation status of Antarctic species • managing human activities to maximise species' resilience to climate change and other external pressures	• share information about respective approaches to species assessment and protection • collaborate on the development and implementation of recovery plans, possibly similar to the existing process for consultation on protected area proposals • make available relevant data (including limitations) for status assessments • share other relevant information, including standard monitoring methods	• No new listings or de-listings of Specially Protected Species. • Informed the revision of Annex II to the Protocol (not yet in force), including to elaborate the processes for listing Specially Protected Species (SC-CAMLR will be able to propose a species for special protection). • Agreed to consider the extent which Important Bird Areas (IBAs) in Antarctica, identified by BirdLife International, are, or should be, represented within the series of ASPAs as 'major colonies of breeding native birds'.	• There has been continuous monitoring of incidental mortality of birds and mammals associated with fisheries. There has been considerable success reducing the incidental mortality of seabirds and marine mammals in CCAMLR fisheries: Working Group on Incidental Mortality Associated with Fisheries (WG-IMAF). • Agreed that because of the substantial reductions in incidental mortality, WG-IMAF could be moved to a biennial meeting schedule. • There were further reductions in incidental mortality through continued mitigation measures, with such low levels that WG-IMAF was disbanded until further needed.

Issue	Outcomes from 2009 Workshop		Activities since 2009	
	Areas of common interest	**Mechanisms for practical cooperation**	**CEP**	**SC-CAMLR**
		• involve other relevant organisations and experts in the assessment and protection of Antarctic species SC-CAMLR to develop a process to inform the CEP of species protection measures that might be taken in the CCAMLR Area		
Spatial marine management and protected areas	• consideration of representative areas, reference areas and resilience areas with respect to spatial protection and management in the marine environment • developing a harmonised approach to protection of the marine environment across the Antarctic Treaty system • utilising the bioregionalisation of the Southern Ocean as a basis for identifying a representative system of marine	• sharing of information, expertise and/or further joint meetings • development of mutual region-specific objectives, and further consideration of overlapping areas of interest for marine protection to facilitate increased cooperation • development of proposals for candidate sites with coordinated input from both committees • development by SC-CAMLR of a process to inform the CEP of spatial management measures that might be taken in the CCAMLR Area	• Supported work by CCAMLR to consider marine spatial protection and management in the CAMLR Convention Area. • Agreed to cooperate with CCAMLR and SCAR to ensure that measures to establish effective, representative and coherent spatial protection of marine biodiversity in the Antarctic Treaty area are implemented on a scientific basis, with the aim of achieving harmonised protection across the Antarctic Treaty system. • Endorsed a terrestrial bioregionalisation – the Antarctic Conservation Biogeographic Regions – for use in conjunction with other tools as a dynamic model for identifying potential ASPAs within a systematic environmental-geographic framework.	• Prioritized the establishment of a representative system of MPAs by 2012. The first MPA in the Convention Area was established on the South Orkney Islands southern shelf. • Held the second workshop on Marine Protected Areas in Brest, France. • Held a special meeting of SC-CAMLR and the Commission in Bremerhaven, Germany to progress two MPA proposals: a Representative System of MPAs in the East Antarctic, and the Ross Sea Region MPA. • There are currently two fully mature MPA proposals that have been forwarded to the Commission for consideration. There is progress on MPA planning in the Weddell Sea and Antarctic Peninsula regions, as

Issue	Outcomes from 2009 Workshop		Activities since 2009	
	Areas of common interest	**Mechanisms for practical cooperation**	**CEP**	**SC-CAMLR**
	protected areas	ATCM Decision 9 (2005) on ASPAs and ASMAs of interest to CCAMLR	• Adopted a new partially marine ASPA (No. 173) at Cape Washington and Silverfish Bay. • Held a workshop on Marine and Terrestrial Antarctica Specially Managed Areas (ASMAs), and currently preparing guidance for the designation of ASMAs. • Will consider recommendations arising from intersessional work to consider protection of outstanding marine values in the marine environment; including: to consider such values when proposing new ASPAs and revising existing ASPA management plans; and 2) complement ongoing work by SC-CAMLR.	well as on precautionary protection for marine areas following ice shelf collapse or retreat. • With respect to ASPAs and ASMAS, the SC continues to review and endorse management plans as part of the longstanding cooperation with the CEP. CCAMLR adopted Conservation Measure 91-02 (2012) on protection of the values of ASPAs and ASMAs, and any proposal for commercial harvesting within an ASMA should only be taken with the prior approval of CCAMLR, consistent with ATCM XXVIII Decision 9 (2005). • In relation to Vulnerable Marine Ecosystems, detection and declaration has been ongoing since 2008. There are currently 76 VME risk areas declared from information through the fishery, 46 VMEs detected and registered through fishery independent research cruises, and the SC has requested for Members to continue detecting VMEs though their national Antarctic programs.
Ecosystem and environmental monitoring	• importance of monitoring for providing advice to parent bodies on the need for and	• identify and utilise relevant repositories of monitoring data, noting important issues of data ownership and sharing	• Acknowledged the potential for remote sensing to contribute significantly to environmental monitoring programmes, including in the context of protected area	• Agreed that the development of FBM for the krill fishery may require CEMP to change or evolve from its present form to include greater spatial coverage, monitor at different spatial

Issue	Outcomes from 2009 Workshop		Activities since 2009	
	Areas of common interest	**Mechanisms for practical cooperation**	**CEP**	**SC-CAMLR**
	effectiveness of management measures • monitoring to assess status and trends of key species and their responses to human activity and a changing Antarctic climate, and the presence and impacts of non-native species	• utilise the outcomes and products of earlier CEP / SCAR / COMNAP discussions on the subject of monitoring • identify and utilise the findings and outcomes of monitoring being conducted by other organisations and programmes • improve understanding of monitoring by national programmes, and explore new and innovative ways to augment existing resources dedicated to monitoring considering monitoring requirements at a future joint meeting	management and monitoring the impacts of climate change. • Recognised the benefits of using unmanned aerial vehicles (UAVs) for research and monitoring, including the potential reduction of environmental risks as compared to other means of collecting such data, and will consider work to develop guidance on the environmental aspects of UAV use. • Expressed strong support for the Southern Ocean Observing System (SOOS), to aid understanding of the Southern Ocean, its associated ecosystems relationship with other oceans, and its role in climate change. • Endorsed the Antarctic Environments Portal, as a voluntary tool to help ensure it is as informed as possible on the state of Antarctic environments.	and temporal scales, to include more or different parameters and revised methods for existing parameters. • Agreed the requirement for ecosystem monitoring is likely to increase in support of feedback management of the krill fishery and MPAs. Technology has allow for recent new initiatives for CEMP monitoring in the Convention Area.

Table 2: Suggested process for CEP & SC-CAMLR to identify and convey shared climate change research and monitoring needs to SCAR, ICED and SOOS

May 2016	CEP XIX reviews / revises Climate Change Response Work Programme (CCRWP)
June 2016	CEP Chair conveys marine research/monitoring components of CCRWP to SC-CAMLR Chair
July 2016	SC-CAMLR Chair prepares discussion paper (in consultation with joint workshop participants) for WG-EMM WG-EMM identifies components of CCRWP also of interest to CCAMLR
August 2016	Discussion at SCAR meeting about preliminary set of CEP/SC-CAMLR shared climate change research/monitoring needs
October 2016	SC-CAMLR XXXV considers advice from WG-EMM, including any feedback from discussions at SCAR, and agrees on shared research and monitoring interests
November 2016	SC-CAMLR Chair and CEP Chair write to SCAR / ICED / SOOS to convey shared research and monitoring interests, and seek advice regarding ability to contribute (i.e. map activities to CEP/SC-CAMLR interests)
2017	SCAR / ICED / SOOS provide advice on ability to contribute and, as appropriate, requirements for support
2017	SC-CAMLR Chair and CEP Chair convey advice from SCAR / ICED / SOOS to CEP and SC-CAMLR for consideration and action as appropriate

Report of the Joint CEP/SC-CAMLR Workshop on Climate Change and Monitoring

APPENDICES

Appendix 1: List of participants

Name	Party	Organization
María Mercedes Santos	Argentina	Instituto Antártico Argentino
Patricia Ortuzar	Argentina	Dirección Nacional del Antártico
Andrea Capurro	Argentina	Dirección Nacional del Antártico
Andrew Constable	Australia	Australian Antarctic Division, (SC-CAMLR Representative)
Ewan McIvor	Australia	CEP Chair
Gwen Fenton	Australia	Australian Antarctic Division, (AAD Chief Scientist)
Phillip Tracey	Australia	Australian Antarctic Division, (CEP Representative)
César Cárdenas	Chile	Instituto Antártico Chileno (INACH)
José Retamales	Chile	Instituto Antártico Chileno (INACH)
Verónica Vallejos	Chile	Instituto Antártico Chileno (INACH)
Enrique Vargas	Chile	DIRECTEMAR (Maritime Interests and Marine Environment Directorate, Chilean Navy)
Geraldine Asencio	Chile	Instituto Antártico Chileno (INACH)
Yang Lei	China	Chinese Arctic and Antarctic Administration (CAA)
Christian Diaz	Colombia	Comisión Colombiana Oceano
Carole Semichon	France	Ministère de l'Environnement, de l'Énergie et de la Mer
Philippe Koubbi	France	Université Pierre et Marie Curie
Heike Herata	Germany	German Environment Agency
Wiebke Schwarzbach	Germany	German Environment Agency
Stefan Hain	Germany	AWI, Helmholtz Centre for Polar and Marine Research
Kentaro Watanabe	Japan	National Institute of Polar Research
Mari Takehara	Japan	Ministry of the Environment of Japan
Danica Stent	New Zealand	Antarctica New Zealand
Neil Gilbert	New Zealand	Department of Conservation
Birgit Njaastad	Norway	Norwegian Polar Institute
Andrew Lowther	Norway	Norwegian Polar Institute
Valery Lukin	Russian Federation	Arctic and Antarctic Research Institute
Sergey Tarasenko	Russian Federation	Arctic and Antarctic Research Institute
Sonia Ramos	Spain	Spanish Polar Committee Technical Secretariat
Mark Belchier	United Kingdom	SC-CAMLR Chair
Susie Grant	United Kingdom	British Antarctic Survey
Marta Soeffker	United Kingdom	Centre for Environment, Fisheries & Aquaculture Science (Cefas)

Name	Party	Organization
Polly Penhale	United States	National Science Foundation
Jeremy Rusin	United States	US National Marine Fisheries Service
Christopher D. Jones	United States	NOAA Antarctic Ecosystem Research Division
Keith Reid	CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Secretariat
Aleks Terauds	SCAR	SCAR (SC-ATS)
Eugene Murphy	SCAR	ICED, British Antarctic Survey
Rodolfo Werner	ASOC	Antarctic and Southern Ocean Coalition/The Pew Charitable Trusts
Ryan Dolan	ASOC	The Pew Charitable Trusts. Global Penguin Conservation Campaign. ASOC
Andrea Kavanagh	ASOC	The Pew Charitable Trusts
Claire Christian	ASOC	Antarctic and Southern Ocean Coalition
Amanda Lynnes	IAATO	IAATO

Appendix 3: List of workshop papers

XP001 rev.1 Introduction from Co-Conveners of the Joint CEP/SC-CAMLR Workshop (United Kingdom, United States)

XP002 Update on CEP activities on matters of mutual interest (Australia)

XP003 Outcomes of the 200 Joint Workshop (Australia)

XP004 SCAR Activities on Climate Change and Monitoring (SCAR)

XP005 Antarctic Climate Change and the Environment (SCAR)

XP006 Update on SC-CAMLR activities on matters of mutual interest (United States)

XP007 The CEP Climate Change Response Work Programme and its relevance for joint CEP/SC-CAMLR effort (Norway)

XP008 rev.3 List of Participants (ATS)

XP009 Current Russian results of studies of climate variability at present and in the past (Russian Federation)

XP010 Antarctic Environments Portal (New Zealand)

XP011 The relevance of the MPA designation process in Domain 1 in the current climate change context (Argentina, Chile)

XP012 Climate Change research conducted by the Chilean Antarctic Program: I. Identifying key species, factors and processes in marine ecosystems of the Antarctic Peninsula (Chile)

XP013 Climate Change research conducted by the Chilean Antarctic Program: II. The terrestrial realm, steady state and horizons (Chile)

XP014 Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) programme (SCAR)

XP015 Report on the activities of the Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) programme (SCAR)

XP016 Population genetic structure of *Sanionia uncinata* moss: A focus to support conservation and management plans in Antarctica (Chile)

XP017 SC-CAMLR Monitoring Activities (CCAMLR)

XP018 Introduction to the Southern Ocean Observing System (SOOS)

XP019 SC-CAMLR work on Climate Change (Australia)

Appendix 2: Workshop Programme

	Day 1 (19th May)			Day 2 (20th May)	
Session 1 (0900-1030)	Welcome and introduction **(Paper 1)**	Co-conveners		**ToR #2**	
	PRESENTATION Outcomes of 2009 Joint Workshop, and update on CEP activities on matters of mutual interest **(Papers 2 & 3)**	**Ewan McIvor**		*PRESENTATION* SC-CAMLR monitoring activities, data sharing and access **(Paper 17)**	**Keith Reid & Mercedes Santos**
				PRESENTATION Introduction to the Southern Ocean Observing System (SOOS) **(Paper 18)**	**Andrew Constable & Louise Newman**
	PRESENTATION Update on SC-CAMLR activities on matters of mutual interest **(Paper 6)**	**Christopher Jones**		***DISCUSSION*** Determine whether existing monitoring programs provide sufficient data to assess climate change impacts or whether new approaches are needed	
	DISCUSSION Review outcomes from previous Joint Workshop, and progress made since 2009				
Morning break					
Session 2 (1100-1230)	**ToR #1**			**ToR #3**	
	PRESENTATION Outline of CEP Climate Change Response Work Program **(Paper 7)**	**Birgit Njaastad**		***DISCUSSION*** Define mechanisms for practical cooperation, including sharing of data and information **(Papers 10 &11)**	
	PRESENTATION Outline of SC-CAMLR work on Climate Change **(Paper 19)**	**Andrew Constable**			
	DISCUSSION Challenges, priorities and areas of cooperation				
Lunch break				Lunch break *1300 - Doña Inés Restaurant, Dreams Hotel*	
Session 3 (1400-1530)	**ToR #1 continued**			**Recommendations**	
	PRESENTATION SCAR activities on climate change and monitoring **(Papers 4 & 5)**	**Aleks Terauds**		***DISCUSSION*** Recommendations to CEP and SC-CAMLR	Co-conveners
	PRESENTATION Integrating Climate and Ecosystem Dynamics (ICED) **(Papers 14 & 15)**	**Eugene Murphy & Rachel Cavanagh**			
	DISCUSSION Review of existing activities that have relevance to the work of CEP and SC-CAMLR **(Papers 9, 12, 13 & 16)**				
Afternoon break					
Session 4 (1600-1730)	**ToR #1 continued**			**Workshop report**	
	DISCUSSION Identify drivers or effects for which measurable responses are required to support the goals of CEP and SC-CAMLR.			***DISCUSSION*** Agree process for finalising the workshop report including recommendations arising.	Co-conveners

1830	*Welcome cocktail* *(INACH, Plaza Muñoz Gamero 1055)*			

Appendix 4: Presentation summaries

These presentation summaries were not adopted or specifically agreed by the workshop, and thus represent the views of the respective authors only.

Workshop Paper 003 – Outcomes of the 2009 Joint Workshop

Ewan McIvor (CEP Chair, Australia)

The first joint workshop of the Committee for Environmental Protection (CEP) and Scientific Committee for the Conservation of Antarctic Marine Living Resources (SC-CAMLR) was held in Baltimore, United States from 3 to 4 April 2009. The workshop aimed to develop a shared understanding of the committees' conservation objectives and priorities, and identify opportunities for collaboration and practical cooperation.

The workshop was co-convened by Drs Bizikov (Russia, Vice Chair SC-CAMLR), Frenot (France, Vice Chair CEP), Gilbert (New Zealand, Chair CEP), and Watters (US, Convener WG-EMM).

The workshop considered five matters of mutual interest: climate change and the Antarctic marine environment; biodiversity and non-native species in the Antarctic marine environment; Antarctic species requiring special protection; spatial marine management and protected areas; and ecosystem and environmental monitoring. On these, the workshop sought to identify: specific areas of common interest; mechanisms for practical cooperation; and a lead body. The outcomes of these discussions are summarised in Table 1.

The workshop noted the many similarities between the structure and functions of the two committees, as well as some differences. For example, the CEP provides advice on actions related to 'protection', while SC-CAMLR provides advice on actions related to 'conservation' (including rational use). Further, while the CEP is mostly reliant on intersessional contact groups to address short-term, management-oriented items of work, SC-CAMLR relies on permanent working groups to address both short- and long-term scientific priorities. Also, the CEP generally relies on external bodies (e.g. SCAR) to collect and synthesise data while SC-CAMLR mostly collects and synthesises data through internal processes.

The workshop identified several general recommendations to the committees, including to:

- provide advice based on the best available science, and ensure the scientific process is not politicised and is transparent;
- focus exchange of information on the five areas of mutual interest;
- seek to ensure that the timing of respective work programs and workshops avoids increasing workloads and travel requirements;
- consider broader use of a consultation process similar to ATCM Decision 9 (2005)[1];
- consider alternative methods of holding joint meetings (e.g. video conferencing);
- consider opportunities for Secretariat representatives to attend the 'other' annual meeting;
- encourage participation by scientists in both committees, recruit and engage the next generation of scientists, and consultation between national CEP and SC-CAMLR representatives; and

[1] Decision 9 (2005) outlines the procedure for consultation with CCAMLR, as appropriate, on proposal for Antarctic Specially Protected Areas or Antarctic Specially Managed Areas which contain marine areas.

- for work programs on issues of mutual interest, identify the scientific capabilities required, the science program that would be sufficient for addressing the issue, the timeframe within which the science needs to be concluded, and the mechanisms necessary to achieve a timely outcome.

The workshop report was presented to CEP XII in ATCM XXXII/WP55, and to SC-CAMLR XXVIII in SC-CAMLR-XXVIII/6. The committees endorsed the recommendations arising, and agreed the workshop had proven successful in enhancing the shared understanding of roles and responsibilities, and in identifying several opportunities for improved cooperation.

References

ATCM XXXII/WP32 Report of the Joint CEP/SC-CAMLR Workshop (France, New Zealand, Russian Federation, United States)

Table 1: Summary of outcomes to discussions at the first joint CEP/SC-CAMLR workshop on matters of mutual interest

Issue	Areas of common interest	Mechanisms for practical cooperation	Lead body
Climate change and the Antarctic marine environment	• need to understand the effects of climate change on the marine environment • advice to parent bodies on adapting or responding to such effects • understand how uncertainty could be incorporated into decision-making procedures	• complementary baselines, reference areas and appropriate indicators to inform an understanding of climate change effects • utilising global standards for collecting relevant environmental and ecological data • regular exchange of information • periodic meetings to review and evaluate the risks of climate change and ancillary effects on the Antarctic marine environment	• n/a – both committees in early stages of work
Biodiversity and non-native species in the Antarctic marine environment	• potential for non-native species to considerably alter marine biodiversity	• CEP to keep SC-CAMLR informed of its work on this issue • use the SCAR Alien Species database to share information	• CEP
Antarctic species requiring special protection	• maintaining / improving the conservation status of Antarctic species • managing human activities to maximise species' resilience to climate change and other external pressures	• share information about respective approaches to species assessment and protection • collaborate on the development and implementation of recovery plans, possibly similar to the existing process for consultation on protected area proposals • make available relevant data (including limitations) for status assessments • share other relevant information, including standard monitoring methods • involve other relevant organisations and experts in the assessment and protection of Antarctic species • SC-CAMLR to develop a process to inform the CEP of species protection measures that might be taken in the	• SC-CAMLR for wholly marine species and land-breeding species outside Treaty area • CEP for wholly terrestrial species • CEP for seals, penguins and seabirds, in

Issue	Areas of common interest	Mechanisms for practical cooperation	Lead body
		CCAMLR Area	consultation with SC-CAMLR as appropriate
Spatial marine management and protected areas	• consideration of representative areas, reference areas and resilience areas with respect to spatial protection and management in the marine environment • developing a harmonised approach to protection of the marine environment across the Antarctic Treaty system • utilising the bioregionalisation of the Southern Ocean as a basis for identifying a representative system of marine protected areas	• sharing of information, expertise and/or further joint meetings • development of mutual region-specific objectives, and further consideration of overlapping areas of interest for marine protection to facilitate increased cooperation • development of proposals for candidate sites with coordinated input from both committees • development by SC-CAMLR of a process to inform the CEP of spatial management measures that might be taken in the CCAMLR Area • ATCM Decision 9 (2005) on ASPAs and ASMAs of interest to CCAMLR	• SC-CAMLR, but not precluding CEP development of marine ASPAs and ASMAs
Ecosystem and environmental monitoring	• importance of monitoring for providing advice to parent bodies on the need for and effectiveness of management measures • monitoring to assess status and trends of key species and their responses to human activity and a changing Antarctic climate, and the presence and impacts of non-native species	• identify and utilise relevant repositories of monitoring data, noting important issues of data ownership and sharing • utilise the outcomes and products of earlier CEP / SCAR / COMNAP discussions on the subject of monitoring • identify and utilise the findings and outcomes of monitoring being conducted by other organisations and programmes • improve understanding of monitoring by national programmes, and explore new and innovative ways to augment existing resources dedicated to monitoring • considering monitoring requirements at a future joint meeting	• dependent on specific tasks and objectives • CEP for monitoring of non-native species

Workshop Paper 002 – Update on CEP activities of mutual interest

Ewan McIvor (CEP Chair, Australia)

General updates

Since the first joint workshop of the CEP and the Scientific Committee for the Conservation of Antarctic Marine Living Resources (SC-CAMLR) in 2009, there have been four new accessions to the Protocol on Environmental Protection to the Antarctic Treaty (Monaco, Pakistan, Portugal, Venezuela), and so there are now 37 CEP Members. The CEP has welcomed the continuing exchange of observers with SC-CAMLR, and the practice of reporting on matters of mutual interest The CEP has moved its consideration of reports from other organisations to earlier in the agenda to ensure that relevant developments can be considered throughout the meeting.

Climate change and the Antarctic marine environment (CEP work plan Priority 1)

The 2010 Antarctic Treaty Meeting of Experts (ATME) on Climate Change and Implications for Antarctic Management and Governance, held in Norway, generated 30 Recommendations, more than half of which related to environmental matters and were directed to the CEP for consideration. To assist with addressing these recommendations, the CEP has adopted a Climate Change Response Work Programme (CCRWP). The CCRWP identifies goals and specific actions to support efforts within the Antarctic Treaty system to prepare for, and build resilience to, the environmental impacts of a changing climate and the associated implications for the governance and management of Antarctica. The CEP has expressed support for strengthening international cooperation on Antarctic climate change monitoring, and the CCRWP identifies several issues on which collaboration between the CEP and SC-CAMLR is desirable.

On other related matters, SCAR has continued to provide the CEP with annual updates on its 2009 Antarctic Climate Change and the Environment report. The CEP has also supported a proposal (still in progress) to test the application of RACER (Rapid Assessment of Circum-Arctic Ecosystem Resilience) methodology to Antarctica, as a possible tool for identifying key features important for conferring resilience. At CEP XIX the Committee will consider suggested revisions to the 2005 *Guidelines for Environmental Impact Assessment in Antarctica* (EIA Guidelines), including to highlight the importance of considering how climate change may affect proposed activities and their associated environmental impacts.

Biodiversity and non-native species in the marine environment (CEP work plan Priority 1)

The CEP has encouraged the further collection of spatially explicit biodiversity data, and has acknowledged the great value of the international Antarctic Biodiversity Portal www.biodiversity.aq, which provides access to both marine and terrestrial biodiversity data. Following advice from the CEP, in 2009 the ATCM adopted revisions to Annex II to the Protocol, including to strengthen requirements for preventing and responding to the introduction of non-native species. The revisions have not yet entered into force. In 2011 the CEP adopted a Non-Native Species Manual, containing key principles and practical guidance to assist Parties to prevent or minimise the risk of the introduction of non-native species, and to monitor and to respond to any introductions. The manual has recently been reviewed and CEP XIX will consider the suggested revisions, as well recommendations that the CEP and

SC-CAMLR work more closely on non-native species issues, and that the CEP initiates focussed work in 2019 on assessing risks of marine non-native species. CEP XIX will also consider suggestions to revise the EIA Guidelines to highlight importance of considering non-native species risks in the EIA process.

Antarctic species requiring special protection

The CEP has not considered any new proposals to list or delist Specially Protected Species under Annex II. The revisions to Annex II adopted in 2009 included to elaborate the process for listing species for special protection, including providing that SC-CAMLR can propose a species for special protection (similar to the provisions for protected area proposals). In 2015 the CEP recognised the value of a report prepared by BirdLife International on an analysis of Important Bird Areas (IBAs) in Antarctica, and agreed to consider the extent to which the IBAs are, or should be, represented within the series of Antarctic Specially Protected Areas (ASPAs), in particular those areas that might qualify as major colonies of breeding native birds.

Spatial marine management and protected areas (CEP work plan Priority 1)

Since 2010 the Secretariat of the Antarctic Treaty has maintained a summary of the CEP's work on marine protected areas[2]. The CEP has regularly welcomed SC-CAMLR's work to consider marine spatial protection and management in the CAMLR Convention Area, and has reiterated the importance of close cooperation between the two committees. In 2009 the CEP agreed to develop a strategy and work towards the establishment of effective, representative and coherent spatial protection of marine biodiversity within the Antarctic Treaty area within three years through the designation of ASPAs and ASMAs. The CEP also agreed to cooperate with CCAMLR and SCAR to ensure that such measures are implemented on a scientific basis, and with the aim of achieving harmonised protection for Antarctic marine biodiversity across the Antarctic Treaty system. It further agreed to focus related work within, but not limited to the 11 priority areas identified by SC-CAMLR in its bioregionalisation of the Southern Ocean. In 2012 the CEP endorsed a terrestrial bioregionalisation – the Antarctic Conservation Biogeographic Regions (ACBRs) – comprising 15 biologically distinct ice-free areas. It agreed to use the ACBRs in conjunction with other tools as a dynamic model for identifying potential ASPAs within a systematic environmental-geographic framework.

The CEP has adopted one new Antarctic Specially Protected Area (ASPA) with a marine component (ASPA 173, Cape Washington and Silverfish Bay), following due consideration by CCAMLR in accordance with ATCM Decision 9 (2005). In 2015 the CEP agreed consideration should be given to the protection of outstanding values in the marine environment when proposing new ASPAs or revising existing management plans. CEP XIX will discuss this further. The CEP also noted that its efforts to advance area protection under the Protocol should complement rather than duplicate ongoing work by CCAMLR.

A CEP Workshop on Marine and Terrestrial Antarctic Specially Managed Areas (ASMAs), held in Uruguay in 2011, recommended that the CEP seek to identify opportunities to draw on SC-CAMLR with respect to good practice in the identification, management and monitoring of marine ASMAs. At CEP XIX the Committee will consider an initial report on

[2] See www.ats.aq/documents/ATCM38/ww/atcm38_ww004_e.pdf

work by the Subsidiary Group on Management Plans (SGMP) to develop guidance for assessing areas for potential ASMA designation.

Ecosystem and environmental monitoring (CEP work plan Priority 2)

The CEP has acknowledged the potential for remote sensing to contribute significantly to environmental monitoring programmes, including in the context of protected area management and monitoring the impacts of climate change (including a specific discussion on monitoring emperor penguin colonies). At its last two meetings, the CEP has considered the benefits and potential environmental risks of the use of unmanned aerial vehicles (UAVs) in Antarctica. It recognised the benefits of using UAVs for research and monitoring, including the potential reduction of environmental risks as compared to other means of collecting such data, and has agreed to consider at CEP XIX initiating work to develop guidance on the environmental aspects of UAV use. The CEP has also expressed strong support for the Southern Ocean Observing System (SOOS), to aid understanding of the Southern Ocean, its associated ecosystems relationship with other oceans, and its role in climate change. Of general relevance to the CEP's work, and possible interest to SC-CAMLR, is the Antarctic Environments Portal[3], which the CEP has endorsed as a voluntary tool to help ensure it is as informed as possible on the State of Antarctic environments.

[3] See www.environments.aq

Workshop Paper 006 – Update on SC-CAMLR activities of mutual interest

Christopher Jones (United States)

General updates

Since the first joint workshop of the CEP and SC-CAMLR in 2009, CCAMLR Membership has remained at 25 Members. SC-CAMLR has welcomed the continuing exchange of observers with the CEP, and the practice of SC-CAMLR annually reporting to the CEP on matters of mutual interest has continued since CEP XIII in 2010.

Climate change and the Antarctic marine environment

SC-CAMLR has acknowledged that climate change has the potential to induce rapid changes within Antarctic marine ecosystems. SC-CAMLR agreed in 2009 that climate impacts have the potential to be detected in part through aligning the CCAMLR Ecosystem Monitoring Program (CEMP) with a broader suite of parameters collected as part of multiple research programs. In 2010, SC-CAMLR recognised that the findings of SCAR's Antarctic Climate Change and the Environment (ACCE) report had clear implications for the work of CCAMLR. SC-CAMLR noted recommendations of particular relevance from the Antarctic Treaty Meeting of Experts on the impacts of climate change for management and governance of the Antarctic region (ATME), and that climate change may increase the vulnerability of different ecosystem components necessitating a more precautionary approach in the establishment of a representative system of marine protected areas.

In 2011, SC-CAMLR drew upon conclusions of the 'Antarctic Krill and Climate Change' workshop jointly sponsored by the EU and the Netherlands relative to krill biology in the face of climate change and the implications for management of krill stocks. Past and future trends in agents of climate change, such as ocean warming, sea-ice decline, and ocean acidification, and their impact on Antarctic krill and ecosystems, were reviewed. SC-CAMLR further noted in 2012 the potential effects of climate change on growth, mortality and recruitment of Antarctic krill and endorsed the proposal for future work to review the decision rules for the krill fishery in light of the potential influence of climate change. Currently, there are alternative decision rules that are being explored that implicitly account for potential influence of climate change.

SC-CAMLR recognised in 2013 that increased warming and acidification are highly likely to impact marine ecosystems during the current century, and noted that Resolution 30/XVIII urges increased consideration of climate change impacts in the Southern Ocean to better inform CCAMLR's management decisions. In 2014 The Scientific Committee noted that development and progress of a feedback management strategy for the krill fishery offers the opportunity to adapt to the impacts of climate change.

Biodiversity and non-native species in the marine environment

Whilst it was acknowledged at the first joint CEP/SC-CAMLR workshop that biodiversity and non-native species in the marine environment is a topic of mutual interest, SC-CAMLR has noted that the CEP would be the lead-body on this issue, and would liaise with SC-CAMLR as appropriate. As such, very little discussion has taken place explicitly on this topic by SC-CAMLR. However, there are implicit issues pertaining to biodiversity within the spatial marine management and protected areas agenda item.

Antarctic species requiring special protection

Continuous monitoring of incidental mortality of birds and mammals associated with fisheries remains a key part of the work of SC-CAMLR and the CCAMLR Scheme of International Scientific Observation. Since the first joint CEP/SC-CAMLR workshop, a considerable amount of progress has been made in reducing the incidental mortality of seabirds and marine mammals in CCAMLR fisheries, principally through the efforts of SC-CAMLR's Working Group on Incidental Mortality Associated with Fisheries (WG-IMAF). In 2010, SC-CAMLR agreed that because of the substantial reductions in incidental mortality, WG-IMAF could be moved to a biennial meeting schedule. This allowed greater involvement of WG-IMAF participants in ACAP, which is aiming to address incidental mortality of albatrosses and petrels, including Convention Area seabirds, in fisheries managed by adjacent RFMOs. From 2011-2014, there were further reductions in incidental mortality through continued mitigation measures. Recognizing this, SC-CAMLR has allowed some season extensions, noting that this requires careful consideration and potential extra mitigation measures. The incidental mortality rates have dropped to such a low level, that WG-IMAF has since been disbanded as a regular working group of SC-CAMLR. Should issues requiring the expertise of this working group arise again in the future, there remains the option of re-establishing WG-IMAF by SC-CAMLR.

Spatial marine management and protected areas

SC-CAMLR has been working on issues related to spatial planning in the Southern Ocean for over 10 years. The first workshop on Marine Protected Areas was held in 2005 in Washington D.C., followed by a workshop on bioregionalisation of the Southern Ocean in Brussels in 2007. Since 2009, the establishment of a representative system of MPAs across the Convention Area has been a high priority for CCAMLR, with the Commission setting a goal of achieving a representative system of MPAs within the Convention Area by 2012. Although this goal was not met, there has been considerable progress in most sectors of the Southern Ocean beyond the South Orkney Islands southern shelf MPA that was established in 2009. In 2011, SC-CAMLR held another workshop on MPAs in Brest, France with the aim of reviewing progress, sharing experience on different approaches to the selection of candidate marine sites for protection, reviewing draft proposals, and developing work programs. Since this time, there has been considerable discussion and development of two MPA proposals: one for the Ross Sea region, and one for a representative system of MPAs covering East Antarctica. SC-CAMLR has agreed that these proposals contain the best available science, and further progress on these proposals in now fully within the remit of the Commission, within which negotiations are expected to continue. Other proposals for MPAs currently in development and being considered by SC-CAMLR include the Weddell Sea and Antarctic Peninsula regions. An additional spatial protection measure under consideration by CCAMLR includes a proposal for precautionary, interim protection of newly-exposed marine areas following the collapse or retreat of ice shelves, as previously recommended by the ATME.

In relation to ASPAs and ASMAs, SC-CAMLR has continued to review and endorse management plans as part of the longstanding cooperation between the two bodies. There were instances where krill fishing occurred in some ASPAs likely due to a lack of awareness of the existence of these designated areas among those responsible for fishing vessels. In response, CCAMLR adopted Conservation Measure 91-02 (2012) on protection of the values of ASPAs and ASMAs, which is designed to ensure that fishing vessels are aware of the location and relevant management plan of all designated ASPAs and ASMAs that have marine components. Further, SC-CAMLR noted that, consistent with the procedure

established in ATCM XXVIII Decision 9 (2005), any proposal to undertake commercial harvesting within an ASMA should be submitted to CCAMLR for its consideration and that the activities outlined in that proposal should only be taken with the prior approval of CCAMLR. SC-CAMLR agreed that the provision of advice from CCAMLR to the ATCM in order that such advice could be included in decision-making, was consistent with the spirit of cooperation and harmonisation between CCAMLR and the ATCM.

Regarding Vulnerable Marine Ecosystems (VMEs), SC-CAMLR continues to collect information on VME indicator taxa from commercial bottom fishing operations, and establish VME risk areas where these activities encounter taxa at a defined threshold. Further, SC-CAMLR continues to request that Members endeavour to detect and identify VMEs though their national Antarctic programs with the aim of registering and protecting these VMEs.

Ecosystem and environmental monitoring

CCAMLR Members continue to collect data as part of the CCAMLR Ecosystem Monitoring Program, and SC-CAMLR has welcomed new initiatives for CEMP monitoring in the Convention Area, including the development of multinational CEMP programs. In 2011, SC-CAMLR agreed that the development of a feedback management system of the krill fishery may require CEMP to change or evolve from its present form to include greater spatial coverage, to monitor at different spatial and temporal scales, and to include more or different parameters and revised methods for existing parameters. In 2012 through 2014, SC-CAMLR agreed the requirement for ecosystem monitoring is likely to increase in support of feedback management of the krill fishery and MPAs.

Workshop Paper 007 – The CEP Climate Change Response Work Plan and its relevance for joint CEP/SC-CAMLR effort

Birgit Njåstad (Norway)

The Protocol on Environmental Protection establishes the Committee for Environmental Protection (CEP) and sets up a clear set of functions for it (Article 11 and 12 of the Environmental Protocol). One of the Committee's key functions is to provide the Antarctic Treaty Parties with advice on the state of the Antarctic environment as basis for sound and relevant management and governance by the Treaty Parties.

Climate and climate change is one of the most important and obvious factors influencing the state of the Antarctic environment. The climates of the Antarctic and Southern Ocean have and are undergoing change and are expected to continue to change into the future. With these changes there has been and will continue to be associated impacts on marine and terrestrial biota. Consequently, climate and climate change are issues which are of key concern to the CEP.

The eighteenth meeting of the CEP discussed and adopted a Climate Change Response Work Programme (CCRWP). The objective of the CCRWP is formulated as follows: *Taking into account the conclusions and recommendations from the ATME on Climate Change in 2010, the CCRWP provides a mechanism for identifying and revising goals and specific actions by the CEP to support efforts within the Antarctic Treaty System to prepare for, and build resilience to, the environmental impacts of a changing climate and the associated implications for the governance and management of Antarctica.*

The CCRWP is focused around a definite number of priority issues. The list of identified priorities is targeted to the climate change related issues relevant to the CEP's functions and agreed priorities. The key content of the CCRWP are the identified response actions for the various climate change related issues of interest to the CEP, i.e. tasks/actions that will move the CEP forward with regard to management of Antarctica in the context of a changing climate.

The health of the Southern Ocean system largely underpins the well-being of the Antarctic environment as a whole. The wide array of issues identified as relevant for CEP action in the CCRWP therefore also spans a large number of marine issues. These marine issues and actions identified and prioritized in the CCRWP are to a large degree also relevant in the context of CCAMLR and would therefore benefit from joint prioritization, understanding and effort. Summarized these issues include:

- Change to marine near-shore abiotic and biotic environment, noting in particular the following needs:
    - Understanding and have the ability to predict near-shore marine changes and impacts of the change
    - Have a broader understanding of what monitoring data will be required to assess climate driven changes to the marine environment
- Ecosystem change due to ocean acidification, noting in particular the following needs:
    - Understanding of the impact of OA to marine biota and ecosystems
- Marine species at risk due to climate change, noting in particular the following needs:

    - Understand population status, trends, vulnerability and distribution of key Antarctic species
    - Improved understanding of effect on climate on species at risk, including critical thresholds that would give irreversible impacts
    - Framework for monitoring to ensure the effects on key species are identified
    - Understand relationship between species and climate change impacts in important locations/areas
- Marine habitats at risk due to climate change, noting in particular the following needs:
    - Understand habitat status, trends, vulnerability and distribution
    - Improved understanding of the effects of climate change on habitat, eg. sea ice extent and duration

The CEP adopted the CCRWP as a work plan and now retains it as a separate document which will be updated annually by populating it with specific actions to address the priority issues, reflect changing priorities and documenting the progress made. The Antarctic Treaty Consultative Meeting has encouraged the CEP to begin implementing the CCRWP as a matter of priority. The CEP and SC-CAMLR need to explore and consider manners to jointly tackle the issues that are of interest to both committees.

Key references:

- Protocol on Environmental Protection to the Antarctic Treaty (http://ats.aq/documents/recatt/Att006_e.pdf)
- CEP Climate Change Response Work Programme (http://www.ats.aq/documents/ATCM38/ww/atcm38_ww010_e.doc)
- Co-Chair's Report from Antarctic Treaty Meeting of Experts on Implications of Climate Change for Antarctic Management and Governance (http://ats.aq/documents/ATCM33/att/ATCM33_att109_e.pdf)

Workshop Paper 019 – SC-CAMLR work on climate change

Andrew Constable (Australia)

Introduction

1. The objective (Article II, see Attachment A) of the Convention on the Conservation of Antarctic Marine Living Resources (The Convention) is to conserve all populations of living organisms (Antarctic Marine Living Resources – AMLR – as defined in Article I) in the ecosystem found south of the Antarctic Convergence (Polar Front). Rational use can be undertaken in the Convention Area but is a subsidiary objective to the conservation objective. Lastly, harvesting is a specific case of rational use that is required to meet specific objectives (Article II, paragraph 3). Aside from the broad requirement to conserve AMLR, Article II, paragraph 3(c), requires that account needs to be given to the effects of environmental changes in order to achieve sustained conservation of AMLR. To that end, environmental variability and change arising from climate change and ocean acidification (hereafter, referred to as CCOA) need to be accounted for in conserving AMLR.

2. Article IX of the Convention (see Attachment A) provides the operational requirements for achieving conservation of AMLR, including the provision of the best scientific evidence available by the Scientific Committee. A fundamental question arising out of Articles II and IX concerns the effects of fishing on the sustainability of species and the marine ecosystem. Also, if fishing were to cease, the requirement is for the marine ecosystem to recover in two to three decades.

3. Sustaining species in the face of CCOA requires accounting for effects on habitats, an organism's physiology, supply of resources, and in modifying interactions between species (Constable and Doust, 2009; Constable et al., 2014; Trathan and Agnew, 2010). Thus, an assessment of the conservation status of species and/or the potential effects of fishing on AMLR will require accounting for the state of the ecosystem had there been no fishing since the beginning of CCAMLR. In the case of CCOA, the question to be addressed by the Scientific Committee is whether the harvest strategy for any species is such that, should the fishery cease, the ecosystem will recover after 20-30 years to where it would have been had there been no fishing since 1980. For convenience, we can refer to this as the Reference State.

4. Articles II and IX provide the impetus for work in the Scientific Committee on the effects of CCOA, in order to provide, in a timely manner, the 'best scientific evidence available' on three issues related to CCOA:

(i) Risks of CCOA

- threatening the conservation of species,
- changing the vulnerability of species and/or foodwebs to the effects of fishing, and
- increasing the risk of invasive marine species in the CCAMLR area;

(ii) Status of AMLR and the Antarctic marine ecosystem relative to the Reference State and whether actions may be required to conserve AMLR because the Reference State had changed;

(iii) Requirements for adapting harvest strategies in the future, in order that

- those harvest strategies, including catch rates, will be consistent with the Reference State in the future, and
- harvesting activities will not increase the risk of failing to conserve AMLR in the long term.

5. This paper summarises the state of knowledge on impacts of CCOA on Southern Ocean ecosystems and the attention that SC-CAMLR has given to CCOA impacts. Lastly it summarises synergies in work with the CEP and SCAR for progressing these topics in the coming years.

Impacts of CCOA on Southern Ocean ecosystems

6. Southern Ocean ecosystems have been changing over the last century from a variety of stressors, including CCOA, whaling and sealing. The most comprehensive understanding of change is for physical and chemical habitats and the biogeochemistry of the region (IPCC, 2013; Turner et al., 2009; Turner et al., 2013). The consequences for food webs is comparatively poorly understood at the circumpolar scale (Constable et al., 2014; De Broyer and Koubbi, 2014; Gutt et al., 2015; Nymand Larson et al., 2014). The West Antarctic Peninsula and Scotia Arc have the best biological coverage, ranging from phytoplankton through top predators, although most pelagic work is focussed on the krill-based food chain with a poor understanding of food chains involving mesopelagic fish (Hill et al., 2012).

7. Our ability to understand the consequences of change in the physical and chemical environment to biological systems is hampered in two ways. First, there are insufficient time series for biota in enough places and times and from across the food web to do an empirical assessment of the current effects of CCOA (Nymand-Larson 2014; Constable et al 2016). Second, end-to-end ecosystem and food web models are yet to be sufficiently developed to fill this gap (Murphy et al., 2012).

8. ICED developed a synthesis on the potential effects of CCOA on habitats and species, with a view to compiling potential effects on food webs (Constable et al 2014). Combined with the bioregionalisation of the Southern Ocean (Grant et al., 2006), a conclusion in this synthesis was to consider the Southern Ocean comprising of four sectors with a high latitude and subantarctic components – East Pacific, Atlantic, Indian and West Pacific (Figure 3 in Constable et al 2014). Each of these sectors is experiencing different scenarios of change in habitats (e.g. sea ice, temperature) and, based on the species assessments, are likely to have different changes in the food webs as well.

CCOA in SC-CAMLR

9. Climate change has been appearing regularly in discussions in SC-CAMLR since 2002. CCOA came on to the agenda of SC-CAMLR in 2008 following a Commission request in 2007 (see Attachment B for extracts from SC-CAMLR reports). The CCAMLR Performance Review of 2008 also emphasised that this issue needed attention. A constant theme since then has been to develop a risk assessment framework for identifying when CCOA impacts may need attention from the Commission, along with developing a 'state of environment' report. Most work in SC-CAMLR has been within the Working Group on Ecosystem Monitoring and Management (WG-EMM). In this regard, WG-EMM has focussed on the effects of CCOA on Antarctic krill (Flores et al., 2012; Kawaguchi et al., 2013) and its habitats (Hill et al., 2013). There has also been consideration of a proposal to

manage ocean areas adjacent to the Antarctica Peninsula uncovered by ice shelf collapse (Trathan et al., 2013).

10. SC-CAMLR does not yet have an explicit strategy and timetable of work for (i) assessing climate change impacts on AMLR and (ii) providing advice to the Commission on how to deal with CCOA. Nevertheless, many Members have engaged with developing approaches to address CCOA impacts when developing strategies on at least three current issues in SC-CAMLR. First, the design of krill feedback management strategies is being investigated with the potential for having decision rules incorporate the Reference State. The Reference State could be determined empirically by using reference areas to measure the state of the krill-based system without fishing, or an ecosystem modelling approach could be used. Second, the current proposals for representative marine protected areas incorporate considerations of adaptation of the system to climate change as well as having reference areas for measuring CCOA impacts. Lastly, food web and ecosystem models are being developed for evaluating management and conservation strategies. End-to-end ecosystem models with links to climate models can provide realistic scenarios for testing these management strategies and how well they will adapt to CCOA. ICED (below) is facilitating the development of these models by the wider international community (Murphy et al, 2012).

Future work: Synergies between SC-CAMLR, CEP, and SCAR

11. In recent years, scientific work on the effects of CCOA on Southern Ocean ecosystems have primarily been occurring in two programs sponsored by SCAR: the IMBER-SCAR program on Integrating Climate Change and Ecosystem Dynamics in the Southern Ocean (ICED) and the SCAR-SCOR Southern Ocean Observing System (SOOS). While there is some overlap in their remit, they are complementary programs working on, respectively, (i) assessments and modelling of change in Southern Ocean ecosystems and (ii) the design and implementation of observing systems and the integration and facilitation of access to the observational data. This work continues to be reported to WG-EMM. Both groups wish to have a continuing relationship in support of CCAMLR.

12. ICED is organising a conference in 2018 (www.MEASO2018.aq) with a principle focus of assessing the status and trends of habitats, species and foodwebs in the Southern Ocean. The assessment is intended to provide the community input on the Antarctic marine ecosystem to the Sixth Assessment of the Intergovernmental Panel on Climate Change (IPCC). It is also intended to provide marine biological input to the SCAR Antarctic Climate Change and the Environment Report. This work could form the basis of an assessment of the current Reference State for CCAMLR and provide a State of Marine Ecosystem report intended in discussions in SC-CAMLR.

13. SOOS is designing the biological component of its observing system to be complementary to the CCAMLR Ecosystem Monitoring Program. This system could provide the observations necessary for, say 5-yearly, strategic assessments of the Reference State while the CEMP provides the tactical observations for the feedback management system. Further, SOOS is in the process of developing an initiative to undertake a circumpolar benchmarking of the Southern Ocean ecosystem. This initiative aims to link the historical time series that have been collected in different parts of the Southern Ocean and then provide the basis for sustained circumpolar biological observations and assessments thereafter.

14. Resolution 30/XXVIII (2009) encourages Members to become engaged in these two programs. The resolution refers to ICED and the Southern Ocean Sentinel, the latter of which has had its aims incorporated into both ICED and SOOS. SC-CAMLR and CEP

would benefit from working with these two bodies to develop the capabilities necessary to deliver the advice on the three CCOA issues of importance to them.

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Workshop Paper 004 – SCAR activities on climate change and monitoring

Aleks Terauds (SCAR)

SCAR undertakes a diverse range of activities on climate change and monitoring. These include the facilitation and coordination of research into the physical and biological manifestations of climate change, the dissemination of research findings at international meetings and the provision of climate related advice to a range of bodies, including the Committee for Environmental Protection (CEP). The role that Antarctica and the Southern Ocean play in the global Earth System is fundamentally important given the dramatic climate related changes that are occurring across much of the region, often with global consequences. The importance of climate related issues in the region was also highlighted in the SCAR Antarctic and Southern Ocean Horizon Scan (Kennicutt *et al*. 2014).

The mechanisms through which these activities are undertaken are diverse. One of the key SCAR subsidiary bodies that acts as an umbrella group for a range of SCAR climate related activities is the Expert Group on Antarctic Climate Change and the Environment (ACCE). Since 2009, when SCAR published the landmark Antarctic Climate Change and the Environment Report (Turner *et al*. 2009), this group has been responsible for compiling annual climate updates at the request of the ATCM (ATCM Resolution 4 (2010)). These updates contain summaries of contemporary Antarctic and Southern Ocean climate related studies, including those that examine the ecological implications of climate science. This group also hosts a progressively updated wiki - where key points from the updates and new studies are made available online on an ongoing basis – ensuring that the most available and up to date information is readily available (see http://acce.scar.org/wiki/Antarctic_Climate_Change_and_the_Environment)

In addition to ACCE, the SCAR Scientific Research Programmes (SRP) play an important role in facilitating and coordinating climate research and monitoring. For example, the SRP Antarctic Thresholds - Ecosystem Resilience and Adaptation (AnT-ERA) supports research into how biological processes are related to environmental change, the SRP State of the Antarctic Ecosystem (AntEco) focusses on past and present patterns of biodiversity, including how organisms respond to a changing climate, and Antarctic Climate Change in the 21st Century (AntClim^{21}) focuses on the physical nature of climate change, including predictions of how Antarctica and the Southern Ocean environments might respond to various degrees of change. The quality of science delivered by these groups is reflected by their contribution to the Fifth Assessment Report of the IPCC and participation in the recent COP21 meeting in Paris.

From a monitoring perspective, SCAR (in conjunction with the Scientific Committee on Ocean Research – SCOR) supports the Southern Ocean Observing System (SOOS) and the Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) group. Both of these groups are international initiatives with a wide range of stakeholders. The primary objective of SOOS is to facilitate the collection and delivery of essential observations on the dynamics and change of Southern Ocean systems, while ICED is a multidisciplinary programme launched in response to the increasing need to develop integrated circumpolar analyses of Southern Ocean climate and ecosystem dynamics. In addition to these established entities, a SCAR Action Group was recently formed to progress the Antarctic Nearshore and Terrestrial Observing System (ANTOS) initiative. This is a biologically focused initiative to coordinate a cross-continent and multi-national assessment of environmental variability and

change. One of the major aims is to foster and facilitate collection and sharing of long-term automated climate and associated environmental observations across Antarctica and national programmes.

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Workshop Paper 014 – Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED)

Eugene Murphy and Rachel Cavanagh (SCAR)

ICED is a regional programme of the International Geosphere-Biosphere Programme (IGBP)'s Integrated Marine Biogeochemistry and Ecosystem Research (IMBER) and is closely linked with SCAR. ICED is undertaking an integrated circumpolar approach to improve our understanding of change, the implications for ecosystems, and implications for ecosystem management. A diverse range of multidisciplinary research is underway through core activities such as historical data rescue and synthesis, fieldwork, and modelling.

This presentation highlights our recent work on ecosystems and change in the Southern Ocean. ICED has convened a series of multidisciplinary workshops on change (e.g. rapid change in polar ecosystems; reviewing the state of change in Southern Ocean ecosystems; developing species and food web models; and scenarios and projections). Considerable progress has been made in understanding the structure and functioning of ecosystems, modelling species and food webs, and with qualitative assessments of change. The use of scenarios to better quantify change is an area we have recently been exploring. This ongoing work will inform projections of change and is relevant to the work of SC-CAMLR, CEP, IPCC and SCAR.

Resource managers need to account for the potential effects of climate change on ecosystems. Yet predicting the effects of change is complex, requiring an understanding of the processes that determine the distribution and abundance of individual species, the structure and functioning of ecosystems within which they occur, and the drivers of change, together with past and present physical and ecological dynamics. Translating this into advice for managers who need to know how particular species or ecosystems may respond to change is difficult. The above-mentioned ICED studies are continuing to progress understanding and capabilities in this area, but we have also identified major gaps in knowledge for a range of important species and regional ecosystems that limit our capacity to develop integrated models and project the impacts of change. Reliable projections of physical aspects of the environment are key but using climate models to reach informative ecological conclusions also brings numerous challenges. For example, although climate models provide projections of parameters known to influence ecology, such as ocean temperature and sea ice extent, there are large uncertainties in the projections and the mechanisms that link them to biological processes. Other issues include reconciling large-scale physical information with the biology of species, often at regional spatial scales, and how well the physical parameters themselves are represented in the models.

ICED's focus on multidisciplinary research and associated activities has enabled the wider Southern Ocean community to work more closely together to jointly consider some of the key challenges and potential solutions. As an exemplar of this we highlight a recent collaborative project between climate scientists and ecologists focused on sea ice change. Through this we aim to produce plausible scenarios of how sea ice (and subsequently other parameters) may change in this region to model the impacts on individual species and ecosystem processes and to provide information that is useful for managers.

We conclude that a combination of multidisciplinary approaches is required to improve the integration of climate science into ecology and ecosystem-based management. By continuing to actively engage across relevant disciplines and stakeholders we can ensure incorporation of

the latest knowledge, help identify the most effective and/or appropriate approaches, and provide guidelines for decision-makers, towards improving the basis for future monitoring and management of Southern Ocean ecosystems.

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See also: http://www.iced.ac.uk/science/publications.htm

Workshop Paper 017 – SC-CAMLR monitoring activities

Keith Reid (CCAMLR Secretariat) and Mercedes Santos (Argentina)

Monitoring undertaken by CCAMLR can be conveniently divided into two general classifications of monitoring; operational and surveillance monitoring. Operational monitoring is put in place in response to a specific management objective, to detect, for example, whether a trigger level has been reached. The design and implementation of an operational monitoring programme require clear definition of the change to be detected and an evaluation of the methods required to detect such a change. An example of operational monitoring in CCAMLR is the fisheries monitoring that is undertaken by the CCAMLR Secretariat. This involves the receipt of catch data from all vessels fishing in the convention area, including daily reports of catch and effort (including the number of vessels in the fishery). These data are used to determine when catch levels approach triggers and to forecast closure date of the fishery based on the catch of the target species or critical non-target taxa such as seabirds. Once a closure date is forecast all vessels in that fishery are informed and their departure from the fishery is monitored using satellite-based vessel monitoring data.

Surveillance Monitoring is based on best available knowledge of the system being monitored, where the emphasis is on collecting basic ecological data that allows the a posteriori attribution of the causes of change. Surveillance monitoring might not be linked directly to trigger for action like fishery monitoring and closures, however, typically the aims of a surveillance monitoring programme include the provision of information for the assessment of long-term changes under 'natural' conditions as well refining the design of monitoring programmes in the future

In CCAMLR examples of surveillance monitoring include marine debris monitoring as well as ecosystem monitoring programs. Monitoring of marine debris, in order to detect and minimize the impact of fisheries related activities in the Convention Area, has been an integral part of the CCAMLR agenda since 1984. Each year since 1989, Members have collected data on beached debris, entanglement of marine mammals, marine debris associated with seabird colonies and animals contaminated with hydrocarbons at various sites around Antarctica. Arising from the analysis of the results of this monitoring, in particular in the attribution of the provenance of marine debris to fishing activity, CCAMLR has taken steps to reduce the amount of debris entering the marine system and to mitigate its impact. Specific measures have been implemented to address the risk associated with entanglement of marine mammals in plastic packaging bands used to secure bait boxes (CM 26-01) and the injury to seabirds caused by the discharge of hooks in offal (CM 25-02).

There has been a recent increase in awareness of the global issue of marine debris and in particular the impact of marine plastics and CCAMLR is now a Member of the UNEPs Global Partnership on Marine Litter (GPML). The GPML is a global partnership gathering international agencies, Governments, NGOs, academia, private sector, civil society and individuals together with the aim to reduce the impacts of marine litter worldwide on economies, ecosystems, animal welfare and human health.

Perhaps the best known element of CCAMLRs monitoring work is the CCAMLR Ecosystem Monitoring Program (CEMP). The aims of CEMP, which was established in 1985, are to:

(i) detect and record significant changes in critical components of the ecosystem, to serve as a basis for the conservation of Antarctic marine living resources; and

(ii) distinguish between changes due to the harvesting of commercial species and changes due to environmental variability, both physical and biological.

CEMP's major function is to monitor the key life-history parameters of selected dependent species to detect changes in the abundance of harvested species. 'Dependent species' are marine predators for which species targeted by commercial fisheries are a major component of their diet. In the case of 'krill-dependent species' used in CEMP they include land-breeding species such as seals and penguins.

CEMP data for 6 species, Chinstrap, Adelie, Gentoo and Macaroni Penguins as well as Antarctic fur seal and Black-browed albatross have been collected from 20 sites around the convention area (see https://gis.ccamlr.org/home). The suite of CEMP parameters response vectors can be grouped by species and by the time scales over which they reflect environmental conditions. Thus, parameters such as arrival mass and duration of the first incubation shifts reflect conditions prior to the onset of the breeding season and can be referred to as ' winter' variables. Parameters that are collected during the period of offspring rearing, such as diet and foraging durations as well as offspring mass at independence can be considered 'summer' vectors. Parameters that measure breeding population size reflect conditions over a longer time frame (and over larger spatial scales) are referred to as 'multi-year' response vectors (see Figure 1).

Since its inception CEMP has evolved to include new data collection sites, providing broader geographic coverage, as well as the introduction of new methodologies (i.e. remote camera networks) to collect monitoring data. As it is a multinational programme, engagement in CEMP also provides a mechanism for collaboration to fill key information gaps that are crucial to the interpretation of the monitoring data. For example, in 2015 the CCAMLR CEMP Special Fund awarded a grant to undertake a coordinated multinational satellite tracking study on the year-round distribution of CEMP monitored penguin species in the Antarctic Peninsula region.

Monitoring data collected on marine debris and as part of CEMP is available from CCAMLR (in line with the Rules for data access and use) and enquires about its use should be directed to data@ccamlr.org

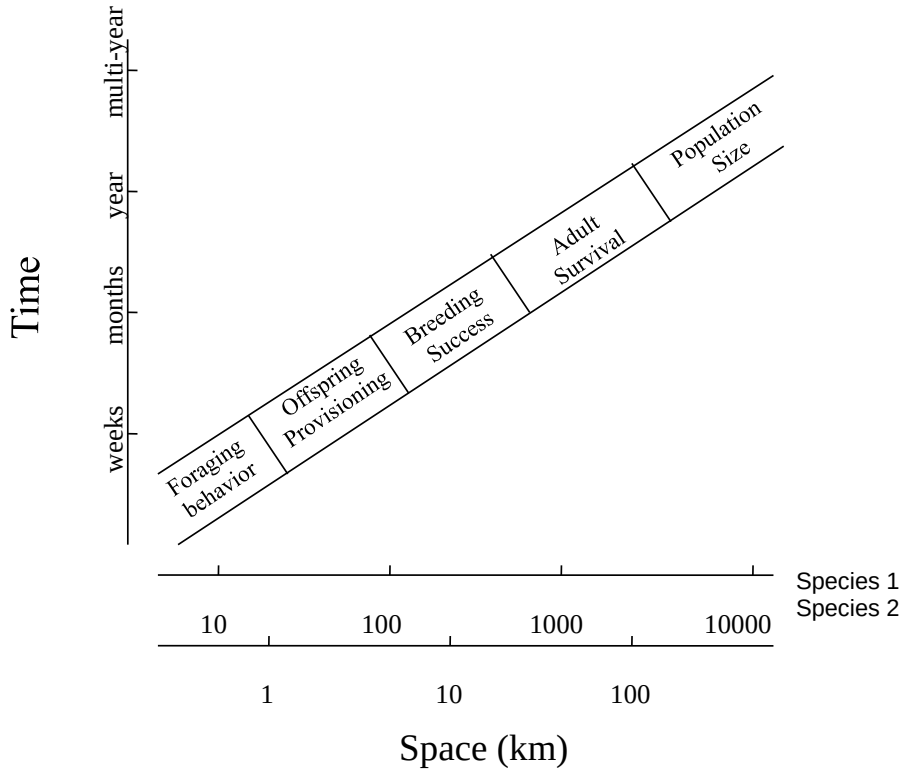

Figure 1 Schematic showing the relationship between the temporal and spatial scales of different CEMP monitoring indices (adapted from Murphy et al. 1998).

Workshop Paper 018 – The Southern Ocean Observing System (SOOS)

Andrew Constable and Louise Newman (Australia)

The Southern Ocean Observing System (SOOS; www.soos.aq) was established by SCAR and SCOR in August 2011 and has been steadily developing its work based on the Initial Science and Implementation Strategy (Rintoul et al., 2012) and 20-year vision (Meredith *et al* 2013). It has an International Project Office (IPO) based at the Institute of Marine and Antarctic Studies, University of Tasmania in Hobart Australia and is coordinated by a Scientific Steering Committee (SSC). It was established because sustained system-wide observations in the Southern Ocean face two main challenges:

- Southern Ocean observations are sparse, difficult, and expensive to obtain, and are often limited in space, time, quality, and variables measured.
- Access to multidisciplinary, quality-controlled, observational data from the Southern Ocean is difficult and time consuming.

Therefore, the mission for SOOS is to facilitate the collection and delivery of essential observations on dynamics and change of Southern Ocean systems to all international stakeholders (researchers, governments, industries), through design, advocacy, and implementation of cost-effective observing and data delivery systems. These essential observations will aid robust assessments of system properties but their selection does not aim to address all questions of all stakeholders. It is intended that individual science projects or specific observational requirements of policy-makers and managers can be built around the baseline variables (Constable et al., 2016).

The SOOS implementation plan has 4 objectives that follow a logical sequence from design of the system, through field implementation, to delivery of the data (Attachment 1):

Objective 1:	Facilitate the design of a comprehensive and multi-disciplinary observing system for the Southern Ocean
Objective 2:	Unify and enhance current observation efforts and leverage further resources across disciplines, and between nations and programmes
Objective 3:	Facilitate linking of sustained long-term observations to provide a system of enhanced data discovery and delivery, utilising existing data centres and programmatic efforts combined with, as needed, purpose-built data management and storage systems
Objective 4:	Provide services to communicate, coordinate, advocate and facilitate SOOS objectives and activities

SOOS will be implemented regionally in the natural areas of focus by nations involved in Southern Ocean activities, although some activities will be coordinated at a circumpolar scale, such as Argo and GO-SHIP. SOOS is therefore developing *Regional Working Groups* that will coordinate and implement the observing system in their defined region, including facilitating improved readiness of particularly measurements and an ability to measure them where needed. Regional Working Group membership will be open, and will have representation from all nations working in the region, and expertise across all disciplines. Five priority regions were identified (* = Working Groups have been established): West Antarctic Peninsula*, Weddell Sea, Indian Sector*, Ross Sea, Amundsen and Bellingshausen Seas. The community is encouraged to register interest of creating working groups or becoming involved in the existing groups.

Capability Working Groups will be used to develop important capabilities for SOOS generally, including (i) developing and implementing technologies, (ii) improving observational design, efficiency and coverage, and (iii) developing methods for managing and disseminating information. Capability working groups have been established for ecosystem Essential Ocean Variables, Censusing Animal Populations from Space, and Southern Ocean Fluxes. A capability working group for under ice observations is also being developed. SOOS Task Teams are also developed to produce targeted products or organise events. Examples of activities undertaken in this category include the development of an international under ice strategy (Rintoul et al, 2015), identification of observational and science gaps in the Ross Sea region (Williams et al, 2015) and a report of community needs for Southern Ocean satellite data which is in preparation (sponsored by SCAR, SOOS, CliC).

Existing national and international projects and programs that contribute to SOOS will be identified and recognised as contributing regionally and/or to enhancing capabilities.

Activities directly related to the work of SC-CAMLR and CEP

Apart from the regional working groups, which will be of direct interest to the implementation of monitoring programs in different regions of the CCAMLR and Antarctic Treaty areas, there are 5 main topics described here that SC-CAMLR and CEP may be interested in participating and/or developing a relationship with SOOS.

ecosystem Essential Ocean Variables (eEOVs)

SOOS has been developing priority variables ("ecosystem Essential Ocean Variables" – eEOVs) for observing dynamics and change in Southern Ocean ecosystems (Constable et al. 2016). An eEOV is a defined biological or ecological quantity, which is derived from field observations, and which contributes significantly to assessments of Southern Ocean ecosystems. Here, assessments are concerned with estimating status and trends in ecosystem properties, attribution of trends to causes, and predicting future trajectories. eEOVs should be feasible to collect at appropriate spatial and temporal scales and are useful to the extent that they contribute to direct estimation of trends and/or attribution, and/or development of ecological (statistical or simulation) models to support assessments. Nine types of eEOVs for Southern Ocean taxa are identified within three classes: state (magnitude, genetic/species, size spectrum), predator-prey (diet, foraging range), and autecology (phenology, reproductive rate, individual growth rate, detritus). Most candidates for the suite of Southern Ocean taxa relate to state or diet. Candidate autecological eEOVs have not yet been developed other than for marine mammals and birds.

Sustained circumpolar marine biological observing

The next phase of the work program is to consider the spatial and temporal issues that will influence the adoption and use of eEOVs in an observing system in the Southern Ocean, noting that existing operations and platforms potentially provide coverage of the four main sectors of the region – the East and West Pacific, Atlantic and Indian – in high latitudes and in subantarctic areas (Constable et al 2014, 2016). Simulation modelling will be used to help design the observing system in the long term. This work is intended to be completed in time for consideration at the 2018 International Conference on Marine Ecosystem Assessment for the Southern Ocean (www.MEASO2018.aq) for establishing an integrated circumpolar marine biological observing program, enhancing efforts already established throughout the region.

Portal for linking metadata, accessing datasets and synthesis products, and coordinating field activities

A great challenge for Southern Ocean science is to overcome the poor discoverability and connectivity between different observational datasets. SOOS is building a data management system primarily focussed at linking data sets from across many data centres using metadata discovery tools and data access tools. A searchable metadata portal within NASA's Global Change Master Directory has been created and is currently being populated with records describing key SOOS datasets. These metadata records will lead the user to the associated data from areas that intersect with the SOOS region and are related to any of the candidate Essential Ocean Variables (EOVs) identified by SOOS. In addition, the GCMD provides web services which will allow other interfaces to be implemented in the future. A data rescue effort has been launched and is focused on historical data by making their metadata discoverable through the SOOS GCMD domain. SOOS is also endeavouring to locate orphan datasets so that they can be documented and housed in easily-accessible data repositories and linked into the portal (an orphan dataset is one that is not publicly documented and available, often because the responsible researchers have been unaware of potential repositories for housing their data).

SOOS is also designing a platform for researchers to easily share their field work plans and to access historical records of field activities. This database and GIS tool is under development but is intended to make available classes of information provided by researchers before their field seasons start. These data can then be used by the research community to better facilitate collaborative activities such as offering and taking advantage of ships-of-opportunity, moorings-of-opportunity, adding sensors to packages, deploying instruments or sharing calibration information.

Assessments of the state of Southern Ocean ecosystems

SOOS aims to contribute to assessments of the state of Southern Ocean ecosystems. It is prepared to work with stakeholders to help link datasets and to facilitate the collection of observations to support such assessments. It will be contributing to the 2018 MEASO conference aimed at providing a state of Southern Ocean ecosystems report on status and trends of habitats, species and food webs.

Circumpolar benchmarking of the state of Southern Ocean ecosystems in 2022.

Integrated whole-of-ecosystem studies and long term biological observations are primarily concentrated in the West Antarctic Peninsula and the Scotia Sea. SOOS is considering how to build on these existing activities to achieve integrated circumpolar biological observing to help inform tactical decisions, such as catch limits and conservation actions in the CCAMLR and CEP, and for strategic long-term assessments of change in polar regions, such as by the Intergovernmental Panel on Climate Change (e.g. Nymand Larson et al 2014).

A component of these considerations is to build on the work of GLOBEC, the International Polar Year and the Census of Antarctic Marine Life and undertake coordinated circumpolar activities in 2022 to provide a circumpolar benchmark of Southern Ocean ecosystems (Figure 1).

The aim is to use observations from satellites, ships (physics, chemistry, biology), land-based observations of predators, and remote platforms such as gliders and moorings, to develop an integrated view of the state of the ecosystem. The design of the core activities are intended to help link time-series of observations from the past with a co-ordinated set of observations to be made in the future. Products will further advance the SCAR Biogeographic Atlas of the Southern Ocean (De Broyer et al 2014, www.atlas.biodiversity.aq), support an updated assessment of the state of the ecosystem in 2025 (MEASO 2025), and support the use of ecosystem models for assessing ecosystem scenarios for the future.

Conclusions

Activities in SOOS relating to ecosystems are of direct interest to CCAMLR and CEP. SOOS provides a framework for observing change in the Southern Ocean and provides access to data streams useful to CCAMLR and CEP in estimating status and trends of habitats, species and the ecosystems of interest to both organisations.

SOOS also aims to facilitate regional and circumpolar coordination of the observing system, reaching to the wider Antarctic science and logistics community, and leading to circumpolar assessments of status, trends and future states of the Southern Ocean ecosystems. Discussions to benchmark the ecosystems in 2022 are progressing with the aim of establishing coordinated circumpolar biological observing by that time.

Work in the Council of Managers of National Antarctic Programs (COMNAP) and support of SOOS by the CEP, ATCM and SC-CAMLR indicates growing support for contributions to and coordination of Southern Ocean ecosystem observing by nations involved in Antarctica and the Southern Ocean. This support also recognises how SOOS and ecosystem modelling will contribute to understanding the future of Southern Ocean ecosystems under climate change.

SC-CAMLR and CEP can both gain from and contribute to SOOS in support of their work to adapt management of the region to climate change. For example, the CEP has a number of elements in its Climate Change Response Work Program that would benefit from SOOS activities, including measuring change in habitats, species and food webs and in determining risks to marine species from climate change. CCAMLR endorsed advice from the Scientific Committee that development of a feedback management strategy for the krill fishery offers the opportunity to adapt to the impacts of climate change (CCAMLR-XXXIII, paragraph 5.89; SC-CAMLR-XXXIII, paragraphs 8.1 to 8.6). These conclusions in CCAMLR indicate that climate change represents a source of uncertainty in the assessment of the Antarctic ecosystems and their harvest potential. SOOS provides an opportunity for obtaining the data necessary to address these challenges and CCAMLR and CEP can benefit from building productive relationships with the broader international scientific community through a partnership with SOOS.

Vessels fishing under the auspices of CCAMLR will be operating throughout the year. They have the capacity to collect valuable environmental information by installing automated sensor systems onboard. Such data together with all the biological information regularly streamed to CCAMLR represent a unique set of information that could be made available to the scientific community through SOOS (noting that procedures associated with accessing

such data will need to be maintained and managed as needed). Further, as SOOS will store and make available scientific data from the international science community outside CCAMLR, CCAMLR scientists will, over time, get access to an expanded source of information that might become crucial for some management issues, such as to support implementation of feedback management of the krill fishery.

SOOS would welcome an open dialogue with SC-CAMLR and CEP on these areas of mutual interest.

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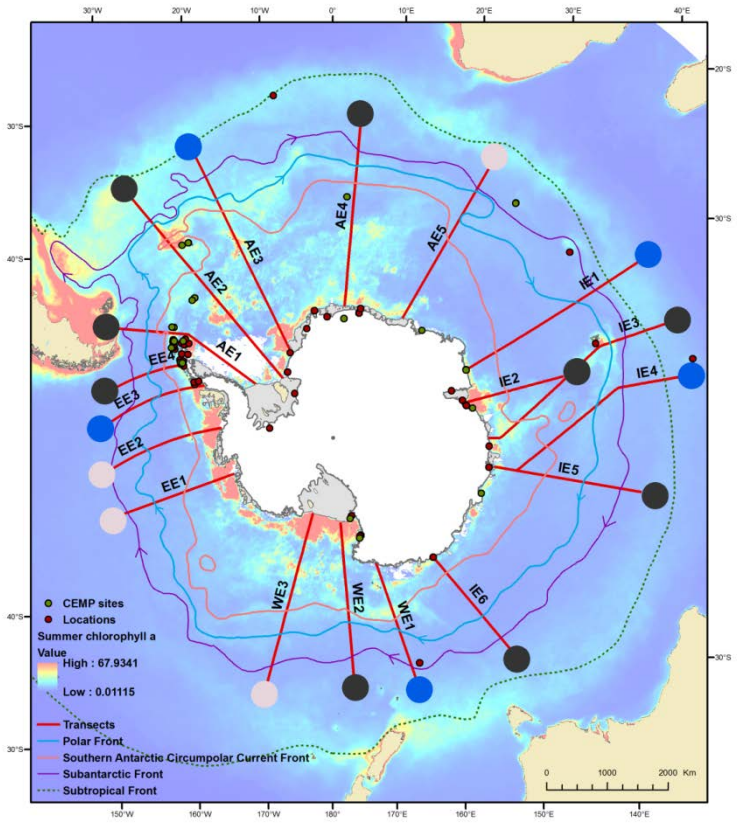

Figure 1 Map of mean summer chlorophyll *a* showing possible transects (red lines) and locations being investigated for measuring biological and ecosystem parameters throughout the Southern Ocean. Transects will be combined with intensive study areas to take account of latitudinal and longitudinal variation in physical and chemical habitats and primary production, giving rise to variation in food webs. Initials indicate regions and transect numbers: EE = East Pacific sector ecosystem transect; AE = Atlantic sector ecosystem transect; IE = Indian sector ecosystem transect; WE = West Pacific sector ecosystem transect. Registered sites for monitoring in the CCAMLR Ecosystem Monitoring Program are shown. Locations are coastal bases or other possible research locations. Large dots show the degree of feasibility that existing operations in the region may be used as ships of opportunity for taking underway measurements along transects. Dark blue dots represent transects that could be feasible for repeated sampling within current operational activity. Lighter blue dots represent transects that could be done repeatedly but with some operational adjustments. Light dots represent desirable transects but not easily undertaken within the current operations.

Workshop Paper 019 – SC-CAMLR work on climate change

Andrew Constable (Australia)

Introduction

1. The objective (Article II, see Attachment A) of the Convention on the Conservation of Antarctic Marine Living Resources (The Convention) is to conserve all populations of living organisms (Antarctic Marine Living Resources – AMLR – as defined in Article I) in the ecosystem found south of the Antarctic Convergence (Polar Front). Rational use can be undertaken in the Convention Area but is a subsidiary objective to the conservation objective. Lastly, harvesting is a specific case of rational use that is required to meet specific objectives (Article II, paragraph 3). Aside from the broad requirement to conserve AMLR, Article II, paragraph 3(c), requires that account needs to be given to the effects of environmental changes in order to achieve sustained conservation of AMLR. To that end, environmental variability and change arising from climate change and ocean acidification (hereafter, referred to as CCOA) need to be accounted for in conserving AMLR.

2. Article IX of the Convention (see Attachment A) provides the operational requirements for achieving conservation of AMLR, including the provision of the best scientific evidence available by the Scientific Committee. A fundamental question arising out of Articles II and IX concerns the effects of fishing on the sustainability of species and the marine ecosystem. Also, if fishing were to cease, the requirement is for the marine ecosystem to recover in two to three decades.

3. Sustaining species in the face of CCOA requires accounting for effects on habitats, an organism's physiology, supply of resources, and in modifying interactions between species (Constable and Doust, 2009; Constable et al., 2014; Trathan and Agnew, 2010). Thus, an assessment of the conservation status of species and/or the potential effects of fishing on AMLR will require accounting for the state of the ecosystem had there been no fishing since the beginning of CCAMLR. In the case of CCOA, the question to be addressed by the Scientific Committee is whether the harvest strategy for any species is such that, should the fishery cease, the ecosystem will recover after 20-30 years to where it would have been had there been no fishing since 1980. For convenience, we can refer to this as the Reference State.

4. Articles II and IX provide the impetus for work in the Scientific Committee on the effects of CCOA, in order to provide, in a timely manner, the 'best scientific evidence available' on three issues related to CCOA:

(iv) Risks of CCOA

- threatening the conservation of species,
- changing the vulnerability of species and/or foodwebs to the effects of fishing, and
- increasing the risk of invasive marine species in the CCAMLR area;

(v) Status of AMLR and the Antarctic marine ecosystem relative to the Reference State and whether actions may be required to conserve AMLR because the Reference State had changed;

(vi) Requirements for adapting harvest strategies in the future, in order that

- those harvest strategies, including catch rates, will be consistent with the Reference State in the future, and
- harvesting activities will not increase the risk of failing to conserve AMLR in the long term.

5. This paper summarises the state of knowledge on impacts of CCOA on Southern Ocean ecosystems and the attention that SC-CAMLR has given to CCOA impacts. Lastly it summarises synergies in work with the CEP and SCAR for progressing these topics in the coming years.

Impacts of CCOA on Southern Ocean ecosystems

6. Southern Ocean ecosystems have been changing over the last century from a variety of stressors, including CCOA, whaling and sealing. The most comprehensive understanding of change is for physical and chemical habitats and the biogeochemistry of the region (IPCC, 2013; Turner et al., 2009; Turner et al., 2013). The consequences for food webs is comparatively poorly understood at the circumpolar scale (Constable et al., 2014; De Broyer and Koubbi, 2014; Gutt et al., 2015; Nymand Larson et al., 2014). The West Antarctic Peninsula and Scotia Arc have the best biological coverage, ranging from phytoplankton through top predators,

although most pelagic work is focussed on the krill-based food chain with a poor understanding of food chains involving mesopelagic fish (Hill et al., 2012).

7. Our ability to understand the consequences of change in the physical and chemical environment to biological systems is hampered in two ways. First, there are insufficient time series for biota in enough places and times and from across the food web to do an empirical assessment of the current effects of CCOA (Nymand-Larson 2014; Constable et al 2016). Second, end-to-end ecosystem and food web models are yet to be sufficiently developed to fill this gap (Murphy et al., 2012).

8. ICED developed a synthesis on the potential effects of CCOA on habitats and species, with a view to compiling potential effects on food webs (Constable et al 2014). Combined with the bioregionalisation of the Southern Ocean (Grant et al., 2006), a conclusion in this synthesis was to consider the Southern Ocean comprising of four sectors with a high latitude and subantarctic components – East Pacific, Atlantic, Indian and West Pacific (Figure 3 in Constable et al 2014). Each of these sectors is experiencing different scenarios of change in habitats (e.g. sea ice, temperature) and, based on the species assessments, are likely to have different changes in the food webs as well.

CCOA in SC-CAMLR

9. Climate change has been appearing regularly in discussions in SC-CAMLR since 2002. CCOA came on to the agenda of SC-CAMLR in 2008 following a Commission request in 2007 (see Attachment B for extracts from SC-CAMLR reports). The CCAMLR Performance Review of 2008 also emphasised that this issue needed attention. A constant theme since then has been to develop a risk assessment framework for identifying when CCOA impacts may need attention from the Commission, along with developing a 'state of environment' report. Most work in SC-CAMLR has been within the Working Group on Ecosystem Monitoring and Management (WG-EMM). In this regard, WG-EMM has focussed on the effects of CCOA on Antarctic krill (Flores et al., 2012; Kawaguchi et al., 2013) and its habitats (Hill et al., 2013). There has also been consideration of a proposal to manage ocean areas adjacent to the Antarctica Peninsula uncovered by ice shelf collapse (Trathan et al., 2013).

10. SC-CAMLR does not yet have an explicit strategy and timetable of work for (i) assessing climate change impacts on AMLR and (ii) providing advice to the Commission on how to deal with CCOA. Nevertheless, many Members have engaged with developing approaches to address CCOA impacts when developing strategies on at least three current issues in SC-CAMLR. First, the design of krill feedback management strategies is being investigated with the potential for having decision rules incorporate the Reference State. The Reference State could be determined empirically by using reference areas to measure the state of the krill-based system without fishing, or an ecosystem modelling approach could be used. Second, the current proposals for representative marine protected areas incorporate considerations of adaptation of the system to climate change as well as having reference areas for measuring CCOA impacts. Lastly, food web and ecosystem models are being developed for evaluating management and conservation strategies. End-to-end ecosystem models with links to climate models can provide realistic scenarios for testing these management strategies and how well they will adapt to CCOA. ICED (below) is facilitating the development of these models by the wider international community (Murphy et al, 2012).

Future work: Synergies between SC-CAMLR, CEP, and SCAR

11. In recent years, scientific work on the effects of CCOA on Southern Ocean ecosystems have primarily been occurring in two programs sponsored by SCAR: the IMBER-SCAR program on Integrating Climate Change and Ecosystem Dynamics in the Southern Ocean (ICED) and the SCAR-SCOR Southern Ocean Observing System (SOOS). While there is some overlap in their remit, they are complementary programs working on, respectively, (i) assessments and modelling of change in Southern Ocean ecosystems and (ii) the design and implementation of observing systems and the integration and facilitation of access to the observational data. This work continues to be reported to WG-EMM. Both groups wish to have a continuing relationship in support of CCAMLR.

12. ICED is organising a conference in 2018 (www.MEASO2018.aq) with a principle focus of assessing the status and trends of habitats, species and foodwebs in the Southern Ocean. The assessment is intended to provide the community input on the Antarctic marine ecosystem to the Sixth Assessment of the Intergovernmental Panel on Climate Change (IPCC). It is also intended to provide marine biological input to the SCAR Antarctic Climate Change and the Environment Report. This work could form the basis of an

assessment of the current Reference State for CCAMLR and provide a State of Marine Ecosystem report intended in discussions in SC-CAMLR.

13. SOOS is designing the biological component of its observing system to be complementary to the CCAMLR Ecosystem Monitoring Program. This system could provide the observations necessary for, say 5-yearly, strategic assessments of the Reference State while the CEMP provides the tactical observations for the feedback management system. Further, SOOS is in the process of developing an initiative to undertake a circumpolar benchmarking of the Southern Ocean ecosystem. This initiative aims to link the historical time series that have been collected in different parts of the Southern Ocean and then provide the basis for sustained circumpolar biological observations and assessments thereafter.

14. Resolution 30/XXVIII (2009) encourages Members to become engaged in these two programs. The resolution refers to ICED and the Southern Ocean Sentinel, the latter of which has had its aims incorporated into both ICED and SOOS. SC-CAMLR and CEP would benefit from working with these two bodies to develop the capabilities necessary to deliver the advice on the three CCOA issues of importance to them.

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Attachment A: CCAMLR Articles II & IX

Article II

1. The objective of this Convention is the conservation of Antarctic marine living resources.
2. For the purposes of this Convention, the term ‘conservation’ includes rational use.
3. Any harvesting and associated activities in the area to which this Convention applies shall be conducted in accordance with the provisions of this Convention and with the following principles of conservation:
   (a) prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment. For this purpose its size should not be allowed to fall below a level close to that which ensures the greatest net annual increment;
   (b) maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and the restoration of depleted populations to the levels defined in sub-paragraph (a) above; and
   (c) **prevention of changes or minimisation of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, taking into account** the state of available knowledge of the direct and indirect impact of harvesting, the effect of the introduction of alien

species, the effects of associated activities on the marine ecosystem and of **the effects of environmental changes,** with the aim of making possible the sustained conservation of Antarctic marine living resources.

Article IX

1. The function of the Commission shall be to give effect to the objective and principles set out in Article II of this Convention. To this end, it shall:

   (a) facilitate research into and comprehensive studies of Antarctic marine living resources and of the Antarctic marine ecosystem;

   (b) compile data on the status of and changes in populations of Antarctic marine living resources and on factors affecting the distribution, abundance and productivity of harvested species and dependent or related species or populations;

   (c) ensure the acquisition of catch and effort statistics on harvested populations;

   (d) analyse, disseminate and publish the information referred to in sub-paragraphs (b) and (c) above and the reports of the Scientific Committee;

   (e) identify conservation needs and analyse the effectiveness of conservation measures;

   (f) formulate, adopt and revise conservation measures on the basis of the best scientific evidence available, subject to the provisions of paragraph 5 of this Article;

   (g) implement the system of observation and inspection established under Article XXIV of this Convention;

   (h) carry out such other activities as are necessary to fulfil the objective of this Convention.

2. The conservation measures referred to in paragraph 1(f) above include the following:

   (a) the designation of the quantity of any species which may be harvested in the area to which this Convention applies;

   (b) the designation of regions and sub-regions based on the distribution of populations of Antarctic marine living resources;

   (c) the designation of the quantity which may be harvested from the populations of regions and sub-regions;

   (d) the designation of protected species;

   (e) the designation of the size, age and, as appropriate, sex of species which may be harvested;

   (f) the designation of open and closed seasons for harvesting;

   (g) the designation of the opening and closing of areas, regions or sub-regions for purposes of scientific study or conservation, including special areas for protection and scientific study;

   (h) regulation of the effort employed and methods of harvesting, including fishing gear, with a view, inter alia, to avoiding undue concentration of harvesting in any region or sub-region;

   (i) the taking of such other conservation measures as the Commission considers necessary for the fulfilment of the objective of this Convention, including measures concerning the effects of harvesting and associated activities on components of the marine ecosystem other than the harvested populations.

3. The Commission shall publish and maintain a record of all conservation measures in force.

4. In exercising its functions under paragraph 1 above, the Commission shall take full account of the recommendations and advice of the Scientific Committee.

5. The Commission shall take full account of any relevant measures or regulations established or recommended by the Consultative Meetings pursuant to Article IX of the Antarctic Treaty or by existing fisheries commissions responsible for species which may enter the area to which this Convention applies, in order that there shall be no inconsistency between the rights and obligations of a Contracting Party under such regulations or measures and conservation measures which may be adopted by the Commission.

6. Conservation measures adopted by the Commission in accordance with this Convention shall be implemented by Members of the Commission in the following manner:

   (a) the Commission shall notify conservation measures to all Members of the Commission;

   (b) conservation measures shall become binding upon all Members of the Commission 180 days after such notification, except as provided in subparagraphs (c) and (d) below;

   (c) if a Member of the Commission, within ninety days following the notification specified in sub-paragraph (a), notifies the Commission that it is unable to accept the conservation measure, in whole or in part, the measure shall not, to the extent stated, be binding upon that Member of the Commission;

   (d) in the event that any Member of the Commission invokes the procedure set forth in sub-paragraph (c) above, the Commission shall meet at the request of any Member of the Commission to review the conservation measure. At the time of such meeting and within thirty days following the meeting, any Member of the Commission shall have the right to declare that it is no longer able to accept the conservation measure, in which case the Member shall no longer be bound by such a measure.