Annex 7

Report of the Meeting of the Workshop on Spatial Management
(Cambridge, UK, 2 to 6 July 2018)

Contents

Page

Introduction 205

Development of general principles for the use of spatial management tools in the CCAMLR area 205

Development of MPA proposals 209
Planning Domain 1 (western Antarctic Peninsula and southern Scotia Sea) 210
Reference areas 210
General discussion on reference areas 212
Discussion of krill reference areas 213
Representing a krill cost layer in Marxan analyses in D1MPA 215
Displacement of fishing catch and effort 216
Other research fishing 217
Summary of activities for the D1MPA 217
Planning Domains 3 and 4 (Weddell Sea) 217
Planning Domains 5 and 6 (Del Cano–Crozet and Kerguelen Plateau) 220

Research and monitoring plans 222
General principles for MPA research and monitoring 222
Development of specific MPA research and monitoring plans 223

Spatial planning data management 225
Research and monitoring plan website 225

Future work 227
Fisheries research evaluation 227
Mechanisms to progress future work on spatial management 228
Communication and outreach 230

Advice to Scientific Committee 230

Close of meeting 231

References 231

Tables 233

Appendix A: List of Participants 235

Appendix B: Agenda 241

Appendix C: List of Documents 242

Report of the Meeting of the Workshop on Spatial Management
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Introduction

1.1 The Workshop on Spatial Management was held at the British Antarctic Survey (BAS), Cambridge, UK, from 2 to 6 July 2018. Prof. Dame Jane Francis (Director of BAS) welcomed participants (Appendix A) to BAS and highlighted the critical importance of the scientific outcomes from the workshop in CCAMLR's science-led role in Antarctic conservation.

1.2 Dr M. Belchier (Chair of the Scientific Committee) informed the Workshop that Dr M. Korczak-Abshire (Poland), one of the Workshop Co-conveners, was not able to attend the Workshop. He conveyed Dr Korczak-Abshire's disappointment at not being able to attend and also her best wishes for a successful meeting. Following a proposal from Dr Belchier, the Workshop welcomed the offer from Dr S. Grant (UK) to convene the workshop. Dr Grant thanked Dr Korczak-Abshire for her support in preparation for the workshop.

1.3 In welcoming the participants to the Workshop, Dr Grant explained that the meeting was being held in the new 'Aurora Cambridge' building, a centre for collaboration and innovation, and she hoped that this would provide a suitable inspiration for a successful Workshop. She also noted the broad engagement by Members in the Workshop that highlighted the importance of the topics on the agenda.

1.4 Dr Grant clarified that the outcome of the workshop would be an adopted report that would be submitted to the Scientific Committee following the process for intersessional working groups. She emphasised the importance of providing clear advice and recommendations to the Scientific Committee on both specific issues for technical questions for regional projects and also for general principles that are relevant to all planning domains. The agenda was adopted unchanged (Appendix B).

1.5 Documents submitted to the meeting are listed in Appendix C and the Workshop thanked all authors of papers for their valuable contributions to the work presented to the meeting.

1.6 In this report, paragraphs that provide advice to the Scientific Committee and its other working groups have been indicated in grey. A summary of these paragraphs is provided in Item 8.

1.7 The report was prepared by T. Brey (Germany), C. Cárdenas (Chile), A. Capurro (Argentina), R. Cavanagh (UK), A. Dahood (USA), C. Darby (UK), A. Dunn and D. Freeman (New Zealand), C. Jones and E. Klein (USA), P. Koubbi (EU), A. Lowther (Norway), M. Santos (Argentina), P. Penhale (USA), K. Reid (Secretariat), M. Söffker (UK), K. Teschke (Germany), P. Trathan (UK), A. Van de Putte (Belgium), G. Watters (USA) and D. Welsford (Australia).

Development of general principles for the use of spatial management tools in the CCAMLR area

2.1 WS-SM-18/14 was presented, highlighting the need for a mechanism to report progress towards the establishment of a representative system of marine protected areas (MPAs) to the

Scientific Committee and the Commission as agreed in 2009, and noting that CCAMLR was behind in its objective of developing a representative system of MPAs by 2012. It described some simple criteria to assess progress towards a representative system of MPAs, taking account of key drivers of large-scale patterns of biodiversity such as ocean depth and temperature between ocean basins. It noted that under these criteria, currently designated MPAs did not constitute a representative system of MPAs, however, if the current Weddell Sea, Domain 1 and East Antarctic MPAs were adopted with their current boundaries, they would make a substantial contribution to achieving a representative system of MPAs.

2.2 WS-SM-18/12 Rev. 1 was presented, assessing the levels of representation of the Douglass et al. (2014) benthic bioregions and Raymond (2014) pelagic bioregions in currently designed and proposed MPAs within the CCAMLR area. The authors made similar conclusions to WS-SM-18/12 Rev. 1, namely that designation of the currently proposed MPAs would make a substantial contribution to overall protection and representativeness of the Southern Ocean and increase their representativeness.

2.3 The Workshop noted that there are multiple ways of achieving regionalisation of oceanic areas. It recognised that this process depends on the spatial scale considered. At the large scale, the bioregionalisation process is mainly constructed on abiotic data that are considered to be proxy of species assemblages or habitats. Bioregions can be defined as biogeochemical provinces as defined by Longhurst (1998) when adding biogeochemical variables to oceanographic and geomorphologic variables, the prefix 'bio' in that case means the addition of chlorophyll or information on planktonic characteristics. Ecoregions are used when combining biogeographic patterns or species assemblages to abiotic regions. Studies (Koubbi et al., 2010 and 2011) have shown that at the macro or mesoscale, ecoregions are principally explained by abiotic regionalisation.

2.4 The Workshop noted that within particular regions or planning domains, there is the capacity to characterise bioregions and ecoregions taking account of fine-scale features and dynamics that may not be reflected in the circumpolar-scale bioregionalisations (e.g. WS-MPA-11/06; Douglass et al., 2014), and it noted that all designated MPAs and MPA proposals currently being considered by CCAMLR were developed using this finer-scale information.

2.5 The Workshop noted that representative protection was one important objective of CCAMLR MPAs, however, other factors such as protection of vulnerable and rare species and unique features, adequacy, connectivity and replication were also important factors to consider in achieving CCAMLR's objectives for MPAs as reflected in Conservation Measure (CM) 91-04. The Workshop noted that in this context, connectivity should be considered at different spatial scales within and between bioregions and latitudes, both within and beyond the CCAMLR area.

2.6 The Workshop noted that CCAMLR used a range of mechanisms other than MPAs to manage activities in space and time, such as shallow water closures, closed fisheries, prohibitions on certain fishing gears, closure of registered vulnerable marine ecosystems (VMEs) etc. that contributed to protection consistent with that provided by MPAs.

2.7 The Workshop agreed to draw on the information contained in WS-SM-18/14 and 18/12 to provide a concise summary of the contribution of current and proposed MPAs towards a representative system of MPAs, and gaps that have yet to be addressed (Table 1).

2.8 The Workshop noted that seven MPAs currently exist in the Convention Area (South Orkney Islands southern shelf (SOISS) MPA, Ross Sea region MPA (RSRMPA), Heard Island and the McDonald Islands, Prince Edward Islands, Crozet Islands, Kerguelen and South Georgia and the South Sandwich Islands); these occur in all three basins of the Southern Ocean (Atlantic, Indian and Pacific) and cover a wide range of depths and latitudes. Several benthic and pelagic bioregions in the Southern Ocean are underrepresented by the existing set of MPAs. These include:

(i) 15 benthic ecoregions identified by Douglass et al. (2014) (Amundsen, Atlantic Basin, Antarctic Peninsula, Central Indian – East Kerguelen Subregion, Central Indian – Prydz Bay Subregion, Central Indian – Wilkes Subregion, Central Indian – West Kerguelen Subregion, Dronning Maud, East Indian Abyssal, Kerguelen – BANZARE Bank Subregion, Kerguelen – Deep Kerguelen Subregion, Ob and Lena, Pacific Basin, South Atlantic, Weddell Shelf)

(ii) four pelagic clusters identified by Raymond (2014) (2 – various polynyas, 3 – icy shallow shelf areas, 11 – one of four sea-ice zones, 17 – temperate waters).

2.9 The Workshop recalled three MPA proposals that have been previously considered by the Scientific Committee (East Antarctic MPA (EAMPA), Weddell Sea MPA (WSMPA), and the MPA in Planning Domain 1 (D1MPA)) can fill many of these gaps and substantially increase representativeness. If these proposals are added to the system of MPAs already in place within the Convention Area, relatively few benthic and pelagic bioregions will remain underrepresented. These include:

(i) six benthic ecoregions identified by Douglass et al. (2014) (Amundsen, Central Indian – Wilkes Subregion, East Indian Abyssal, Ob and Lena, Pacific Basin, South Atlantic)

(ii) one pelagic cluster identified by Raymond (2014) (17 – temperate waters).

2.10 The Workshop advised the Scientific Committee that within the Convention Area:

(i) the existing set of MPAs is not representative of all benthic and pelagic bioregions in the Southern Ocean

(ii) establishment of the EAMPA, WSMPA and D1MPA would substantially increase representativeness.

2.11 The Workshop noted that the pelagic cluster which is currently underrepresented by the existing and proposed MPAs (17 – temperate waters) will be included within an initiative to develop a new MPA in the high seas of Planning Domains 5 and 6 (CCAMLR-XXXI, paragraph 5.57; SC-CAMLR-XXXV, paragraphs 5.30 and 5.31).

2.12 The Workshop recalled that the Commission had made the development of a representative system of MPAs a priority for the Scientific Committee in 2009, and had requested that progress towards this objective be provided. The Workshop therefore recommended that the Scientific Committee evaluate and report progress towards achieving the Commission's stated goal of a representative system of MPAs. The Workshop suggested the Scientific Committee and Commission review Table 1, and regularly update it to continue to track progress.

2.13 The Workshop recommended that the Scientific Committee continue to develop criteria to enable the assessment of CCAMLR's progress towards a representative system of MPAs and the other goals of CM 91-04.

2.14 WS-SM-18/10 commented on the use of MPAs for spatial management in the CCAMLR area. The paper noted that MPA designation requires baseline data established in advance of the MPA coming into force as part of the planning process. This data should be provided for development and justification of objectives, boundaries, monitoring and research plans, measurable criteria and indicators of the performance and efficiency of the MPA. This baseline data will be used to assess whether the MPA achieves its specific objectives.

2.15 WS-SM-18/10 further pointed out the necessity to clarify how long an MPA can exist without baseline data and provided proposals to unify requirements for designating MPAs, including:

(i) developing a standardised approach and criteria for designating MPAs, using the current Japanese MPA checklist (CCAMLR-XXXIV/19) as a basis. This checklist should be endorsed as an annex to CM 91-04

(ii) endorsing the baseline data and related measurable criteria and indicators of the performance and efficiency of the MPA as an annex to the Research and Monitoring Plan (RMP) and the relevant changes in CM 91-04

(iii) the RMP should be detailed for reporting periods: both in relation to planned research and monitoring activity and the information that should be obtained.

2.16 The Workshop did not discuss all the matters raised in the paper, as they were beyond the terms of reference of the Workshop. In response to proposal (ii), it noted that there were links on the CCAMLR website to the *Basic Documents* that developed the scientific case for the designation of MPAs in the Ross Sea region and the SOISS MPAs, and the EAMPA proposal.

2.17 The Workshop further recalled the agreement of the Scientific Committee (SC-CAMLR-XXXIII, paragraph 5.46) on the development of MPA reports, analogous to Fishery Reports, and noted that this could be a useful mechanism to summarise the information used to support designation of CCAMLR MPAs, and data derived from research and monitoring activities relevant to each MPA's specific objective. Mechanisms for providing access to baseline data used to develop MPAs and RMPs was discussed under Item 5.

2.18 SC-CAMLR-XXXVI/01 was presented summarising the discussions at the CCAMLR Workshop for the Development of a *Dissostichus mawsoni* Population Hypothesis for Area 48 (WS-DmPH-18) that was held in Berlin, Germany, in February 2018.

2.19 The Workshop noted that all three stock hypotheses developed at WS-DmPH-18 indicated that the spatial extent of Antarctic toothfish (*Dissostichus mawsoni*) populations were likely to be mesoscale or greater, and hence spatial protection of habitats of all life stages of species may span more than one planning region. It noted that one key uncertainty in the description of habitats for this species is the distribution of early life-history stages such as eggs and larvae, and encouraged Members to develop research to address this data gap. It also noted that circulation models in this area could be usefully applied to understand connectivity between

areas during the pelagic life stages of *D. mawsoni*. It further encouraged Members to collect tissue samples to facilitate high-throughput sequencing studies of *D. mawsoni* population structure as described in WS-DmPH-18/08.

2.20 The Workshop noted that CCAMLR managed *D. mawsoni* fisheries consistent with Article II through measures other than just spatial protection, such as the conservation measures that regulate exploratory fishing in this region. It also noted that WS-DmPH-18 had concluded that, as the Weddell Sea MPA was developed to protect more than just *D. mawsoni* habitats, consideration of *D. mawsoni* should not be the only driver for the development of MPAs in this region. However, it welcomed the consideration of the outcomes of WS-DmPH-18 in the revised documentation to support the WSMPA (paragraphs 3.50 to 3.73).

Development of MPA proposals

3.1 WS-SM-18/P01 described a modelling framework that combines satellite data on sea-surface chlorophyll-a, a regional oceanographic model and diatom abundances from sediment grabs with particle tracking to model the food available to benthic biota. It demonstrated that fluctuating seabed currents are important in the redistribution of surface productivity at the seafloor along the East Antarctic shelf and the modelled food availability is important in determining the distribution of benthic biota. The availability of suspended food near the seafloor was shown to be correlated with the abundance of benthic suspension feeders, while the deposition of food particles was correlated with decreasing suspension feeder richness and more abundant deposit feeders in depths >200 m.

3.2 The Workshop agreed that this was a useful framework that could potentially be applied in other parts of the Convention Area to predict spatial distributions of benthic biodiversity, as well as how changes in the environment may influence the composition of seafloor communities and benthic ecosystems.

3.3 The Workshop also noted that this approach could be used to provide broad predictions of the presence of VME indicator taxa that may be present in areas where Members notify their intention to conduct bottom fishing, and where there is currently no information. The Workshop agreed that this framework could be useful as part of a review of CCAMLR's approach to managing impacts on VMEs.

3.4 WS-SM-18/P02 described a new multi-species modelling approach, called Regions of Common Profile, for characterising ecoregions. This method characterises ecoregions by grouping sites with a similar composition of species, and describes the patterns of variation in assemblages using environmental data. This approach was exemplified using demersal finfish and environmental data on the Kerguelen Plateau, and was successful at quantifying seven ecoregions and mapping their spatial distribution across the northern plateau. Validation at independent sites indicates the model was able to reasonably predict the occurrence of individual species across the plateau, as well as the species composition at sites.

3.5 The Workshop agreed that this approach can potentially be used for characterising ecoregions, and can assist in spatial management of specific regions of the Southern Ocean.

3.6 The Workshop cautioned that different demersal finfish can demonstrate ontogenetic changes as a function of their life-history strategy, with adult demersal fish often utilising

different habitats than juveniles. The focus of this study, however, was the distribution of adult fish assemblages. The Workshop acknowledged that distributions can change with seasons, and noted that this particular study was designed to provide average spatial distributions across seasons, but predictions for the individual seasons sampled can be generated if included in the model as a sampling factor. The Workshop further noted that the approach could be used with either presence–absence, abundance or biomass data, depending on the data available, to produce different types of ecoregions.

3.7 The Workshop agreed that this approach has several potential uses. For example, outputs from the Regions of Common Profile method can potentially be used to:

- define biogeographic patterns and provide an ecological understanding of them
- inform or assess the representativeness of spatial planning options
- provide a baseline map of the distribution of assemblages/ecoregions
- inform the design of future sampling (e.g. ecological stratification), with potential applications to monitoring.

3.8 The Workshop noted that related statistical methods have the further potential to detect, attribute and understand ecological change using temporal data (i.e. which species are changing; drivers of change; which areas are undergoing change; where monitoring efforts should be targeted).

3.9 The Workshop noted that the statistical methods presented have advantages for analysing and interpreting ecological and biodiversity data, and recommended their further development and application within CCAMLR.

Planning Domain 1 (western Antarctic Peninsula and southern Scotia Sea)

Reference areas

3.10 WS-SM-18/05 reviewed some of the reasons why the krill fishery is challenging to manage and considered ways in which management could be improved, whilst responsible and precautionary harvesting continues. The authors proposed an experimental framework to help improve the scientific basis for management, following support for such an approach by the Scientific Committee (SC-CAMLR-XXXVI, paragraphs 3.17 to 3.22). The paper suggested that the framework will increase ecological understanding by using an experimental approach to fishing, coupled with the use of krill reference areas (KRA) and krill fishing areas (KFA).

3.11 WS-SM-18/05 used specific terms (KRA and KFA) in order to avoid confusion with other uses of the term ‘reference area’, recognising that spatial management processes may have a number of differing objectives that could each benefit from a reference area.

3.12 The authors emphasised that the proposed experimental framework should not be seen as an alternative approach to the designation of an MPA in Domain 1 (D1MPA), as introduced to the Scientific Committee in 2017 (SC-CAMLR-XXXVI/17, XXXVI/18, XXXVI/BG/21 and XXXVI/BG/22) and which is still under development and discussion by CCAMLR Members.

3.13 WS-SM-18/05 proposed the use of the existing small-scale management units (SSMUs), modified to take into account biological and physical environmental characteristics, as the

geographic and spatial basis for a set of differing treatments. The paper also highlighted that small adjustments of SSMU boundaries would enhance reporting for the krill fishery in Subareas 48.1 and 48.2.

3.14 WS-SM-18/05 identified a number of treatments based on seasonal, or year-round closures, and highlighted how enhanced scientific data collection using existing methods and approaches could be used to enhance ecological understanding of possible impacts (or lack thereof) of krill fishing. The authors also considered how treatments could be designed to help disentangle confounding drivers of change, including climate change.

3.15 The Workshop thanked the authors of WS-SM-18/05, recognising that this was a discussion document intended to help further the management of the krill fishery, noting that any such experimental framework would need to be undertaken in the context of the precautionary approach. It also noted that it should be considered in the context of feedback management (FBM), the developing risk assessment framework for krill and the D1MPA proposal, since all these initiatives contemplate the use of reference areas. It noted that considerations of these initiatives and how to harmonise relevant aspects might be undertaken at the planned joint meeting of WG-EMM and SG-ASAM scheduled for 2019.

3.16 The Workshop noted a number of candidate hypotheses that could be addressed by the experimental framework in WS-SM-18/05, recognising that the design of the framework was important for the type of questions or hypotheses that might be addressed. The Workshop also noted that temporal reversal of treatments, where treatments are switched on, or off, offers a useful way to identify impacts. The Workshop emphasised that understanding the likely effect size would be important and that a power analysis would be useful.

3.17 WS-SM-18/17 was presented by CCAMLR scholarship recipient Lic. A. Capurro, mentored by Drs Grant and Santos. The paper noted the importance of scientific reference areas in D1MPA and highlighted that well-designed reference areas could help maintain resilience in the face of climate change, assess the potential impact of fisheries on dependent predators and contribute to monitoring the efficacy of the D1MPA. The paper recognised that these areas need to be characterised based on the availability of scientific information, the understanding of krill fishery dynamics, and the existence of scientific long-term monitoring programs or study sites, and that in Domain 1 there was already available a considerable understanding of these topics. The paper illustrated potential locations for scientific reference areas in the South Orkney Islands (SOI), northwest Antarctic Peninsula (NWAP) and southwest Antarctic Peninsula (SWAP) based on a two-level scheme that considered areas upstream and downstream of fishing grounds, and climate change as a mean to provide further comparisons to disentangle the confounding effects of impacts of natural variability, climate change and fishing. The authors indicated that CCAMLR Ecosystem Monitoring Program (CEMP) sites provided a useful and valuable framework to compare sites across the Convention Area and that it might be useful to review and revise the CEMP methods, including an agreement on the information it can provide to progress with the data collected in relation to D1MPA.

3.18 The Workshop thanked the authors for the paper and noted the importance of scientific reference areas in the context of MPA planning, in particular for Domain 1. It recognised these areas could serve different purposes, including providing resilience to climate change, assessing the effect of fisheries and evaluating broader D1MPA conservation objectives. The Workshop highlighted the need to define clear hypotheses for scientific reference areas, including their potential location, size and duration, the specific purposes each area was designed for, also in

relation to the objectives of the D1MPA. The Workshop noted that General protection zones (GPZ) already included in the D1MPA proposal could serve as scientific reference area(s). It also recognised that different proposals in different MPA domains could define scientific reference areas differently according to their own specific objectives.

3.19 The Workshop welcomed the paper, and acknowledged the valuable contributions made by Lic. Capurro to the progression of work on Planning Domain 1 as part of her CCAMLR scholarship during the last two years and encouraged her ongoing engagement in the work of CCAMLR.

General discussion on reference areas

3.20 The Workshop noted the commonalities between establishing scientific reference areas in the D1MPA (WS-SM-18/17) and developing an experimental approach to evaluating the effects of fishing (WS-SM-18/05). The Workshop highlighted that scientific reference areas should serve to test specific hypotheses, which included, but were not limited to, understanding the effects of fishing. It noted that reference areas could be designed in concert with experimental fishing areas to further test hypotheses related to understanding fishing impacts. The Workshop recognised that an experimental approach for evaluating the effects of krill fishing could be incorporated in a research and monitoring plan for D1MPA. It also noted that particular attention was needed in relation to the scale and size of the potential krill fishing reference areas so that they do not compromise any of the MPA conservation objectives.

3.21 The Workshop recalled that the majority of predator monitoring data available for addressing questions related to predators in an experimental framework have been collected under CEMP, and most relate to penguin population processes.

3.22 The Workshop noted that monitoring technology, particularly for predators, is changing. CEMP might usefully include any monitoring data that are used in management advice. The Workshop therefore recommended that the Scientific Committee undertake a comprehensive review of CEMP.

3.23 The Workshop considered the utility of CEMP in an experimental framework, and recalled previous analyses of CEMP data (SC-CAMLR-XXX, paragraph 3.18), which highlighted the need to ensure congruence of monitoring metrics in order to address some key questions in relation to fishery–predator ecosystem interactions, recognising also that some CEMP indices can be used as leading or trailing indicators.

3.24 Dr S. Kasatkina (Russia) recalled that in her opinion at present there is no scientific evidence that the fishery affects the resources of krill and dependent predators. She stressed that such evidence is not present even in the years of the greatest pressure of the fleet (1980–1991) both in terms of catch and in terms of fishing effort. She pointed out that at present there are no scientifically tested indicators for revealing the impact of the fishery on dependent predators. Moreover, in her view there is no understanding of how CEMP indices can be used to identify the impact of the fishery, or even how many years would be required to detect a response to a given impact. She underlined that it was her opinion that it is impossible to reveal or assume the ecosystem effect of the fishery in the absence of data on krill biomass and distribution variability over different spatial–temporal scales, the abundance and population characteristics of predators (rather than one penguin species), and their krill consumption.

3.25 The Workshop agreed that there is no evidence that the krill fishery has not been managed in a precautionary and ecosystem-based manner using CCAMLR's existing management approaches. It further noted that developing an experimental approach for advancing the management of the krill fishery requires the comprehensive analysis of available data from the fishery, including acoustic survey data, environmental sampling and CEMP data. This analysis should form part of the establishment of an experimental approach, providing baseline data for candidate hypotheses.

Discussion of krill reference areas

3.26 The Workshop discussed the utility of krill reference areas in the context of D1MPA planning, recognising that the experimental approach is not an alternative or competing proposal to D1MPA, but is a complementary initiative.

3.27 The Workshop recognised that reference areas could be used for a variety of purposes and could form part of the RMP for the MPA. It agreed that within the D1MPA proposal there is a need to consider reference area for understanding the impacts of the krill fishery.

3.28 The Workshop recalled that finite research programs have been used within the management of the toothfish fishery (CM 24-01, Annex 24-01/B), but that this was a new concept in relation to the krill fishery. It therefore recognised that developing a 'proof of concept' whereby key questions could be addressed by the use of contrasting treatments in fished areas and closed areas, would be valuable for the development of the krill fishery in Domain 1.

3.29 In considering the development of krill reference areas, the Workshop agreed that a number of issues required attention. It noted that, inter alia, it would need to consider:

(i) the feasibility of defining one or more practical and tractable questions related to local krill abundance, and dependent predators (especially when attempting to provide a 'proof of concept')

(ii) whether particular questions were more likely to provide answers within a reasonable time scale

(iii) the operational and logistic capacity required to undertake relevant research and monitoring, as well as analysis of results

(iv) what the indicators might be that could be used to address a particular question; whether it is possible to make direct measurements on particular ecosystem components, or whether proxies have to be measured; and the spatial and temporal resolution of data required

(v) what outcomes of the experiment might be, and what the management actions should be, given a particular result.

3.30 The Workshop recognised that there are many questions related to the impact of the fishery on both krill and upon krill-dependent predators. It noted that interpreting results may be more difficult if initial questions were related to upper trophic levels, given the cumulative

impacts of environmental variability on primary production, secondary production and on krill consumers. The Workshop noted that a hierarchy of questions could eventually be considered, but each question might require a different reference area and experimental framework, and that starting simply would maximise the likelihood of a useful result.

3.31 In considering questions about krill, the Workshop agreed that issues of flux and oceanographic and ecological connectivity were of considerable importance. However, it noted that addressing questions related to krill swarm size distribution, depletion, dispersal and disturbance are likely to be relevant for land-based krill predators, and might be feasible over small spatial and temporal scales.

3.32 The Workshop recalled previous work (e.g. WG-EMM-09/18; WG-EMM-16/17; SC-CAMLR-XXXV/11; SC-CAMLR-XXXV/BG/14; WG-EMM-18/P11) which showed changes in krill catch per unit effort (CPUE) as the fishing fleet targeted krill fishing hotspots. When CPUE decreased, the fleet moved in order to achieve higher CPUE values elsewhere. Such displacements occur every 4–17 days and, according to persistence and sea-ice conditions, previously exploited zones might be revisited (WG-EMM-18/P11). Such a pattern of fishing is plausibly related to dispersal or depletion of the aggregation. At present, it is uncertain whether declines in CPUE are due to reduced biomass levels, disrupted krill swarm dynamics, altered flux, or for other operational reasons (SC-CAMLR-XXXV/BG/14). Without further information, it appears that the replenishment of krill is apparently insufficient to maintain catch rates within an area where catches are concentrated. However, more information is needed to validate this interpretation.

3.33 Dr Kasatkina cautioned that it will be difficult to understand the impact of variability in krill distribution in the fishing grounds without taking into account the behaviour of different vessels.

3.34 The Workshop noted that addressing such questions would help increase understanding about the ecosystem consequences of the krill fishery, as it would provide answers to questions about the potential for localised fishing effort to cause depletion, dispersal and disturbance over spatial and temporal scales relevant to predators. Such questions, including in relation to fishery performance, could be addressed using a combination of CPUE, acoustic assessments during fishing operations, and repeated research surveys over small spatial scales. The Workshop also noted that data on natural variability in krill distribution patterns, as well as local estimates of predator abundance and krill consumption (e.g. WG-EMM-18/33), would be important. With an improved understanding about krill depletion or disturbance, the Workshop noted that questions about impacts on predators may be easier to address. For example, does depletion or disturbance of fished aggregations have impacts on predators and on subsequent fishery operations? However, the Workshop also recognised that some questions about the impact of the fishery on predators may be straightforward to address without information on krill.

3.35 The Workshop noted that new methods, such as the risk assessment (e.g. WG-FSA-16/47 Rev. 1, 16/48 Rev. 1, WS-SM-18/04 and 18/P03), can synthesise predator data to develop management advice; such methods did not exist, and were not contemplated, when CEMP was established.

3.36 In developing questions related to krill, the Workshop agreed that a plausible scenario might include a krill fishery research zone (KFRZ) (recognising the value of replication where feasible) within D1MPA, possibly near to existing CEMP sites in the Bransfield Strait.

3.37 The Workshop agreed that a suitability decision matrix (e.g. WG-SAM-18/17, Figure 1), modified for use with the krill fishery, would be valuable. The matrix summarises the characteristics of cells within an underlying geographical grid. Such an approach might also be developed through a process comparable to the stock hypothesis developed for toothfish (WG-SAM-18/33 Rev. 1). The Workshop considered how to develop a suitability matrix relevant to the krill fishery in Subareas 48.1 and 48.2, based on a geographic grid of cells overlaid across the areas of krill fishing. This would then allow candidate reference areas to be identified. The Workshop recognised that in developing a 'proof of concept' the question(s) to be addressed should be tractable, but that with experience, more complex questions could be considered.

3.38 The Workshop agreed that candidate research questions should be developed related to detecting reduced biomass levels, disrupted krill swarm dynamics, altered flux, or for other operational reasons associated with aggregation of fishing vessels in fishing hotspots, and spatial and/or functional overlap with predators.

3.39 The Workshop agreed that it would be necessary to produce a table of attributes for each cell in the suitability matrix. It further agreed that the question(s) and table(s) should be developed intersessionally in the D1MPA Expert Group, in order that candidate reference areas could be proposed at a future date. It further agreed that the D1MPA Expert Group should consider how to develop the suitability matrix, in order to explore whether multiple questions can be addressed by one geographical grid represented by a single matrix, or whether a separate matrix is necessary for each question. The Workshop recognised that both spatial and temporal scale were important in developing the KFRZ and that the initial proposed resolution (1.0° longitude × 0.5° latitude) may be too coarse for some questions.

3.40 The Workshop recalled recent work directed towards the RSRMPA RMP, recalling the three elements in relation to the MPA-specific objectives, which include representativeness, threat mitigation and scientific reference areas (CM 91-05, Annex 91-05/C). The Workshop agreed that this structure could provide a useful and overarching framework for developing the D1MPA RMP. It also recalled that such a plan should deliver sufficient scientific information to allow the Scientific Committee to advise the Commission on what management actions may be required to ensure the achievement of the D1MPA objectives. The Workshop noted that reference areas to assess the potential impact of the krill fishery could be included within this framework.

Representing a krill cost layer in Marxan analyses in D1MPA

3.41 WS-SM-18/18 described the process for considering how to best represent the krill fishery in Marxan analyses for the Domain 1 MPA process. It provided a wide range of Marxan scenarios considering different cost layers with different krill fishing periods and dynamic ranges, noting the limitations of using fishery cost layers to represent the high spatial–temporal variability of the krill fishery in Domain 1. It concluded that using fishery cost layers was not the most effective means of considering the fishery in the D1MPA preliminary proposal and that other methods, for example, fishery displacement, could be more appropriate to deal with the krill fishery dynamics. In addition, the paper included the valuable contributions made in the D1MPA Expert Group, as the appropriate mechanism to discuss, evaluate and incorporate Members' varying interests and opinions to finally develop an agreed set of boundaries towards the designation of the D1MPA.

3.42 The Workshop thanked the authors of the paper and recognised that, given the spatial and temporal variation observed in the environment and in the krill fishery, it was not possible to generate a meaningful cost layer given available data in Domain 1 and noted that consideration of the fishery displacement could be a better approach.

3.43 The Workshop also noted the active work, participation and high level of engagement of the D1MPA Expert Group, highlighting the importance of sharing documents and expertise. It congratulated the D1MPA Expert Group for its collaborative approach to developing technical advice as part of MPA planning process. It also encouraged other Members to join and participate in the e-group.

Displacement of fishing catch and effort

3.44 WS-SM-18/P03 highlighted that a principal concern with implementing MPAs is the potential for new and unexpected consequences brought about by the displacement of fishing effort from closed areas. WS-SM-18/P03 evaluated two MPA scenarios with associated displacement of the krill fishery, quantifying the potential for altered risks of krill depletion for predators, as well as outcomes for the fishery. The authors employed both a static and a dynamic risk assessment, and considered three alternative redistributions of displaced catches. Collectively, results of the study indicated a well-designed MPA in the Scotia Sea may protect krill-dependent predators, and give rise to both benefits and costs for the fishery. Results further indicated such an MPA may also preclude requirements for further spatial management of fishing outside its boundaries and substitute for spatially explicit catch limits in the Antarctic krill (*Euphausia superba*) fishery. Finally, WS-SM-18/P03 noted the value of using both static and dynamic approaches to risk assessment in dialogue.

3.45 The Workshop thanked the authors and noted the usefulness of employing both static and dynamic approaches to assess the costs and benefits associated with implementing MPAs with associated fisheries displacement. It welcomed the finding that both approaches reached similar conclusions, regarding risks and benefits of MPAs.

3.46 The Workshop considered a number of areas where further development might be valuable. These included varying competition coefficients for individual predators and the fishery; whether spatial–temporal scales of predator–fishery interactions could be varied to more specifically reflect known aggregation of the fishery; whether some areas are more valuable for the fishery; and whether fishing fleet dynamic models might be included. The Workshop also considered that displacement of effort was an important criterion to consider. Other areas discussed, i.e. (i) increasing fishing levels beyond the trigger and (i) outcomes of climate change in relation to krill biomass, are already considered in the current work (i) or under consideration by the authors of WS-SM-18/P03 in ongoing work (ii).

3.47 The Workshop recognised that it may not be possible to address all of these areas of development, given the existing modelling. Nevertheless, it recognised that continued development and use of the model would be valuable, particularly as coherent results from this, and other modelling approaches (e.g. Ecopath with Ecosim (Dahood, 2017), WG-FSA-16/47 Rev. 1 and 16/48 Rev. 1) would build confidence for management. The authors of WS-SM-18/P03 noted they are also in the process of engaging other modelling approaches (namely Ecopath with Ecosim). The Workshop therefore encouraged future work and further development, and the potential for connections with static risk assessment introduced (WS-SM-18/04).

Other research fishing

3.48 The Workshop noted that existing research fishing for toothfish (WG-SAM-18/05 Rev. 1) and a proposal for crab fishing (WG-SAM-18/06) overlap with Domain 1 and agreed that consideration should be given to how these broader issues are integrated with the D1MPA process.

Summary of activities for the D1MPA

3.49 The Workshop recognised the progress made in relation to the D1MPA planning work carried out intersessionally. For example, it recalled discussions at WG-EMM, the Scientific Committee and the Commission in 2017, which proposed further consideration of fishing activities (SC-CAMLR-XXXVI, paragraph 5.27), including the use of a krill cost layer (WS-SM-18/18) and potential displacement of fishing effort in relation to the D1MPA preliminary proposal (WS-SM-18/P03). The Workshop also recalled discussions about mitigation of the effects of climate change and the risks of krill fishing having a negative impact on the ecosystem (SC-CAMLR-XXXVI, paragraph 5.29), which have been considered through the use of reference areas (WS-SM-18/05 and 18/17). It also welcomed the initiation of the D1MPA Expert Group (CCAMLR-XXXVI, paragraph 5.67) which has been established to engage interested parties, including industry experts and non-governmental organisations (NGOs). It noted that work by different participants has already been shared through this Expert Group, indicating the value of engagement, and that this will contribute to a revised D1MPA proposal.

Planning Domains 3 and 4 (Weddell Sea)

3.50 WG-SAM-18/33 reviewed the current knowledge existing on *D. mawsoni* in Area 48 in terms of spatio–temporal distribution patterns, reproduction biology, behaviour (including, e.g. feeding and diet) and movement.

3.51 The review brought together information considered in pre-meeting discussions, e-groups and document reviews, the discussions on the relevant information and data gaps, potential stock hypotheses and approaches to testing them. The deliberations resulted in formulation of three alternative, nested stock hypotheses for *D. mawsoni* in Area 48, and recommendations for research to test these hypotheses were developed. The hypotheses will be used by WG-FSA and WG-SAM in the evaluation of future research proposals.

3.52 The report of WS-DmPH-18 (SC-CAMLR-XXXVII/01) emphasised that the alternative hypotheses should not hinder progress toward spatial management in this or any other region of the Convention Area.

3.53 The Workshop noted that the information in the review covered a large area and time scale and in some cases, data is sparse, but was sufficient to formulate hypotheses for testing using more focused research.

3.54 The Workshop noted that the analysis is in its first phase and discussed the categories used for determining life history stages, movement of fish based on the release of tagged fish and recapture positions only, and the need for distinguishing toothfish eggs to species in analysis of breeding areas where species overlap.

3.55 The Workshop congratulated the authors and contributors on the volume and detail of the information collated and noted that such collaborative documents, prior to a meeting, could form a useful basis for future large-scale reviews.

3.56 WS-DmPH-18/01 summarised the knowledge on the occurrence of pelagic and demersal fish species as well as krill occurrence in the wider Weddell Sea based on Soviet and German expeditions. The participants of the Workshop welcomed the valuable summary of knowledge of fish and krill occurrence in the historic sampling. It was noted that some of the data and conclusions related to areas outside the Weddell Sea, for example Joinville and D'Urville Islands. It was also highlighted that:

(i) in recent years the areas noted as historically exploited have been ice covered and are not accessible

(ii) following the ban on bottom trawling in the majority of the Convention Area, many of the benthic species described in the paper as commercially exploited would no longer be available to a fishery

(iii) in several instances the taxonomy used in the paper needs to be updated.

The Workshop noted that this historic data was a valuable resource and asked Members who held historic data for the Weddell Sea to consider making the data available to all CCAMLR Members.

3.57 Dr Kasatkina noted that the revision of the WSMPA proposal is needed. This revision requires new information on the commercial potential for dominant species in the MPA to designate areas for protection and fishing activity. This new information may be provided from research programs in the Weddell Sea.

3.58 WS-DmPH-18/02 represented a statistical analysis of ice conditions in the Weddell Sea with the aim of identifying areas suitably ice-free for research related to MPA development. One aim of this study was to provide estimates of accessibility that facilitate planning of fishery research carried out by commercial vessels.

3.59 The Workshop noted that ice-breaking research vessels are capable of carrying out research and monitoring in areas of the Weddell Sea, particularly those less regularly accessible to commercial vessels. Also, that there are remote sensing methods currently available that allow generating data without having to be on-site.

3.60 Dr Kasatkina noted that the revisions of the WSMPA proposal should provide clarifications of the MPA boundary as well as the boundary of reference areas taking into account ice cover and accessibility.

3.61 WS-SM-18/08 explained modifications in the draft WSMPA area and asked for advice regarding the establishment of reference areas. The Workshop participants requested clarification on:

(i) the differences in management measures between GPZ and fisheries research zone (FRZ)

(ii) the basis for the 5 tonne research limit for toothfish.

3.62 It was noted that the approach used in Annex 6, Figure 1, could be a method by which the potential for research area(s) to viably address specific objectives in the research and monitoring of an MPA could be evaluated.

3.63 In conclusion, the Workshop provided the following advice:

(i) the location and size of reference areas would depend on the scientific question/hypothesis and may involve areas inside or outside MPAs

(ii) investigations of the potential impact of longline fishing on benthic ecosystems (i.e. whether longlines cause physical disturbances on the benthic fauna) could be carried out within the existing research blocks in Subarea 48.6 by comparing fished areas (i.e. known longline tracks) with unfished areas between these tracks

(iii) large-scale unfished reference areas outside the existing fisheries research blocks might be used to answer other scientific questions, for example whether longline fishing for *D. mawsoni* has wider trophic impacts. This could be accompanied by a statistical power analysis to determine that the sampling design would be able to detect such impacts

(iv) the most appropriate location and size of such reference areas should be determined on the basis of a set of parameters/attributes specific to the question to be answered. These parameters/attributes could be compiled in form of a table (see example in Table 2) as a transparent decision-support tool to aid the establishment of the reference area by indicating the occurrence of these parameters/attributes (e.g. in terms of high, medium or low) within the investigated area.

3.64 The authors of WS-SM-18/08 thanked the Workshop for this advice and informed the meeting that regarding answering the specific question about potential wider trophic impacts from longline fishing, they will further work on the relevant parameters/attributes to be taken into account and further develop Table 2 accordingly. The results of this work will be posted on the WSMPA e-group on the CCAMLR website.

3.65 Dr S. Hain (Germany) invited all participants at the Workshop to become a member of the WSMPA e-group and to post there any further scientific questions/hypotheses, which would require establishing a reference area within the proposed WSMPA to allow comparative analyses between fished and unfished areas.

3.66 WS-SM-18/09 presented a discussion on the conclusions from WS-DmPH-18. The authors considered that the current lack of knowledge, particularly the unknown influence of spatio–temporal variability in environmental conditions, make the interpretation of the existing sparse data difficult. An alternative approach to collect data was proposed, in the context of opening exploratory fisheries in Subareas 48.1, 48.2, 48.4, 48.5 and 48.6 with obligatory operational research actions by each vessel, including a large-scale longline international survey.

3.67 The Workshop noted that the approach proposed in WS-SM-18/09 was unlikely to enhance CCAMLR's ability to achieve its objective. Furthermore, it was noted that a substantial volume of information is available and that further analysis of these data, as outlined in WG-SAM-18/33, will identify research/data gaps that can be targeted within research proposals.

3.68 Dr Kasatkina noted that multivessel surveys should be designated for a period of four years with 10 participating vessels from Member countries. She noted that implementation of the abovementioned will allow to collect adequate data to support the available retrospective data and develop a science-based hypothesis of the life history and stock for *D. mawsoni* in Area 48 as well as obtain data for parameterising the model and facilitating stock assessment in Area 48.

3.69 WS-SM-18/10 commented on the use of MPAs for spatial management in the CCAMLR area. The authors of this paper mentioned that MPAs for spatial management in the Convention Area require clarity regarding the designation of MPAs, including its rationale, planning and functioning. Proposals on unified approaches and criteria for designating MPAs were suggested.

3.70 WS-SM-18/11 stressed the distinct spatio–temporal variability in atmospheric and oceanographic conditions in the Weddell Sea and questioned the validity of a toothfish stock hypothesis that does not take into account this variability. The authors suggested that more research time is needed before the impact of environmental variability can be factored into the hypotheses. The authors noted that spatial–temporal variability of environmental conditions will be the critical factor in the synthesis of the available retrospective data for the development of the hypothesis on life cycle and toothfish stock in Area 48.

3.71 The Workshop noted that, at the scale at which the stock hypotheses were developed for *D. mawsoni* in Area 48 for the design of future research, environmental variability would not undermine the hypotheses (paragraphs 3.51 to 5.53). Therefore, those developed by WS-DmPH-18 were considered suited to the needs of evaluation of research plans and MPA design.

3.72 The Workshop discussed the potential links between atmospheric and oceanographic conditions and toothfish life-history stages and recognised the difficulties in identifying those links. Furthermore, the need was raised to develop robustness tests for evaluating if management tools, such as MPAs, can help to get a better idea on, for example, spatial–temporal variation.

3.73 WS-SM-18/13 reflected on recommendations concerning issues and questions raised at WG-EMM-17 and SC-CAMLR-XXXVI with respect to the WSMPA proposal. The authors presented updates on data layers and a robustness testing of the WSMPA Marxan model and discussed the critical use of some data layers (including cost layer). The Workshop acknowledged the huge amount of work and welcomed the updates from the WSMPA project team.

Planning Domains 5 and 6 (Del Cano–Crozet and Kerguelen Plateau)

3.74 WS-SM-18/07 presented a new analysis on top predator trophic hotspot distribution in the sub-Antarctic Indian Ocean area. It complements WG-EMM-16/43 and 16/54 which provided scientific elements to the development of MPAs around Crozet and Kerguelen Islands. The paper used a comprehensive dataset of telemetry-derived movement across a guild of marine top predators to spatially resolve trophic hotspots, and then compare these to the national jurisdiction MPAs designated around Crozet, Kerguelen and Heard Islands. The authors clearly

show that adequate protection of a suite of top predators would incorporate high-seas areas, and highlight that areas both within and beyond the CCAMLR area must be considered in order to afford increased protection. For example, 50% of predator trophic hotspots are located in the high seas, including the CCAMLR area.

3.75 Building on the results of this paper and on WG-EMM-16/43 and 16/54, future work will focus on: (i) highlighting that the new bioregionalisation analysis conducted also considered spatio–temporal dynamic features, (ii) extending the research and monitoring timeseries with additional biologging and oceanographic surveys, and (iii) testing for differences between this recent bioregionalisation approach with previous efforts at ecoregionalisation based on mid-trophic pelagic species (i.e. euphausiids and myctophids).

3.76 On behalf of the authors of WS-SM-18/07, Prof. Koubbi asked the Workshop to provide advice on the following:

(i) Considering that WS-SM-18/07 only includes data from the French and Australian sub-Antarctic islands, how should work progress to include similar data on the Prince Edward Islands, and should efforts be extended further west towards Bouvetøya?

(ii) Determine general and specific objectives for a new MPA proposal, inter alia, trophic hotspots, pelagic (including mid-trophic level species such as euphausiids and mesopelagic fish) resources and the inclusion of climate change-driven consequences on the representativeness of ecoregions.

3.77 The Workshop noted that similar top predator work had been conducted at the Prince Edward Islands, and welcomed the offer by Dr A. Makhado (South Africa) to assist with inclusion of these data in a future proposal.

3.78 The Workshop also noted that a logical progression of this work westwards to Bouvetøya was warranted given the growing evidence of movement overlap between sub-Antarctic islands of multiple predator species. It further noted that, given the movement of top predators across large latitudinal gradients, marine spatial planning should integrate across sub-Antarctic and Antarctic regions as far as possible.

3.79 The Workshop noted that including dynamic features within static MPA boundaries is challenging, unless MPAs are of a sufficient size to incorporate dynamic variability. It further noted a challenge in affording spatial protection across multiple jurisdictions and requested that the Scientific Committee consider how CCAMLR might communicate with regional fisheries management organisations to address these issues into the future.

3.80 The Workshop noted that the Retrospective Analysis of Antarctic Tracking Data, a Scientific Committee on Antarctic Research (SCAR) initiative to provide circumpolar characterisation of top predator hotspots, could be useful to CCAMLR as an additional data layer to facilitate consideration of latitudinal and longitudinal connectivity in current and future marine spatial planning.

3.81 The Workshop welcomed the further development of MPA proposals in Planning Domains 5 and 6 and looked forward to results being tabled to the Scientific Committee and its working groups as they are developed. The Workshop recommended that the Scientific

Committee consider the creation of an expert group to continue the development of MPAs in these planning domains, using the model established for the D1MPA. It noted that not everyone involved in the proposed work was directly involved in the CCAMLR community and requested that mechanisms be developed to allow external experts to participate in the expert group (paragraph 6.13).

Research and monitoring plans

General principles for MPA research and monitoring

4.1 WS-SM-18/04 described considerations for developing the risk assessment for the krill fishery in Area 48. This process had the potential to support several CCAMLR initiatives and might be particularly relevant to maintaining spatial management of the trigger level if CM 51-07 were to lapse as scheduled in 2021.

4.2 The Workshop welcomed the paper and noted the importance of working collaboratively to develop a risk assessment. It further highlighted the utility of collating available data into a risk assessment framework which would allow for greater understanding of the spatial and temporal distribution of data, risks and uncertainty. It also observed that one of the strengths of the risk assessment approach was to guide decisions in cases of limited data availability. It noted the example of the Spatially Explicit Fisheries Risk Assessment being utilised by New Zealand (see Ministry for Primary Industries, 2017, chapter 3). The Workshop commented on the need to consider ecological processes and functions such as flux and measuring the impact of the fishery on krill predators when developing the risk assessment. The Workshop encouraged interested Members to participate in this collaborative work and looked forward to seeing future results from this project.

4.3 WS-SM-18/06 focused on hierarchical monitoring plans and their use for determining patterns of change in the Antarctic marine ecosystem. It highlighted the technical advances made in research techniques since the implementation of CEMP, and the potential of a hierarchical approach for identifying and using appropriate, cost-effective new tools. The paper elaborated on the utility of hierarchical approaches to monitoring for detecting ecological changes, encouraging collaboration and providing valuable insight into MPA processes.

4.4 The Workshop observed that the hierarchical approach highlighted the importance of scales, which had been discussed in several sessions at the Workshop. It also noted the importance of collaborating and coordinating research efforts with international groups such as the Southern Ocean Observing System (SOOS), SCAR and the Ocean Biogeographic Information System (OBIS).

4.5 The Workshop emphasised the challenge of identifying ecological and environmental changes outside the normal range of variation, and that such determinations would be scale dependent. It observed that such shifts could require management action or further scientific inquiry, but more discussions would be needed to determine the appropriate action. Finally, the Workshop recalled the importance of identifying knowledge gaps, and that the hierarchical approach could aid in identifying such gaps, determining achievable actions and developing specific plans for responses to change.

4.6 WS-SM-18/10 focused on the collection and availability of scientific evidence and information to designate and monitor MPAs and underlined that establishment of the baseline data should be provided in advance to the MPA planning process. This paper proposed unified approaches and criteria for designating MPAs and relevant changes in CM 91-04.

4.7 The Workshop agreed that the collection of field data was important, but noted that the particular need for this depended on the particular objectives and scale of an MPA. The Workshop noted that the availability of new sampling techniques such as satellites, and the use of these alternative approaches to collecting data, were also of relevance to MPA monitoring and research (for example, the techniques described in WS-SM-18/07). The Workshop noted that CCAMLR's working groups routinely discussed matters relating to experimental design and monitoring and that this advice could be drawn upon in relation to MPA monitoring.

Development of specific MPA research and monitoring plans

4.8 WS-SM-18/01 presented baseline data layers used for spatial planning, monitoring and research in relation to the RSRMPA. It was noted that CM 91-05 and the RSRMPA RMP require that information that supported the proposal for the establishment of the MPA be made available. This paper detailed the baseline data layers used to develop the RSRMPA.

4.9 WS-SM-18/02 presented candidate baseline data for seven previously identified key indicator species which described the current status of marine ecosystems in the Ross Sea region and could be used as benchmarks to evaluate MPA performance. The Workshop recognised the value of having a collated set of agreed baseline data which could aid in documenting future population changes. The Workshop observed that it could be useful to reference additional zooplankton data collected by the Continuous Plankton Recorder Survey (SCAR-CPRAG) and to review the data provided for silverfish and krill.

4.10 The Workshop noted that baseline data described the information available at the onset of the MPA designation. Baseline data comprised both synthesised data used to develop the MPA boundaries (e.g. as described in WS-SM-18/01) as well as describing indicator data that can be used to assess whether the objectives have been met (e.g. as described in WS-SM-18/02).

4.11 Dr Kasatkina noted that it is important to clarify how indicators in WS-SM-18/02 can be used to assess whether the RSRMPA achieves its objectives. If there is no fishing, the change of these indicators will be primarily determined by the influence of the environmental variability and natural ecological interaction and not direct human activities.

4.12 WS-SM-18/03 presented projects from New Zealand that could be contributed to the project list for the RSRMPA RMP. The Workshop recommended that the project list database specification be revised to include additional fields (x–xiv below) and revise the fields (i) and (viii) as per below:

Revised fields –

(i) Principal scientist and point of contact
(viii) What information will be or has been obtained.

Additional fields recommended –

(x) Index (to assist with sorting)
(xi) Project title
(xii) Project identification code (e.g. project or funding number)
(xiii) Status (complete, ongoing, future)
(xiv) Contact affiliation.

4.13 The Workshop thanked the authors for developing this type of initiatives and noted the importance of making this information visible not only for Members but also for national Antarctic programs in order to allow for potential collaboration with scientists that might not necessarily engage with CCAMLR.

4.14 The Workshop noted that the collation of projects presented in WS-SM-18/03 demonstrated that considerable progress had been made towards the ambitious program of work specified in the RMP. The Workshop recommended that Members contribute to the project list database as detailed in the RSRMPA RMP (SC-CAMLR-XXXVI/20).

4.15 Dr M. Vacchi (Italy) indicated that the Italian Antarctic Research Program (PNRA) has also been developing a similar exercise, compiling information on projects related to the Ross Sea region from season 2012/13 to date. The initiative is expected to be fully developed later in the year and results will be available during the Scientific Committee meeting in 2018. In addition, Dr Vacchi announced that PNRA has recently launched a call in which there is a specific topic dedicated to the proposals related to research and monitoring of the RSRMPA under indications of CM 91-05.

4.16 WS-SM-18/16 presented a plan to release 15 pop-off satellite tags (PSATs) in the southern and western RSRMPA GPZ(i) and five additional PSATs on the northern Subarea 88.1/88.2 seamounts in the 2018/19 season using a redesigned and reengineered PSAT specifically for use on toothfish. In addition, juvenile and adult otoliths will be collected with the intention of analysing otolith microchemistry.

4.17 The Workshop noted that the PSAT component could provide insight into movements between various zones of the RSRMPA, whereas the otolith microchemistry component could address key gaps in relation to the life-history hypothesis for *D. mawsoni* in the Ross Sea, as well as confirm the role of the RSRMPA in relation to providing ecosystem services in the form of fish migrating downstream to regions outside the MPA.

4.18 The Workshop welcomed the planned research, noting that this was a US and New Zealand collaborative effort, and was a good example of collaborative efforts between Members to undertake research under the RMP.

4.19 WS-SM-18/15 presented a framework for an RMP for the SOISS MPA.

4.20 The Workshop agreed that the proposed framework sets out the components of a draft SOISS MPA RMP to be developed as part of the 2019 review, based on the draft initially proposed in 2014 (SC-CAMLR-XXXIII/11). This aims to address the requirements of CM 91-04, and takes account of general principles from the RSRMPA RMP (SC-CAMLR-XXXVI, paragraphs 5.39 to 5.42) and the proposed WSMPA RMP.

4.21 The Workshop noted that a report on the analyses from research and monitoring in the area will need to be undertaken in order to provide scientific advice for review by the Commission in 2019, including to provide scientific advice on the extent to which the objectives of the MPA were being met.

4.22 Dr Kasatkina noted that Domain 1 was characterised by different oceanic environments, ecosystems and biodiversity of pelagic and benthic zones. Dr Kasatkina noted that the choice of the SOISS MPA as a reference area may not allow useful comparative studies to monitor natural variability and long-term change or to understand the effects of harvesting or other human activities on Antarctic marine living resources and ecosystems.

4.23 Dr Trathan noted that there are various different uses for reference areas, and one of the properties of the SOISS MPA is that the southern portion of the MPA shows interannual variation in oceanographic and sea-ice properties, something that is potentially related to krill availability. How krill gets onto the shelf is a vital issue for understanding availability to both the fishery and predators.

4.24 The Workshop agreed the proposed framework for the SOISS MPA RMP in WS-SM-18/15 and recommended that it be submitted to the Scientific Committee, and that a project list and summary of research and monitoring activities be developed in time for the next review of the MPA in 2019.

4.25 The Workshop noted that while general principles may help to determine research and monitoring activities or themes that are common across different MPAs, individual RMPs will be uniquely designed, given the specific characteristics and objectives of individual locations.

Spatial planning data management

Research and monitoring plan website

5.1 The Secretariat provided an overview of progress made on the development of the website for interaction with the RSRMPA RMP as requested during the Scientific Committee meeting in 2017 (SC-CAMLR-XXXVI, paragraphs 5.44 to 5.46). The website has two parts: a web-based architecture to submit and explore project documentation and associated metadata along with a link to the (meta)data repository (data.ccamlr.org).

5.2 The Secretariat demonstrated the (meta)data repository (data.ccamlr.org repository) that used the DKAN structure, an open-source open data publishing platform that identifies locations where relevant data are deposited, either in external open-access data repositories or within the DKAN data repository for data that cannot be found elsewhere.

5.3 The Workshop noted that different resources in the portal might require different levels of accessibility consistent with CCAMLR's rules for data access and rules. It suggested that it would be useful for the Secretariat to develop the system following the same access permissions as for other parts of the CCAMLR website.

5.4 The Secretariat showed a test version of the portal that allows Members to interact with the RSRMPA RMP (including Project Lists) and facilitates automated tracking of indicators that quantify scientific effort, and provides links and access to baseline data and associated datasets through the DKAN (meta)data repository/data.ccamlr.org.

5.5 The Workshop congratulated the Secretariat on the impressive progress and requested the Secretariat to continue this work and make the portal available to Members as soon as possible.

5.6 The Workshop expressed interest in providing regular feedback to the Secretariat to further improve the system through active participation of representatives in the Data Management Group (DMG).

5.7 The Workshop recommended that information in the DKAN (meta)data repository and the RSRMPA RMP should be explorable in a geospatial context within the portal. An approximate geospatial extent of the region of interest would be desirable and facilitate discovering who is working in the area or is executing relevant research. Additionally, shapefiles with spatial data should be easily viewable in the CCAMLR online geographic information system (GIS), noting that this might introduce a requirement for file type specification.

5.8 The Workshop agreed that the areas to which a research project is aligned should be entered as text rather than having a more formal geospatial definition.

5.9 The Workshop suggested that the project data should also include information on outcomes, as well as linkages to the relevant (CCAMLR) papers/publications and the relevant metadata records in the DKAN repository (paragraph 4.12).

5.10 The Workshop noted that one of the important features of the portal is that it provides linkages between RSRMPA RMP objectives, projects, datasets, data products and CCAMLR publications. The Workshop encouraged approaches that ensure that the linkages are easy to understand and that the differences between objective, projects, datasets and publication are clear.

5.11 The Workshop noted that different Members have different systems for aggregating information on relevant projects, however, all Members should encourage researchers to contribute relevant information. The Workshop noted that it is important to make the submission process as simple and easy as possible, including having the entry form and the project information available in all four languages of the Commission.

5.12 The Workshop recommended that adding projects to the project list portal follows a similar workflow to the submission of meeting papers by requiring approval from the nominated representative of the submitting Member.

5.13 The Workshop also recommended that in the future it may be useful to consider how research being conducted by non-Members can be incorporated into the system.

5.14 The Workshop noted that the current web-based portal is predominantly an input system and development efforts should include mechanisms to provide the required outputs for reviews through the generation of effort and coverage indicators in the required periodic reports.

5.15 Regarding integration or discovery of information available in other systems, the Workshop recommended that the Secretariat and the DMG should survey relevant sources and consider mechanisms for facilitating access where necessary. This includes projects and data from non-Members and/or organisations such as SCAR and the Committee for Environmental Protection (CEP). Specific systems that were discussed in the Workshop include:

(i) DueSouth, a database for sharing plans for upcoming Southern Ocean and Antarctic research projects developed by SOOS

(ii) the SOOS Southern Ocean mooring sites map that provides information on the deployment locations of moorings in the Southern Ocean

(iii) the SCAR Antarctic Biodiversity Portal that aggregates publicly available Antarctic and Southern Ocean data.

5.16 The Workshop noted that the repository should not attempt to duplicate data held outside CCAMLR but that data used for determining the MPA boundaries should be kept within the repository as it is a snapshot of synthesised data used to determine the MPA boundaries.

5.17 The Workshop agreed that having a GIS repository for baseline data that is easily accessible would be valuable. The Workshop noted the importance of this in order to enable others to reanalyse and reinterpret data layers that were compiled during the RSRMPA planning process. The authors also encourage other Members to contribute additional information that could complement this database.

5.18 The Workshop also recalled the requirements of CM 91-05, paragraph 24, on monitoring traffic within the MPA and requested the Secretariat to include a web-based entry system for Members to notify entry and exit of vessels into and out of the MPA.

Future work

Fisheries research evaluation

6.1 WG-SAM-18/21 provided an overview of priority research topics and identified key attributes for fisheries-directed research programs that would be needed to evaluate the objectives of the RSRMPA.

6.2 The Workshop noted that this paper had been discussed at WG-SAM (Annex 6, paragraphs 6.45 to 6.47) and agreed with the views of WG-SAM that the criteria outlined in the paper were useful in guiding the Scientific Committee and its working groups in their evaluations of research within and outside of the RSRMPA. The Workshop also recalled that, as one aspect of the RSRMPA is to provide a gradient in local exploitation rates for toothfish, this would have to be taken into account when determining which catch limit allocations facilitate research fishing.

6.3 The Workshop highlighted the need to ensure that a mechanism is needed to coordinate research fishing when conducted by multiple Members in the same area and to ensure that the research being conducted is not compromised by operations of the Olympic fishery.

6.4 The Workshop recommended that the Scientific Committee use the following for ranking the quality and priority of current and proposed fisheries-related research that contributes towards research under MPA RMPs. The research proposal should:

(i) identify which priority research elements are addressed

(ii) explicitly integrate core concepts of good scientific research design (replication, randomisation and reference areas) to ensure robust experimental results

(iii) explain why the proposed research or data collection cannot be conducted during the exploratory fishery

(iv) provide a detailed rationale for the choice of comparable reference areas

(v) demonstrate how coordinating vessels will employ robust standardised procedures, including how the vessels involved will provide high-quality and comparable data, especially with respect to toothfish tag-survival and tag-detection rates

(vi) demonstrate Members' capacity to conduct high-quality and timely shore-based analyses necessary to utilise the data to inform the RMP evaluation process

(vii) describe the mechanism by which research fishing is coordinated with other research fishing and with any Olympic fishery, and how the research will avoid being compromised by spatial and temporal interactions

(viii) provide an environmental impact assessment for the research, and an assessment of how the research may impact the objectives of the MPA.

6.5 The Workshop agreed that the general principles described in WG-SAM-18/21 should be relevant to fisheries-related research generally under CM 24-01.

Mechanisms to progress future work on spatial management

6.6 The Workshop agreed that the Workshop had provided an excellent opportunity for detailed consideration on a range of spatial management issues, and had underlined the need for ongoing work required to provide advice to the Scientific Committee.

6.7 The Workshop agreed that due to the increased workload related to spatial management, and expectation of that workload continuing to increase, including with the requirement for MPA reviews, there was a need for further focused meetings to maintain progress and to avoid the fragmentation of effort.

6.8 The Workshop requested the Scientific Committee to consider how best to achieve the ongoing work on spatial management in the context of its other priorities. Options discussed included the creation of a new working group or further spatial management workshop(s); however, differences in the interpretation of the relative status of Scientific Committee working groups or workshops may need to be taken into consideration.

6.9 The Workshop recalled the request from the Scientific Committee for the Secretariat to establish a position in the Secretariat dedicated to spatial management/MPA-related work (SC-CAMLR-XXXVI, paragraph 5.47 and CCAMLR-XXXVI, paragraph 4.9). The Science Manager informed the Workshop that this issue was currently being addressed as part of the review of the Secretariat Strategic Plan that would be considered by the Commission at CCAMLR-XXXVII.

6.10 The Workshop further recalled the discussion of the Scientific Committee following the Scientific Committee Symposium (SC-CAMLR-XXXV/12) and the recognition of the need for flexibility in the approach to address strategic issues and respond to emerging priorities of the Scientific Committee.

6.11 The Workshop noted the updated terms of reference for the MPA Special Fund (SC-CAMLR-XXXVI, paragraph 5.52), which can be used to support a range of activities relating to the further development and management of a system of MPAs, including facilitating workshops and the attendance of scientific experts.

6.12 The Workshop noted that cooperation with other scientific programs is important for spatial management, for example the Domain 1 Expert Group involves SCAR, SOOS and the Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) and the RSRMPA process involved SOOS and SCAR. The Workshop noted the positive experience in inviting relevant experts to meetings and receiving information from expert groups, noting that current mechanisms include:

(i) invitation of individual experts

(ii) contributions outside the CCAMLR process (i.e. contributions by individuals and groups in the absence of representation at meetings), for example via papers, discussions, meetings and other involvement in the broader process

(iii) expert participation via the Member delegations. Noting, however, that different Member delegations have differing policies in this regard.

6.13 The Workshop recommended that the Scientific Committee consider means to facilitate and improve engagement and interactions with relevant scientific programs and experts. The Workshop agreed this was particularly important given the range of science expertise required to address the diverse issues involved in spatial management. It requested the Scientific Committee clarify the mechanisms for inviting relevant experts to participate in its work.

6.14 The Workshop noted examples of existing, effective interactions with other scientific programs, including, but not limited to:

(i) SOOS Regional Working Groups –

Ongoing interactions include representation and involvement of CCAMLR Members on SOOS Regional Working Groups, including the Ross Sea and West Antarctic Peninsula. A CCAMLR–SOOS Synergies Workshop was held in April 2018 (SC-CAMLR-XXXVI, paragraph 10.17).

(ii) ICED –

The ICED program is undertaking integrated circumpolar analyses to improve understanding of change and the implications for Southern Ocean ecosystems and for management of human impacts (WG-EMM-17/36). There is much potential for ICED and CCAMLR to work together on spatial management (e.g. WS-SM-18/17). This includes, but is not limited to, joint ICED–CCAMLR activities on projections of change with a focus on Area 48, including a recent workshop on krill (SC-CAMLR-XXXV, paragraphs 6.18 and 6.19; WG-EMM-18/09), together

with ICED research focused on understanding the structure and functioning of Southern Ocean ecosystems, their variability and response to change across a range of spatial and temporal scales, on key species – from krill to whales, and the structure of food webs (WG-EMM-16/22). ICED will continue to develop activities, in consultation with CCAMLR and with SCAR, to support CCAMLR's work.

(iii) SCAR –

The Workshop welcomed an update from Dr A. Terauds (Australia) on new SCAR initiatives, including the agreement to form a Krill Action Group (SC-CAMLR-XXXVI, paragraphs 10.9 to 10.11), and a new SCAR Proposed Scientific Research Programme Planning Group: Integrated Conservation Planning for Antarctica and the Southern Ocean (Ant-ICON) that will focus on coordinating, facilitating and delivering science to support conservation in Antarctica and the Southern Ocean. Much research within SCAR has relevance to spatial planning and SCAR indicated its willingness to assist in the continued provision of objective scientific advice to CCAMLR in this regard. SCAR also indicated it will work actively with CCAMLR Members to ensure that this advice is timely and relevant.

Communication and outreach

6.15 The Workshop noted that there was relatively little publicly accessible information on CCAMLR's work on MPAs, including the establishment of the Ross Sea MPA. A potential consequence of this is that rather than celebrate its achievements in respect of MPAs it was left to others to create the public narrative on the subject. The Workshop suggested that options for involving Members in reviewing web content may provide a mechanism for the Secretariat to include a greater diversity of content on the website.

Advice to Scientific Committee

7.1 The paragraphs containing the advice of the Workshop to the Scientific Committee are summarised below; these advice paragraphs should be considered along with the body of the report leading to the advice:

(i) progress towards establishing a representative system of MPAs (paragraphs 2.10, 2.12 and 2.13)

(ii) review of CEMP (paragraph 3.22)

(iii) spatial management and experimental approaches in the krill fishery (paragraph 3.25)

(iv) development of RMPs (paragraph 3.40)

(v) MPAS that span multiple jurisdictions (paragraph 3.79)

(vi) development of MPA proposals in Domains 5 and 6 (paragraph 3.81)

(vii) RMP for the SOISS MPA (paragraph 4.24)

(viii) website development for the RSRMPA RMP (paragraph 5.12)

(ix) criteria for the evaluation of proposals for research fishing in MPAs (paragraph 6.4)

(x) future work planning to achieve the required work on spatial management (paragraphs 6.8 and 6.13).

Close of meeting

8.1 Dr Grant thanked all participants for their cooperative and constructive engagement that had led to such a productive and successful outcome. She particularly thanked the rapporteurs, the Secretariat and the local hosts, in particular Ms Pilvi Muschitiello, who had provided excellent facilities in the Aurora building.

8.2 On behalf of the Workshop, Prof. Koubbi thanked Dr Grant for her hard work and friendly chairing that had allowed intense and fruitful discussions. He also thanked Dr Grant for her considerable intersessional work that had helped to make substantial progress on spatial management issues.

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Table 1: Preliminary assessment of indicators of representativeness by existing and proposed MPAs in the Convention Area. Adapted from WS-SM-18/12 and 18/14. This table does not include representative coverage that is provided by other conservation measures (paragraph 2.6).

	Area (10^3 km^2)	Ocean Basin	Bathymetric range	Latitudinal range	# of benthic ecoregions represented[1]	# of pelagic clusters represented[1]
CCAMLR MPAs						
SOISS MPA (CM 91-03)	93.8	Atl	0–2000 m	62–64°S	1	0
RSRMPA (CM 91-05)	2060.0	Pac	0–5000 m	60–85°S[2]	3	6
Sub-Antarctic MPAs						
HIMI	70.8	Ind	0–3500 m	49–57°S	1	1
Prince Edward Is	161.3	Ind	0–3500 m	42–51°S	1	2
Crozet Is	574.7	Ind	0–4600 m	42–50°S	1	2
Kerguelen	567.2	Ind	0–4900 m	45–53°S	1	3
SG & SSI	1069.9	Atl	0–8300 m	51–60°S	3	4
Proposals considered by SC-CAMLR						
D1MPA (SC-CAMLR-XXXVI/18)	447.1[3]	Atl, Pac	0–5600 m	58–73°S	2	6
EAMPA (CCAMLR-XXXVI/17)	1095.0	Ind	0–5000 m	60–68°S	5	8
WSMPA (CCAMLR-XXXV/18)	1800.0	Atl	0–5300 m	60–78°S[4]	4	7
Summary[5]						
Total existing MPAs	4597.7 (13%)	Atl, Ind, Pac	0–8300 m	42–85°S	8 (35%)	15 (79%)
Total proposed MPAs	3432.0 (10%)	Atl, Ind, Pac	0–5600 m	58–83°S	10 (43%)	12 (63%)
Total existing and proposed	8029.7(23%)	Atl, Ind, Pac	0–8300 m	42–85°S	17 (74%)	16 (84%)
Total Convention Area	35724.3	Atl, Ind, Pac	0–8400 m	45–85°S	23	19[6]

[1] Benthic ecoregions and pelagic clusters are respectively from Douglass et al. (2014) and Raymond (2014). An ecoregion or cluster is considered 'represented' if at least 5% of its area is included within an MPA or set of MPAs. The threshold of 5% is arbitrary and does not indicate whether coverage is comprehensive or adequate. These bioregions may differ from those actually used to develop each MPA (paragraph 2.4).

[2] Approximately the southernmost latitude of the Ross Ice Shelf.

[3] Does not include the area of the SOISS MPA.

[4] Approximately the northern latitude of the Ronne-Filchner Ice Shelf.

[5] Values in parentheses indicate percentages relative to the Convention Area.

[6] Raymond (2014) identified 19 pelagic clusters, however, one of these (Cluster 18 temperate waters) does not occur in the Convention Area and is not considered here.

Table 2: Example table to be used in investigating the establishment of reference areas in Subarea 48.6 to enable comparisons between fished and unfished areas.

Examples of parameters/attributes	Geographic areas							
	20°W–15°W	15°W–10°W	10°W–05°W	05°W–0°	0°–05°E	05°E–10°E	10°E–15°E	15°E–20°E
Ice conditions/accessibility								
Possibility of long-term analyses in the context of national Antarctic programs								
Background information available on benthic ecosystems and food webs								
Similar benthic habitats and ecosystems								
Distance to fisheries research blocks								
Previous fishing effort								
Current fishing effort								
Contribution to specific objectives of the WSMPA, such as: • Representative examples of ecosystems and habitats based on ecological and environmental features • Higher productivity areas • Ecosystems and habitats vulnerable to the effects of climate change								

Appendix A

List of Participants

Workshop on Spatial Management
(Cambridge, United Kingdom, 2 to 6 July 2018)

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Appendix B

Agenda

Workshop on Spatial Management
(Cambridge, United Kingdom, 2 to 6 July 2018)

1. Introduction

    1.1 Opening of the meeting
    1.2 Adoption of the agenda and organisation of the meeting

2. Development of general principles for the use of spatial management tools in the CCAMLR area

3. Development of MPA proposals

    3.1 Planning Domain 1 (western Antarctic Peninsula and southern Scotia Sea)
    3.2 Planning Domains 3 and 4 (Weddell Sea)
    3.3 Planning Domains 5 and 6 (Del Cano–Crozet and Kerguelen Plateau)

4. Research and monitoring plans

    4.1 General principles for MPA research and monitoring
    4.2 Development of specific MPA Research and Monitoring Plans

5. Spatial planning data management

6. Future work

    6.1 Priority research topics to inform future work on spatial management
    6.2 Cooperation with other scientific programs
    6.3 Future organisation of spatial management work by the Scientific Committee and its working groups

7. Other business

8. Advice to the Scientific Committee

9. Adoption of report and close of meeting.

Appendix C

List of Documents

Workshop on Spatial Management
(Cambridge, United Kingdom, 2 to 6 July 2018)

WS-SM-18/01	Baseline data layers used for spatial planning, monitoring and research in relation to the Ross Sea region Marine Protected Area M. Pinkerton and B. Sharp
WS-SM-18/02	Candidate baseline data for ecosystem indicators in the Ross Sea region A. Dahood and G.M. Watters
WS-SM-18/03	Summary of New Zealand research projects relevant to the Ross Sea region Marine Protected Area M. Pinkerton and J. Scarrow
WS-SM-18/04	Developing the risk assessment framework for the Antarctic krill fishery in Area 48 P. Trathan, V. Warwick-Evans, E. Young, S. Thorpe, E. Murphy, N. Kelly, S. Kawaguchi and D. Welsford
WS-SM-18/05	An experimental approach for the Antarctic krill fishery: advancing management and conservation through the use of Krill Reference Areas and Krill Fishing Areas P.N Trathan and O.R. Godø
WS-SM-18/06	Hierarchical monitoring plans to determine patterns of change in the Antarctic Marine Ecosystem P. Trathan
WS-SM-18/07	Predator trophic hotspots in the Indian sector of the subantarctic Southern Ocean: how do they overlap with marine protected areas? M. O'Toole, S. Sergi, A. Baudena, C. Cotté, C. Bost, C. Guinet, H. Weimerskirch, M.A. Hindell, P. Koubbi and F. d'Ovidio
WS-SM-18/08	Informing and seeking advice from WS-SM 2018 about the revisions of the WSMPA proposal S. Hain, K. Teschke, H. Pehlke and T. Brey

WS-SM-18/09	Comments on the development of a *Dissostichus mawsoni* Population Hypothesis for Area 48. Proposals on the WS-SM-18 advice to the to the Scientific Committee and its Working Group Delegation of the Russian Federation
WS-SM-18/10	Comments on the use of MPA for spatial management in the CCAMLR area Delegation of the Russian Federation
WS-SM-18/11	Peculiarities of spatial-temporal variability of oceanological conditions in the Weddell Sea region in the context of the development of a stock hypothesis for Antarctic toothfish (*Dissostichus mawsoni*) in Area 48 V. Shnar and S. Kasatkina
WS-SM-18/12 Rev.	Progress towards a representative network of Southern Ocean protected areas C. Brooks, S. Chown, L. Douglass and B. Raymond
WS-SM-18/13	Scientific background document in support of the development of a CCAMLR MPA in the Weddell Sea (Antarctica) – Version 2018 – Reflection on the recommendations by WG-EMM-17 and SC-CAMLR-XXXVI K. Teschke, H. Pehlke and T. Brey
WS-SM-18/14	Are we there yet? Evaluating and reporting progress towards a Representative System of Marine Protected Area across the CAMLR Convention Area D.C. Welsford
WS-SM-18/15	Research and Monitoring Plan for the South Orkney Islands Southern Shelf Marine Protected Area (MPA Planning Domain 1, Subarea 48.2) P.N. Trathan and S. Grant
WS-SM-18/16	Proposed initiative to contribute to Ross Sea region MPA research and monitoring activities using pop-up satellite tags and otolith chemistry on *Dissostichus mawsoni* C.D. Jones
WS-SM-18/17	The identification of scientific reference areas in the wider context of MPA planning – report of the CCAMLR scholarship recipient A. Capurro, M.M. Santos, R. Cavanagh and S. Grant

WS-SM-18/18	Further information in relation to krill fisheries in the D1MPA process A. Capurro and M.M. Santos with contributions from the D1MPA Expert Group

Other Documents

WS-SM-18/P01	Abundance and richness of key Antarctic seafloor fauna correlates with modelled food availability J. Jansen, N.A. Hill, P.K. Dunstan, J. McKinlay, M.D. Sumner, A.L. Post, M.P. Eléaume, L.K. Armand, J.P. Warncock, B.K. Galton-Fenzi and C.R. Johnson *Nature Ecology & Evolution*, 2 (2017): 71–80, doi: 10.1038/s41559-017-0392-3
WS-SM-18/P02	Model-based mapping of assemblages for ecology and conservation management: A case study of demersal fish on the Kerguelen Plateau N.A. Hill, S.D. Foster, G. Duhamel, D. Welsford, P. Koubbi and C.R. Johnson *Diversity Distrib*., 23 (2017): 1216–1230
WS-SM-18/P03	What's the catch? Profiling the risks and costs associated with marine protected areas and displaced fishing in the Scotia Sea E.S. Klein and G.M. Watters *PLos ONE* (submitted)
SC-CAMLR-XXXVII/01	Report of the Co-conveners of the CCAMLR Workshop for the Development of a *Dissostichus mawsoni* Population Hypothesis for Area 48 (19 to 21 February 2018, Berlin, Germany) Workshop Co-conveners (C. Darby (UK) and C. Jones (USA))
WS-DmPH-18/01	Materials on biodiversity in Subareas 48.6 and 48.5 in the frame of the Weddell Sea MPA Delegation of the Russian Federation
WS-DmPH-18/02	On seasonal and interannual dynamics of ice conditions in the Weddell Sea and its relation to the WSMPA planning Delegation of the Russian Federation
WG-SAM-18/21	Guidelines for fisheries-directed research addressing the Ross Sea region Marine Protected Area Research and Monitoring Plan S. Parker and A. Dunn

WG-SAM-18/33 Rev. 1 Annex to WS-DmPH-18 report: Towards the development of a stock hypothesis for Antarctic toothfish (*Dissostichus mawsoni*) in Area 48

M. Söffker, A. Riley, M. Belchier, K. Teschke, H. Pehlke, S. Somhlaba, J. Graham, T. Namba, C.D. van der Lingen, T. Okuda, C. Darby, O.T. Albert, O.A. Bergstad, P. Brtnik, J. Caccavo, A. Capurro, C. Dorey, L. Ghigliotti, S. Hain, C. Jones, S. Kasatkina, M. La Mesa, D. Marichev, E. Molloy, C. Papetti, L. Pshenichnov, K. Reid, M.M. Santos and D. Welsford