Annex 5

Report of the Working Group
on Ecosystem Monitoring and Management
(Bremerhaven, Germany, 1 to 10 July 2013)

CONTENTS

REPORT OF THE WORKING GROUP ON ECOSYSTEM MONITORING AND MANAGEMENT

(Bremerhaven, Germany, 1 to 10 July 2013)

INTRODUCTION

Opening of the meeting

1.1 The 2013 meeting of WG-EMM was held at the German Shipping and Maritime Museum, Bremerhaven, from 1 to 10 July 2013. The meeting was convened by Dr S. Kawaguchi (Australia) and local arrangements were coordinated by Dr S. Hain from the Alfred Wegener Institute (AWI), Helmholtz Centre for Polar and Marine Research, with support from the German Federal Ministry of Food, Agriculture and Consumer Protection. The meeting was opened by Prof. K. Lochte, Director of the AWI.

1.2 Prof. Lochte welcomed the Working Group to its first meeting in Germany, and noted WG-EMM's wide remit for scientific assessments and the development of management advice on the status of Antarctic marine ecosystems and on aspects of spatial protection, including marine protected areas (MPAs) and vulnerable marine ecosystems (VMEs). In particular, this latter aspect was of special interest to the AWI, as the institute is currently carrying out scientific analyses for a German proposal for a CCAMLR MPA in the Weddell Sea. The first conceptual outline of this project was presented in WG-EMM-13/22 and the AWI would welcome contributions and input from working group experts to this work. Prof. Lochte wished the Working Group a successful and productive meeting and all participants a pleasant stay in Bremerhaven.

1.3 Dr Kawaguchi welcomed the participants (Appendix A) and outlined the work for the meeting. The agenda focused on the krill-centric ecosystem and issues related to the management of the krill fishery and spatial management (MPAs and VMEs). An evening colloquium was held at the AWI on 4 July 2013 entitled 'Science and scientific research in Antarctica under CCAMLR and at the AWI: A mutual information exchange'.

Adoption of the agenda and organisation of the meeting

1.4 The Working Group discussed the provisional agenda and agreed to expand item 2 to include specific consideration of climate change (consideration of this is presented in the future work section of this report). The revised agenda was adopted (Appendix B). Subgroups were formed to address detailed aspects of the agenda.

1.5 Documents submitted to the meeting are listed in Appendix C. While the report has few references to the contributions of individuals and co-authors, the Working Group thanked all authors of papers for their valuable contributions to the work presented to the meeting.

1.6 The Working Group noted that the CCAMLR website had evolved into a very useful and versatile meeting resource, and thanked the Secretariat for redeveloping the site.

1.7 In this report, paragraphs that provide advice to the Scientific Committee and its other working groups have been highlighted; these paragraphs are listed in Item 5.

1.8 The report was prepared by Drs A. Constable (Australia), C. Darby (UK), L. Emmerson (Australia), J. Hinke (USA), T. Ichii (Japan), K.-H. Kock (Germany), D. Ramm, K. Reid (Secretariat), G. Skaret (Norway), P. Trathan, J. Watkins (UK) and G. Watters (USA).

THE KRILL-CENTRIC ECOSYSTEM AND ISSUES RELATED TO MANAGEMENT OF THE KRILL FISHERY

Issues for the present

Fishing activities

Summary report on the fishery

2011/12

2.1 Twelve vessels from six Members fished for krill in Subareas 48.1, 48.2 and 48.3 in 2011/12 and the total catch of krill was 161 085 tonnes (Subarea 48.1: 75 630 tonnes; Subarea 48.2: 29 040 tonnes; Subarea 48.3: 56 415 tonnes) (see WG-EMM-13/37 Rev. 1). These catches did not trigger any closures in the fishery.

2.2 Norway reported the largest catches of krill with a total of 102 800 tonnes, the Republic of Korea reported 27 100 tonnes, Japan reported a catch of 16 258 tonnes, Chile reported 10 662 tonnes and the People's Republic of China (hereinafter referred to as China) reported 4 265 tonnes.

2.3 Most of the catch in 2011/12 was taken in four small-scale management units (SSMU): 50 218 tonnes from South Georgia East (SGE); 28 832 tonnes from South Orkney West (SOW); 28 657 tonnes from Bransfield Strait West (APBSW) and 20 424 tonnes from Drake Passage East (APDPE).

2.4 The Working Group noted that catches were concentrated in a small number of fine-scale rectangles (0.5° latitude × 1.0° longitude) within each SSMU (WG-EMM-13/37 Rev. 1, Figure 3). As an example, in Subarea 48.3, fishing was highly concentrated, often occurring in the same rectangle each season; there was also some evidence from analyses undertaken in 1996 that the fishery may move in a westerly direction along the South Georgia northern shelf as the season proceeds. These areas fished in the winter also correspond with the summer foraging grounds of some krill-dependent predators. Since scientific information on winter krill abundance in all subareas in Area 48 is limited, the Working Group agreed that acoustic data collected by fishing vessels would help understand patterns of krill abundance in the areas fished.

2012/13

2.5 Eleven vessels licensed from five Members (Chile, China, Republic of Korea, Norway and Ukraine) fished for krill in Subareas 48.1, 48.2 and 48.3. The total catch reported to May 2013 was 151 161 tonnes, 86% of which was taken from Subarea 48.1. So far this season, Chile has reported catching 2 028 tonnes of krill, China 23 934 tonnes, Korea 30 677 tonnes, Norway 106 327 tonnes and Ukraine 2 507 tonnes.

2.6 The monthly cumulative catch of krill in the fishery reported to May 2013 is greater than any of those reported to May in the past five seasons. Fishing has concentrated in Bransfield Strait in SSMUs Bransfield Strait West (BSW: 81 631 tonnes to date) and Bransfield Strait East (BSE: 17 553 tonnes). Subarea 48.1 was closed on 14 June and will remain closed to krill fishing until the end of the season (30 November 2013). The total reported catch in Subarea 48.1 at the time of the closure was 154 100 tonnes (99% of the apportioned limit of 155 000 tonnes; see Conservation Measure (CM) 51-07).

2.7 The Working Group noted that it was the second time that the krill fishery had triggered a closure in Subarea 48.1; the first occasion was in 2009/10 near the end of the fishing season. The recent closure occurred in the middle of the fishing season, reflecting a more rapid uptake of the catch during the first half of 2012/13. This more rapid uptake of catch resulted from concentrated krill aggregations and favourable weather/ice conditions.

2.8 The Working Group noted that sea-ice extent is an important factor influencing the location of the krill fishery. In 2012/13, sea-ice coverage was reported to be less extensive in Subarea 48.1, where fishing was concentrated, whereas coverage was extensive in Subarea 48.2, where relatively little fishing has been reported so far.

2.9 The Working Group agreed that it would be useful to have a consolidated summary of information related to the krill fishery in a similar format to the fishery reports that are completed for finfish fisheries in WG-FSA (www.ccamlr.org/node/75667). The Secretariat agreed to coordinate the preparation of a draft krill fishery report for consideration at WG-EMM-14 that would be similar in content to a finfish Fishery Report. It may include an analysis of the history and spatial distribution of catches, including methods of conversion to green weight, observer coverage and data collection, length-frequency distribution data and information of by-catch, as well as an analysis of notifications for the forthcoming season. As in a finfish Fishery Report, it would also summarise the current methodology for advising on catch limits and the background to the parameters used in this process.

2.10 The Working Group considered that it would be useful to have this Krill Fishery Report translated into the four official languages of CCAMLR and requested the Scientific Committee and the Commission to consider this issue.

Notifications for the 2013/14 fishing season

2.11 Six Members submitted notifications for a total of 19 vessels intending to participate in krill fisheries in 2013/14. The notifications are for trawl fisheries in Subareas 48.1, 48.2, 48.3 and 48.4; there was no notification for krill fisheries in Divisions 58.4.1 and 58.4.2, or the exploratory krill fishery in Subarea 48.6. The total intended krill catch was 545 000 tonnes (WG-EMM-13/37 Rev. 1, Table 7).

2.12 The Working Group reviewed all notifications (CCAMLR-XXXII/05 to XXXII/10) and confirmed that the required information had been provided. However, in line with the development of the feedback management strategy, a more thorough and detailed review process was conducted to facilitate the understanding of the krill fishery. The Working Group sought clarification of specific elements (Table 1) and requested that notifying Members submit any additional information to the Secretariat by 1 September 2013. In addition, the Working Group also requested that Members provide information on the make, type and frequencies of echosounders used on each vessel to assist with the development of the proof-of-concept program (paragraphs 2.137 to 2.142). This additional information will be appended to the original notifications.

2.13 The Working Group also reviewed the information requirements for notifications for krill fisheries (CM 21-03, Annexes A and B). The Working Group agreed that:

(i) information requirements for net configuration should be strengthened, and descriptions of trawl nets and seal exclusion devices should be submitted to WG-EMM for review and subsequent inclusion in the CCAMLR fishing gear library (www.ccamlr.org/node/74407), and relevant documents may be referred to in subsequent notifications

(ii) information on the relative amounts of product (% of catch), notified fishing months, expected proportion of time for each fishing technique, and the simple check-box to indicate the presence of mammal exclusion devices (this is a mandatory requirement) should be removed.

The Working Group requested the Scientific Committee to consider these revisions for notifications in 2014/15.

2.14 The Working Group noted that the revised guidelines for estimating green weight of krill (Appendix D) will require the Secretariat to update the C1 data form for use in 2013/14. The Working Group also requested that the Secretariat include examples of how to enter the green weight estimation parameters in the C1 form. Such examples should be placed on the CCAMLR website and would assist crew in completing the form.

Green weight

2.15 WG-EMM 13/41 and 13/42 Rev. 1 reported methods used for estimating green weight and associated uncertainty on board Norwegian krill fishing vessels (*Saga Sea*, *Antarctic Sea* and *Juvel*) and on board the Chilean krill fishing vessel *Betanzos* respectively. All vessels produce meal and/or oil on board, and report direct measurements of green weight to CCAMLR. *Betanzos* and *Juvel* both use flow meters (that measure the volume of krill and water) to estimate catch, where green weight is estimated from a measured volume in a time unit via a volume-to-mass conversion factor. On board the *Saga Sea* and *Antarctic Sea*, flow scales (that measure the mass of krill and water) are used, in these cases the conversion between measured catch weight and green weight is an estimate of the mass of krill remaining once water has been removed. Both papers presented details about processing methods, procedures for estimating catch and preliminary results.

2.16 The Working Group welcomed the contributions in WG-EMM-13/41 and 13/42 Rev. 1 since such information was important for progressing the work on deriving uncertainty estimates from the reported catch. Other Members engaged in the krill fishery were encouraged to submit similar descriptions and analyses to WG-EMM-14.

2.17 The Working Group reviewed the guidelines for estimating green weight of krill (CM 21-03, Annex B). The Working Group agreed that:

(i) some of the methods needed clarification regarding parameters needed for estimation and estimation procedure

(ii) some methods for green weight estimation used by some vessels, but not presently included, should be added to the guidelines

(iii) information related to observation steps and frequency of observations should be added.

2.18 The Working Group agreed that the revised guidelines more precisely address which information was expected to be provided by the industry related to green weight estimation, and requested the Scientific Committee to consider these revisions as part of the revised notifications in 2014/15.

Scientific observation

2.19 Analyses of the scientific observer coverage during the 2011/12 fishing season were presented in WG-EMM-13/38. During 2012 all 12 vessels that participated in the krill fishery carried observers for some, or all, of their fishing operations. From a total of 860 vessel days of fishing in 2012, observations of krill length measurements were collected on 375 days, and fish by-catch from 34 taxa was measured on 554 days. The Working Group appreciated this level of coverage and noted that the scientific observer coverage (79% of vessel months) exceeded the minimum requirements in CM 51-06.

2.20 The monthly length frequencies of krill exhibited the greatest changes between months in Subarea 48.1 when fishing occurred both in Bransfield Strait and to the west of the South Shetland Islands. The Working Group noted that the choice of fishing location, resulting from ice and weather conditions, appeared to be having an impact on the aggregated length distributions and that this required more detailed information and analysis.

2.21 As the time series of data develops the influence on length-frequency distribution resulting from fishing location, growth and recruitment should become clearer. In addition, the Working Group noted that the length-frequency distributions from commercial fisheries could also be compared with those recorded in the diet of predators and from research surveys at appropriate time and space scales.

2.22 The Working Group welcomed the presentation of the spatial distribution of fish by-catch in WG-EMM-13/38 and looked forward to further data collection by observers.

2.23 The Working Group recognised that differences in gear type, and consequently sampling methodology, would require standardisation of the data before spatial CPUE and

length frequencies could be fully utilised, but noted the outcomes of the discussion in WG-EMM-12 (SC-CAMLR-XXXI, Annex 6, paragraphs 2.38 to 2.40) in which the effect of vessel in that analysis on the length of krill caught was relatively minor compared to the spatial and temporal effects of the fishing strategy.

Observer sampling

2.24 As an aid to progressing future discussions, the Working Group requested that the Secretariat provide to WG-EMM in 2014 an analysis of the amount of data that has been submitted for each of the forms in the krill observer logbooks in order to allow review of the data availability, and as a basis for a review for the continued utility of the different data collection strategies.

2.25 The Working Group recalled that it is the responsibility of the vessel to report fish by-catch, and that of the observer to provide quantitative samples of the species composition. The Working Group reiterated that the rationale for the observer fish by-catch sampling was to obtain a quantified estimate of the fish by-catch through a structured sampling scheme (SC-CAMLR-XXXI, Annex 6, paragraphs 2.42 and 2.43). Other fish by-catch that is not recorded as part of the observer sampling process should be reported by the vessel as part of the C1 reporting requirement.

2.26 A draft identification guide for fish by-catch in the krill fishery (WG-EMM-13/07) was designed to assist observers in the identification of the most important fish by-catch taxa as requested by WG-EMM-12 (SC-CAMLR-XXXI, Annex 6, paragraph 2.44). The Working Group agreed that this guide provided a useful resource and noted the request from the Secretariat for Members to provide identification material (including photographs) of frequently reported taxa. Where possible, observers should identify by-catch to species level but, recognising that in some cases this was a specialist task, identification to the family level may be more appropriate.

2.27 The Working Group discussed the data collected by observers noting that some observers did not report fish by-catch while some fish by-catch reports included invertebrate by-catch. The Working Group requested those Members with vessels not providing fish by-catch to investigate the reasons why this is not occurring. It also asked those Members collecting information on invertebrate by-catch to provide a paper describing the reasons for the work, the protocol and results in order to allow WG-EMM to consider the desirability of expanding this aspect of observer data collection.

2.28 It was noted that length data on both finfish and krill were collected by observers but that the current krill observer logbooks required the measurement of krill to be recorded to the nearest mm below and finfish to the nearest cm below. Given that the majority of the fish by-catch is <5 cm in length, the Working Group requested that the K10(ii) form be revised to require fish lengths to be recorded to the nearest mm below.

2.29 WG-EMM agreed that it could be potentially useful to collect additional information on fishing behaviour, such as the reason for changing local fishing grounds (e.g. ice conditions and salp concentration), in addition to the information recorded on form K8 which is for large-scale movements across areas and subdivisions. Information on vessel movements

among fishing grounds could be linked to the analysis of VMS described in paragraph 2.86(ii). Such information would be linked to the work of SG-ASAM which may ask for additional information to be collected dependent on its requirements. Dr Kawaguchi, as Convener of WG-EMM, undertook to coordinate this.

2.30 The Secretariat is developing a standard algorithm for reporting on data quality from the observer scheme logbook forms (WG-SAM-13/40). As part of this process, the Secretariat had requested that, if observers were to add additional rows or columns to logbook forms, these should be added at the right-hand side or bottom of the form and not in the middle of the form.

Krill biology, ecology and management

Krill distribution and abundance

2.31 WG-EMM-13/40 presented preliminary results from the first cruise in the five-year winter oceanographic and biological sampling program of the US AMLR Program. Acoustic estimates of Antarctic krill density were obtained for ice-free areas only and were extremely low (0.79 g m^{-2} using the CCAMLR-approved method). Net sampling revealed that ice krill (*Euphausia crystallorophias*) was found only within the ice-covered areas, while Antarctic krill (*E. superba*) and bigeye krill (*Thysanoessa macrura*) were found in both ice-covered and ice-free areas but were more abundant in ice-covered waters. The length-frequency distribution of *E. superba* was similar in both ice-covered and ice-free regions with a modal length of 22 mm. The energy density of Antarctic krill and *T. macrura* was greater in winter than in summer.

2.32 The Working Group discussed whether the depth distribution of the large krill would change between winter and summer and agreed it would be appropriate to sample deeper than the 170 m maximum net depth used in WG-EMM-13/40.

2.33 WG-EMM-13/24 presented results from a survey of Antarctic krill populations in the outflow regions of the northwestern Weddell Sea in January–March 2013. Antarctic krill densities estimated from net samples were found to be highest in the western Peninsula region and lower in ice-covered Weddell Sea waters. The overall krill density was below the long-term average for the area and the stock was dominated by two- and three-year-old krill (mode 35 mm). The largest krill were found in the deep water north of the South Shetland Islands, however, such krill were low in abundance and spawning appeared to be late and poor, likely leading to very poor survival of the resulting krill larvae.

2.34 The Working Group noted that these two surveys overlapped in areal coverage and therefore provided an opportunity to compare winter and summer conditions which was very valuable. Thus, for instance, the dominant winter mode of 22 mm krill had grown to form the dominant mode of 35 mm krill observed in the summer. In addition, there was a striking scarcity of large krill found in both surveys.

2.35 The Working Group emphasised the importance of undertaking winter surveys and particularly welcomed the development of a winter program in this area, especially now that

the commercial fishery had moved to a winter-focused operation. Such surveys also provided opportunities for further collaboration, and the Working Group welcomed and encouraged comparisons with winter and summer surveys.

2.36 It was noted that, while the krill densities estimated from these research surveys appeared to be low, the catch in the commercial fishery was one of the highest taken in this subarea. In summer 2013, commercial fishing vessels operated close to the German research vessel sampling in the Bransfield Strait.

2.37 The Working Group noted that there was a large degree of similarity in the krill length-frequency distribution derived from the CCAMLR Observer measurements and the research vessel for this period, and that this may have positive implications for surveys conducted by fishing vessels. The Working Group agreed that, while such a concordance suggested that the size selectivity of the fishing vessels in this comparison was similar to that of the research vessel, it did not imply that all fishing vessels have the same net selectivity. The Working Group also recalled the analysis from last year (paragraph 2.23) where vessel effect had a very small influence on variation in the length-frequency distributions from krill fishery observer data.

2.38 The Working Group noted that WG-EMM-13/40 reported problems undertaking quantifiable ship-board acoustic measurements in the ice-covered areas. Sampling in ice-covered areas is technically challenging, requiring the development of techniques often different from those used in ice-free areas. The Working Group noted that new technologies, such as remote and autonomous vehicles, drop-cameras etc., were being developed in a variety of fora both inside and outside CCAMLR and it was important to be able to make use of, and assess, these different technologies.

Multi-year abundance analyses

2.39 The interannual variability in abundance and biomass of krill using the 15-year time series of acoustic observations undertaken in the Western Core Box survey area at South Georgia was presented in WG-EMM-13/14. The krill identification and biomass estimation using the CCAMLR-approved method produced maximum densities in 500 m sampling intervals greater than 10 000 g m^{-2}. The overall mean krill density determined each year was very sensitive to the number and density of the densest krill swarms detected. Years of moderate to high overall krill density (>30 g m^{-2}) were interspersed with years (1999–2000, 2004, 2009–2010) of low density (<30 g m^{-2}).

2.40 The Working Group noted that the interannual pattern of variation in median values of krill density presented in WG-EMM-13/14 was different from the pattern of variation in mean krill density. The Working Group suggested that the differences in interannual variation between the mean and median krill density, and the implications for understanding predator response indices, should be evaluated.

2.41 The Working Group noted that the analysis in WG-EMM-13/14 was based on a spatial scale of 500 m and that this was likely to be a key spatial scale at which many of the krill predators would operate. Therefore, the presentation of acoustic estimates at this scale was to

be encouraged in order to develop a better understanding of the spatial and temporal variability of krill swarms and aggregations at scales relevant to foraging predators.

2.42 The Working Group also noted that the underlying patterns of krill swarm aggregation dynamics were also extremely relevant to the understanding of how fishery indices (such as CPUE) may be used to characterise krill biomass distributions.

Length-frequency distributions to determine growth and recruitment

2.43 WG-EMM-13/39 described interannual and spatial variability in estimates of growth derived from length-frequency distributions of the omnivorous euphausiid *T. macrura*. Two surveys (conducted one month apart) per year were undertaken by the US AMLR Program from 1995 to 2011. Here, growth is estimated for four years with very different temperature and primary production characteristics; in each cruise, stations were grouped into warmer Antarctic Circumpolar Current (ACC) and colder Weddell Sea categories. Growth rates were higher in the ACC water than in Weddell Sea water in all four years, showing a strong correlation with temperature, but no correlation with chlorophyll-*a* concentration.

2.44 WG-EMM-13/P01 presented a general method for estimating a growth model from length-frequency samples collected from a single population on two separate dates. This method is then applied to the 19-year krill length-frequency data series of the US AMLR Program. These growth estimates align closely with existing growth rates for Antarctic krill but the new estimate rates show high between-year variation in annual growth. These growth rate variations correlated with chlorophyll-*a* concentration but large amounts of variation of growth is unexplained by environmental correlates.

2.45 WG-EMM-13/23 described a sensitivity analysis using a simple individual-based model of krill population dynamics to investigate length-based recruitment indices and their potential use with the krill length-frequency data collected from the krill fishery. The model tested the effect of plausible ranges of growth, mortality and recruitment rates on length-based recruitment indices. The results of the sensitivity analysis indicated that all of the indices of annual recruitment tested were at least as sensitive to changing recruitment as they were to mortality and/or growth. Furthermore, since the population size structure at a given time was the result of a mixture of several annual cohorts, using such indices to quantify the intensity of a given recruitment event would need to take into account the magnitude of previous recruitment events.

2.46 The Working Group recognised that there was a large degree of similarity between the results and, in particular, the common assumptions underlying estimates of growth derived from length-frequency distributions. It was emphasised that growth, mortality, recruitment and advection will all influence the shape of the length-frequency distribution and it is therefore important to understand such interactions when deriving population estimates of growth or recruitment.

2.47 The Working Group noted that the range of the environmental variables over which relationships with growth were investigated could have a major effect on the relationships observed. Thus, for some studies, the temperature range observed was relatively small

compared to the total range that the species may encounter, while simple measures of chlorophyll-*a* concentration take no account of the nutritional value of different types of phytoplankton (such as diatoms and dinoflagellates).

Net selectivity

2.48 WG-EMM-13/34 described the use of a model-based method to evaluate selection of Antarctic krill in towed fishing gear. FISHSELECT has been developed as an alternative to expensive fishing experiments and has previously been used in investigations into net selectivity for various species of finfish and the crustacean *Nephrops norvegica*. It uses a combination of measurements of animal morphology and the shapes of the relevant mesh types to predict the size selectivity of the net. The paper described the morphological cross-sections derived for Antarctic krill and the comparison of model-derived predictions of net selectivity against selectivity trials on board the Norwegian trawler *Saga Sea*.

2.49 The Working Group welcomed this work and agreed that such an approach could have great utility in assessing selectivity of the different fishing gears used to sample krill. However, the Working Group also agreed that the selectivity of the mesh in a net was only a small component of the total selectivity of the fishing gear, which would depend on a range of factors that include the overall net design, the conditions under which the net is fishing, and the amount of catch in the codend of the net.

2.50 The Working Group strongly encouraged further development of work to determine total net selectivity. The Working Group further noted that, while this paper dealt with net selectivity, it could also provide information on mortality of krill passing through the net, and further investigations on the level of escape mortality should be encouraged.

2.51 The Working Group noted that selectivity is inherent not only in all net data (both commercial trawls and research nets) but also in length-frequency data obtained from sampling predator diets. It was agreed that it would be very valuable to be able to use different sources of length-frequency data to determine spatial and temporal changes in krill population structure. Further work on this topic, including any necessary standardisation techniques to take account of different sampling strategies, was strongly encouraged.

Climatic variability and future changes in habitat

2.52 WG-EMM-13/20 described the potential future climate change effects on the habitat of Antarctic krill in the Atlantic and Antarctic Peninsula sectors of the Southern Ocean (0°–90°W). Climate model projections for warming in this sector suggest further widespread warming of 0.27° to 1.08°C over the next century. A statistical model linking Antarctic krill growth to temperature and chlorophyll-*a* to assess the influence of projected warming on habitat quality suggests that growth in the region of the ACC will be particularly vulnerable to warming, while growth in the region to the south of the ACC is relatively insensitive to warming. The direct effects of warming could reduce the area of growth habitat by up to 20%, while reduction of growth habitat within the range of predators, such as fur seals foraging from South Georgia, could be up to 50%.

2.53 The Working Group welcomed this analysis and noted that this paper, involving collaboration with climate scientists, was the first to be presented to the Working Group that demonstrated how results from the Intergovernmental Panel on Climate Change (IPCC) assessments can be utilised to provide analyses of direct relevance to CCAMLR.

2.54 The Working Group further agreed that the likely timescale and magnitude of these potential changes indicated in WG-EMM-13/20 could confound our ability to detect ecosystem changes due to fishing. It was therefore essential that feedback management strategies be able to take this duality into account so that attribution of the causes of change could be achieved as far as possible.

2.55 While the paper dealt with potential changes of future climate warming, the Working Group noted that warming had already been occurring in the Antarctic Peninsula region, and therefore it might be possible to utilise the changes that had already occurred to validate predictions for this current time period. For instance, it was noted that the current predicted Antarctic krill growth rates (WG-EMM-13/20, Figure 2) in the Marguerite Bay region are high; this could be validated against current measured growth rates in this region.

Analysis of krill CPUE

2.56 WG-EMM-13/25 provided a development of the analyses presented in WG-EMM-12/50, examining the relationship between krill fishery standardised CPUE and an index of environmental variability (the Antarctic oscillation (AAO) index) for the period 1986 to 2011. The analysis had shown that over these 25 years the timing of the fishery has moved from a spring/summer focus to an autumn/winter focus. The most significant switching of the fishery regime had occurred in the last six years (2006–2011), when the fishery in Area 48 and its Subareas 48.1, 48.2 and 48.3 had moved to a 'high CPUE' state; this period coincided with both major changes in fishing technology and a period with the highest positive values for the AAO index. An analysis of CPUE dynamics from fishery fleets using traditional trawling with many years' experience, showed a significant increase in CPUE in the period from 2006 to 2011 and these conventional trawls had CPUE significantly higher than vessels using continuous fishing methods. The authors concluded that it was ongoing climate changes influencing the space–time distribution of krill, rather than the fishing technology, that was responsible for the changes in CPUE observed in this study.

2.57 WG-EMM-13/32 analysed the dynamics of the krill fishery in Subarea 48.1 in relation to environmental variability, emphasising the importance of this subarea in the current krill fishery, with over half the total catch in the last three years being taken in this subarea. The paper presented the dynamics of the AAO index in relation to the variability of environmental parameters (air temperature, atmospheric transport intensity and ice situation) in Subarea 48.1. The CPUE dynamics observed in Subarea 48.1 are considered consistent with climatic changes of these environmental parameters. Recent environmental warming has led to reductions in winter sea-ice around the Antarctic Peninsula, thus facilitating the switch from spring/summer to winter fishing in this area.

2.58 The Working Group welcomed this reanalysis in WG-EMM-13/25 and noted that understanding the operation of the present day fishery and the factors determining both its evolving spatial and temporal distribution is very important in determining management

strategies. It was noted that while ongoing climatic changes may have caused the changes in the spatial–temporal patterns of krill distribution which is reflected in the observed changes of the fishery strategy, it is also clear that the krill fishery has become more spatially concentrated as well, and that this could also account for the increased fishery CPUE. The effect of concentrating fishing in areas with high density would need to be analysed to distinguish any confounding with possible environmental effects.

2.59 The Working Group noted that there are a large number of variables affecting CPUE and that these would likely be different from those considered in early analyses of fishery CPUE (Butterworth, 1988; Mangel, 1988; SC-CAMLR-VIII, Annex 4). Thus, for example, fishing strategy is linked with products being derived from catch, with status of processing and with quality of catch as well as spatial distribution of krill, and so is likely to impact CPUE. The Working Group therefore agreed that an up-to-date consolidated summary of the underlying variables affecting CPUE and the overall utility of these measures would be valuable. The Working Group agreed that understanding how the fishery operates is a priority and encouraged further analyses of fishery operations and the factors determining its strategy and efficiency.

2.60 The Working Group welcomed the increased submission of papers dealing with krill biology and ecology and encouraged further submissions on all topics of biology and ecology that would be necessary to underpin our knowledge of how the Southern Ocean ecosystem operates in a variable and changing environment.

2.61 The Working Group made a general observation that, when analyses of data are presented to the Working Group, model descriptions, residual diagnostic plots and standard statistical outputs, such as the probability level associated with model parameters, should be provided to allow the Working Group to review alternative hypotheses.

Issues for the future

Feedback management strategy

2.62 The Working Group noted several general points relevant to the development of a feedback management strategy and advised that these points be communicated more broadly within CCAMLR so that understanding of feedback management might be improved, in particular that:

(i) advice relevant to feedback management will include advice on the overall catch limit for the krill fishery and on the spatial distribution of the catch limit

(ii) while the work plan to develop a feedback management strategy has been noted (CCAMLR-XXX, paragraph 4.17), general guidance on desirable elements of a feedback management strategy is not available

(iii) CEMP and other observations can provide important data for formulating advice on fishery catch limits and the spatial distribution of these limits as they relate to the ecosystem effects of fishing

(iv) decision rules on how to respond to indicators from the CEMP or other observations would help specify what measures need to be taken to achieve the objectives in Article II, and these rules might include what types of data need to be collected if the value of an indicator crosses some threshold (e.g. if an indicator falls below some threshold, a krill survey might be required)

(v) indicators that reflect processes at different time and space scales might be used in different decision rules to adjust fishing over a range of time and space scales. For example, regional estimates of predator abundance or recruitment and trends in krill biomass may be used to establish an overall catch limit and spatial distribution of that catch limit for a period of several years, whereas adjusting the spatial distribution of that catch limit over shorter time periods might occur in response to indicators such as predator condition or estimates of standing krill biomass collected just prior to a fishing season (sometimes known as leading indicators). Indicators might be composite indices that integrate changes in multiple observation series.

2.63 The Working Group advised the Scientific Committee that its plan to develop a feedback management strategy by 2014 (SC-CAMLR-XXX, Annex 4, paragraphs 2.155 and 2.157) no longer seems feasible. WG-EMM-13/04 summarised the reasons why this is the case. Although WG-EMM has made concerted efforts to advance the development of a feedback management strategy, experience since 2011 has demonstrated that several factors have made it difficult for all Members to develop a common understanding. For example:

(i) communication among Members on issues relevant to feedback management has largely been limited to the regular meetings of WG-EMM

(ii) the regular meetings of WG-EMM and WG-SAM have full agendas, and there is insufficient time to work on feedback management issues at these meetings

(iii) the different research groups working to develop candidate feedback management strategies have emphasised work that would mature over different time frames and is focused on different spatial scales. Thus, discussion within WG-EMM has been confusing, and it has been difficult to envision how some management procedures might be implemented in a practical sense

(iv) the work to advance feedback management is highly technical, and WG-EMM needs more time to evaluate and understand several details

(v) it has proven difficult to follow the six steps agreed in 2011 (SC-CAMLR-XXX, Annex 4, paragraphs 2.155 and 2.157) sequentially, and improved understanding can likely be developed by considering issues more holistically.

2.64 Despite the difficulties noted in the preceding paragraph, the Working Group agreed that staged development of a feedback management strategy remains feasible if:

(i) in the short term, work focuses on the use of existing data and monitoring efforts (e.g. existing CEMP data and results from acoustic surveys by fishing vessels)

(ii) in the medium term, work progresses to extending data collection and monitoring efforts (e.g. establishing new CEMP sites, using remotely sensed

imagery and increasing acoustic survey effort on both fishing vessels and research vessels) while also investing in the tailoring of models to available data and the development of operational ecosystem models

(iii) in the long term, ecosystem models are used to guide the establishment of a 'final' feedback management strategy.

2.65 The Working Group noted its previous discussion on the staged development and implementation of a feedback management strategy (SC-CAMLR-XXX, Annex 4, paragraph 2.179 and Figure 4) and recommended that the four stages in the development of the fishery would be:

(i) Stage 1 – continuation of the current trigger level and its spatial distribution among subareas (CM 51-07 is to be reviewed in 2014).

(ii) Stage 2 – an increase from the trigger level to a higher interim catch limit and/or changes in the spatial distribution of catches that are adjusted based on decision rules that take account of results from the existing CEMP and other observation series such as absolute (or relative) biomass (or density) estimates made from krill surveys conducted by fishing vessels (it is expected that advice on this stage can be provided to the Scientific Committee in 2015 if WG-EMM, WG-SAM and/or SG-ASAM have sufficient time to evaluate methods as per SC-CAMLR-XXVIII, Annex 6, paragraphs 5.11 to 5.17).

(iii) Stage 3 – a further increase to a higher interim catch limit and/or changes in the spatial distribution of catches that are adjusted based on decision rules that take account of results from an 'enhanced' CEMP and other observation series (it is expected that this stage can be developed in the medium term).

(iv) Stage 4 – a fully developed feedback management strategy that is based on forecasts from ecosystem models may involve structured fishing and/or reference areas (SC-CAMLR-XXX, Annex 4, paragraphs 2.167 to 2.174 and 2.180) and includes catches up to the precautionary catch limit and/or changes in the spatial distribution of catches that are adjusted based on decision rules that take account of results from an enhanced CEMP and other observation series (it is expected that this stage will be developed over the long term).

2.66 In all stages, the spatial distribution of catches might be among subareas, individual or groups of SSMUs, or other areas that are defined by considering the spatial scales over which the fishery operates and over which CEMP data and other observations integrate.

2.67 The Working Group agreed that, during the implementation of each stage, it would work to continue the research and data collection that would be needed to advance to the next stage. It was also agreed that advancement from one stage to the next should not occur on a fixed schedule. Rather, advancement towards stage 4 should be determined by the availability and relevance of scientific information and tools so that progress to implement a fully developed feedback management strategy occurs at a pace that is determined by scientific advancement.

2.68 With respect to stage 1, the Working Group considered whether, on the basis of current uncertainties, the trigger level and its spatial subdivision are still regarded as being suitable to achieve the objectives of the Convention without further controls on the fishery. Implementation of the trigger level and its spatial distribution in CMs 51-01 and 51-07 are predicated on three conditions:

(i) catches up to the trigger level will not compromise the ability of the Commission to achieve the objectives of the Convention

(ii) the permitted spatial pattern of fishery catches will not compromise the ability of the Commission to achieve the objectives of the Convention

(iii) long-term ecosystem change will not invalidate the first two conditions during the period over which a feedback management strategy is developed.

2.69 The Working Group noted that the Commission will expect advice on CM 51-07 during 2014 and suggested a work plan, to be undertaken by interested Members during the 2013/14 intersessional period, to evaluate the conditions listed in the preceding paragraph and on which stage 1 is predicated:

(i) review the status and trends of the krill population and the spatial distribution of the krill stock relative to predators

(ii) estimate how much krill is needed to support predators in each subarea and to review predator foraging behaviours to characterise the link between successful feeding and the distribution and aggregation density of krill swarms, both the per-capita krill requirements of predators and how predator performance may be impacted when those requirements cannot be met, and to review the abundance of predators in each subarea

(iii) review the spatial distribution of fishing effort and the behaviour of the fishery to describe situations in which the distribution of fishing effort may change the availability of krill to predators

(iv) consider uncertainties in each of the above work elements to determine if the trigger level and its spatial distribution among subareas will meet the objectives of the Convention with a high level of confidence.

2.70 Existing datasets may be useful for evaluating these work elements. For example, the US AMLR time series around the South Shetland Islands and British Antarctic Survey (BAS) time series at South Georgia may be used to address element (ii), and catch and effort data from the fishery may be used to address elements (i) and (iii). Dr Watters indicated his willingness to share the US AMLR time series with Members interested in advancing these work elements. Dr S. Kasatkina (Russia) indicated that she will undertake an analysis of temporal and spatial variation in CPUE by the krill fishery in relation to variation in the US AMLR acoustic data. Dr Kasatkina agreed to provide a paper summarising this analysis to WG-EMM in 2014.

2.71 The Working Group noted that, with reference to stage 1, it would be important to consider whether the current management approach for the krill fishery (where fishing up to the subarea catch limits established in CMs 51-01 and 51-07 is spatially unconstrained)

impacts existing CEMP sites. Within each subarea, fishing activity can be highly concentrated in just a few fine-scale rectangles (paragraph 2.4) and, although the performance of predators monitored at CEMP sites integrates over processes at several spatial scales (e.g. at 10s to 100s km^2 during the breeding season and 100s to 1 000s km^2 or more during winter), some Members considered that such concentration of fishing activity might have adverse scientific consequences in stage 1. These Members noted that the baseline variation observed at current CEMP sites is considered to reflect natural variation and, after the establishment of a feedback management strategy, increased variation in CEMP parameters beyond that baseline might be used within a decision rule to adjust a catch limit or the spatial distribution of fishing.

2.72 The Working Group also noted that in recent years fishing effort in Subarea 48.1 has increased along the western coast of the Antarctic Peninsula. If the spatial distribution of fishing effort expands, either within stage 1 or stage 2, it may become difficult to identify reference areas for use in stage 4. For example, some Members considered the area around Cierva Cove to be a good candidate for establishing a reference area (WG-EMM-13/27), but fishing activity in this area during the 2012/13 fishing season may make this view questionable (paragraph 2.97).

2.73 Some participants indicated an interest to progress work on stage 2 immediately, simultaneous with evaluation of the trigger level and its spatial distribution. There is some urgency in proceeding to develop stage 2 because the krill fishery continues to expand, with increased numbers of vessels participating in the fishery (paragraph 2.11) and the increased ability of these vessels to attain subarea catch limits before the nominal end of the fishing season on 30 November each year (paragraph 2.6).

2.74 Evaluation of stage 1 may identify practical approaches, based on existing capabilities, for use in developing stage 2, such as:

(i) increasing the frequency of small-scale or larger-scale krill surveys, using research vessels, vessels of opportunity (e.g. as described in WG-EMM-13/17 Rev. 1) and specified fishery operations (e.g. surveys by fishing vessels early and late in the season as described in WG-EMM-13/15)

(ii) expanding the number of CEMP sites or sites where predator monitoring compatible with CEMP is conducted

(iii) assessing changes in the environment that could impact on krill, predators or fishing vessels (e.g. by participating in the work envisioned in WG-EMM-13/13)

(iv) develop data integration models considering time and space variations in the data.

2.75 Work to progress stage 2 could be done by establishing subarea-based intersessional task groups specifically tasked to propose, in detail, a feedback management strategy based on existing data sources available in each subarea. The work of these intersessional groups could be facilitated through a web-based communication forum managed by the Secretariat (groups.ccamlr.org).

2.76 The Working Group agreed to establish two intersessional task groups: one to advance the development of a feedback management strategy in Subarea 48.1 and another to advance

such development in Subarea 48.2. Drs Watters and Hinke agreed to co-convene the task group for Subarea 48.1, and Dr Trathan and Lic. M. Santos (Argentina) agreed to co-convene the task group for Subarea 48.2. Both task groups met briefly during WG-EMM to plan a future course of work.

2.77 The task group for Subarea 48.1 first discussed the work it intends to conduct with respect to stage 1. All Members that participate in this task group will review the work recently published by Watters et al. (2013) with the objective of determining whether the work presented therein is sufficient to advise the Scientific Committee and the Commission on CM 51-07 in 2014. The task group agreed to complete this review by 1 January 2014 and identify whether additional work is required to advise on CM 51-07. If additional work is required, the task group will specify what that work is and identify one or more individuals to complete the work in time to be reviewed by WG-EMM in 2014.

2.78 The task group for Subarea 48.1 then discussed work planned to progress the development of a feedback management strategy in stage 2. It was agreed that work in the task group will proceed on two parallel themes: a predator theme, and a krill and fishery theme. Work on the predator theme will be coordinated by Dr Hinke, and work on the krill and fishery theme will be coordinated by Dr O. Godø (Norway). Members of the task group will work within the theme with which they have the most expertise or interest, noting that:

(i) work on both themes will proceed to characterise important spatial distributions (i.e. predator foraging distributions, and the distributions of fishing effort and of krill within key fishing grounds). These parallel efforts will be synthesised to provide an improved characterisation of temporal and spatial overlap between krill predators and the fishery

(ii) this synthesis will be viewed within the context of an analysis, to be coordinated by the Secretariat, of how sea-ice affects the spatial distribution of fishing effort

(iii) both themes will work to propose candidate decision rules for adjusting the catch limit in Subarea 48.1 (or for adjusting the proportion of a larger regional catch limit for Area 48 that is taken in Subarea 48.1) on the basis of indicators (i.e. from CEMP monitoring activities and from the fishery or research surveys of krill) that are currently available and expected to be available in the near future. These decision rules may involve adjustments to the spatial distribution of catches within Subarea 48.1

(iv) after important spatial distributions have been characterised and candidate decision rules have been developed, the task group will formulate a detailed proposal for a feedback management strategy in Subarea 48.1. This proposal will be submitted to WG-EMM in 2015.

2.79 The task group for Subarea 48.2 discussed the available data collected at the South Orkney Islands. Currently there are two CEMP sites where penguins are monitored. At Signy Island, three species are monitored with five indices reported annually for Adélie penguins, five for chinstrap penguins, and three for gentoo penguins. At Laurie Island, two species are monitored with six indices reported annually for both Adélie and chinstrap penguins. The task group proposed that Argentina and the UK analyse these data collectively to determine how penguin populations are changing across the South Orkney Islands archipelago. Specific

comparisons to be made across these two CEMP sites will include a comparison of metrics describing penguin diets with information from the fishery. For example, it would be valuable to compare length frequencies of krill in penguin diets with those in commercial catches. It would also be valuable to examine diet compositions and relate these to environmental signals. The task group will also examine population trends in relation to the annual level of fishery extraction and annual environmental indices from both local weather stations and from remote sensing data. The task group will consider compiling a 'state of the ecosystem' report for Subarea 48.2 which could be used to consider the conditions of stage 1. The task group also suggested that it may be possible to use the model described in Watters et al. (2013) to further examine the conditions in stage 1.

2.80 The task group for Subarea 48.2 recognised that there are few data describing the prey field available to penguins, as annual acoustic surveys of krill have been carried out only recently. This means that few observations can currently be used to relate the prey available to penguins to the breeding performances of these birds. This will change in the future as Norway has made a commitment to maintain its annual krill survey into the future (SC-CAMLR-XXXI, paragraph 3.37). At present, however, the lack of prey field information means it could be very difficult to relate penguin responses to the annual harvest of the fishery. Historical data from acoustic surveys around the South Orkney Islands are available from the US AMLR Program (two surveys) and from the CCAMLR-2000 Survey. It was recognised that new information on krill distribution and biomass will be needed to move to stage 2. Information from a recently deployed mooring between Coronation Island and the Inaccessible Islands will provide information on the prey field, however, such data will only begin to become available later this year.

2.81 The task group for Subarea 48.2 also recognised that penguin foraging trip data could provide valuable information about the responses of predators to variations in krill availability, however, these data are expensive to collect and analyse. Although support for such studies would potentially be difficult to maintain over the long term, valuable information to support stage 2 could potentially be collected in only a few years (e.g. see discussion regarding the frequency of tracking studies in WG-EMM-13/08). The deployment of static cameras, use of remote sensing to estimate predator abundance and some other new techniques could also potentially help broaden the data available to WG-EMM for relating predator responses to the annual Norwegian acoustic biomass estimates.

2.82 The Working Group requested that all Members engage in the work of the intersessional task groups to evaluate stage 1 during 2014 and develop candidate feedback management strategies for stage 2 during 2014 and 2015. If possible, Members participating in the work of the task groups should submit their analysis methods and results for review by WG-SAM before consideration by WG-EMM. Given recent advancements in understanding krill and the Antarctic marine ecosystem (e.g. WG-EMM-13/21), Members were advised to consider results from papers published outside of the usual CCAMLR literature when conducting their work.

2.83 Discussions to coordinate work across the task groups for Subareas 48.1 and 48.2 will occur at the regular meetings of WG-EMM. These discussions will aim to ensure that the

separate approaches being developed by each task group can be harmonised so that the approach taken in Subarea 48.1 does not have a negative impact on the performance of the approach taken in Subarea 48.2 and vice versa.

2.84 The Working Group agreed that progressing work within the intersessional task groups for Subareas 48.1 and 48.2 would require a concerted effort and agreed there was insufficient capacity to simultaneously support task groups for Subareas 48.3 and 48.4. Task groups for these subareas will be formed when work for Subareas 48.1 and 48.2 has progressed further. It was noted that a workshop to study linkages across Area 48, similar to the Area 48 Workshop held in 1998, would be useful to consider how stage 2 feedback management strategies in Subareas 48.1 and 48.2 could be linked to such approaches in Subareas 48.3 and 48.4.

2.85 While the Working Group noted the priority region for developing a feedback management strategy was Area 48, it welcomed the development of procedures for other regions if that were possible. Dr C. Southwell (Australia) indicated that it may be possible for some Members to develop a feedback management strategy for Divisions 58.4.1 and 58.4.2 in 2014 and 2015.

2.86 To move beyond stage 2, several specific studies and field projects would be expected to provide important information. A non-exhaustive list of these studies and projects includes:

(i) quantifying the krill densities and/or biomass that are required to support both the fishery and krill predators

(ii) understanding fleet dynamics and how the fishery determines where it will operate using haul-by-haul, VMS and high-resolution sea-ice data and by talking directly with fishery operators

(iii) expanding acoustics estimation of krill density and distribution using research vessels and fishing vessels (which have the potential to survey large areas) and the use of such estimates in stock assessment models

(iv) establishing and maintaining periodic regional predator censuses (and estimates of total predator demand for krill)

(v) determining where new CEMP sites should, if possible, be established and what types of monitoring activities should be undertaken at those sites, noting that automated cameras can substantially expand monitoring activities at existing and new CEMP sites

(vi) methods for determining the flux of krill past CEMP sites.

2.87 The Working Group noted that specifying the location for new CEMP sites is a complex issue that involves practical, as well as scientific, considerations. At a minimum, to be practical, CEMP sites should be safely accessible and, from a scientific perspective, it would be useful if the temporal period or spatial area over which a new CEMP site might integrate (e.g. the summer and winter foraging areas of predators monitored at the site) fills a gap in coverage that is not currently provided by an existing CEMP site.

2.88 Several other issues were considered with respect to the establishment of new CEMP sites and reference areas during stage 4:

(i) New CEMP sites that provide monitoring of predator performance in reference areas could be useful for observing natural variability, trends and estimating rates of change attributable to climate change. When historical data are not available from a location, it may take several years of monitoring to observe these trends and estimate such rates at new CEMP sites. In general, the power to detect changes will increase with increases in the time over which monitoring occurs, increases in the magnitude of change, increases in the number of replicate CEMP sites and reference areas and decreases in observation error.

(ii) The sizes of candidate reference areas need to be considered in the context of krill flux, with increased flux expected through smaller areas and decreased flux expected through larger areas.

(iii) The locations of candidate reference areas need to be sited sufficiently close to fished areas to be comparable but sufficiently far from fished areas so that they are not unduly impacted by fishing.

2.89 The Working Group also noted that in advancing from stage 2 to stage 3 it would be important to learn from mistakes made during the development of stage 2. It is important to be flexible so that experience in application of any feedback management strategy can be used to facilitate future improvements.

2.90 Advancement to stages 3 and 4 could benefit from broader collaboration with other groups. WG-EMM-13/12 and 13/36 list several opportunities for such collaboration. The ICED (Integrating Climate and Ecosystem Dynamics in the Southern Ocean) program is developing ecosystem models and facilitating field programs (e.g. the Southern Ocean Sentinel) that may be particularly useful for developing advice related to feedback management. The SOOS (Southern Ocean Observing System) also offers opportunities for further data collection in the field, and temporally and spatially extensive datasets are needed to validate forecasts from ecosystem models like those being developed through ICED. COMNAP (Council of Managers of National Antarctic Programs), SCAR (Scientific Committee on Antarctic Research) and the International Whaling Commission Scientific Committee can also provide various forms of support to WG-EMM's efforts towards developing a feedback management strategy.

2.91 The Working Group agreed that the greatest benefits can be derived from cooperation with programs and committees outside of the CCAMLR community if Members interested in WG-EMM's work to develop a feedback management strategy engage directly with these entities. Direct engagement can help ensure that work conducted by such programs and committees can progress in directions that answer questions and address issues of direct relevance to WG-EMM. There are many mechanisms to facilitate such engagement (e.g. joint workshops and formal observation at regular meetings) and the Working Group's discussion of these mechanisms and related issues is summarised in paragraphs 6.1 to 6.11.

2.92 The Working Group noted the need to investigate quantitative objectives for implementing Article II in the contexts of climate change and feedback management. WG-EMM-13/20 forecasted substantial changes in growth habitat for Antarctic krill under a

range of climate change scenarios. The Working Group noted that climate change effects may, under some scenarios, be so great that they dwarf any effects from fishing. Feedback management strategies developed elsewhere generally incorporate reference points specifying, e.g. the relative abundances of various taxa that the management approach aims to achieve or to avoid (Caddy and Mahon, 1995). There is a need to identify operational objectives that are consistent with the principles of conservation in Article II of the Convention and acknowledge forthcoming changes caused by climate. These operational objectives could be expressed as reference points.

CEMP and WG-EMM-STAPP

2.93 The Working Group considered the following papers relevant to CEMP and WG-EMM-STAPP: WG-EMM-13/06 that presented a summary by the Secretariat of CEMP data submitted in 2012/13; WG-EMM-13/27 that presented population abundance estimates of chinstrap and gentoo penguin colonies on the Danco Coast; WG-EMM-13/43 and 13/09 for Adélie penguin populations at Esperanza/Hope Bay and along the East Antarctic coastline; WG-EMM-13/11 that reviewed monitoring plans for the Adélie penguin; WG-EMM-13/26 that presented a proposal for the use of satellite imagery to monitor Adélie penguins; WG-EMM-13/08 and 13/18 that presented results and proposed synthesis tools for penguin tracking studies. In addition, Dr Southwell provided an update on recent intersessional work related to WG-EMM-STAPP and there was discussion regarding submission of monitoring data to the CEMP and the use of the CEMP fund.

2.94 The Working Group noted that six Members had submitted CEMP monitoring data covering 13 parameters for 13 sites from the 2012/13 breeding season. Coverage included data from five seabird species and Antarctic fur seals. WG-EMM-13/06 indicated that no data was submitted from Area 88 and the Working Group noted that there were numerous other CEMP sites for which no data have been submitted recently. The Working Group recognised that some CEMP sites have had little or no monitoring activity since their inception and noted that future monitoring in some areas might be unlikely given financial and logistical constraints. The Working Group welcomed news that data reporting from Area 88 may resume in the near future (paragraph 2.107).

2.95 The Working Group noted that updated observations of penguin population sizes in Hope Bay (WG-EMM-13/43) and Cierva Cove (WG-EMM-13/27) were of considerable interest to WG-EMM-STAPP and CEMP. In particular, the updated census of the large colony of Adélie penguins in Hope Bay suggested a population decline from 123 890 breeding pairs in 1985 to 102 899 in 2012. The Working Group agreed that the new census data provided important information relevant to the estimation of prey consumption, a longstanding goal for understanding trophic interactions in the krill-centric ecosystem. The Working Group noted that the ongoing work to collect diet composition data and monitor foraging ranges of Adélie penguins in Hope Bay may provide useful ecological data that differ from data derived from smaller colonies.

2.96 The Working Group requested that future updates from census work provide an estimate of observation uncertainty as well as reporting, where possible, on factors that influence accuracy. Such estimates of uncertainty assist interpretation of trends in the

population by enabling an assessment of whether population changes may arise from demographic (i.e. changes in survival or recruitment rates to the colony) or behavioural changes (i.e. deferred breeding under adverse environmental conditions).

2.97 WG-EMM-13/27 suggested that the penguin colonies monitored near Cierva Cove within ASPA No. 132 may provide useful references for comparisons with other colonies in more commonly fished areas. This suggestion was based on observations of historically low fishing activity in the immediate vicinity of the colonies. However, information from the krill fishery report (WG-EMM-13/37 Rev. 1) indicated that the fisheries had recently operated in the vicinity of Cierva Cove, which may require the determination of criteria for a reference site and their evaluation to see if the fisheries had impacted the site and whether it could be used as a reference site (paragraphs 2.71 and 2.72).

2.98 In general, the Working Group raised a number of issues that concerned the establishment of potential reference sites (i.e. areas with relatively low or no fishing effort). The Working Group noted that a reference site may require a krill biomass estimate as baseline information from which to judge whether fishing impacts were detectable. Furthermore, the changing spatial distribution of the fishery might make identifying reference sites difficult. Alternatively, an assessment of changes in the rate at which monitored parameters vary may allow an assessment of the effects of fishing. This approach could also control for changing environmental conditions if reference sites were subjected to the same patterns of environmental variation in fished areas. Additional discussions relevant to determining potential locations for new CEMP monitoring sites (i.e. areas where no monitoring is currently conducted) was considered during discussions about the development of a feedback management strategy (paragraphs 2.71 and 2.72).

2.99 The Working Group welcomed the updated census data of Adélie penguins in the East Antarctic. WG-EMM-13/09 provided an up-to-date estimate of 1.31 million breeding pairs for Divisions 58.4.1 and 58.4.2 as a major contribution to WG-EMM-STAPP. The new estimate is substantially higher than a previous estimate of 767 000 breeding pairs in 1993. This increase is attributed to the discovery of new colonies, more thorough treatment of uncertainty to adjust raw count data and true population increases. The Working Group noted that this new estimate benefited from the use of remote cameras and aerial surveys. Such methods enable an efficient expansion of effort and provide a clear example of the utility of alternative census methods.

2.100 The Working Group noted the initiatives summarised in WG-EMM-13/11 for new and continuing studies on penguin populations and associated population processes by the UK. Methodologies that will be used include digital aerial survey from manned and remote-controlled platforms, satellite remote sensing, automated individual recognition and weighing, and time-lapse camera and automated image analysis. The Working Group noted that the methods presented in WG-EMM-13/11 parallel initiatives of other programs and broadly present progress on expanding the existing monitoring capabilities of CEMP. The initiatives had the benefit of including monitoring of penguin response parameters in addition to population size, including survival, demography and phenology, which would lead to a greater understanding of underlying ecosystem processes.

2.101 WG-EMM-13/26 presented a proposal to develop a tool to integrate and assimilate data using a Dynamic Bayesian Network to assist CEMP in obtaining estimates of local, regional and continental population estimates for the Adélie penguin. The tool would

assimilate remote sensing data from satellite imagery with field census data from long-term monitoring networks such as CEMP sites and predictions from state–space population models to compute metrics of Adélie penguin abundance at any user-defined spatial or temporal scale. The paper has been submitted to WG-EMM as one of several potential stakeholders who may be interested in using the tool and to seek input into the design of a user interface. The Working Group noted that the results from the proposal could augment work that is done through both CEMP and WG-EMM-STAPP.

2.102 The Working Group agreed that validation of new methods and tools, such as those described in WG-EMM-13/11 and 13/26, was an important step toward ensuring efficient use of new monitoring methods. The Working Group also noted that feedback management strategies could be developed, such that methods and approaches could be modified in the future when alternate methods have been evaluated.

2.103 The Working Group thought that the Bayesian model presented in the WG-EMM-13/26 proposal would be better evaluated by WG-SAM and encouraged the authors to submit the proposal for that purpose in 2014. The Working Group noted that while there are benefits to engaging the broader scientific community for delivery of CCAMLR-relevant assessments and methods, there is a need to ensure that these approaches are consistent with CCAMLR's needs and can be maintained and kept active into the future.

2.104 The Working Group noted that, in an ecosystem monitoring context, the large-scale approach taken in WG-EMM-13/26 may complement the more detailed data collected on a wider range of parameters at CEMP sites. While the Working Group recognised that the approach had the potential to provide broad-scale monitoring on Adélie penguin population size, there may be particular uncertainties associated with such a broad approach and these may need to be evaluated and considered against an alternate approach of monitoring population size at fewer sites using more direct methods. The Working Group agreed that in considering how to take CEMP forward to a feedback management strategy, it is important to determine the appropriate parameters and sites required to represent change over spatial and temporal scales of relevance for CCAMLR.

2.105 In relation to other items of ongoing WG-EMM-STAPP work identified in SC-CAMLR-XXXI, Annex 6, paragraphs 2.141 to 2.145, Dr Trathan indicated that the work plan to analyse Antarctic fur seal population data from South Georgia was expected to be completed in 2014 or 2015.

2.106 WG-EMM-13/30 presented data on annual variation and long-term trends in the number of breeding Adélie penguins at colonies along the western Ross Sea coast from 1981 to 2012. There were different long-term trends between northern and southern metapopulations, and between colonies in the southern metapopulation. It noted that:

(i) colonies showed evidence of density-dependent population regulation between years

(ii) interannual variation in southern metapopulation colonies was synchronised between years, presumably responding to environmental variability

(iii) wide-spread breeding failure in the southern Ross Sea was considered to correspond with oceanographic disruption associated with the grounding of two large icebergs in the southwest Ross Sea from 2001 to 2005.

2.107 The Working Group welcomed the submission of these results of long-term monitoring and noted their potential importance to both CEMP and WG-EMM-STAPP. In the case of the penguin population size data, the Secretariat advised the Working Group that the early part of the time series had been submitted to CEMP (up until 2003) and that discussions are currently under way with New Zealand to facilitate the submission of more recent data, which were collected using Standard Method A3b, to CCAMLR as part of CEMP.

2.108 WG-EMM-13/31 examined how Adélie penguin chick size, mass and condition varied among breeding colonies of different sizes on Ross Island during a period of high environmental variability. The presence of two giant icebergs from 2001 to 2005 increased sea-ice concentrations while reducing adult foraging efficiency and provided a natural experiment to test the effects of environmental conditions and competition on chick size, mass and condition. The results showed that size, mass and condition of Adélie penguin chicks are greater during times when environmental conditions allow for more efficient parental foraging and when chicks are fed silverfish rather than krill. In addition, the paper showed that in some cases increased intraspecific competition for available prey in the vicinity of larger colonies may be a more important driver of chick size than abiotic factors, with chicks smaller and lighter at larger colonies.

2.109 The Working Group noted that WG-EMM-13/30 and 13/31 demonstrate the complex relationships between predator populations and their biotic and abiotic environment, and the difficulty in distinguishing between the relative impacts of biotic and abiotic drivers in this region.

Partitioning krill consumption estimates developed by WG-EMM-STAPP using foraging data

2.110 Estimating krill consumption in small spatial units such as small-scale management units (SSMUs) will require the development of predictive foraging-environment models to partition region-wide krill consumption estimates (SC-CAMLR-XXXI, Annex 6, paragraph 2.147). At the request of WG-EMM in 2011, Dr Trathan has been liaising with representatives from BirdLife International and the SCAR Expert Group on Birds and Marine Mammals to assess areas of common interest and expertise that may expedite this work (SC-CAMLR-XXXI, Annex 6, paragraph 2.149). Through this liaison, funding has been obtained to develop a penguin tracking database described in WG-EMM-13/18, which is the first step in this process. The proposed database is similar to a successful database built by BirdLife International for petrels and albatross to build links between data owners and their data, to provide tools to support data submission and standardisation as well as to foster further seabird conservation work. The database would allow spatial analyses to be undertaken that would help inform a variety of CCAMLR analyses on the spatial planning processes.

2.111 The Working Group noted that the penguin tracking database approach would need to be consistent with CCAMLR's objectives and Dr Trathan indicated that BirdLife International would welcome CCAMLR's involvement on the steering committee to ensure this was the case.

2.112 WG-EMM-13/08 provided a synopsis of recent Australian Antarctic Division (AAD) GPS and satellite telemetry data for three major Adélie penguin population areas in the East Antarctic. The data highlighted the differences in summer and winter foraging activities and the association of the penguins with sea-ice during the winter months. The data will be an important contribution to the development of species–environment–foraging models for understanding krill consumption estimates of Adélie penguins in Divisions 58.4.1 and 58.4.2 when combined with results of population abundance and distribution outlined in WG-EMM-13/09.

CEMP Fund

2.113 The Working Group noted that the deadline (1 June) for submission of proposals to use the CEMP Fund for 2013 had passed and that several steps were required to define an administrative process for use of the fund. The Working Group recalled that these steps were outlined in the 2012 report of the Scientific Committee, including prioritisation of possible projects (SC-CAMLR-XXXI, paragraph 11.17) and development of a strategic plan for use of the CEMP fund (SC-CAMLR-XXXI, paragraph 11.19).

2.114 In reference to SC-CAMLR-XXXI, paragraph 11.17, the Working Group discussed priorities for the three possible projects/concepts that include:

(i) a workshop to explore revision of CEMP data collection methods to integrate new technologies (TDRs, cameras and remote sensing) and improve accuracy of data collection

(ii) conducting data 'mining' activities relevant to CEMP

(iii) construction of remotely operating cameras for use at multiple sites within the CAMLR Convention Area.

2.115 Of the three options outlined in SC-CAMLR-XXXI, paragraph 11.17, there was general agreement among the Working Group that the third project be accorded a high priority because of the benefit of expanded spatial and temporal monitoring afforded by remotely operated camera systems in the near term. There was acknowledgement that the current krill fishery potentially operates at a different spatial scale than current CEMP monitoring, and that an understanding of scales relevant to predator monitoring would be necessary in order to provide input for the development of a feedback management strategy.

2.116 The Working Group discussed general priorities for the CEMP Fund, acknowledging that the fund should be used in a way consistent with a strategic plan to progress the development of a feedback management strategy. Camera observing systems, including unmanned aerial vehicles (UAV) and stationary units were raised as potential candidates for CEMP Fund proposals. In particular, the Working Group noted that a primary benefit of both types of observing systems was that they provide an opportunity to expand spatial and

temporal monitoring efforts with minimal human disturbance. Remote cameras require infrequent service and can remain in the field for many months to years. UAVs can provide a rapid means for full-colony census work and the experience of some Members with UAVs in the Antarctic suggests that there is minimal behavioural response of seabirds and seals to small UAVs at low elevations (30–60 m). The Working Group noted that ethical considerations for the use of UAVs in the field may become important as their use expands. The Working Group noted that an expansion of monitoring for CEMP with camera systems is compatible with the plan for a staged development for a feedback management strategy.

2.117 The Working Group also discussed whether the CEMP Fund could be used to help develop image analysis systems. There was general agreement that vertical (downward-facing) photos from aerial surveys and oblique angle photos from stationary cameras on the ground would require separate image analysis techniques. The Working Group noted that current analysis of photos from stationary camera systems to provide a host of CEMP-like data, including reproductive success, breeding phenology and possibly foraging trip duration and body condition data, could be done manually or with automated software. Work to develop automated methods for some of these parameters is under development.

2.118 The Working Group noted that some Members provide support for ongoing CEMP monitoring via national programs, but there has been less commitment to monitoring studies from some national programs because it is not clear how the CEMP data are used for management purposes. A better demonstration of tangible management outcomes that derive from CEMP data may provide general incentives for new, or continuation of, monitoring by those national programs. An alternative use of the CEMP Fund could be to provide support for analysis of data with the goal of producing management-relevant results.

2.119 The Working Group then discussed how the CEMP Fund might be managed (SC-CAMLR-XXXI, paragraph 11.19), with special attention to developing a strategic plan for CEMP (SC-CAMLR-XXXI, paragraph 11.19i). In particular, developing priority outcomes of CEMP would be important to ensure that future CEMP activity align with the staged development of a feedback management strategy. The Working Group agreed that its work plan to develop a feedback management strategy should inform how CEMP would be developed further. In this regard, the Working Group considered that the strategic plan for CEMP should mirror the staged development of a feedback management strategy (paragraph 2.65). The Working Group noted that, initially, monitoring at existing CEMP sites could be strengthened (e.g. by using automated cameras to estimate breeding phenology when researchers cannot arrive on site in time to do so themselves). Then, over the medium term, new CEMP sites could be established to fill gaps in the temporal and spatial coverage provided by existing sites. Finally, over the long term, CEMP could be further enhanced to support periodic predator censuses and estimates of predator demand at regional spatial scales.

2.120 The Working Group acknowledged that technological developments in monitoring and analysis should also be considered with respect to CEMP and encouraged interested Members to work intersessionally to initiate consideration of these issues by the Working Group in 2014. Such an intersessional group may wish to involve participants of outside groups (e.g. SOOS) to engage relevant expertise.

2.121 The Working Group considered a general plan to establish a CEMP Fund Management Group. The Working Group agreed that an interim task group be formed to coordinate with

the Secretariat and the CCAMLR community to develop the management group. The interim task group would work until the meeting of the Scientific Committee in October 2013 to:

(i) define an administrative process for the management group, including linkages to a draft strategic plan (paragraph 2.113)

(ii) begin a search for Members interested in serving in the management group

(iii) develop an application pro forma for proposals to access the CEMP Fund.

2.122 The Working Group noted that the management group would consist of a Junior Vice-Chair, a Senior Vice-Chair and a Convener. Annual appointments to each position, with advancement from Junior Vice-Chair to Senior Vice-Chair to Convener, may provide a model for the administrative process.

2.123 The Working Group welcomed the voluntary participation of Drs Godø and Constable as the interim task group to progress work towards establishing the management group.

CEMP data and CEMP site designation

2.124 The Secretariat described how the process for data submission and acknowledgement of receipt of CEMP data differs from the designation of a CEMP site requiring additional protection under CM 91-01. Designation under CM 91-01 was intended to provide additional protection to a site where CEMP data was collected in order to ensure that activities at that site did not compromise the ability to collect the CEMP data. It was further noted that where Members sought specific protections for land-based monitoring sites where CEMP data are collected, that designation as an Antarctic specially managed area (ASMA) or Antarctic specially protected area (ASPA) under the Antarctic Treaty System may provide more effective mechanisms to afford this protection and would also harmonise the process for protection to terrestrial sites between CCAMLR and the ATCM (SC-CAMLR-XXVIII, Annex 4, paragraphs 5.28 to 5.30; CCAMLR-XXVIII, paragraph 12.5).

2.125 WG-EMM-13/33 presented information on a draft management plan, based on the requirements of CM 91-01, for new CEMP sites on Petermann and Galindez Islands in the Argentine Islands, Penola Strait, West Antarctic Peninsula area.

2.126 The Working Group welcomed the commitment from Ukraine to continue to collect monitoring data and to submit that data to the Secretariat as part of CEMP. The Working Group also urged Ukraine to consider the most appropriate mechanism for affording additional protection for these sites depending on the requirements to restrict activities that might compromise the ability to collect CEMP data. The Working Group looked forward to receiving an update on progress on the draft management plan contained in WG-EMM-13/33 in the near future.

2.127 The Secretariat clarified the procedure for submitting CEMP data from a site where such data has not previously been submitted. The Secretariat explained that this procedure simply involved specifying the location of the site/colony and the CEMP standard methods that were used in the collection and submission of the data to the Secretariat. Where a formal

acknowledgement was required, the Secretariat offered to provide a letter to the data originators to acknowledge that a CEMP site had been included in the CEMP database and that data had been submitted.

2.128 WG-EMM reiterated its acknowledgement (SC-CAMLR-XXXI, Annex 6, paragraphs 2.136 to 2.139) that additional monitoring data on krill-dependent predators exist, but that they are not currently submitted to CEMP. The Working Group confirmed that submission of such datasets would be welcomed but noted that other data portals are available that may contain more general ecosystem data (paragraph 6.5).

2.129 Dr M. Korczak-Abshire (Poland) notified the Working Group that Poland has just started to contribute monitoring data from its research program in King George Bay, King George Island, active since 2007, to the CEMP database. The Working Group welcomed this development and Poland's important contribution to CEMP.

2.130 The Working Group noted that the procedure for establishing a CEMP site and new time-series of data for CEMP is not easily understood. It requested the Secretariat to prepare a consolidated document for posting on the CCAMLR website containing descriptions of the current procedures, along with how methods are reviewed and standardised and how CEMP data are archived and validated.

Integrated assessment model

2.131 Dr Watters provided WG-EMM with a brief update on progress to develop an integrated assessment model for krill. Since the last meeting of the Working Group, work has focused on trying to reconcile differences between the time series of acoustic biomass estimates from US AMLR surveys and the time series of densities and size compositions from German and US AMLR research net tows in Subarea 48.1. The approach has been to fit all three time series (acoustics, German and US net densities combined and combined net size compositions) within the integrated model and estimate separate selectivity functions for the acoustics and the net tows. Last year, data from the acoustics and net tows were fitted in separate models. Estimating selectivity functions for each data series has been proven useful for integrating these data series into a single model. Work is also under way to handle the acoustics data in a different manner. Rather than fitting to estimates of acoustic biomass (where, external to the assessment model, the nautical area scattering coefficients (NASC) are converted to biomass using the size ranges of krill observed in net tows), consideration is being given to fitting NASC using the size ranges of krill predicted by the model. It is expected that an update on the integrated assessment model will be provided as a paper submitted to WG-SAM or WG-EMM next year.

Surveys from fishing vessels

2.132 WG-EMM-13/15 described the potential for using commercial fishing vessels as research platforms in the Southern Ocean and summarised the requirements to be met if scientific data collection from such vessels is to be carried out. Given that these requirements are met, data collection may be divided into four categories:

(i) non-interfering – happening during normal fishing operation
(ii) briefly interfering – ad hoc tasks like retrieval of moorings
(iii) routine monitoring surveys
(iv) specifically designed case studies.

2.133 The concept was exemplified by a new krill fishing vessel which is currently being built by the Norwegian fishing company Olympic. The vessel will be equipped for scientific use under the guidance of the Institute of Marine Research (IMR) in Bergen and will meet most requirements for being used as a research platform, including drop keel for acoustic instruments, a hangar for operating oceanographic instruments and cabin space for 20 extra scientific crew.

2.134 WG-EMM-13/35 provided an example of the use of a fishery vessel for a scientific survey. Fishery vessels from the Norwegian fishing companies Aker and Olympic have carried out annual monitoring surveys around the South Orkney Islands in January/February of 2011–2013. Among the various datasets collected, there is systematic observation of krill predators, including penguins, seals, whales and flying birds. The paper presented penguin observations with some preliminary results. Chinstrap penguins completely dominate the observations and the paper indicated specific areas with generally higher abundance of penguins. However, the authors cautioned that there are substantial differences in survey coverage and survey methods so comparison between years was premature.

2.135 Mr X. Wang (China) presented an example of acoustic data collected from a Chinese fishing vessel, where noisy data had been cleaned up using acoustic post-processing software. The Working Group welcomed the Chinese contribution and several other Members indicated that representatives of their domestic krill fishing vessels had expressed their willingness to collaborate in the acoustic data collection.

2.136 Dr Watkins, Co-convener of SG-ASAM, provided a verbal update of the progress of the CCAMLR 'proof-of-concept' program to investigate the scientific use of acoustic data collected from commercial fishing vessels (SC-CAMLR-XXXI, Annex 6, paragraph 2.167). Planning for the proof-of-concept program had been taking place during the intersessional period using an SG-ASAM correspondence group on the CCAMLR website to facilitate exchange of ideas.

2.137 The proof-of-concept program is currently being implemented in the krill fishery in 2013 and participating vessels have been requested to collect and submit example digital acoustic data to the Secretariat. These data will be evaluated for their potential use in providing information on distribution and abundance of krill. The program is being conducted in two stages:

(i) stage 1 is being implemented in 2013 to evaluate the current setup of acoustic equipment on participating vessels. The information collected will be used to develop instrument-specific instructions for stage 2

(ii) stage 2 will consist of acoustic data collected during a range of vessel activities, speeds and weather conditions to assess more fully the quality and utility of acoustic data from commercial fishing vessels.

2.138 For stage 1, participating vessels have been requested to collect trial position- and time-referenced acoustic data as follows:

(i) collect and submit a small set of position- and time-referenced data for initial testing. It is recommended that these data be recorded over an interval of 1 to 2 minutes

(ii) complete a form on essential metadata requirements for the initial proof-of-concept data collection

(iii) submit the data file(s) and completed form to the Secretariat via email.

2.139 The Working Group thanked the Co-convener of SG-ASAM for the update and strongly encouraged nations participating in the krill fishery to engage in both the SG-ASAM correspondence group and also in the proof-of-concept study.

2.140 The Working Group noted that the proof of concept contained no description of best practice for acoustic data collection on board fishing vessels. Protocols for data collection will be developed as part of future work in SG-ASAM, facilitated by the knowledge of the nature and quality of acoustic data which will arise during the proof-of-concept phase.

2.141 The Working Group further noted that SG-ASAM had taken account of the possibility that acoustic data provided by the fishing vessels, both in terms of sample quality and ways they are collected, will likely comprise a range of different levels of quality. The information provided by the data will therefore vary. These differences were taken into consideration and described by SG-ASAM (SC-CAMLR-XXXI, Annex 4), summarising a hierarchy of purposes for use for acoustic data of different quality.

2.142 The Working Group noted that as part of the future work of SG-ASAM, there will be a need to decide where and how the analysis of the acoustic data from different Members is going to be done. Similarly, the work towards standardisation of the data between the vessels will be important future work for SG-ASAM.

Joint WG-SAM–WG-EMM focus symposium on spatial modelling in 2014

2.143 The Scientific Committee asked the Conveners of WG-SAM and WG-EMM to prepare terms of reference for a symposium on spatial models (SC-CAMLR-XXXI, paragraph 15.2). The Working Group noted that spatial modelling is important to the work of SC-CAMLR and has been progressed through the following activities:

(i) a workshop in 2002 on SSMUs (SC-CAMLR-XXI, Annex 4, Appendix D)

(ii) a workshop in 2004 on modelling ecosystems relevant to developing management procedures for krill fisheries (SC-CAMLR-XXIII, Annex 4, Appendix D)

(iii) a joint CCAMLR-IWC workshop in 2008 on ecosystem data for modelling (SC-CAMLR-XXVII, Annex 12)

(iv) the development during the period 2005–2008 of models to consider spatial subdivision of krill catch limits (Plagányi and Butterworth, 2012; Watters et al., 2013)

(v) discussions in 2011 and 2012 on feedback management of krill fisheries, e.g. WG-EMM-12/19

(vi) discussions in 2012 and 2013 on climate change impacts on krill and the ecosystem, e.g. WG-EMM-13/20

(vii) WG-FSA modelling of finfish populations.

2.144 The Working Group noted the response of WG-SAM (Annex 4, paragraph 5.1) that while WG-SAM recognised the scientific utility of a workshop on spatial modelling, it currently has a very full workload.

2.145 The Working Group noted the ICED program of activities (WG-EMM-13/12 and 13/13) and that the ICED program has suggested developing joint activities of value to both the CCAMLR and ICED communities. The Working Group suggested that the Scientific Committee should consider how to further progress spatial modelling to support its work. One possibility is to approach ICED to determine if that group can help to address the needs of SC-CAMLR in the development of spatial models. Outcomes and recommendations for modelling approaches would be most useful if made available to WG-SAM and WG-EMM in time for their 2015 meetings.

SPATIAL MANAGEMENT

Marine protected areas (MPAs)

3.1 The Working Group recalled that the Scientific Committee had tasked WG-EMM with coordinating the work to support the planning and designation of MPAs (SC-CAMLR-XXVI, paragraph 3.93; SC-CAMLR-XXXI, paragraph 5.34). Consideration of work related to the designation of MPAs is therefore a standing agenda item for WG-EMM.

3.2 The Working Group recalled that planning processes for the designation of MPAs had originally centred around 11 priority areas (SC-CAMLR-XXVII, paragraph 3.55iv), but work had subsequently been focused on nine CCAMLR MPA planning domains (SC-CAMLR-XXX, paragraph 5.20). The Working Group recollected that these domains covered the whole Convention Area whereas the priority areas had covered only part of the Convention Area. The Working Group further noted that the domains better reflect the scale and location of current and planned research efforts and consequently can be helpful as reporting and auditing units (SC-CAMLR-XXX, Annex 6, paragraph 6.6). Furthermore, it recalled that the boundaries of the planning domains were not intended to confine or restrict research or other work to develop MPAs (SC-CAMLR-XXX, Annex 6, paragraph 6.7).

3.3 The Working Group discussed recent work in Planning Domains 1, 3, 4 and 5.

Domains 3 (Weddell Sea) and 4 (Bouvet–Maud)

3.4 WG-EMM-13/22 contained an initial conceptual outline and a description of the schedule of work needed to determine the scientific justification for the potential future designation of MPAs in the Weddell Sea. The paper noted that the area to be considered in the scientific analyses extends beyond Domain 3 and encompasses the southern part of Domain 4.

3.5 The Working Group noted that MPA planning was originally focused on 11 priority areas identified by WG-EMM on the basis of the results from workshops in 2006 and 2007, but was replaced by 9 planning domains resulting from the MPA Workshop in 2011 (paragraph 3.2). The new scheme divided the Weddell Gyre ecosystem into two separate planning domains, therefore creating some unintended confusion.

3.6 The Working Group recognised that the biogeography of ecological communities may span domain boundaries. This is the case in the Weddell Sea, where a single topographic and ecological entity on the eastern Weddell Sea shelf spans the boundaries between Domains 3 and 4. The Working Group suggested that, as a priority, the authors finalise the definition of the planning area as this will make retrieval and collation of available geo-referenced data more efficient. It will also facilitate data contributions and input from other experts who are part of the scientific analysis process.

3.7 The Working Group noted that the work plan identifies a time schedule, with defined milestones and deliverables. It also noted that the work plan identifies a wide range of data that have already been collated, while a number of data gaps have also been identified, including for phytoplankton and zooplankton, penguins, flying seabirds and part of the fish assemblages, in particular *Dissostichus* spp., and mesopelagic fish such as myctophids. The Working Group encouraged scientists from all CCAMLR Members with relevant data and expertise to contribute to, and actively engage in, the work; it also noted that SCAR-MarBIN could form a valuable data source, particularly the *Biogeographic Atlas of the Southern Ocean*, which will be released later this year.

3.8 The authors of WG-EMM-13/22 informed the Working Group that an international expert workshop concerning the scientific evaluation of the Weddell Sea is scheduled for early April 2014; the workshop will be organised and hosted by the AWI in Bremerhaven, Germany (contacts: Thomas.Brey@awi.de and Katharina.Teschke@awi.de). The major objective of the workshop will be to bring together scientists and experts from all CCAMLR Members to discuss the available data and any preliminary results derived from ongoing scientific studies and analyses to establish a robust scientific basis for formulating subsequent candidate proposals for spatial protection. Further information about the workshop will be circulated via an SC CIRC in the near future.

3.9 The Working Group welcomed the new initiative, and noted that the proposed work plan was consistent with the planning processes carried out in other parts of the Convention Area. The Working Group also encouraged interested scientists to attend the international expert workshop and to contribute data and expertise.

3.10 Dr A. Petrov (Russia) made the following statement:

> 'Our position on MPA discussion was announced at the last meeting of the Scientific Committee and was discussed among the countries and it was supported by several countries and by the Chair of the Scientific Committee (SC-CAMLR-XXXI, paragraphs 5.35, 5.74, 5.77 to 5.80).
>
> We think that in discussions of MPAs there should be a clear understanding between the Members. In the case if this proposal (WG-EMM-13/22) will be presented in the Scientific Committee and will be translated in four official languages of CCAMLR according to the procedure we will take part in discussion of this proposal. Now we would like to reserve our opinion on that proposal (WG-EMM-13/22) until the meeting of the Scientific Committee, where as I mentioned above the procedure provides the official translation of documents and interpretation during the discussion.'

Domain 1 (Western Antarctic Peninsula – South Scotia Arc)

3.11 Dr J. Arata (Chile) presented a brief outline of the data so far collated following the workshop in Valparaiso, Chile, in May 2012 (WG-EMM-12/69), on the identification of appropriate protection objectives and spatial data to represent those objectives, to inform upon MPA designation within Domain 1. He reported that, consistent with the protection objectives agreed at that workshop, considerable amounts of spatial data had now been collated and converted to GIS 'shapefiles'; further that appropriate metadata detailing the methods were also complete. Dr Arata reported that the GIS shapefiles and metadata would now be circulated to the group of scientists who had contributed the original data in order that the synthesised data could be validated and any errors corrected.

3.12 The Working Group noted that for a number of objectives the corresponding datasets remain to be converted, including information on areas of oceanographic upwelling, zooplankton and other prey species distributions, the location of penguin colonies and the winter distribution of various top predators. It noted that such data would be necessary prior to the start of any further work and encouraged their delivery as soon as feasible.

3.13 The Working Group debated how the collated data might now be made available to scientists within the CCAMLR community, recognising that this was a generic issue for all planning domains. It considered the following alternative approaches and requested that the Scientific Committee provide advice on how to proceed; the Working Group also noted that other approaches may be appropriate:

(i) data could be located within a private area of the CCAMLR website accessible only to a CCAMLR subgroup (groups.ccamlr.org)

(ii) data could be located within the private data area of the CCAMLR website dedicated to GIS shapefiles and data layers, available to all Members.

3.14 The Working Group noted that not all data layers need to be subjected to the same levels of restriction on access. The Working Group recalled that for data layers used in the design of MPA proposals in Domains 7 and 8 (i.e. the East Antarctic and the Ross Sea

region), summarised or derived data layers previously described in CCAMLR working group papers were available for download by all Members with access to the CCAMLR website, whereas layers containing raw data from CCAMLR databases (e.g. C2 catch histories) require a data request to the Secretariat.

3.15 Dr Arata reported on plans to develop an MPA proposal for consideration by WG-EMM in 2014; he welcomed interested individuals to contact him in order to help formulate the proposal.

3.16 The Working Group recalled the proposed time frame for the development of candidate systems of MPAs in Domain 1 (SC-CAMLR-XXXI, paragraph 5.18) and encouraged Members to work on the development of other proposals for consideration by WG-EMM in 2014.

3.17 The Working Group welcomed the progress made and congratulated Dr Arata and colleagues on their valuable contribution.

3.18 WG-EMM-13/10 presented a draft MPA Report for the South Orkney Islands southern shelf MPA; it noted that the report will subsequently contribute to the broader MPA Report for Planning Domain 1. The paper noted that there are many studies that have relevance to the development of the MPA Report for the South Orkney Islands, including, inter alia, oceanographic influences upon krill and the krill fishery in the Scotia Sea as well as historical information from finfish fisheries, the crab fishery and benthic surveys. Other papers, reports and studies also exist that relate to krill predators. The authors therefore encouraged scientists and researchers with relevant information to contribute towards a revised version of the document (however, see also paragraph 3.22).

3.19 The authors noted that the South Orkney Islands southern shelf MPA (CM 91-03) was designated prior to the agreement of the general framework for the establishment of CCAMLR Marine Protected Areas (CM 91-04) and that the requirements of the framework may need to be applied to this MPA conditional on advice from the Commission. The authors also noted that this is the first time that a draft MPA Report has been considered in detail by the Working Group. The authors therefore requested guidance from WG-EMM about the most appropriate structure for the MPA Report; currently WG-EMM-13/10 is structured using headings and subheadings taken from WG-EMM-12/49, but with a number of additional sections.

3.20 Dr Petrov stated:

> ‘Some Members noted that MPA in Subarea 48.2 was established in 2009 (CM 91-03) and until now it has not been adjusted in accordance with the requirements of Conservation Measure 91-04, although this measure was established in 2011.’

3.21 Dr Trathan agreed that the South Orkney Islands southern shelf MPA needed to be considered in the context of CM 91-04; however, he noted that it also needed to be considered in the context of other planning work in Domain 1. The development of new proposals for Domain 1 will provide opportunities for the existing MPA to be harmonised with CM 91-04 (paragraphs 3.15 and 3.16).

3.22 The Working Group recommended that WG-EMM-13/10 be revised to form three separate documents (paragraph 3.34):

(i) a management plan
(ii) a research and monitoring plan
(iii) an MPA Report that describes: (a) the evidence used to designate the MPA, and (b) information relevant to the MPA, but available subsequent to the designation of CM 91-04.

3.23 Drs Petrov and Kasatkina noted that the monitoring and research program outlined in WG-EMM-13/10 needed clarifications. They noted that it is necessary to define more exactly the following aims:

(i) Monitoring the effects of harvesting and other human activities on Antarctic marine living resources and on the ecosystem. Considering that the Antarctic fishery in the MPA area does not conduct, the localisation of the krill fishery in area of Coronation Islands and the close of fishery in Subarea 48.2 from the beginning of the 1990 that points of the Report should be reviewed.

(ii) Protection of features critical to the function of local ecosystems. Variability of the following features (krill flux, Southern Antarctic Circumpolar Current Boundary and the Southern Antarctic Circumpolar Current Front, frontal zone) is defined only by climatic processes and the regulation and management of them is impossible.

3.24 Dr Trathan indicated that the intention of WG-EMM-13/10 was to initiate a dialogue to develop the management plan, the research and monitoring plan and the MPA Report for the South Orkney Islands southern shelf MPA so that it was consistent with planning work for Domain 1 and CM 91-04. On the specific points raised, he noted that studies related to the recovery of finfish stocks would be of considerable interest, whilst variability in krill abundance and distribution was of evident importance.

3.25 Dr Kasatkina noted that the timeline of the research activities with detailed information on research areas should be included in the research/monitoring plan. It should include the number of participating Member vessels and the deadlines for report submission.

3.26 Dr Trathan recalled that under CM 91-04 all Members may undertake research and monitoring activities in accordance with the research and monitoring plan, and that the operational uncertainties of Antarctic research precluded specific and detailed commitments within a research and monitoring plan designed to be accessible to all Members and to be implemented over a number of years or decades.

3.27 Dr Kasatkina noted that the analysis of climate impact on the ecosystem was announced as one of the aims of the MPA establishment. However, the description of the current state of the ecosystem, and its individual elements at the moment of MPA establishment, were not presented.

3.28 Dr Trathan indicated that in WG-EMM-13/10 the implications of climate change were only included as a proposed objective for the South Orkney Islands region, not as a specific objective for the South Orkney Islands southern shelf MPA. The specific objectives for the

MPA were detailed in section 2.2 of the document and included protection objectives, e.g. pelagic bioregions, seasonal sea-ice areas, areas of high primary productivity, frontal areas and penguin foraging areas. He added that climate change was well known to be affecting areas within Domain 1, including at the South Orkney Islands, and that therefore a proposal for such an objective was reasonable for the wider South Orkney Islands region and also consistent with CM 91-04, paragraph 2(vi).

3.29 Dr Kasatkina noted that the large area of the MPA and the proposed research program imply a huge amount of complex scientific investigation which could only be undertaken by a group of research vessels with systematic and previously agreed expeditions (with methods, duration and areas of investigation outlined). The current proposal does not include details of the participants who will undertake the research in the MPA or details of any cooperation with other Members or organisations.

3.30 Dr Trathan recalled that under CM 91-04 all Members may undertake research and monitoring activities in accordance with the research and monitoring plan and that progress in implementing the plan could depend on the active engagement of different Members. He noted that CM 91-04 does not require these specific details. He also added that the extent and complexity of the plan required the active engagement of a range of Members in order to develop an appropriately scaled and realistic proposal.

3.31 Dr Petrov noted that it is necessary to provide an explanation for the period increase of MPA status from five years to 10 years (WG-EMM-13/10, part 6, point 3) and that discussion on the review period may be possible only after the presentation of the report (in accordance with CM 91-03).

3.32 Dr Trathan explained that the intent of WG-EMM-13/10, part 6, point 3, was a proposal to provide the Scientific Committee with the opportunity to review the research and monitoring plan, in case it was no longer fit for purpose. This proposal was additional and separate to the requirement under CM 91-04, paragraph 5(v) that stipulates that Members conducting activities according or related to the research and monitoring plan will compile a report on those activities every five years, including any preliminary results for review by the Scientific Committee. Dr Trathan emphasised that this proposal was also distinct from the review of the conservation measure itself (CM 91-03, paragraph 9) which stipulates a review at five-year intervals.

3.33 The Working Group recommended the Scientific Committee consider providing translations of the MPA Reports into the official languages which would allow for a better understanding of the research activities that take place in MPAs (paragraph 2.10).

3.34 The Working Group recommended that the authors circulate an SC CIRC encouraging interested individuals to contribute towards the revised version, suggesting that revisions of text should be located within a private area of the CCAMLR website accessible to a CCAMLR subgroup (groups.ccamlr.org).

Domain 5 (del Cano – Crozet)

3.35 Dr T. Samaai (South Africa) and Prof. P. Koubbi (France) reported that they are developing plans for Domain 5 and are beginning to collate data. The Working Group welcomed the continuation of this work (SC-CAMLR-XXXI, Annex 6, paragraphs 3.52 to 3.57) and looked forward to receiving further information in the future.

Vulnerable marine ecosystems (VMEs)

3.36 Notifications of encounters with VMEs during the course of research are notified under CM 22-06, Annex B. No new notification was made in 2013.

3.37 The Working Group encouraged participants and Member's national Antarctic research programs to continue work on the detection and identification of new VMEs in accordance with CM 22-06 and to notify these VMEs to WG-EMM.

ASMAs and ASPAs

3.38 The Working Group thanked Dr E. Secchi (Brazil) for introducing WG-EMM-13/05 on behalf of the ASMA No. 1 Management Group and noted that the Working Group had already considered the potential for commercial fishing to negatively impact the broad range of ecological and scientific values in the ASMA (SC-CAMLR-XXXI, Annex 6, paragraphs 3.8 to 3.15). This potential was reflected in the revised management plan for ASMA No. 1 by ensuring that any fishing should be conducted in a manner that is consistent with the values of the ASMA.

3.39 The Working Group noted the suggestion in the WG-EMM-13/05 that, consistent with the procedure established in ATCM XXVIII Decision 9 (2005), any proposal to undertake commercial harvesting should be submitted to CCAMLR for its consideration and that the activities outlined in that proposal should only be taken with the prior approval of CCAMLR. The Working Group agreed that the provision of advice from CCAMLR to the ATCM in order that such advice could be included in decision-making was consistent with the spirit of cooperation and harmonisation between CCAMLR and the ATCM.

3.40 The Working Group noted that CM 91-02 had been adopted last year to raise awareness of the geographic location and the management plans of ASMAs and ASPAs with marine components and requested that the Secretariat include a report of any fishing that occurs in ASMAs and ASPAs in its regular report on the krill fishery to the Scientific Committee.

ROLE OF FISH IN THE ROSS SEA ECOSYSTEM

4.1 WG-EMM-13/28 summarised information pertinent to the question if, and to what extent, the fishery on Antarctic toothfish (*Dissostichus mawsoni*) might impact on Weddell seals. Several methods from scat analyses to stable isotope method and nutritional value

assessment were applied to estimate the potential importance of toothfish for Weddell seals. Different methods led to different estimates with respect to the importance of individual food components which are currently difficult to reconcile. The paper noted that available evidence does not support the conclusion that toothfish are a major component in the diet of Weddell seals throughout the entire year or at the scale of the entire Ross Sea ecosystem. However, given its high metabolisable energy content, toothfish are likely to be important for Weddell seals in particular locations and at particular times of the year when energy demand increases, such as the period between pup weaning and embryo implantation, during which time breeding females must rapidly regain body mass lost during lactation. The paper noted that current understanding is hindered by:

(i) insufficient information on Weddell seal diet due to inadequate temporal coverage and biased methodology

(ii) uncertainty regarding Weddell seal abundance and spatial foraging patterns in the Ross Sea region.

4.2 WG-EMM-13/29 reviewed information on the potential importance of Antarctic toothfish in the diet of type C killer whales in the Ross Sea. The paper reported direct observations of predation in the McMurdo Sound area, and circumstantial evidence based on the high metabolisable energy content of toothfish relative to other prey, and likely availability of toothfish and potential alternate prey in this area. It noted that the balance of evidence suggests that toothfish are unlikely to constitute a major component in the diet of type C killer whales throughout the year or at the scale of the entire Ross Sea ecosystem, but are likely to be important for type C killer whales in McMurdo Sound in summer and potentially in other locations on the Ross Sea shelf. Research priorities to resolve remaining uncertainties include improved population estimates for type C killer whales and improved data indicative of spatial and temporal foraging patterns.

4.3 Dr Petrov noted that for the entire history of the fishery in the Ross Sea there were no observer reports on the impact of killer whales on fishing gear (longline), i.e. killer whales have not eaten caught fish from the hooks.

ADVICE TO THE SCIENTIFIC COMMITTEE AND ITS WORKING GROUPS

5.1 The Working Group's advice to the Scientific Committee and its working groups is summarised below; the body of the report leading to these paragraphs should also be considered.

5.2 The Working Group provided advice to the Scientific Committee and other working groups on the following topics:

(i) Krill fishery –

(a) activities in 2012/13 (paragraphs 2.6 and 2.7)
(b) krill fishery report (paragraphs 2.9 and 2.10)
(c) fishery notifications for 2013/14 (paragraphs 2.11 and 2.12, Table 1)
(d) green weight estimation (paragraphs 2.17 and 2.18)
(e) notification format (paragraphs 2.13 and 2.14, Appendix D)

(f) observer coverage in 2012/13 (paragraph 2.19)
(g) observer data forms (paragraph 2.28).

(ii) Krill biology and ecology –

(a) winter surveys (paragraph 2.35)
(b) CEMP fund (paragraphs 2.114, 2.115, 2.118, 2.121 to 2.123)
(c) climate variability impact on krill habitat (paragraph 2.54).

(iii) Feedback management strategy –

(a) development of the strategy (paragraphs 2.62 to 2.70, 2.74 and 2.76)
(b) surveys by fishing vessels (paragraphs 2.137 and 2.138)
(c) spatial modelling (paragraph 2.145).

(iv) Marine protected areas –

(a) MPA reports (paragraph 3.33)
(b) ASMAs and ASPAs (paragraphs 3.39 and 3.40).

(v) Future work –

(a) interaction with other scientific programs (paragraph 6.9).

FUTURE WORK

6.1 The Working Group considered a number of papers that related to international programs and organisations that conduct science of relevance to CCAMLR (WG-EMM-13/12, 13/13, 13/16, 13/17 Rev. 1, 13/19 and 13/36).

6.2 The Working Group noted the activities in the wider scientific community on understanding, assessing and monitoring climate change impacts on Antarctic and Southern Ocean marine ecosystems. WG-EMM-13/36 summarised activities in the IMBER-ICED program, SOOS, SCAR and COMNAP. Activities in SOOS, ICED (Southern Ocean Sentinel) and COMNAP are being coordinated to develop an integrated system to assess change in Southern Ocean ecosystems. It would be beneficial to coordinate activities at CEMP sites with at-sea activities to develop a circumpolar program for monitoring change. The SOKI wiki (www.soki.aq) is being used to help coordinate and develop these activities in ICED and SOOS.

6.3 A series of workshops and conferences are being held over the next 12 months that will support scientific work on climate change impacts on Southern Ocean ecosystems. These are described in WG-EMM-13/13 and 13/36 and include:

(i) Southern Ocean Food Webs and Scenarios of Change (ICED workshop at BAS, Cambridge, UK, November 2013)

(ii) Future Oceans – Research for marine sustainability: multiple stressors, drivers, challenges and solutions (IMBER Open Science Conference, Bergen, Norway, June 2014) – two workshops:

(a) Detecting, Projecting and Managing the Impacts of Change in Southern Ocean Ecosystems

(b) End-to-End Modelling for Research and Management

(iii) SOOS workshops throughout the year on monitoring ecosystem essential ocean variables.

6.4 The Working Group noted the request in WG-EMM-13/19 for information on datasets relevant to the Working Group's work that require digitisation. The authors of WG-EMM-13/19 intend to compile a list of such datasets and relevant metadata. This list will be made publically available to help facilitate future data recovery processes.

6.5 There are also a number of initiatives currently under way to develop data portals and repositories (through ICED, SOOS, SCAR, etc.) containing data that are likely to be of interest to CCAMLR. The Working Group recognised that it was unlikely that there would be a single repository that included all such data and that it is important to be aware of the developing range of data sources available. It requested that the Secretariat provide appropriate links on the CCAMLR website.

6.6 The Working Group noted the joint ICED-CCAMLR session at IMBER 2014 (WG-EMM-13/13) and welcomed this as an indication of the long-term interest and support of programs like ICED in the work of CCAMLR (SC-CAMLR-XXIV, Annex 4). However, the Working Group also noted that the dates for the IMBER meeting coincided with the regular timing of WG-SAM and WG-EMM.

6.7 The Working Group noted the report of the SCAR–CCAMLR Action Group meeting (SC-CAMLR-XXXI, paragraph 10.6) that had provided an opportunity for both SCAR and CCAMLR to better understand the processes and structures of the two organisations (WG-EMM-13/16). In considering the suggestion in WG-EMM-13/16 that engagement with SCAR scientists may be more effective at WG-EMM than at the Scientific Committee, the Chair of the Scientific Committee recalled that the proposal for standing invitations to scientists from other expert bodies, such as the IWC, was still under discussion.

6.8 The Science Manager indicated that a follow-up meeting with representatives from SCAR was planned for the SCAR Biology Symposium in July 2013 and would include feedback from the discussions at WG-EMM, as well as the potential coordination of population status and trends data for seabirds and marine mammals that were collected by CCAMLR and other organisations such as ACAP and the IWC.

6.9 In welcoming the papers on interactions with other programs/organisations, there was recognition that many scientists are involved in a number of international programs, including CCAMLR, and that taking experience of CCAMLR into other fora was very helpful in promoting the science undertaken in CCAMLR. However, noting the importance of the informal links created by individual scientists, the Working Group agreed that there is a need for clarity in the process for engagement with other programs, such as SCAR, SOOS and

ICED, to distinguish between individual scientists with experience of CCAMLR providing personal insights and those appointed by the Scientific Committee as observers to represent CCAMLR.

6.10 The Chair of the Scientific Committee indicated that a paper on the process for the engagement of experts in the working groups would be presented to the Scientific Committee this year. This would include a process for the selection of experts, as well as consideration of how to structure meetings in order to optimise their engagement (e.g. experts coming to a focus topic session would not be expected to remain for the entire working group meeting), as well as the implications of expanding participation for meeting logistics.

6.11 The Working Group welcomed the establishment of the SONA program (WG-EMM-13/17 Rev. 1) that will use ships of opportunity in the Southern Ocean to collect and analyse acoustic data to a set of common protocols. The Working Group noted the overlap between this proposal and the ongoing work of SG-ASAM, and encouraged coordination with CCAMLR, noting that many of the international partners are also part of SG-ASAM (paragraph 2.136).

OTHER BUSINESS

Accessibility and availability of working group papers

7.1 The Working Group noted that the new CCAMLR website had delivered a greater discoverability of the large archive of working group papers, and the Secretariat sought the views of the working groups on how these papers might be made publically available (WG-SAM-13/17). The proposal contained in WG-SAM-13/17 included the application of a variable embargo period to each paper that would determine when a paper would be available publically, including an option to have a paper available only on request from the Scientific Committee representative (see also Annex 4, paragraphs 5.2 to 5.6).

7.2 The Working Group agreed with the consideration of WG-SAM that working group papers that are placed in the public domain on the CCAMLR website should have a disclaimer that makes it clear that the paper may not have been reviewed by the working group, that the content of the paper does not necessarily reflect the views of CCAMLR and that the paper should be considered in the context of the relevant working group report.

7.3 The Working Group was concerned that making working group papers available in the public domain might compromise the subsequent publication in the peer-reviewed literature as some journals considered that a paper in the public domain was ‘published’, and noted that this may affect the embargo period that is chosen for some papers.

7.4 The Working Group thanked the Secretariat for this initiative and looked forward to the proposal to the Scientific Committee that incorporated the advice from all of the working groups.

Editorial procedures of *CCAMLR Science*

7.5 The Working Group discussed a proposal for revising the editorial procedures for papers submitted to *CCAMLR Science*. The proposal included a recommendation that papers

that are to be considered for publication in *CCAMLR Science* should be submitted in the format required for the journal to the relevant working group meeting or within one month of the working group meeting.

7.6 In considering the proposal, the Working Group considered whether there was a need for all papers in *CCAMLR Science* to be submitted via the working groups. Inviting submissions that do not require consideration by the working groups might bring in additional papers relevant to the work of CCAMLR, but there would likely need to be an editorial policy which ensures that submissions address issues of relevance to CCAMLR.

7.7 The Working Group agreed that it was useful to remove the two-stage review process but noted that working group papers may differ from peer-reviewed papers in format and content. In some cases authors of working group papers focus only on the details relevant to the working group and reduce the description of the broader context (that would be required in a peer-reviewed paper). However, the Working Group agreed that there was need for a balance of the desire for brevity with the recognition of the importance of including sufficient context as this is particularly important for engaging those who are new participants in the working group.

7.8 The Working Group also suggested that the 'Instructions for Authors' and the journal format be reviewed and the visibility of the journal on the CCAMLR website should be enhanced.

Global Environment Facility (GEF) proposal

7.9 Dr Samaai introduced WG-EMM-13/44 that provided an updated proposal for a GEF-funded project that was originally presented as WG-EMM-10/32. The Working Group welcomed the update on progress noting its previous discussion (SC-CAMLR-XXIX, Annex 6, paragraphs 6.1 to 6.3), including that the proposal had been endorsed by the Scientific Committee (SC-CAMLR-XXIX, paragraph 17.1) and encouraged South Africa to engage all GEF-eligible CCAMLR Members in discussion to ensure full engagement and to allow sufficient time for consultation both within and between delegations. The Working Group looked forward to receiving future updates on progress from South Africa on this project that has the potential to develop capacity in a number of important areas for CCAMLR.

CCAMLR web-based GIS

7.10 The Secretariat presented a prototype of the CCAMLR web-based GIS which is being developed jointly with the British Antarctic Survey (BAS) to provide state-of-the-art capacity

for displaying geo-referenced data relevant to CCAMLR (WG-EMM-12/70). This development will include capacity building at the Secretariat and a phased handover of the system to the Secretariat.

7.11 The development of the GIS will be implemented in two stages, with stage 1 nearing completion and stage 2 being implemented in 2014. The prototype is currently located at gis.ccamlr.org and contains basic data layers (e.g. management areas, bathymetry, sea-ice). An option to download data is available to users authenticated on the CCAMLR website. The Secretariat encouraged users to provide feedback.

7.12 The Working Group requested the Secretariat to develop guidelines for how the data posted on the website could be accessed to satisfy the Rules for Access and Use of CCAMLR Data.

CCAMLR scholarships

7.13 The two recipients of the CCAMLR scholarship in 2012 gave presentations to the Working Group describing the research that they were undertaking and how this will contribute to the objectives and priorities of CCAMLR.

7.14 Lic. Santos provided a description of the penguin research being conducted by Argentina in Subareas 48.1 and 48.2, including the work presented in WG-EMM-13/27 and 13/43 and also an inter-site comparison of penguin demography and foraging behaviour that will be presented to WG-EMM-14. Lic. Santos informed the Working Group that Argentina was currently focused on land-based penguin research but logistic constraints often meant that access to the monitoring site at Cierva Point was restricted and that because of this she hoped that it may be possible to deploy remote cameras to augment and enhance existing CEMP data collected. She thanked CCAMLR for the scholarship and her mentors Drs E. Barrera-Oro (Argentina) and Hinke for their help and guidance in understanding feedback management. She also dedicated her work to the memory of the late Dr Alejandro Carlini (1963–2010).

7.15 Mr Wang described the work undertaken to digitise photographs of the screen of the echosounder on krill fishing vessels and to develop an algorithm to produce an estimate of the density of krill swarms encountered during fishing operations in order to study the spatio–temporal variation in swarm characteristics. He also informed the Working Group that one Chinese vessel was recently equipped with a Simrad EK60 echosounder that would provide quantitative acoustic data that would also contribute to the work of SG-ASAM. Mr Wang thanked CCAMLR for the scholarship, his mentor Dr X. Zhao (China) and scientists from IMR in Norway for their help during the period that he was on board the krill fishing vessel *Juvel*.

7.16 The Working Group warmly welcomed the presentations by both of the CCAMLR scholarship recipients, noting that their positive engagement in the work of CCAMLR was exactly the outcome for which the scholarship scheme, including the mentoring arrangements, had been established.

ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

8.1 The report of the meeting of WG-EMM was adopted.

8.2 In closing the meeting, Dr Kawaguchi thanked all participants for their contributions to the meeting, the subgroup coordinators for leading detailed deliberations, the rapporteurs for preparing the report and the Secretariat for its support. Dr Kawaguchi also thanked the AWI and the German Federal Ministry of Food, Agriculture and Consumer Protection for hosting the meeting, and Dr Hain and colleagues for their kind hospitality and assistance during the meeting. Dr Kawaguchi also thanked Prof. S. Kleingärtner, director of the German Shipping and Maritime Museum, for generously providing the meeting venue.

8.3 Dr Zhao, on behalf of the Working Group, thanked Dr Kawaguchi for guiding detailed consideration of the work of WG-EMM, including the further development of a feedback management strategy for the krill fishery.

8.4 The Working Group also thanked Lic. Santos and Mr Wang, the 2012 recipients of the CCAMLR scholarship, for their contributions to the meeting (paragraphs 7.13 to 7.16).

REFERENCES

Butterworth, D.S. 1988. A simulation study of krill fishing by an individual Japanese trawler. In: *Selected Scientific Papers, 1988 (SC-CAMLR-SSP/5)*, Part I. CCAMLR, Hobart, Australia: 1–108.

Caddy, J.F. and R. Mahon. 1995. Reference points for fisheries management (*Fish. Tech. Pap*., 347). Food and Agriculture Organization of the United Nations.

Mangel, M. 1988. Analysis and modelling of the Soviet Southern Ocean krill fleet. In: *Selected Scientific Papers, 1988 (SC-CAMLR-SSP/5)*, Part I. CCAMLR, Hobart, Australia: 127–235.

Plagányi, É.E. and D.S. Butterworth. 2012. The Scotia Sea krill fishery and its possible impacts on dependent predators: modeling localized depletion of prey. *Ecol. Appl*., 22: 748–761.

Watters, G.M., S.L. Hill, J. Hinke, J. Matthews and K. Reid. 2013. Decision-making for ecosystem-based management: evaluating options for a krill fishery with an ecosystem dynamics model. *Ecol. Appl*., 23: 710–725.

Table 1: Summary of specific elements on the notifications for krill fisheries in 2013/14 requiring clarification.

Member	Element requiring clarification
Chile	Method for estimating conversion factors for whole and meal product Type of echosounder used by each vessel (make, model, frequencies)
China	Method for weighing 1 000 kg of krill, for use in the estimation of conversion factors Mesh sizes of trawl nets, and minimum mesh size for the codend (including any liner) Type of echosounder used by each vessel (make, model, frequencies)
Korea, Republic of	Method for estimating conversion factors for whole and meal product Detailed drawings for the seal exclusion devices Information on the explosive sound device Type of echosounder used by each vessel (make, model, frequencies)
Norway	Product types and percentages (total should sum to 100%) Information on discarded product (location, composition, quantities) Type of echosounder used by each vessel (make, model, frequencies)
Poland	Method for estimating conversion factors for whole and meal product Type of echosounder used by each vessel (make, model, frequencies)
Ukraine	Method for estimating conversion factors for whole and meal product Circumference of the net mouth opening Type of echosounder used by each vessel (make, model, frequencies)

Appendix A

LIST OF PARTICIPANTS

Working Group on Ecosystem Monitoring and Management
(Bremerhaven, Germany, 1 to 10 July 2013)

Convener	Dr So Kawaguchi Australian Antarctic Division Department of Sustainability, Environment, Water, Population and Communities so.kawaguchi@aad.gov.au
Argentina	Lic. María Mercedes Santos Instituto Antártico Argentino mechasantos@yahoo.com.ar
Australia	Dr Andrew Constable Australian Antarctic Division Department of Sustainability, Environment, Water, Population and Communities andrew.constable@aad.gov.au
	Dr Louise Emmerson Australian Antarctic Division Department of Sustainability, Environment, Water, Population and Communities louise.emmerson@aad.gov.au
	Dr Jess Melbourne-Thomas Australian Antarctic Division Department of Sustainability, Environment, Water, Population and Communities jess.melbourne-thomas@aad.gov.au
	Dr Colin Southwell Australian Antarctic Division Department of Sustainability, Environment, Water, Population and Communities colin.southwell@aad.gov.au
Brazil	Dr Eduardo Secchi Universidade Federal do Rio Grande FURG Instituto de Oceanografia edu.secchi@furg.br

Chile	Prof. Patricio Arana Pontificia Universidad Católica de Valparaíso parana@ucv.cl Dr Javier Arata Asesor de la Dirección INACH jarata@inach.cl
China, People's Republic of	Mr Xinliang Wang Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences wangxl@ysfri.ac.cn Dr Xianyong Zhao Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences zhaoxy@ysfri.ac.cn
European Union	Dr Volker Siegel Institute of Sea Fisheries Johann Heinrich von Thünen-Institute Federal Research Institute for Rural Areas, Forestry and Fisheries volker.siegel@ti.bund.de Dr Jan Andries Van Franeker IMARES jan.vanfraneker@wur.nl
France	Prof. Philippe Koubbi Laboratoire d'Oceanographie de Villefranche/mer koubbi@obs-vlfr.fr
Germany	Prof. Thomas Brey Alfred Wegener Institute for Polar and Marine Research thomas.brey@awi.de Ms Patricia Brtnik German Oceanographic Museum patricia.brtnik@meeresmuseum.de Dr Stefan Hain Alfred Wegener Institute for Polar and Marine Research stefan.hain@awi.de

	Mr Fritz Hertl Federal Environment Agency (UBA) fritz.hertel@uba.de
	Dr Karl-Hermann Kock Johann Heinrich von Thünen-Institute Federal Research Institute for Rural Areas, Forestry and Fisheries Seafisheries Institute karl-hermann.kock@ti.bund.de
	Dr Wiebke Schwarzbach Federal Environment Agency (UBA) wiebke.schwarzbach@uba.de
	Dr Katharina Teschke Alfred Wegener Institute for Polar and Marine Research katharina.teschke@awi.de
Japan	Ms Chika Fukugama Fisheries Agency of Japan chika_fukugama@nm.maff.go.jp
	Dr Taro Ichii National Research Institute of Far Seas Fisheries ichii@affrc.go.jp
Korea, Republic of	Mr Sung Jo Bae Insung Corporation bae123@insungnet.co.kr
	Mr Christopher Garnett Insung Corporation chiristophergarnett@yahoo.co.uk
	Ms Jihyun Kim Institute for International Fishery Cooperation zeekim@ififc.org
	Dr Inja Yeon National Fisheries Research and Development Institute ijyeon@korea.kr
New Zealand	Dr Ben Sharp Ministry for Primary Industries ben.sharp@mpi.govt.nz

Norway	Dr Olav Rune Godø Institute of Marine Research olavrune@imr.no
	Dr Tor Knutsen Institute of Marine Research tor.knutsen@imr.no
	Dr Georg Skaret Institute of Marine Research georg.skaret@imr.no
Poland	Dr Małgorzata Korczak-Abshire Institute of Biochemistry and Biophysics of the Polish Academy of Sciences korczakm@gmail.com
Russian Federation	Dr Svetlana Kasatkina AtlantNIRO ks@atlant.baltnet.ru
	Dr Andrey Petrov VNIRO petrov@vniro.ru
	Ms Daria Petrova OOO «Orion» petrovadarya.a@gmail.com
South Africa	Dr Azwianewi Makhado Department of Environmental Affairs amakhado@environment.gov.za
	Dr Toufiek Samaai Department of Environmental Affairs tsamaai@environment.gov.za
Ukraine	Dr Gennadi Milinevsky National Taras Shevchenko University of Kyiv genmilinevsky@gmail.com
	Dr Leonid Pshenichnov YugNIRO lkpbikentnet@rambler.ru

United Kingdom

Dr Chris Darby
Centre for Environment, Fisheries and Aquaculture Science (Cefas)
chris.darby@cefas.co.uk

Dr Simeon Hill
British Antarctic Survey
sih@bas.ac.uk

Mr Robert Scott
Centre for Environment, Fisheries and Aquaculture Science (Cefas)
robert.scott@cefas.co.uk

Dr Iain Staniland
British Antarctic Survey
ijst@bas.ac.uk

Ms Helen Stevens
Foreign and Commonwealth Office
helen.stevens@fco.gov.uk

Dr Phil Trathan
British Antarctic Survey
pnt@bas.ac.uk

Dr Jon Watkins
British Antarctic Survey
jlwa@bas.ac.uk

United States of America

Dr Jefferson Hinke
US AMLR Program
jefferson.hinke@noaa.gov

Dr Christopher Jones
US AMLR Program
Southwest Fisheries Science Center
National Marine Fisheries Service
chris.d.jones@noaa.gov

Dr George Watters
US AMLR Program
Southwest Fisheries Science Center
National Marine Fisheries Service
george.watters@noaa.gov

Secretariat

Ms Doro Forck
Publications Officer
doro.forck@ccamlr.org

Dr David Ramm
Data Manager
david.ramm@ccamlr.org

Dr Keith Reid
Science Manager
keith.reid@ccamlr.org

Dr Stéphane Thanassekos
Fisheries and Ecosystems Analyst
stephane.thanassekos@ccamlr.org

Mr Andrew Wright
Executive Secretary
andrew.wright@ccamlr.org

Appendix B

AGENDA

Working Group on Ecosystem Monitoring and Management
(Bremerhaven, Germany, 1 to 10 July 2013)

1. Introduction

    1.1 Opening of the meeting
    1.2 Adoption of the agenda and appointment of rapporteurs
    1.3 Review of requirements for advice and interactions with other working groups

2. The krill-centric ecosystem and issues related to management of the krill fishery

    2.1 Issues for the present
        2.1.1 Fishing activities
        2.1.2 Scientific observation
        2.1.3 Krill biology, ecology and management
        2.1.4 Role of fish in the Ross Sea ecosystem

    2.2 Issues for the future
        2.2.1 Feedback management strategy
        2.2.2 CEMP and WG-EMM-STAPP
        2.2.3 Integrated assessment model
        2.2.4 Fishing vessel surveys
        2.2.5 Joint WG-SAM–WG-EMM focus symposium on spatial modelling in 2014
        2.2.6 Climate change

3. Spatial management

    3.1 Marine Protected Areas (MPAs)
    3.2 Vulnerable Marine Ecosystems (VMEs)
    3.3 ASMA and ASPA

4. Role of fish in the Ross Sea ecosystem

5. Advice to the Scientific Committee and its working groups

6. Future work

7. Other business

8. Adoption of the report and close of the meeting.

Appendix C

LIST OF DOCUMENTS

Working Group on Ecosystem Monitoring and Management
(Bremerhaven, Germany, 1 to 10 July 2013)

WG-EMM-13/01	Provisional Agenda for the 2013 Meeting of the Working Group on Ecosystem Monitoring and Management (WG-EMM)
WG-EMM-13/02	List of participants
WG-EMM-13/03	List of documents
WG-EMM-13/04	Some thoughts on our work towards establishing feedback management scheme for krill fishery S. Kawaguchi (Convener, WG-EMM)
WG-EMM-13/05	Draft revised Management Plan for ASMA No. 1: Admiralty Bay, King George Island, South Shetland Islands J. Leal Madruga (Submitted by Brazil on behalf of the ASMA No. 1 Management Group – Brazil, Ecuador, Peru and Poland)
WG-EMM-13/06	CEMP indices: 2013 update Secretariat
WG-EMM-13/07	Fish identification guide for Observers in CCAMLR krill fisheries Secretariat
WG-EMM-13/08	Winter and summer foraging location of Adélie penguins from Mawson, Davis and Casey L. Emmerson, N. Kokubun and C. Southwell (Australia)
WG-EMM-13/09	Adélie penguin breeder abundance in CCAMLR Divisions 58.4.1 and 58.4.2 C. Southwell, J. McKinlay, L. Emmerson (Australia), A. Takahashi (Japan), C. Barbraud, K. DeLord and H. Weimerskirch (France)
WG-EMM-13/10	Draft MPA Report for the South Orkney Islands, Subarea 48.2; Part of CCAMLR MPA Planning Domain 1, Western Peninsula – South Scotia Arc P. Trathan and S. Grant (United Kingdom)

WG-EMM-13/11	New contributions to penguin monitoring to help underpin the development of feedback management approaches for the Antarctic krill fishery N. Ratcliffe, A. Fox, P. Fretwell, T. Hart and P. Trathan (United Kingdom)
WG-EMM-13/12	Developing research on Antarctic krill to facilitate the development and updating of feedback management procedures E.J. Murphy, R.D. Cavanagh (United Kingdom), A. Constable (Australia), E.H. Hofmann (USA), S.L. Hill, N.M. Johnston, P.N. Trathan and J.L. Watkins (United Kingdom)
WG-EMM-13/13	ICED workshop and conference session on Southern Ocean foodwebs and scenarios of change R.D. Cavanagh on behalf of the international ICED Scientific Steering Committee
WG-EMM-13/14	Inter-annual variability in krill density at South Georgia: 1997–2012 S. Fielding, J.L Watkins, P. Trathan, P. Enderlein, C. Waluda, C. Goss, G. Stowasser, G. Tarling and E. Murphy (United Kingdom)
WG-EMM-13/15	Commercial fishing vessel as research vessels in the Antarctic – requirements and solutions exemplified with a new vessel O.R. Godø (Norway), C. Reiss (USA), V. Siegel (Germany) and J.L. Watkins (United Kingdom)
WG-EMM-13/16	Report of the first SCAR-CCAMLR Joint Action Group meeting CCAMLR Secretariat and SCAR Executive Office
WG-EMM-13/17 Rev. 1	Southern Ocean Network of Acoustics (SONA) S. Fielding (United Kingdom), E. Josse (France), R. Kloser (Australia), R. O'Driscoll (New Zealand), C. Reiss (USA), G. Skaret (Norway) and M. Cox (Australia)
WG-EMM-13/18	Developing a penguin tracking database to help determine their most important foraging areas M. Hindell (SCAR), B. Lascelles (BirdLife) and P. Trathan (United Kingdom)
WG-EMM-13/19	Historical data synthesis in the Southern Ocean: Priority data sets N.M. Johnston, E.J. Murphy, J.R.D. Silk, C.M. Waluda, S.L. Hill and R.D. Cavanagh (United Kingdom) on behalf of the ICED Scientific Steering Committee
WG-EMM-13/20	Potential climate change effects on the habitat of Antarctic krill S.L. Hill, T. Phillips and A. Atkinson (United Kingdom)

WG-EMM-13/21	Recent British Antarctic Survey publications relevant to the agenda of WG-EMM 2013 Delegation of the United Kingdom
WG-EMM-13/22	Proposal for the establishment of a marine CCAMLR MPA in the Weddell Sea (Antarctica) – First conceptual outline K. Teschke, B. Dorschel, J. Gutt, S. Hain, H. Hellmer, K. Jerosch, R. Knust, K.-H. Kock, M. Schlüter, V. Siegel and T. Brey (Germany)
WG-EMM-13/23	A sensitivity analysis of a simple krill individual-based model designed to investigate length-based recruitment indices S. Thanassekos and K. Reid (Secretariat)
WG-EMM-13/24	Antarctic krill populations in the outflow region of the north-western Weddell Sea V. Siegel (European Union)
WG-EMM-13/25	Dynamic of the krill fishery in the Area 48 and its relation to climate variability and changes in fishing technology P.S. Gasyukov and S.M Kasatkina (Russia)
WG-EMM-13/26	Bayesian data-model synthesis for biological conservation and management in Antarctica H.J. Lynch and M. Schwaller (USA)
WG-EMM-13/27	Evaluation of populations of chinstrap and gentoo penguins at Cierva Cove (ASPA N° 132). Is this site an appropriate control area for non-fishing effects? M.M. Santos, N.R. Coria, E. Barrera-Oro (Argentina) and J.T. Hinke (USA)
WG-EMM-13/28	A critical re-examination of the evidence for a possible dependence of Weddell seals (*Leptonychotes weddellii*) on Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea, Antarctica R. Eisert, M.H. Pinkerton (New Zealand), S.D. Newsome and O.T. Oftedal (USA)
WG-EMM-13/29	To what extent do type C killer whales (*Orcinus orca*) feed on Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea, Antarctica? L. Torres, M.H. Pinkerton (New Zealand), R. Pitman, J. Durban (USA) and R. Eisert (New Zealand)

WG-EMM-13/30	Abundance and trends in the breeding population of Adélie penguins (*Pygoscelis adeliae*) in the western Ross Sea P. O'B. Lyver, M. Barron, K.J. Barton, S. Gordon (New Zealand), D. Ainley, A. Pollard (USA), P.R. Wilson and M.H. Pinkerton (New Zealand)
WG-EMM-13/31	Competition-mediated prey availability drives Adélie penguin (*Pygocelis adeliae*) chick size, mass and condition at colonies of differing size in the southern Ross Sea A.L. Whitehead (Australia), P. O'B. Lyver (New Zealand), G. Ballard (USA), K. Barton, B.J. Karl (New Zealand), D.G. Ainley, K. Dugger, S. Jennings (USA), A. Lescroël (France) and P.R. Wilson (New Zealand)
WG-EMM-13/32	The dynamic of krill fishery and the environment in the Antarctic Peninsula Subarea (48.1) S.M. Kasatkina, V.N. Shnar and S.N. Burikin (Russia)
WG-EMM-13/33	Information for the management plan for CEMP sites within the Argentine Islands Delegation of Ukraine
WG-EMM-13/34	A method to evaluate selection of Antarctic krill in towed fishing gears L.A. Krag, B. Herrmann (Denmark), S. Iversen, A. Engås, S. Nordrum and B.A. Krafft (Norway)
WG-EMM-13/35	Observations of penguins in the waters off South Orkney Islands, 2011–2013 B.A. Krafft, G. Skaret (Norway) and P. Trathan (United Kingdom)
WG-EMM-13/36	Assessing status and change in Southern Ocean ecosystems A. Constable (Australia), D. Costa (USA), E. Murphy (United Kingdom), E. Hofmann, O. Schofield (USA), A. Press (Australia), N. Johnston (United Kingdom) and L. Newman (Australia)
WG-EMM-13/37 Rev. 1	Krill fishery report: 2013 update Secretariat
WG-EMM-13/38	A summary of scientific observer deployments and data collection in the krill fishery during the 2011, 2012 and 2013 seasons CCAMLR Secretariat
WG-EMM-13/39	Temperature-dependent growth of *Thysanoessa macrura*: inter-annual and spatial variability R.M. Driscoll, C.S. Reiss and B.T. Hentschel (USA)

WG-EMM-13/40	Abundance, distribution, energy density and trophic position of euphausiids during winter 2012: preliminary results from the first US AMLR Winter Survey C. Reiss and C. Jones (USA)
WG-EMM-13/41	Uncertainty in green weight estimates from Norwegian krill fishing vessels G. Skaret and T. Knutsen (Norway)
WG-EMM-13/42 Rev. 1	Preliminary assessment of the green weight for a flow meter method J.A. Arata and C. Arias (Chile)
WG-EMM-13/43	Abundance estimation of Adélie penguins colony at Esperanza/Hope Bay M.M. Santos, N.R. Coria, E. Barrera-Oro (Argentina) and J.T. Hinke (USA)
WG-EMM-13/44	Proposal for GEF (Global Environment Facility) funding to support capacity building and training to the GEF-eligible countries with Antarctic interests Delegation of South Africa

Other documents

WG-EMM-13/P01	Among-year variation in growth of Antarctic krill *Euphausia superba* based on length-frequency data A.O. Shelton, D. Kinzey, C. Reiss, S. Munch, G. Watters and M. Mangel (USA) *Mar. Ecol. Prog. Ser.*, 481: 53–67
CCAMLR-XXXII/05	Notification of Chile's intention to participate in the krill fishery in 2013/14 Submitted by the Secretariat on behalf of Chile
CCAMLR-XXXII/06	Notification of the People's Republic of China's intention to participate in the krill fishery in 2013/14 Submitted by the Secretariat on behalf of the People's Republic of China
CCAMLR-XXXII/07	Notification of the Republic of Korea's intention to participate in the krill fishery in 2013/14 Submitted by the Secretariat on behalf of the Republic of Korea
CCAMLR-XXXII/08	Notification of Norway's intention to participate in the krill fishery in 2013/14 Submitted by the Secretariat on behalf of Norway

CCAMLR-XXXII/09	Notification of Poland's intention to participate in the krill fishery in 2013/14 Submitted by the Secretariat on behalf of Poland
CCAMLR-XXXII/10	Notification of Ukraine's intention to participate in the krill fishery in 2013/14 Submitted by the Secretariat on behalf of Ukraine

Appendix D

REVISED INFORMATION REQUIREMENTS FOR NOTIFICATIONS FOR KRILL FISHERIES

Replacement for Annex 21-03/A

NOTIFICATION OF INTENT TO PARTICIPATE IN A FISHERY FOR *EUPHAUSIA SUPERBA*

General information

Member: _____

Fishing season: _____

Name of vessel: _____

Expected level of catch (tonne): _____

Intended fishing subareas and divisions

This conservation measure applies to notifications of intentions to fish for krill in Subareas 48.1, 48.2, 48.3 and 48.4 and Divisions 58.4.1 and 58.4.2. Intentions to fish for krill in other subareas and divisions must be notified under Conservation Measure 21-02.

Subarea/Division	
48.1	
48.2	
48.3	
48.4	
58.4.1	
58.4.2	

Fishing technique: □ Conventional trawl
□ Continuous fishing system
□ Pumping to clear codend
□ Other method: Please specify _____

Product types and methods for direct estimation of green weight of krill caught

Product type	Method for direct estimation of green weight of krill caught, where relevant (refer to Annex 21-03/B)[1]
Whole frozen	
Boiled	
Meal	
Oil	
Other product, please specify	

[1] If the method is not listed in Annex 21-03/B, then please describe in detail _____

Net configuration

Net measurements	Net 1		Net 2		Other net(s)	
Net opening (mouth)						
Maximum vertical opening (m)						
Maximum horizontal opening (m)						
Net circumference at mouth (m)						
Mouth area (m^2)						
Panel average mesh size[1] (mm)	Outer[2]	Inner[2]	Outer[2]	Inner[2]	Outer[2]	Inner[2]
1st panel						
2nd panel						
3rd panel						
…						
Final panel (Codend)						

[1] Inside measurement of stretched mesh based on the procedure in Conservation Measure 22-01.
[2] Size of outer mesh, and inner mesh where a liner is used.

Net diagram(s): _____

For each net used, refer to the relevant net diagram in the CCAMLR fishing gear library if available (www.ccamlr.org/node/74407), or submit a detailed diagram and description to the forthcoming meeting of WG-EMM.

Marine mammal exclusion device

Device diagram(s): _____

For each type of device used, refer to the relevant diagram in the CCAMLR fishing gear library if available (www.ccamlr.org/node/74407), or submit a detailed diagram and description to the forthcoming meeting of WG-EMM.

Collection of acoustic data

Provide information on the echosounders and sonars used by the vessel.

Type (e.g. echosounder, sonar)			
Manufacturer			
Model			
Transducer frequencies (KHz)			

Collection of acoustic data (detailed description): _____

Outline steps which will be taken to collect acoustic data to provide information on the distribution and abundance of E. superba *and other pelagic species such as myctophiids and salps (SC-CAMLR-XXX, paragraph 2.10).*

Vessel information

Conservation Measure 10-02, paragraph 3*

(i)	Name of fishing vessel Previous names (if known) Registration number IMO number (where relevant) External markings Port of registry	
(iii)	Previous flag (if any)	
(iv)	International radio call sign	
(v)	Name of vessel owner(s) Address of vessel owner(s) Name of beneficial owner(s) (if different from vessel owner(s)) Address of beneficial owner(s)	
(vi)	Name of licence owner (if different from vessel owner(s)) Address of licence owner	
(vii)	Type of vessel	
(viii)	Where was vessel built When was vessel built	
(ix)	Vessel length overall LOA (m)	
(x)	12 × 7 cm colour photographs • 1 × starboard side of the vessel • 1 × port side of the vessel • 1 × stern view	*Ensure side photographs display the full overall length and complete structural features of the vessel and the stern photograph is taken directly from astern; include these in the section 'Supporting Documentation'*
(xi)	Details of the implementation of the tamper-proof requirements of the satellite monitoring device installed on board	

* Information referred to in paragraph 3(ii) is not required (CM 21-03, paragraph 2)

Conservation Measure 10-02, paragraph 4 (to the extent practicable)

(i)	Name of operator (if different from vessel owner(s)) Address of operator
(ii)	Names and nationality of master and, where relevant, of fishing master
(iii)	Type of fishing method(s)
(iv)	Vessel beam (m)
(v)	Vessel gross registered tonnage
(vi)	Vessel communication types and numbers (INMARSAT A, B and C)
(vii)	Normal crew complement
(viii)	Power of main engine(s) (kW)
(ix)	Carrying capacity (tonne) Number of fish holds Capacity of all holds (tonne)
(x)	Any other information in respect of each licensed vessel that is considered appropriate (e.g. ice classification) for the purposes of the implementation of the conservation measures adopted by the Commission

GUIDELINES FOR ESTIMATING THE GREEN WEIGHT OF KRILL CAUGHT

Method	Equation (kg)	Parameter			
		Description	Type	Estimation method	Unit
Holding tank volume	$W*L*H*\rho*1\ 000$	W = tank width	Constant	Measure prior to fishing	m
		L = tank length	Constant	Measure prior to fishing	m
		ρ = density of the sample	Variable	Volume-to-mass conversion	kg/litre
		H = depth of krill in tank	Haul-specific	Direct observation	m
Flow meter	$V*F_{krill}*\rho$	V = volume of krill and water combined	Haul[1]-specific	Direct observation	litre
		F_{krill} = fraction of krill in the sample	Haul[1]-specific	Flow meter volume correction	-
		ρ = density of krill in the sample	Variable	Volume-to-mass conversion	kg/litre
Flow scale	$M*(1–F)$	M = mass of krill and water combined	Haul[1]-specific	Direct observation	kg
		F = fraction of water in the sample	Variable	Flow scale mass correction	-
Plate tray	$(M–M_{tray})*N$	M_{tray} = mass of empty tray	Constant	Direct observation prior to fishing	kg
		M = mean mass of krill and tray combined	Variable	Direct observation, prior to freezing with water drained	kg
		N = number of trays	Haul-specific	Direct observation	-
Meal conversion	$M_{meal}*MCF$	M_{meal} = mass of meal produced	Haul-specific	Direct observation	kg
		MCF = meal conversion factor	Variable	Meal to whole krill conversion	-
Codend volume	$W*H*L*\rho*\pi/4*1\ 000$	W = codend width	Constant	Measure prior to fishing	m
		H = codend height	Constant	Measure prior to fishing	m
		ρ = density of the sample	Variable	Volume-to-mass conversion	kg/litre
		L = codend length	Haul-specific	Direct observation	m
Other	*Please specify*				

[1] Individual haul when using a conventional trawl, or two-hour period when using the continuous fishing system

Observation steps and frequency

Holding tank volume	
Prior to fishing	Measure the width and length of the holding tank (if the tank is not rectangular in shape, then additional measurements may be required)
Every month[1]	Estimate the volume-to-mass conversion derived from the drained mass of krill in a known volume (e.g. 10 litres) taken from the holding tank
Every haul	Measure the depth of krill in the tank (if krill are held in the tank between hauls, then measure the difference in depth)
	Estimate the green weight of krill caught (using equation)
Flow meter	
Prior to fishing	Ensure that the flow meter is measuring whole krill (i.e. prior to processing)
Every month[1]	Estimate the volume-to-mass conversion derived from the drained mass of krill in a known volume (e.g. 10 litres) taken from the flow meter
Every haul[2]	Obtain a sample from the flow meter and: measure the volume of krill and water combined estimate the flow meter volume correction derived from the drained volume of krill
	Estimate the green weight of krill caught (using equation)
Flow scale	
Prior to fishing	Ensure that the flow scale is measuring whole krill (i.e. prior to processing)
Every haul[2]	Obtain a sample from the flow scale and: measure the mass of krill and water combined estimate the flow scale mass correction derived from the drained mass of krill
	Estimate the green weight of krill caught (using equation)
Plate tray	
Prior to fishing	Measure the mass of the tray (if trays vary in design, then measure the mass of each type)
Every haul	Measure the mass of krill and tray combined
	Count the number of trays used (if trays vary in design, then count the number of trays of each type)
	Estimate the green weight of krill caught (using equation)
Meal conversion	
Every month[1]	Estimate the meal to whole krill conversion by processing 1 000 kg (drained mass) of whole krill
Every haul	Measure the mass of meal produced
	Estimate the green weight of krill caught (using equation)
Codend volume	
Prior to fishing	Measure the width and height of the codend
Every month[1]	Estimate the volume-to-mass conversion derived from the drained mass of krill in a known volume (e.g. 10 litres) taken from the codend
Every haul	Measure the length of codend containing krill
	Estimate the green weight of krill caught (using equation)

[1] Measured monthly; a new monthly period will commence when the vessel moves to a new subarea or division

[2] Individual haul when using a conventional trawl, or two-hour period when using the continuous fishing system