

**Report of the Meeting of the Working Group
on Statistics, Assessments and Modelling**
(Norwich, UK, 25 to 29 June 2018)

Contents

	Page
Introduction and opening of the meeting	169
Adoption of the agenda and organisation of the meeting	169
Assessments to estimate sustainable yield in established/assessed fisheries	169
Development of management advice consistent with Article II for fisheries with more limited data	171
Data acquisition and management	173
Data Management Group update	175
Review of research plan proposals and results	176
Generic advice for research plans	176
Spatial context of Area 48 fisheries	177
Tool for analysis of sea-ice distribution	178
Proposals and research results from Area 48	178
Proposals and research results from Subarea 48.1	178
Proposals and research results from Subareas 48.2 and 48.4	179
Proposals and research results from Subarea 48.6	180
Proposals and research results from Subarea 58.4	181
Proposals and research results from Division 58.4.1 and 58.4.2	181
Proposals and research results from Division 58.4.3a	182
Proposals and research results from Division 58.4.4b	183
Review of research proposals and results for Subarea 88.1	183
Review of research proposals and results for Subarea 88.3	187
Future work	188
Other business	188
Advice to the Scientific Committee	189
Adoption of report and close of meeting	190
Reference	190
Table	191
Figure	193
Appendix A: List of Participants	194
Appendix B: Agenda	198
Appendix C: List of Documents	199

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Introduction and opening of the meeting

1.1 The 2018 meeting of WG-SAM was held at the University of East Anglia (UEA), Norwich, UK, from 25 to 29 June 2018. The meeting Convener, Dr S. Parker (New Zealand), welcomed participants (Appendix A). The meeting was hosted by Cefas and in welcoming participants to the meeting, Dr Stuart Rogers (Cefas Chief Scientist) highlighted the important relationship between Cefas and UEA in delivering high impact applied science to support fisheries. He wished participants every success in their meeting and an enjoyable stay in Norwich.

Adoption of the agenda and organisation of the meeting

2.1 Dr Parker reviewed the provisional agenda and the terms of reference for WG-SAM and highlighted that the priorities identified by the Scientific Committee for the work of WG-SAM should form the main part of the work of the Working Group. The meeting agenda was adopted (Appendix B).

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

2.3 In this report, paragraphs that provide advice to the Scientific Committee and its other working groups have been indicated in grey. A summary of these paragraphs is provided in Item 9.

2.4 The report was prepared by M. Belchier and C. Darby (UK), A. Dunn (New Zealand), T. Earl (UK), C. Jones (USA), S. Mormede (New Zealand), C. Péron (France), K. Reid (Secretariat), M. Söffker (UK) and D. Welsford (Australia).

Assessments to estimate sustainable yield in established/assessed fisheries

3.1 The Working Group noted WG-SAM-18/14 and 18/P01 outlining the increased capabilities and flexibility of the Casal2 assessment software compared to the CASAL software currently used to provide management advice, and comparing performance in the Ross Sea region. The Working Group recalled its previous advice on the steps to be undertaken for validating stock assessment software (SC-CAMLR-XXXIII, Annex 5, paragraphs 2.26 to 2.29), and recognised the work already undertaken towards this. The Working Group recommended that in order to further validate the software, Casal2 models could be run in 2019 and compared with the 2019 CASAL assessment.

3.2 The Working Group noted that due to the modular nature of the software, consideration would need to be given to how validations of software versions would be undertaken. This may include incorporating current toothfish assessments within the software test suite to ensure quality control of updated software versions. The Working Group invited Members to participate by working intersessionally to look at the software and code on GitHub (<https://github.com/NIWAFisheriesModelling/CASAL2>), report errors or issues, test the software with current assessments, and to contribute additional unit tests and tests suites to the code base.

3.3 The Working Group noted WG-SAM-18/22, which discussed ways of incorporating trends in productivity parameters and parameter variability that may be related to changes in environmental conditions into future assessments and management. The Working Group noted the importance of potential environmental variability on the early stages of larval development, which will affect the level of recruitment estimated by the assessment models, and highlighted the importance of collecting data through egg and larval surveys to gain information on recruitment patterns of toothfish.

3.4 The Working Group recommended that WG-FSA consider updating CCAMLR's Fishery Reports to include a section on changes in model parameters and productivity assumptions, and that this section consider the impact of observed changes in biological parameters on management advice. The Working Group noted that the parameters that could be evaluated could include mean recruitment, recruitment variability, mean length at age, mean weight at length, natural mortality and maturation ogives. The Working Group encouraged Members to develop methods that can be used to evaluate the importance of observed changes on resulting advice.

3.5 The Working Group noted that CASAL has a limited capacity to model changes in productivity parameters (other than growth and recruitment), but that Casal2 (paragraph 3.1) can allow such changes to be incorporated. Changes in these parameters may lead to revised estimates of initial and current biomass, and yields, and hence the advice resulting from the CCAMLR decision rules. The Working Group noted that changes in the productivity parameters used in the assessment can be based on observations without an underlying hypothesis about the cause of the changes, but that such a hypothesis is required to choose the appropriate parameters for projections as used in the CCAMLR decision rule. Further work is required to consider the methods of incorporating this into projections. Sensitivity testing or management strategy evaluation would be informative to determine whether the decision rules remain precautionary under different assumptions about future potential changes in productivity parameters.

3.6 The Working Group noted the draft report from the Independent Stock Assessment Review for Toothfish (SC-CAMLR-XXXVII/02) and thanked the Convener, the independent experts and the participants for the thorough review. The Working Group noted that the review had concluded that the current assessment methodology is appropriate for the management of these stocks, and that the review panel had recognised the large body of ongoing work that has contributed to the assessments. The Working Group welcomed the suggestions for areas of future work to further develop these assessments and encouraged Members presenting stock assessments to address these.

3.7 The Working Group welcomed the acknowledgement by the review panel that CCAMLR was a leader in the use of tagging data in stock assessments, and that the review

panel had noted that the approach to resolve differences in tagged fish survival and tag-detection rates between vessels in the Ross Sea region assessment was appropriate. The Working Group recommended Members continue to develop approaches to reduce differences in tagged fish survival and tag-detection rates between vessels.

3.8 The Working Group noted that advances in pop-up satellite archival tag (PSAT) tagging technology may allow for updated estimates of tagging mortality, and that analysis of tag recaptures at length may allow for estimation of ongoing tag mortality and identification of size-dependant survival. The Working Group noted that increasing scientific electronic monitoring using video cameras would provide insights into the relative importance of vessel procedure and environmental effects on tagged fish survival and tagged fish detection. The Working Group noted that conclusions drawn from vessel performance comparisons in assessed fisheries may be useful for informing the evaluation of research proposals.

3.9 The Working Group recommended the development of spatial overlap statistics to assist in evaluating the prospects of informative estimates of biomass being created from a proposed tagging program. The Working Group noted that improvements in tagging performance in individual vessels may provide useful insights that can be applied to improve the performance of all vessels, but recognised that changing tag performance adds additional complexity when compiling tagging data time series to estimate stock size.

3.10 The Working Group noted WG-SAM-18/34 which outlined a standard set of diagnostics that should be presented for icefish assessments, building on the work of WG-FSA-17 (SC-CAMLR-XXXVI, Annex 7, paragraphs 3.13 and 3.14).

3.11 The Working Group welcomed the work, and recommended that the diagnostics be included in the annual Fishery Reports for icefish and that Members continue to work to standardise the information presented in the assessment papers and Fishery Reports for toothfish assessments.

Development of management advice consistent with Article II for fisheries with more limited data

4.1 Following the recommendation by the Scientific Committee that the qualitative approach to setting catch limits in data-poor and research block fisheries developed by WG-FSA-17 should be tested and further developed, WG-SAM-18/23 presented a quantitative approach, formalising and coding the rules set out by WG-FSA-17. The paper presented results from a simulation approach examining the performance of the trend analysis rules through different scenarios of population abundances, uncertainty in biomass estimates and abundance trends. The paper concluded that the trend analysis rules performed well, and increased or decreased catch limits with increasing or decreasing simulated populations.

4.2 The Working Group noted that the qualitative assessment of trends and slopes by WG-FSA-17 was replicated in a quantitative approach, and advice on catch limits and trends in stock trajectory was almost identical when using the linear method or the ‘two-over-three’ method in these simulations. As the linear method allows the estimation to be performed when data for some years are not available, the Working Group considered that this method was more widely applicable, and should be used.

4.3 The Working Group noted that the trend analysis method was still in the early stages in the process of formalisation and testing, however, was confident that the method in its current form was an improvement over previous approaches to setting catch limits in data-poor and research block fisheries. The Working Group recommended further work to ensure that the advice derived was consistent with CCAMLR objectives, including:

- (i) a management strategy evaluation, in particular including sampling error and model misspecification, would provide more information about the performance of the method, and potentially identify situations where an alternative method would be preferable
- (ii) using data from the research fisheries directly could show different results from the linear regression component of the method – this step would require further method development and testing to ensure it considers the full suite of decisions carried out when calculating the biomass
- (iii) test how the trend analysis rules perform with different coefficients of variation (CVs) and biomass estimate distributions, different catch-per-unit-effort (CPUE) and variable tag returns, and research-block specific simulations, as well as different scenarios where populations change in response to catches and overall management approaches
- (iv) further work is needed to address uncertainties around tagging and CPUE-based biomass estimates, as they drive the algorithm to the specified bounds in decreasing or increasing catch limits
- (v) statistically test between apparently conflicting trends in biomass point estimates, and test for significant differences between tag-based and CPUE-by-seabed based approaches.

4.4 The Working Group noted that the trend analysis rule to determine whether the trend was increasing, decreasing, stable, or uncertain, as described in WG-SAM-18/23, was applied during the meeting to the 2017 biomass estimates calculated by the Secretariat. Results were presented to the Working Group and showed that the management advice would have been identical to that reached at WG-FSA-17. The method was shown to provide almost identical results when using a slope definition of ± 0.15 instead of ± 0.1 .

4.5 The Working Group recommended the above approach be used with a slope value of ± 0.1 , noting no change in the slope determination as a result of biomass CVs of 0.2 or 0 and that this method be used to provide management advice for setting catch limits in research blocks.

4.6 The Working Group requested that the Secretariat calculate biomass estimations and corresponding slopes for each research block for WG-FSA-18 based on this approach, including methods to incorporate the CV of each biomass estimate used in the determination of slope for the trends in biomass for discussion at WG-FSA-18.

4.7 The Working Group recalled that in the past, it had highlighted that using tag-based assessments would be preferable over CPUE-by-seabed approaches in exploratory and data-poor fisheries (SC-CAMLR-XXX, Annex 5), however, that the success of recapturing tagged fish is variable between fisheries and that tagging performance metrics vary among vessels. It noted that simulations should be carried out to determine the number of tagged fish and tag

recaptures considered sufficient to move to tag-based biomass calculations, and to examine tagging mortality and tag-detection performance and their effects on biomass estimation in data-poor fisheries.

Data acquisition and management

5.1 WG-SAM-18/20 provided results of a pilot study using a scientific electronic monitoring system that collects video data from three cameras along with time-linked sensor data on vessel operations and location.

5.2 The Working Group agreed that the system worked well in this pilot study, and has the potential to assist in improving the accuracy and quality of data recording, with an added benefit of allowing observers more time for biological and other sampling by reducing the time spent on tasks such as line setting observations, determining species mix, or size compositions.

5.3 The Working Group acknowledged that there are several vessels fishing in the Convention Area that are currently using systems similar to this, and some have low-light and thermal cameras that can detect seabirds prior to and during setting operations. The Working Group noted that whilst the initial cost of setting up such an integrated system on a vessel is significant, it is relatively minimal thereafter. The Working Group agreed that these sorts of systems showed great promise to support observers in their Scheme of International Scientific Observation (SISO) duties, and encouraged other Members to explore the use of scientific electronic monitoring on their vessels.

5.4 WG-SAM-18/24 provided a review of the toothfish tagging procedures on four Ukrainian vessels (*Calipso*, *Koreiz*, *Marigolds* and *Simeiz*) in the 2017/18 fishing season. The Working Group noted the tagging procedure of each vessel in relation to the factory location, the container of water designed to hold the fish before tagging, tagging tables and the distance fish are transported through the vessel during the tagging procedure.

5.5 The Working Group noted that the presentation of results accompanying WG-SAM-18/28 included a description of squid depredation on a tagged toothfish after it was released and noted that at present, knowledge on depredation by squid was based on anecdotal accounts and SISO reports. The Working Group recalled WG-FSA-15/07, which provides guidance on how to identify signs of depredation from different species, including giant and colossal squid. The Working Group encouraged Members to develop approaches to quantify the occurrence of squid depredation, including observations of post-capture mortality due to squid.

5.6 The Working Group inquired as to the utility and purpose of using holding tanks during the toothfish tagging process, as opposed to immediately tagging and releasing the selected toothfish. Dr L. Pshenichnov (Ukraine) clarified that fish can be held for a time to determine their condition and suitability for tagging, as some specimens may be more appropriate to retain than release. The Working Group agreed that it would be valuable to evaluate the use of holding tanks in relation to fish handling and tagging best practices.

5.7 The Working Group recommended that WG-FSA consider including a record of whether a vessel uses holding tanks, as well as the characteristics of the tank and water supplied, as part of its tagging procedure in future notifications, as this may assist in understanding variability in tag performance between vessels.

5.8 The Working Group recommended that the Scientific Committee consider holding a focus topic or workshop on toothfish tagging practices to better inform tagging practices by all Members fishing in the Convention Area, as these data serve as a primary driver underpinning current stock assessments of toothfish. Such a focus topic could be held during an off-assessment year under CCAMLR's current biennial toothfish assessment practice and could benefit from invited experts on fish handling procedures.

5.9 WG-SAM-18/27 described a preliminary analysis of oceanographic measurements collected on Ukrainian vessels undertaking research during the 2017/18 season. This initiative deployed compact microprocessor-controlled salinity, temperature, depth recorders (CTDs) on longlines. It was noted that Ukraine intends to undertake further analysis of these trials, and these results will be submitted to WG-FSA.

5.10 The Working Group noted that these compact CTDs provide useful information in relation to broad differences in habitats and water column physical characteristics used by toothfish. However, these compact CTDs need to be calibrated.

5.11 The Working Group agreed that it would be very useful to undertake comparisons of these and other compact CTD loggers paired with more sophisticated and precise CTD instrumentation to characterise their performance and nature of potential data errors collected with these CTDs.

5.12 The Working Group recommended that this information be made available or brought to the attention of established data infrastructures such as SCAR/SCOR through the Southern Ocean Observing System (SOOS), or PANGAEA.

5.13 WG-SAM-18/19 introduced a research proposal designed to collect information on catchability of longlines on toothfish by sampling an area with both bottom trawl and longline gear types.

5.14 The Working Group noted that there have been considerable difficulties catching toothfish with bottom trawls in previous research cruises. Further, there appear to be species- and size-specific difficulties catching toothfish with bottom trawl. Previous efforts have demonstrated little success catching Antarctic toothfish (*Dissostichus mawsoni*) relative to Patagonian toothfish (*D. eleginoides*), as well as difficulties catching larger toothfish possibly due to differences in vertical distribution or avoidance behaviour.

5.15 Comparisons of bottom trawl versus longline catchability are further complicated due to other factors that influence longline performance such as gear type, number of hooks, depth, soak time etc. The Working Group noted that there could also be substantial benthic impacts while undertaking such an experiment.

5.16 The Working Group noted that during previous exploratory fishing trials using bottom trawls to catch toothfish, very few were caught, although the method represents an effective way to sample other demersal species often caught by longlines, such as macrourids. These trials demonstrated no clear relationship between what was caught in the trawl versus what is captured with longlines.

5.17 The Working Group recommended that prior to undertaking such comparisons, it would be valuable to review previous efforts and trials using bottom trawls to catch toothfish in the Convention Area. Examples of such trials are described in WG-SAM-15/34, WG-FSA-12/51, WG-FSA-08/56 and van Wijk et al. (2000).

5.18 WG-SAM-18/18 described a photographic reference set of otoliths for *D. mawsoni* from the Ross Sea region. Two photographs are provided for each prepared otolith (one unaltered, and one with the location of each counted annulus indicated). Each otolith is linked to an Excel spreadsheet that provides associated metadata.

5.19 The Working Group welcomed the material provided in WG-SAM-18/18 and recalled that there are other reference sets (such as for *D. eleginoides*) that are either available, or could be made available for training purposes, or to verify consistency between readings.

5.20 The Working Group requested that the Secretariat develop a central repository for reference sets of otoliths provided by Members to facilitate access to reference sets, along with manuals associated with the preparation of otoliths included in the reference set.

5.21 WG-SAM-18/29 provided a summary of information on otolith ageing methodology of *Dissostichus* spp. by Ukrainian scientists and included descriptions of equipment and procedures for processing and reading ages from otoliths.

5.22 The Working Group welcomed this work and noted that there are a variety of methodologies that can be employed to prepare and age *Dissostichus* spp. otoliths. Dr Welsford invited Members with an interest in otolith ageing to contact the Australian Antarctic Division and visit Hobart, potentially just prior to WG-FSA, as an opportunity to compare methodologies between Members.

Data Management Group update

5.23 The Data Management Group (DMG) was first established in 2017 as an e-group. The current Convener of the DMG, Dr C. Reiss (USA), provided a summary of the intersessional activities of the DMG. The Working Group recalled that the role of the DMG is to be a conduit between CCAMLR data users and the Secretariat, and to provide feedback and advice on:

- (i) communication of information on data and metadata management and development
- (ii) development of data quality standards and rules
- (iii) development of data infrastructure, including data submission processes
- (iv) provision of data extracts to Members
- (v) development of data analysis tools.

5.24 The Working Group noted that the e-group discussions summarised by the Convener of the DMG concerned 12 points, primarily in relation to quality assurance/quality control, automatic updates to the database, and whether data that Members requested had been adequate. Other issues raised in the e-group included other data-related activities such as electronic web-based Catch Documentation Scheme for *Dissostichus* spp. (e-CDS) data. There was some concern that this data may take precedence over Scientific Committee data issues, and the Convener underscored that it was important to have an optimal balance between the requirements of various data users.

5.25 The Working Group recalled the origins of the request to form a DMG (SC-CAMLR-XXXV, Annex 5, paragraphs 2.15 to 2.20, 5.7, 5.14, 5.15 and 6.8) and emphasised that its priorities lie with points i–v of the terms of reference, and was mindful that the DMG should focus on addressing some of the high-priority items outlined in the DMG e-group.

5.26 The convener of the DMG requested additional engagement and structured, specific feedback from all data end users in relation to progress and evaluation of paragraphs 5.23(i–v) above.

5.27 The Working Group received a report from the CCAMLR Executive Secretary on the status of data management. The Working Group noted the Secretariat’s recognition that data management represents one of the key services it provides to CCAMLR, and that it has embarked on a program to respond to feedback and advice from the DMG. Specific feedback to the Secretariat stressed the need for transparency about the process, and the need to ensure integrity of the data.

5.28 The Working Group noted that preliminary work has been undertaken to establish the roles and responsibilities of different departments within the Secretariat in respect of the wide range of data that are held by the Data Centre. These data include:

- (i) catch and effort data
- (ii) data on compliance and management
- (iii) scientific data
- (iv) administrative data.

5.29 It was noted that roles and responsibilities will be defined in relation to data acquisition, entry, integrity, storage and extraction. The establishment of roles will be followed by documentation of processes, particularly the processes for engagement with data owners and data users and the development of data quality and integrity checks and algorithms. Dialogue with the DMG will be maintained throughout.

5.30 The Convener of the DMG noted that additional consideration from the e-group would be forthcoming as the Secretariat implements the elements of the new data systems. The Working Group recognised that the Secretariat is updating the data management in a way that data integrity is maintained, and that datasets will continue to increase in size and scope. The Working Group requested that a timeline of progress on the data systems be provided to Members.

Review of research plan proposals and results

Generic advice for research plans

6.1 In respect of the research plans involving toothfish, the Working Group recommended that:

- (i) research proposals provide a summary of previous WG-SAM, WG-FSA and Scientific Committee recommendations within their proposals, and describe how the proposal has addressed these points when these proposals are submitted to WG-FSA

- (ii) all research plans submit a summary table comprising the applicable milestones of the research from the beginning of the plan, planned and actual achievement dates, papers submitted, and noting any changes in the milestone time tabling to assist the working groups in evaluating research plan performance and progress towards objectives (e.g. Table 1)
- (iii) all research proposals provide a clear summary of the start of the program, the end date and the years that the current proposal covers
- (iv) a summary of the information required to complete Table 1 of Conservation Measure (CM) 24-05 including the specific conservation measures from which an exemption is required to conduct the research be included
- (v) by-catch should be recorded to the highest taxonomic resolution, in particular for macrourids and icefishes, where good identification guides exist
- (vi) tag-overlap statistics be reported at the scale of the research block and at the scale required in CM 41-01 in order to address possible confounding effects of spatial differences in toothfish length frequency
- (vii) greater clarity be provided in demonstrating the linkage between research objectives and the development and testing of stock hypotheses
- (viii) the objectives of the research plans be described in terms of outcomes instead, with data collection as a means to achieving the outcomes.

6.2 The Working Group also noted that there was considerable variability in the timeframes over which future research programs were notified. The Working Group requested that the Scientific Committee consider how research timeframes could be standardised.

6.3 The Working Group recognised the potential for differences in the interpretation of the need for an exemption from conservation measures under CM 24-01 for different research activities involving Antarctic marine living resources. The Working Group requested the Scientific Committee to review the objectives and provisions of CM 24-01 and provide clear guidance to Members on appropriate criteria for the application of this measure.

Spatial context of Area 48 fisheries

6.4 The Working Group considered SC-CAMLR-XXXVII/01, the report of the Co-conveners of the CCAMLR Workshop for the Development of a *Dissostichus mawsoni* Population Hypothesis for Area 48 held from 19 to 21 February 2018 in Berlin, Germany, and noted that the main outputs of the Workshop were three alternative stock hypotheses which are provided in the report's annex (WG-SAM-18/33 Rev. 1).

6.5 The Working Group thanked the Co-conveners Drs Darby and Jones and all participants for their valuable contributions to the Workshop and, in particular, thanked Dr Söffker for her major contribution in preparing the annex containing the extensive background information developed through the Development of a *D. mawsoni* Population Hypothesis for Area 48 e-group and considered at the Workshop, as well as the subsequent outputs including detailed figures of the different stock hypotheses.

6.6 The Working Group noted that the meeting had been very productive and demonstrated that focussed meetings to consider specific questions were useful. The Working Group noted that such targeted meetings could be convened within the current working group structure rather than adding additional meetings to the annual Scientific Committee meeting schedule.

6.7 The Working Group noted that a key priority arising from the Workshop was the development of egg and larval dispersal models. Such modelling could be carried out as ‘desktop’ research without the need for further on-water research activities. The Working Group recognised that extensive modelling of krill transport and dispersion had been undertaken in Area 48 and should form a good basis for any future *D. mawsoni* studies. It was noted that egg and larval sampling could be carried out by plankton tows undertaken by fishing vessels.

6.8 The Working Group recommended that future toothfish research in the region should address the data gaps and hypotheses highlighted at the Workshop and this should be incorporated into Members’ research plans within Area 48.

Tool for analysis of sea-ice distribution

6.9 The Working Group considered WG-SAM-18/01 which described the development by German scientists of a statistical ‘decision support’ tool for retrospective analysis of fishing ground accessibility in the Weddell Sea. The Working Group thanked the authors for providing information on this very useful development and noted that it could be used to assess trends in size and location of areas of ice-free waters with high productivity used by foraging predators, as well as assisting in the planning of potential fisheries research in the region.

6.10 The Working Group noted that the development of an interactive user interface gave the tool great flexibility and the use of ‘sliders’ meant that it was possible to investigate the differences in accessibility to a given area by vessels with different classes of ice strengthening and at any given period. The author’s clarified that ‘accessibility’ was calculated on a daily basis.

6.11 The Working Group noted that the tool could be used for planning aspects of research in many disciplines in the Weddell Sea and that it could also be used to assess longer-term trends in accessibility in the region. The Working Group looked forward to using the tool and would be able to provide feedback on its use to the developers once available.

Proposals and research results from Area 48

Proposals and research results from Subarea 48.1

6.12 WG-SAM-11/18 was presented describing a proposal by Ukraine to conduct research on *D. mawsoni* in Subarea 48.1.

6.13 The Working Group recalled discussions at WG-FSA-17 (SC-CAMLR-XXXVI, Annex 7, paragraphs 4.53 to 4.55) and SC-CAMLR-XXXVI (SC-CAMLR-XXXVI, paragraphs 3.83 and 3.85) regarding a similar proposal by Ukraine in 2017. It requested clarification as to how the new proposal had taken account of these discussions.

6.14 Dr K. Demianenko (Ukraine) noted that the vessel proposed now had experience of operating in the CCAMLR area, and that it had documented tagging procedures on board, addressing concerns expressed in 2017. He also noted that the vessel intended to conduct plankton tows and CTD casts during research fishing.

6.15 The Working Group agreed that several substantial issues identified in WG-FSA-17 and the Scientific Committee still remained to be addressed before the Ukrainian proposal was suitable to be assessed according to the checklist developed at WG-FSA-17 (e.g. SC-CAMLR-XXXVI, Annex 7, Table 4). It also requested that information in the proposal be structured so that the research plan checklist could be easily completed by WG-FSA-18. It further noted that the research plan should take account of the new CM 24-05 which applies to research notified under CM 24-01. Dr Demianenko agreed to provide a revised proposal addressing all these points to WG-FSA-18.

Proposals and research results from Subareas 48.2 and 48.4

6.16 WG-SAM-18/13, summarising the results from a third year of research fishing for *D. mawsoni* by Ukraine in Subarea 48.2, and WG-SAM-18/28, describing the plan for the fourth year of research under the plan, were presented.

6.17 The Working Group noted that the majority of information presented in the results related to toothfish. It recalled that the proposal indicated that there would be detailed studies of by-catch species, seabirds and mammals observed during the research. It noted that as these studies had been planned, and the research was now in its fourth year, they should be presented to WG-FSA-18. It also recalled that WG-FSA-17 had provided specific recommendations on reporting (SC-CAMLR-XXXVI, Annex 7, paragraphs 4.45 to 4.49) from this research plan, and recommended that a paper be submitted to WG-FSA-18 addressing those points. It further recommended that length-frequency data in research reports should be catch weighted if every fish is not measured from the catch, and that the CCAMLR GIS could be used to present maps of sampling stations. It also requested that the proposal include reporting against research milestones to enable WG-FSA-18 to assess how the research was progressing towards its objectives.

6.18 WG-SAM-18/26 was presented summarising results from a longline survey conducted by Chile in the northern area in Subarea 48.2. The Working Group noted that the research fishing had not achieved its planned objectives as the vessel had ceased fishing due to low catch rates and operational difficulties. It further noted that there was no proposal for Chile to continue research in Subarea 48.2. It therefore requested the proponents of the Ukrainian research consider the impact of Chile's withdrawal on progress towards the objectives of its research plan in Subarea 48.2.

6.19 WG-SAM-18/15, summarising the second year of study by the UK to determine connectivity between toothfish populations in Subareas 48.2 and 48.4, and WG-SAM-18/30, describing the plan for the third year of research under the plan, were presented. The Working Group noted that the research was proceeding according to plan with 3 years of data collection to be followed by 2 years of data analysis. It noted that in the third year, two stations would be moved to sample fishable grounds with lower risk to lost gear, and cameras would be deployed on the fishing gear. The Working Group noted that under the current sampling design, the two

vessels involved sampling stations such that temporal and spatial effects on catch and by-catch may be confounded. It therefore recommended that sampling in the forthcoming season address this issue, for example by randomly allocating sampling stations to vessels. It also recommended that the species composition of Macrourid by-catch be determined to the finest taxonomic resolution possible.

6.20 WG-SAM-18/25 was presented summarising results from a demersal finfish survey conducted by Chile in the northern area of Subarea 48.1 and Subarea 48.2, including collection of biological data, parasites and tissue samples from 21 species of notothenioids.

6.21 The Working Group noted that the survey stations in Subarea 48.1 were unable to be completed due to a large catch (33 tonnes) of mackerel icefish (*Champscephalus gunnari*) taken during a target trawl of an acoustic mark, and the stations in Subarea 48.2 could not be completed due to time constraints. Consequently, the demersal trawl data was unsuitable to develop robust biomass estimates, however, it did indicate that marbled rockcod (*Notothenia rossii*) was the dominant species on the Elephant Island Shelf, and catches of small juvenile *C. gunnari* (~10 cm) on the western shelf of Elephant Island in depths <100 m during this survey have been observed in previous surveys in this region, indicating the presence of a nursery area for this species.

6.22 The Working Group noted that there was no plan for Chile to conduct surveys in this region in the next season, however, the acoustic data collected would be further analysed and presented to WG-FSA-18, and future surveys are being considered.

Proposals and research results from Subarea 48.6

6.23 The Working Group considered three papers relating to research plans and results of research conducted in Subarea 48.6, including a summary of results from research fishing carried out by Japan and South Africa (WG-SAM-18/32), a joint proposal by Japan and South Africa to continue the research in Subarea 48.6 (WG-SAM-18/04), and a new research proposal to conduct research in the exploratory longline fishery for *D. mawsoni* in Subarea 48.6 submitted by Spain (WG-SAM-18/02).

6.24 The Working Group welcomed the joint progress report on research fishing from South Africa and Japan (WG-SAM-18/04) and noted that the disaggregation of data by vessel was very useful and provided additional clarity on the distribution of fishing activities. The Working Group noted that there was little spatial overlap of vessels in some areas which made it hard to disentangle vessel and spatial effects and this should be addressed in future research plans.

6.25 The Working Group noted that catch limits had been reached in three of the four research blocks but <30% of the catch limit was taken from research block 486_4 although the Scientific Committee had previously discussed whether this block was a higher priority than research block 486_5 (SC-CAMLR-XXXV, paragraphs 2.7 (i) and (ii)). The Working Group noted that a combination of timing and coordination issues between vessels and inaccessibility of research block 486_4 due to sea-ice had led to this situation arising.

6.26 The Working Group noted a considerable amount of data had now been collected during the course of the research undertaken by Japan and South Africa in Subarea 48.6 but greater clarity was needed on what subsequent analyses were to be carried out and over what timescale.

The Working Group noted that it was difficult to track current outputs against the original milestones set out at the outset of the research. The Working Group welcomed the development of a table of milestones presented in WG-SAM-18/04 but noted the timeframe for the development of stock assessment models had been pushed back by a year. It encouraged the research proponents to collaborate on development of stock assessments as well as the on-water research activities. It was also noted that Japan had started to process otoliths from this research and anticipated that > 200 would be processed this year.

6.27 The Working Group considered a proposal by Spain to conduct research fishing in Subarea 48.6 (WG-SAM-18/02) and noted that the vessel proposed by Spain to undertake the research had a higher degree of ice strengthening than the South African or Japanese vessels that may allow better access to research blocks 486_4 and 486_5.

6.28 The Working Group noted that there was a need to consider each new research proposal in its own right, however, it was also necessary to consider what additional value and scientific knowledge the research proposal would bring to an area within which multi-Member research activity was already undertaken. The Working Group also noted that the addition of another vessel using a different gear type (Spanish longline system versus trotline) could slow progress towards the existing research objectives. The Working Group noted that there was uncertainty around the temporal overlap between Spain's proposed research and the planned activities of South Africa and Japan in the region, especially given the participation of the Spanish vessel in other fisheries and research plans.

6.29 The Working Group noted uncertainty around the process by which the Spanish proposal could be integrated with the existing research proposals from South Africa and Japan given that they are at different stages of development. The Working Group recommended that the proposal should be developed further and Spain should coordinate its research efforts with Japan and South Africa and encouraged the submission of a multi-Member proposal for consideration at WG-FSA.

Proposals and research results from Subarea 58.4

Proposals and research results from Division 58.4.1 and 58.4.2

6.30 WG-SAM-18/35 reported the initial results of the exploratory fishery in Divisions 58.4.1 and 58.4.2 in 2017/18 on behalf of all the proponents. Four trips from three Members (Australia, France and Spain) were carried out, noting that two research blocks were not sampled this year. The authors noted that extensive biological data had been collected, toothfish ageing is ongoing, and CTD and video data are now also collected. Further details of the results will be presented at WG-FSA.

6.31 The Working Group thanked the proponents for their thorough report, carried out in a replicable format using R markdown, and suggested it might form the start of a standardised fishery characterisation (paragraph 6.1). The R markdown scripts are available to Members from the Secretariat.

6.32 The Working Group noted that although two research blocks were not fished, all proponents were involved in planning and coordinating fishing operations and off-the-water research and, therefore, not attaining full catch limits did not compromise the research.

6.33 The Working Group noted movements of tagged fish between the research blocks, including the movement of a fish at liberty for eight years, tagged originally in small-scale research unit (SSRU) 881H and recovered in research block 5841_5. It noted recaptures of several tagged fish moving among research blocks and that there was potential to calculate tag loss due to movement out of research blocks as per methods developed for Divisions 58.5.1 and 58.5.2. The Working Group further noted that 14 tagged fish were recaptured in 2018 in research block 5841_2 compared to a maximum of one recapture a year in previous years, which warranted further investigation. As there is a good spatial overlap between vessels in this exploratory fishery, the Working Group recommended that the case-control estimation of effective tagging survival and effective tag-detection rates be applied to these data, and compared with the results of the same method applied in the Ross Sea region, where some of the same vessels also fish.

6.34 The Working Group noted that this exploratory fishery has accumulated enough data to investigate an integrated assessment of stock size. It further noted that it was a good case study for the transition from local area estimates of biomass in research blocks to the assessment of stock size. The proponents noted that although the area is very large, and may contain more than one stock, a fully integrated assessment was the ultimate goal. However, for this year the plan was to attempt to combine local biomass estimates from research blocks with habitat models using the method presented in WG-FSA-17/16 to provide broader-scale abundance indices.

6.35 WG-SAM-18/17 presented a four-year research proposal for exploratory fishery in Divisions 58.4.1 and 58.4.2 on behalf of all Members. Significant progress was made in the first research plan, including understanding the ecology of the target species, and by-catch. The proponents developed an approach to reviewing research blocks based on the number of tagged fish available, ice conditions and a series of other parameters to identify the best locations to further progress a stock assessment. They noted that the number of vessels notified for Divisions 58.4.1 and 58.4.2 has increased to seven, which is likely to increase the proportion of the catch limit taken and collection of data over the entire area. A more detailed research plan will be provided at WG-FSA, including research blocks to be considered.

6.36 The Working Group congratulated the proponents on the matrix of potential survey areas (Figure 1) and recommended that stock hypotheses be included in the matrix when proposing research blocks for the new proposal. The Working Group looked forward to the development of stock hypotheses being presented to CCAMLR.

6.37 The Working Group recognised that this proposal follows on from a five-year research plan with many outputs still to come and welcomed the reassurance that this plan would be reviewed in the light of newly available information.

Proposals and research results from Division 58.4.3a

6.38 WG-SAM-18/08 presented an updated research plan for research blocks 1 and 2 in Division 58.4.3a from France and Japan, proposing to continue the current research on *D. eleginoides* with an unmodified survey design.

6.39 The Working Group noted that a stock hypothesis was not included as part of this research proposal. It encouraged the development of a stock hypothesis (Table 1) for Division 58.4.3a and noted that the *D. eleginoides* found there are likely associated with the broader Kerguelen Plateau stock.

6.40 The Working Group recommended that a summary of progress and a revised research proposal be presented to WG-FSA and that it provide a summary of previous WG-SAM and WG-FSA working group and Scientific Committee recommendations, and describe how the proposal has addressed these points.

Proposals and research results from Division 58.4.4b

6.41 WG-SAM-18/31 summarised the progress of the research fishery for *D. eleginoides* in Division 58.4.4b. WG-SAM-18/03 presented an updated research plan for research blocks 1 and 2 in Division 58.4.4b, proposing to continue the current research operation with the same survey design as to date.

6.42 The Working Group noted the use of two different gear types on two different vessels, which have sometimes operated in separate locations over time. The Working Group recommended that catch and tagging results be presented for both vessels and for each vessel individually, and recalled its advice from WG-SAM-17 that recommended the use of mixed models (GLMM, GAMM) to establish whether factors such as year, vessel, or fishing location drive the observed results, or whether the patterns observed were independent of the patterns in fishing activities.

6.43 The Working Group noted the catch of 45 kg of sea pens (*Pennatulacea*) as by-catch from the research, and noted that the catch of sea pens appeared high. The Working Group requested that further information on the location(s) and amount of catch of this taxon be presented at WG-FSA in 2018.

6.44 The Working Group noted the ongoing decline in CPUE in research block 5844b_2 since the beginning of this research program, and noted that this issue should be considered by WG-FSA.

Review of research proposals and results for Subarea 88.1

6.45 The Working Group noted WG-SAM-18/21 which reviewed priority research topics and identified key attributes for fisheries-directed research programs that would be needed to evaluate the objectives of the Ross Sea region marine protected area (MPA). The authors noted that key priority research elements had been set out in CM 91-05, Annex 91-05/C, and that these should be used to provide guidance in the design of regional research program objectives. The authors outlined a set of criteria that could be used by the Scientific Committee and its working groups for ranking the quality and priority of current and future multiyear research programs:

- (i) identify which priority research elements are addressed

- (ii) explicitly integrate core concepts of good experimental design (replication, randomisation and reference areas) to ensure robust experimental results
- (iii) explain why the proposed research or data collection cannot be conducted during the exploratory fishery
- (iv) provide a detailed rationale for the choice of comparable areas
- (v) demonstrate that coordinating vessels will employ robust standardised procedures, including that the vessels involved will provide high-quality and comparable data, especially with respect to toothfish tagging performance
- (vi) demonstrate the capacity to conduct high-quality and timely off-the-water analyses necessary to utilise the data to inform the research and monitoring plan (RMP) evaluation process.

6.46 The Working Group noted that there has been confusion as to the linkage between the application of CM 24-01 and the interpretation of the regulations for the MPA special research zone (SRZ). It was noted that, while the SRZ has specific objectives as outlined in CM 91-05, there is no mechanism to separate the effects of structured research plans from the Olympic fishery and that interactions are currently highly likely and that this will likely confound the results of the research.

6.47 The Working Group therefore considered that, in addition to the criteria that it has developed for evaluating research plans, the criteria outlined in the paper were useful in guiding the Scientific Committee and its working groups in their evaluations of research within and outside of the Ross Sea region MPA and, consequently, recommended that WG-SAM-18/21 be distributed and presented at the other 2018 Scientific Committee working group meetings and to the Scientific Committee for consideration and further development of recommendations.

6.48 WG-SAM-18/09 presented a proposal for a winter survey in the north of Subareas 88.1 and 88.2. The survey follows the successful survey conducted in the Ross Sea in the winter of 2015/16. The survey will be coordinated with a survey to be conducted within the SPRFMO area adjacent to the CAMLR Convention Area at a similar time.

6.49 The survey objectives are to test three hypotheses to describe the reproductive ecology of *D. mawsoni*:

- (i) *D. mawsoni* eggs are buoyant and accumulate under sea-ice
- (ii) *D. mawsoni* spawn throughout the Pacific–Antarctic fracture zone
- (iii) biological characteristics of the northern spawning population change as younger, fatter, female fish move to the north for spawning during winter.

6.50 The aim of the survey design is to sample across the Pacific–Antarctic fracture zone of the Ross Sea region for spawning toothfish while conducting plankton tows to sample eggs and larvae during September and October. It is also proposed that five satellite tags will be deployed in collaboration with the USA.

6.51 The Working Group noted that the catch limit would need to be held back from the Olympic fishery, but that it may not be achieved in the effort-limited survey. It was considered

that it may be more optimal to allocate the catch limit from the upcoming season and then to reallocate any uncaught catch into the upcoming season.

6.52 The Working Group also noted the potential for the collection of genetic samples across a range of life-history stages to complement and contribute to research that is ongoing by Australia, and which would contribute to the stock definition across the area. The proponents confirmed that these samples, and other requests that fit within the scope of the survey, would be collected.

6.53 WG-SAM-18/10 presented a report of the first year of the two-year Ross Sea shelf survey. It was noted that the survey is contributing information to the assessment on the strength of recruitment year classes, which can be seen passing through the age structures generated each year. The further development of such surveys and the importance of such surveys for young fish coming into the assessed population was highlighted by the stock assessment review panel (SC-CAMLR-XXXVII/02).

6.54 WG-SAM-18/07 presented a proposal for a research survey to be conducted by four vessels within the SRZ of the Ross Sea region MPA (RSRMPA). The research program has the objectives of investigating the life cycle, distribution and movement, biological parameters and stock structure of *Dissostichus* species in the eastern part of the Ross Sea over the shelf and continental slope within SSRU 882A.

6.55 Dr S. Kasatkina (Russia) noted that the proposal includes research considered a priority within the research and monitoring plan for the RSRMPA and that the proposal would provide information on genetic linkages, gonad histology, diet studies and biological parameters.

6.56 The Working Group welcomed the undertaking to link the outcomes of this research with the topics from the RMP (SC-CAMLR-XXXVI/20) presented in the proposal.

6.57 The Working Group recalled that WG-FSA-17 had noted that a systematic survey design in the proposal was a suitable approach to develop time series of a range of data such as abundance indices and catch composition and biological characteristics in the SRZ, but systematic surveys may not be able to account for changes in sea-ice or catch limits and this may compromise the survey series.

6.58 WG-SAM requested further information in the revised proposal concerning:

- (i) the rationale for the change to the catch limits in the revised proposal
- (ii) the alternative stock hypothesis that the proposal is trying to test
- (iii) why a CASAL assessment or Chapman biomass estimate is required for a subregion within the Ross Sea, when there is an assessment conducted for the wider area
- (iv) the inclusion of a vessel which has released approximately 700 tagged toothfish in the Ross Sea, which have resulted in no recaptures
- (v) how the research can be conducted without interaction with the SRZ Olympic fishery.

6.59 Dr Kasatkina indicated that further clarification would be provided in the next version of the proposal presented to WG-FSA-18. She also noted that after a grid pattern of fishing positions was achieved in the first year, a stratified design for future years would be presented to allow more powerful statistical analysis to be conducted.

6.60 The Working Group recalled previous discussions at WG-SAM and WG-FSA concerning some confusion surrounding the application of CM 24-01 within the SRZ, particularly:

- (i) the separation of research and Olympic fishing within the SRZ
- (ii) administration of catch limits.

6.61 The Working Group recalled the previous WG-FSA advice (SC-CAMLR-XXXVI, Annex 7, paragraph 3.114) that this issue should be considered by the Scientific Committee.

6.62 WG-SAM-18/06 presented a proposal for a new fishery for crabs in Subareas 88.2 and 88.3 to be conducted by two vessels. The proposal was submitted as a research plan under CM 24-01.

6.63 The objective of the 3-year program is to study the species composition, biology, life cycle, distribution and structure of the crab stocks to assess their resource potential in the Bellingshausen Sea (Subarea 88.3) and Amundsen Sea (Subarea 88.2). The target species of the program is any member of the crab group (Order Decapoda, infra-orders Anomura and Brachyura). Dr Kasatkina informed the Working Group that no pots are proposed to be set in Subarea 48.1.

6.64 The Working Group requested that the Scientific Committee consider this proposal as a new fishery under CM 21-01 not CM 24-01.

6.65 It also noted that the fishery in Subarea 48.3 had failed due to poor condition of the crabs and a high degree of parasitism. Discard of small crabs was high and there were concerns about discard survivorship. The Scientific Committee had recommended pot modifications to introduce panels that decayed to ensure that lost pots did not constitute a ghost fishing risk.

6.66 The Working Group asked for details as to the research design of the survey, which seemed to concentrate at the depths at which toothfish vessels have fished which could result in high by-catch. It was noted that in Subarea 88.3 the fishery had operated at depths between 500 and 1 000 m and that a stratified research design with depth should be applied in order to examine the depth distribution of the species.

6.67 Further, the Working Group suggested that the experimental design of exploring new areas may benefit from the approaches used in developing research plans for toothfish in new areas, such as using short lines (minimal effort) and a mechanism to spread effort to better characterise CPUE across a large area (SC-CAMLR-XXXII, Figure 1).

6.68 Dr Kasatkina thanked the Working Group for the constructive comments and indicated that further clarification would be provided in a revised proposal for the new fishery. She also noted that national observer training would be provided in the identification of craboids prior to the survey.

Review of research proposals and results for Subarea 88.3

6.69 The progress report on the joint research for *Dissostichus* spp. in Subarea 88.3 by the Republic of Korea and New Zealand in 2017/18 (WG-SAM-18/05) was presented. The Working Group noted that the New Zealand vessel *Janas* did not complete the survey because the vessel could not access the southern research blocks due to heavy sea-ice conditions and safety considerations.

6.70 The Working Group noted that no toothfish had been recaptured during the survey and that this was likely due to the low catches and ice/weather conditions. The proponents recognised that recapturing tagged fish was the highest priority, particularly in research blocks 883_3 to 883_5, which are typically more accessible. The Working Group noted that recovery of tagged fish, and therefore biomass estimation, was most likely in research blocks 883_3, 883_4 and 883_5.

6.71 The Working Group recognised that fishing in research blocks 883_1 and 883_2 could provide information to inform a stock structure hypothesis but was unlikely to contribute to biomass assessment. The Working Group recommended the proponents consider mechanisms to reallocate the available research catch limit among participants to increase the probability of tagged fish recaptures to meet the research plan objectives.

6.72 The Working Group noted that *Macrourus* spp. was the main by-catch taxon during the Korean research fishing. The Working Group agreed that with little information available from this area, it was important to identify by-catch to species level during research fishing and report the results to WG-FSA-19 (paragraph 6.1).

6.73 The Working Group noted that the tag-overlap statistic from WG-SAM-18/05 was 72% but that the size distribution of tagged fish did not reflect very well the size distribution of the large fish from the catch. The Working Group recommended to document the tagging procedure and fish handling practices through scientific electronic monitoring recordings from the survey to better understand why large fish were not tagged in proportion to the catch.

6.74 The Working Group considered the new research proposal for *Dissostichus* spp. in Subarea 88.3 by Ukraine (WG-SAM-18/12). Ukraine noted that scientific electronic monitoring has been installed on the proposed vessel and that the recordings could be made available to the working groups. The Working Group noted that there was a need to consider each new research proposal in its own right, however, it was also necessary to consider what additional value and scientific knowledge the research proposal would bring to an area within which multi-Member research activity was already undertaken (paragraph 6.28). The Working Group recommended Ukraine to highlight this additional value of their research survey and to address the criteria in Table 6 of WG-FSA-17 in a revised proposal to WG-FSA-18.

6.75 The Working Group recommended to better describe the fishing gear configuration proposed and submit the description to the CCAMLR gear library. The Working Group noted that having three gear types included in the research could allow comparisons among gear types but could also introduce variability in research performance.

6.76 The Working Group noted uncertainty around the process by which the Ukrainian proposal could be integrated with the existing research proposals from Korea and New Zealand given that they are at different stages of development. The Working Group recommended that the proposal should be developed further and Ukraine should coordinate its research efforts with Korea and New Zealand before the submission of a multi-Member proposal for consideration at WG-FSA-18.

Future work

7.1 The Working Group noted that a considerable amount of its time was spent reviewing research proposals for research fisheries. Further, it noted that these research proposals were expected to be revised and reviewed again at WG-FSA each year. It also noted that there were examples of research plans that were successfully delivering on their on- and off-water milestones, and that if research proponents used these as examples to emulate in developing research plans, any review process would be more efficient.

7.2 The Working Group recommend that these plans do not need to be reviewed twice each year, and that a single review could be completed by WG-FSA.

7.3 The Working Group noted that the Scientific Committee had identified nine high-priority items for consideration by WG-SAM on its work program (SC-CAMLR-XXXVI/BG/40), but that it was unable to consider all of these at its meeting this year due to the large number of research plans presented.

7.4 The Working Group also noted that it may be able to progress high-priority items at future meetings if focus topics or workshops were scheduled and prioritised above other items. It noted that there had been considerable success in progressing the work of the Scientific Committee at focused workshops previously, and noted the success of last year's SISO meeting and at the Berlin Workshop to develop a stock hypothesis for toothfish in Area 48.

7.5 The Working Group noted that development and review of quantitative methods was still required by the Scientific Committee and that WG-SAM could continue to provide this function. However, the Working Group also noted that many of these functions could be carried out by focused workshops that had the benefit of bringing together a broad range of expertise of regular delegates and other experts.

7.6 The Working Group noted that the development of Casal2 may require additional work at a future meeting to consider validations and comparisons of the software with CASAL before being used to provide management advice, but that this was not likely to be required before assessment advice was due to be reviewed in 2021. It further noted that the development of stock assessments from new areas resulting from successful research plans, and quantitative work to further progress management of krill, and a response to the outcomes from the stock assessment review panel, will also need to be developed and progressed in the coming years.

7.7 The Working Group therefore requested the Scientific Committee consider the most efficient and effective way to ensure priority issues are addressed, through working groups and/or workshops.

Other business

8.1 WG-SAM-18/16 provided an update on the proposal for the MPA in the Weddell Sea (WSMPA) to CCAMLR that will be submitted to CCAMLR-XXXVII. The main changes in the proposal compared to 2016 included:

- (i) extending the proposal for the general protection zone (GPZ) along the Antarctic Peninsula, including the Larsen ice shelf to protect more toothfish habitat, which has allowed greater flexibility in the design of the eastern part of the WSMPA

- (ii) focussing the research and monitoring plan on all life-history stages of toothfish rather than simply focussing on adult toothfish
- (iii) the requirement for reference areas for examining the ecosystem effects of fishing, noting that the MPA proposal would not seek to interfere with existing conservation measures including the designation of research blocks in Subarea 48.6.

8.2 The authors of WG-SAM-18/16 requested feedback from WG-SAM on the aspects of the proposal, in particular on the design, selection and location of reference areas.

8.3 The Working Group recognised the need for reference areas (i.e. fished and unfished areas) as a tool for studying the effects of the fishery on biodiversity. The Working Group noted that while it was unlikely to find a fished and an unfished area that are otherwise ecologically identical, this may not be necessary if there are gradients of the levels of historical fishing across otherwise comparable areas with which to examine potential impacts. It also noted that methods existed for estimating the historical fishing footprint in the Convention Area and that these could be updated to inform this process (WG-FSA-15/62 Rev. 1).

8.4 The Working Group agreed that there was a range of criteria that could be used to identify appropriate reference areas and that these would depend on the specific objective of the comparisons. The Working Group recommended that the approach used in Figure 1 to categorise the information available relative to the selection of research areas in Division 58.4.1 could be a useful way to approach selection of reference areas.

8.5 The Working Group agreed that the impact of sea-ice-conditions on vessel accessibility in the Weddell Sea is a critical factor in planning research and monitoring in the WSMMPA (WG-SAM-18/12; WS-DmPH-18/02) and that this should be included in the revision of the boundaries of WSMMPA and the reference areas.

8.6 Dr Kasatkina noted that the revision of the WSMMPA proposal also requires information on target species in the MPA in order to designate areas for protection and fishing activity.

Advice to the Scientific Committee

9.1 The Working Group's advice to the Scientific Committee and its working groups is summarised below; these advice paragraphs should be considered along with the body of the report leading to the advice:

- (i) Development of management advice consistent with Article II for fisheries with more limited data –
 - (a) the application of the trend analysis rule to determine whether the trend was increasing, decreasing, stable, or uncertain to be used to provide management advice for setting catch limits in research blocks (paragraph 4.5).
- (ii) Data acquisition and management –
 - (a) approaches to understanding variability in tag performance between vessels. as these data serve as a primary driver underpinning current stock assessments of toothfish (paragraphs 5.7 and 5.8).

- (iii) Generic advice for research plans –
 - (a) information requirements for research plans (paragraph 6.1)
 - (b) approaches to standardising the timeframes for research proposals (paragraph 6.2)
 - (c) guidance to Members on appropriate criteria for the application for exemption from conservation measures under CM 24-01 (paragraph 6.3).
- (iv) Review of research plan proposals and results –
 - (a) research to address data gaps and hypotheses for *D. mawsoni* life history in Area 48 (paragraph 6.8)
 - (b) request for advice on the separation of research and Olympic fishing and the administration of catch limits within the SRZ (paragraph 6.61)
 - (c) request that the Scientific Committee consider a proposal for a new fishery for crabs in Subareas 88.2 and 88.3 submitted as a research plan under CM 24-01 be considered under CM 21-01 not CM 24-01 (paragraph 6.64).

Adoption of report and close of meeting

10.1 In closing the meeting, Dr Parker thanked all participants for their hard work in preparation for, and engagement in, the Working Group meeting. He also noted that this was his fourth meeting as Convener and that it was timely to consider a succession strategy to introduce a new Convener of WG-SAM.

10.2 Dr Parker thanked the hosts, in particular Drs Earl and Söffker, for the support provided by Cefas to the successful Working Group meeting.

10.3 On behalf of the Scientific Committee and the Working Group, Mr Sarralde (Senior Vice-Chair of the Scientific Committee) thanked Dr Parker for his four years of successfully convening the Working Group as well as his considerable intersessional work to progress the important issues on the agenda of WG-SAM.

Reference

van Wijk, E.M., A.J. Constable, R. Williams and T. Lamb. 2000. Distribution and abundance of *Macrourus carinatus* on BANZARE Bank in the southern Indian Ocean. *CCAMLR Sci.*, 7: 171–178.

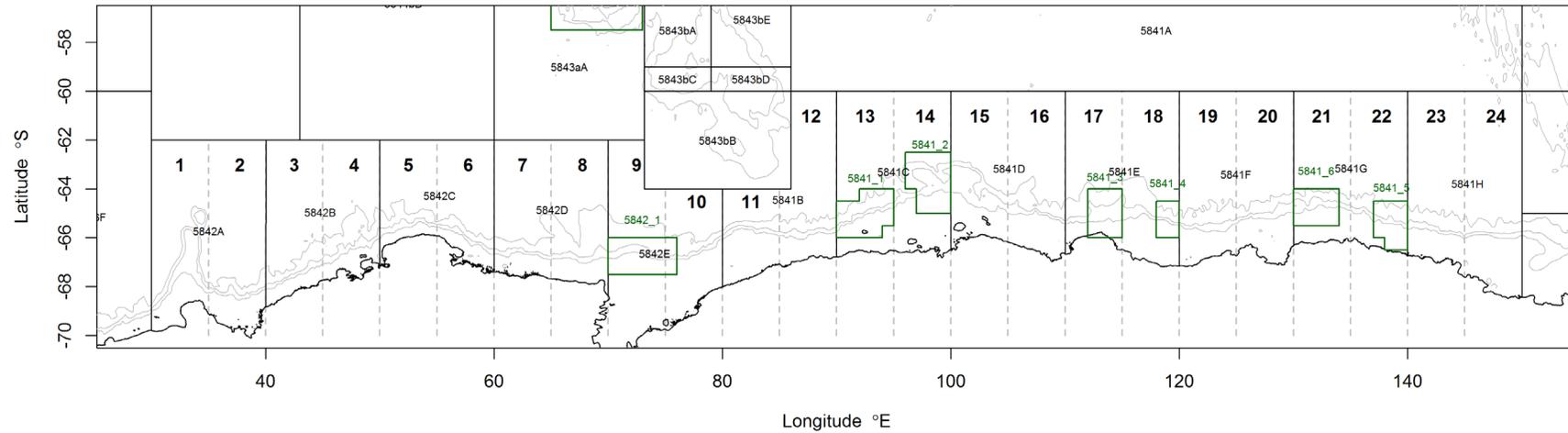
Table 1: Example table of potential milestones and proposed and actual achievement dates that could be appended to annual research reports for research plans and research proposals.

Milestones (from SC-CAMLR-XXXVI, Annex 7, Table 2)	Milestone applicable	e.g. Year 1		e.g. Year 2		e.g. Year 3	
		WG-SAM	WG-FSA	WG-SAM	WG-FSA	WG-SAM	WG-FSA
		e.g. paper #	e.g. paper #	e.g. paper #	e.g. paper #	e.g. paper #	e.g. paper #
Fishing operations:							
1. Fishing operational data specified in the research plan (e.g. standardisation of gear or procedures or data to be collected).							
2. Sampling requirements as specified in the research plan (e.g. fish length, weight, otoliths, by-catch species composition, tags deployed, VME sampling).							
Biological sampling and analysis:							
3. Tissue samples collected as specified: otolith sampling, gonad sampling, other.		e.g. due date		e.g. preliminary	e.g. reported	e.g. updated protocol	e.g. reported
Sample processing as agreed:							
4. Otoliths to be aged, validation procedures completed and adequate for use.		e.g. due date	e.g. due date	e.g. new due date	e.g. new due date	e.g. some aging, due date for validation	e.g. preliminary results
5. Maturity analysis as specified (methods, sample sizes, by sex)							
Biological parameter estimation:							
6. Length-weight relationships		e.g. due date		e.g. preliminary results	e.g. preliminary results		e.g. final results
7. Maturity ogive parameter values							
8. Age-length keys, growth model parameters.							
Tagging data:							
9. Tagging rate achieved, tag releases by season in each research block, overlap statistic achieved.							
10. Vessel calibration studies conducted		e.g. n/a		e.g. n/a		e.g. n/a	
By-catch data:							
11. Data and samples collected as specified in the research plan							
12. Analyses conducted as specified in the research plan (e.g. Satellite tagging, Oceanography, Diet)							

(continued)

Table 1 (continued)

Milestones (from SC-CAMLR-XXXVI, Annex 7, Table 2)	Milestone applicable	e.g. Year 1		e.g. Year 2		e.g. Year 3	
		WG-SAM	WG-FSA	WG-SAM	WG-FSA	WG-SAM	WG-FSA
		e.g. paper #	e.g. paper #				
Data analysis, as specified in the research plan:							
13. Hypothesis testing of stock structure							
14. Vessel calibration studies as specified: catch rate and size selectivity, tagged fish survival, and tag detection analysis							
15. IUU estimation (current and historical)							
16. Expected tagging programme performance							
17. Preliminary stock status, and biomass estimates, and harvest rate incorporating data collected to date (e.g. selectivity, size, biological parameters)							
18. Analysis of biological data for target and non-target species							
19. Analysis of potential effects of fishing on the ecosystem		e.g. n/a		e.g. n/a		e.g. due date	
Other milestones in the proposal							



Division		58.4.2										58.4.1													
SSRU		A	A	B	B	C	C	D	D	E	E	B	B	C	C	D	D	E	E	F	F	G	G	H	H
With research block										1				1	2			3	4			6	5		
Segment		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
a) Objectives	Available tags	M	L	L	L	L	L	L	L	H	H	L	L	H	H	M	L	H	H	L	L	H	H	H	M
	Recaptures	L	L	L	L	L	L	L	L	L	L	L	L	M	M	L	L	H	M	L	L	H	M	M	L
	Local assessment	L	L	L	L	L	L	L	L	H	L	L	L	H	H	L	L	H	H	L	L	H	H	L	L
	Area-wide assessment	L	L	L	L	L	L	L	L	M	M	M	M	H	H	H	H	H	H	H	H	H	H	L	L
	Key life-history stages	H	M	L	L	L	L	L	M	H	H	M	L	M	H	H	L	M	M	L	L	L	L	L	L
	No data for habitat model	M	H	H	H	H	H	M	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L
	Avoid VME	H	M	M	M	H	M	M	M	H	H	M	M	H	H	M	M	H	H	M	M	H	H	L	L
b) Viable fishery	Catch rates	M	L	M	M	H	H	H	H	H	M	M	H	H	H	M	L	M	M	M	M	M	M	H	H
	Fishing history	L	L	L	L	L	L	L	L	M	M	L	L	H	H	M	L	H	M	L	L	H	H	M	L
	Habitat area	H	L	L	M	L	L	L	L	L	L	L	L	L	M	H	L	M	L	L	M	M	L	L	L
	Sea ice	H	L	M	M	H	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	H	H	H	M
c) Stock hypothesis	See Key life-history stages																								

Figure 1: Suitability of geographic five-degree-longitude sections (upper panel) against the criteria under WG-SAM-11 (SC-CAMLR-XXX, Annex 5, paragraph 2.40) (lower panel). Suitability is marked as high (H, green), medium (M, orange) or low (L, red). Upper panel: Black lines = SSRU boundaries, green lines = research blocks in Divisions 58.4.1 and 58.4.2 as set out in Conservation Measures 41-11 and 41-05 (from WG-SAM-18/17, Figure 1).

List of Participants

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(Norwich, United Kingdom, 25 to 29 June 2018)

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Agenda

Working Group on Statistics, Assessments and Modelling
(Norwich, United Kingdom, 25 to 29 June 2018)

1. Introduction
2. Opening of the meeting
 - 2.1 Adoption of the agenda and organisation of the meeting
3. Assessments to estimate sustainable yield in established/assessed fisheries
4. Development of management advice consistent with Article II for fisheries with more limited data
5. Data acquisition and management
6. Review of research plan proposals and results
 - 6.1 Proposals and research results from Area 48
 - 6.1.1 Proposals and research results from Subarea 48.1
 - 6.1.2 Proposals and research results from Subareas 48.2 and 48.4
 - 6.1.3 Proposals and research results from Subarea 48.6
 - 6.2 Proposals and research results from Subarea 58.4
 - 6.2.1 Proposals and research results from Division 58.4.1
 - 6.2.2 Proposals and research results from Division 58.4.2
 - 6.2.3 Proposals and research results from Division 58.4.3
 - 6.2.4 Proposals and research results from Division 58.4.4
 - 6.3 Review of research proposals and results for other areas
 - 6.3.1 Review of research proposals and results for Subarea 88.1
 - 6.3.2 Review of research proposals and results for Subarea 88.2
 - 6.3.3 Review of research proposals and results for Subarea 88.3
7. Future work
8. Other business
9. Advice to the Scientific Committee
10. Adoption of report and close of meeting.

List of Documents

Working Group on Statistics, Assessments and Modelling
(Norwich, United Kingdom, 25 to 29 June 2018)

- | | |
|--------------|--|
| WG-SAM-18/01 | Predicting fishing ground accessibility in the Antarctic Weddell Sea
H. Pehlke, K. Teschke and T. Brey |
| WG-SAM-18/02 | Research plan for the 2018/19 exploratory longline fishery of <i>D. mawsoni</i> in Subarea 48.6 by Spain
Delegation of Spain |
| WG-SAM-18/03 | Continuation proposal of a multi-Member longline survey on Patagonian toothfish (<i>Dissostichus eleginoides</i>) in Division 58.4.4b in 2018/19 by Japan and France
Delegations of Japan and France |
| WG-SAM-18/04 | Proposed continuation of a multi-Member longline survey on Antarctic toothfish (<i>Dissostichus mawsoni</i>) in Statistical Subarea 48.6 in 2018/19 by Japan and South Africa
Delegations of Japan and South Africa |
| WG-SAM-18/05 | Progress report on the joint research for <i>Dissostichus</i> spp. in Subarea 88.3 by the Republic of Korea and New Zealand and notification of research in 2018/19
Delegations of the Republic of Korea and New Zealand |
| WG-SAM-18/06 | Research program on study of life cycle, species compositions, biology and resource potential of craboids (Anomura, Decapoda) in the Pacific Ocean Antarctic Area in 2018–2021 by Russian Federation
Delegation of the Russian Federation |
| WG-SAM-18/07 | Research program to examine the life cycle and resource potential of <i>Dissostichus</i> species in the Special Research Zone within the Ross Sea region marine protected area (RSRMPA) in 2018–2027 by Russian Federation
Delegation of the Russian Federation |
| WG-SAM-18/08 | Continuation of multi-Member research on the <i>Dissostichus eleginoides</i> exploratory fishery in 2018/19 in Division 58.4.3a by France and Japan
Delegations of France and Japan |

WG-SAM-18/09	Notification for scientific research in 2019/20 under CM 24-01: Proposal for a winter longline survey of Antarctic toothfish in the northern region of Subareas 88.1 and 88.2 Delegation of New Zealand
WG-SAM-18/10	Results of the seventh Ross Sea shelf survey to monitor abundance of Antarctic toothfish in the southern Ross Sea, January 2018, and notification for research in 2018/19 D. Stevens, X. Fu, S. Mormede and S. Parker
WG-SAM-18/11	Plan of research program of the Ukraine in Subarea 48.1 in 2019 Delegation of Ukraine
WG-SAM-18/12	Plan of research program of the Ukraine in Subarea 88.3 in 2019 Delegation of Ukraine
WG-SAM-18/13	Proposal for continuation of the Ukrainian research survey in Subarea 48.2 in 2018/19 season (fifth year of research) Delegation of Ukraine
WG-SAM-18/14	Introducing Casal2 for toothfish stock assessments S. Mormede
WG-SAM-18/15	Outline for year 3 of the 3-year longline survey to determine toothfish population connectivity between Subareas 48.2 and 48.4 M. Söffker and M. Belchier
WG-SAM-18/16	Informing and seeking advice from WG-SAM-18 about the revisions of the WSMPA proposal S. Hain, K. Teschke, H. Pehlke and T. Brey
WG-SAM-18/17	Draft proposal for multi-Member research on the <i>Dissostichus mawsoni</i> exploratory fishery in East Antarctica (Divisions 58.4.1 and 58.4.2) from 2018/19 to 2021/22 Delegations of Australia, France, Japan, Republic of Korea and Spain
WG-SAM-18/18	A photographic reference set for Antarctic toothfish (<i>Dissostichus mawsoni</i>) from the Ross Sea region C. Sutton and S. Parker
WG-SAM-18/19	Research concept on catchability to study toothfish abundance/stocks in the Antarctic marine areas K. Demianenko, L. Pshenichnov, O. Diripasko and V. Gurianov

WG-SAM-18/20	Results of a scientific electronic monitoring pilot study on the FV <i>Janas</i> during the 2017/18 Ross Sea fishing season B. Plum, A. Smith and S. Parker
WG-SAM-18/21	Guidelines for fisheries-directed research addressing the Ross Sea region Marine Protected Area Research and Monitoring Plan S. Parker and A. Dunn
WG-SAM-18/22	Monitoring and managing the effects of environmental change on toothfish assessments M. Pinkerton, A. Dunn, S. Mormede and S. Parker
WG-SAM-18/23	Simulating performance of trend analysis for setting catch limits in exploratory toothfish research plans S. Hoyle, S. Parker, A. Dunn and S. Mormede
WG-SAM-18/24	Short review of the procedure for realisation of the fish tagging program on vessels of Ukraine in the season 2017/18 Delegation of Ukraine
WG-SAM-18/25	Cruise Report – Research Project: Demersal finfish distribution, abundance, and their biological characteristics in Statistical Subareas 48.1 (northern area) and 48.2 Delegation of Chile
WG-SAM-18/26	The preliminary report on the survey for <i>Dissostichus</i> spp. in Subarea 48.2, season 2017/18 Delegation of Chile
WG-SAM-18/27	Preliminary results of oceanological research of Ukrainian vessels in the CCAMLR area for the season 2017/18 V. Paramonov
WG-SAM-18/28	The preliminary report on the survey in Subarea 48.2 in 2018 (the fourth year of the planned 5-year-old investigations) Delegation of Ukraine
WG-SAM-18/29	Information report on the age determination methods of toothfish <i>Dissostichus</i> spp. I.V. Slypko and P.M. Zabroda
WG-SAM-18/30	Preliminary results from the second year of a three-year survey into the connectivity of toothfish species in Subareas 48.2 and 48.4 M. Söffker, K. Olsson and M. Belchier

- WG-SAM-18/31 Annual report of research fishing operations at Division 58.4.4b in 2016/17 fishing season
Delegations of Japan and France
- WG-SAM-18/32 Annual report of research fishing operations at Subarea 48.6 in 2016/17 fishing season
Delegations of Japan and South Africa
- WG-SAM-18/33 Rev. 1 Annex to WS-DmPH-18 report: Towards the development of a stock hypothesis for Antarctic toothfish (*Dissostichus mawsoni*) in Area 48
M. Söffker, A. Riley, M. Belchier, K. Teschke, H. Pehlke, S. Somhlaba, J. Graham, T. Namba, C.D. van der Lingen, T. Okuda, C. Darby, O.T. Albert, O.A. Bergstad, P. Brtnik, J. Caccavo, A. Capurro, C. Dorey, L. Ghigliotti, S. Hain, C. Jones, S. Kasatkina, M. La Mesa, D. Marichev, E. Molloy, C. Papetti, L. Pshenichnov, K. Reid, M.M. Santos and D. Welsford
- WG-SAM-18/34 Diagnostic tools for *Champscephalus gunnari* stock assessments
D. Maschette, T. Earl and R. Sinègre
- WG-SAM-18/35 Rev. 1 Joint report on exploratory fishing in Divisions 58.4.1 and 58.4.2 between the 2011/12 and 2017/18 fishing seasons
Delegations of Australia, France, Japan, Republic of Korea and Spain
- Other Documents
- WG-SAM-18/P01 Casal2: New Zealand's integrated population modelling tool
I. Doonan, K. Large, A. Dunn, S. Rasmussen, C. Marsh and S. Mormede
Fish. Res., 183 (2016): 498–505
- SC-CAMLR-XXXVII/01 Report of the Co-conveners of the CCAMLR Workshop for the Development of a *Dissostichus mawsoni* Population Hypothesis for Area 48
(19 to 21 February 2018, Berlin, Germany)
Workshop Co-conveners (C. Darby (UK) and C. Jones (USA))
- SC-CAMLR-XXXVII/02 Summary Report of the CCAMLR Independent Stock Assessment Review for Toothfish
(Norwich, United Kingdom, 18 to 22 June 2018)