Annex 4

Report of the Meeting of the Working Group on Statistics, Assessments and Modelling
(Concarneau, France, 17 to 21 June 2019)

Contents

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Introduction

1.1 The 2019 meeting of WG-SAM was held at the Concarneau Marine Station in Concarneau, Finistère, France, from 17 to 21 June 2019. The meeting Co-conveners, Dr C. Péron (France) and Dr S. Parker (New Zealand), welcomed participants (Appendix A). The meeting was hosted by the Muséum national d'Histoire naturelle and in welcoming participants to the meeting, Dr M. Eléaume (Curator of Echinoderms, Muséum national d'Histoire naturelle and Scientific Committee Representative for France) provided an overview of the meeting facilities and encouraged all participants to enjoy all that Concarneau has to offer.

Adoption of the agenda and organisation of the meeting

2.1 Dr Parker reviewed the provisional agenda and the papers that had been submitted for consideration of WG-SAM and how these addressed the priorities identified by the Scientific Committee for the work of WG-SAM. In order to streamline the work of the meeting, the provisional agenda was revised and 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. Baird (New Zealand), M. Belchier (UK), C. Chazeau (France), C. Darby (UK), A. Dunn (New Zealand), T. Earl (UK), N. Gasco (France), C. Jones (USA), D. Maschette (Australia), K. Reid (Secretariat), M. Söffker (EU), S. Thanassekos (Secretariat), D. Welsford and P. Ziegler (Australia).

Assessments to estimate sustainable yield

3.1 WG-SAM-2019/04 presented work to estimate natural mortality (M) within the CASAL assessment for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region in response to the recommendations of the CCAMLR Independent Stock Assessment Review for Toothfish (SC-CAMLR-XXXVII, Annex 5). This was accomplished by setting selectivity in the northern fishery to a logistic instead of a double normal (i.e. fully selected older fish) and including M as an estimable parameter. The resulting estimate of M was similar to the current externally estimated value of M used in the model and B_0 was higher.

3.2 The Working Group noted that although this assessment was data rich, estimating M within assessments may overestimate biomass when there is model mis-specification, and hence may not be precautionary. The Working Group recalled that likelihood profiles indicated that different cohorts of tagging data provide conflicting estimates of M, and that further work would be required to identify the most influential data on estimates of M.

3.3 The Working Group noted that the current CASAL model uses a constant M over time and age, and further work would be required to test whether it is feasible to estimate temporal trends in M, and to evaluate the impact of changes in M on the management of the stock through simulations and management strategy evaluations.

3.4 WG-SAM-2019/27 presented preparatory work towards the update of the assessment of Patagonian toothfish (*D. eleginoides*) in Division 58.5.2. The paper presented revised estimates of the maturity-at-age relationship and estimates of removals due to lost longlines using either the geometric mean of catch rates from the fishing season during which the gear was lost, or the catch-per-unit-effort (CPUE) from the recovered part of the longline.

3.5 The Working Group recommended that the mean CPUE from the season be used to estimate mortality from lost gear to provide an unbiased estimate of the expected mortality and that the sensitivity of including this mortality in the stock assessment for Division 58.5.2 be evaluated.

3.6 An updated maturity ogive for female fish was calculated in response to comments from the CCAMLR Independent Stock Assessment Review for Toothfish (SC-CAMLR-XXXVII, Annex 5) combining a logistic fitted curve with assumed zero maturity at ages 1–5. The Working Group agreed that this maturity ogive could be used in the assessment to provide management advice in 2019 and welcomed the paper's proposals to provide a bridging analysis or sensitivity analysis to understand the causes of any changes to the status of the stock.

3.7 Dr Söffker informed the Working Group that biological data from toothfish fishing activities collected in the Southern Indian Ocean Fisheries Agreement (SIOFA) area adjacent to the Convention Area was initially planned to be submitted for information of WG-SAM, but in consultation with the Co-conveners of WG-SAM, this would be more relevant to the work of WG-FSA, and would be presented there.

3.8 An updated CASAL assessment model for *D. eleginoides* in Division 58.4.4b was presented in WG-SAM-2019/30. The Working Group welcomed the substantial progress that has been made in developing the model. The Working Group recommended that age–length keys (ALKs) be calculated separately for each year, and the impact of using smaller length classes be investigated. The Working Group noted that the required number of otoliths can be calculated based on a target coefficient of variation (CV). The Working Group recommended that CVs are indicated as part of the growth model and length–weight model fits. The Working Group drew attention to previous work on standard diagnostics (WG-SAM-2015 report, paragraphs 2.33 to 2.43 and Appendix D) and recommended that these should be presented for this assessment.

3.9 The Working Group noted that CASAL can be used to estimate a constant harvest rate (F_{CAY}) that would lead the stock to 50% B_0 based on the selectivity and biological estimates, regardless of the initial status of the stock. The assessments available to the Working Group gave a preliminary indication that harvest rates of 4–6% would be consistent with achieving

this target. The Working Group noted that this was consistent with the 4% value estimated by previous work (Welsford, 2011) to calculate a precautionary harvest rate for exploratory fisheries where there is no estimate of B_0. The timescale for achieving the target of 50% B_0 may be long if the stock is depleted. Details of the calculation, and how to perform it, are given in the CASAL manual (sections 3.1 and 7.5.1).

3.10 The Working Group noted that this method could be applied to provide catch advice for stocks where there are uncertainties in the historic catch data due to unquantified illegal, unreported and unregulated (IUU) fishing, or in other circumstances where the virgin biomass is unknown.

3.11 The Working Group recommended that Members developing stock assessments calculate the harvest rate associated with achieving 50% B_0 to help evaluate the yield calculations using the CCAMLR decision rules, and further recommended that Members with historic assessments available present the harvest rates that these assessments would indicate so that the variability over assessments can be better understood.

3.12 WG-SAM-2019/32 addressed the recommendation in WG-FSA-2018 report, paragraphs 2.28 to 2.31, by analysing the time series of changes in the biological productivity parameters in Subarea 48.3, particularly whether the proportion of females in the catch, maturity at length and age, length–weight relationships and growth rates have changed through time.

3.13 The Working Group noted variation through time in the Subarea 48.3 sex ratio, maturity, growth and length–weight parameter estimates, but no systematic trends. When the effects of confounding factors, such as depth, were included in the analysis, there was no indication of systematic change that would indicate potential impacts from external influences such as the fishery or climate change. The current stock assessment is robust to the changes in growth parameters.

3.14 The Working Group noted that the revised Fisheries Reports could provide a valuable source of information as to where changes in management practices had occurred that would impact the data collected.

3.15 Dr S. Kasatkina (Russia) noted that the history of the fishery in Subarea 48.3 indicates that the percentage of fish caught in older age groups in recent times (2010–2017) has decreased and young fish remained predominant in toothfish catches. She noted that WG-SAM-2019/32 does not provide clarity as to whether this was an effect of changes in the fishery selectivity or in the distribution of the stock or whether this was a change in the population structure under the impact of the fishery. She noted that it will be important to understand how fishing will influence the stock in the future.

3.16 The Working Group recalled that the variation in length distributions had been reviewed previously by WG-FSA-2018 (WG-FSA-2018 report, paragraphs 3.18 to 3.20) as well as WG-SAM-2019/32. The length (or age) distribution of the catch is influenced by a combination of factors resulting from the overlap of the fishery and the stock in time, by area and depth, as well as the selectivity of the fishing gear.

3.17 The Working Group noted that longline fisheries for toothfish provide an example of why the length structure of the fishery catch may not represent the length structure of the underlying population. A range of fishery-dependent and fishery-independent research has

determined that smaller toothfish of both species typically occupy shallow depths on the Antarctic and sub-Antarctic shelves. Fishing in deep water results in catches of large fish but does not imply that smaller fish are absent from the population.

3.18 The Working Group recalled that the underlying population structure can currently be best estimated within a stock assessment model, such as CASAL, which integrates across the catch distribution and the trends in the tagging data. The CCAMLR Independent Stock Assessment Review for Toothfish (SC-CAMLR-XXXVII, Annex 5) has reviewed the assessment and endorsed its use for providing management advice. The independent review panel noted that the reviewed assessments provide precautionary management advice and are world-leading.

3.19 The Working Group also recalled that changes in the catch structure resulting from fishery selection, recruitment events and movement of the stock through time are compensated for by the use of the CCAMLR decision rules, whatever the resulting catch structure.

3.20 The Working Group noted that as there had been no proposal for a change of version, that CASAL version 2.30-2012-03-21 rev. 4648 remains the current approved CCAMLR version for use in assessments.

Cross-cutting issues in longline fisheries affecting data quality

Tagging

4.1 WG-SAM-2019/07 presented a new tag-linking approach that has been developed by the Secretariat to provide greater flexibility in linking recaptures to releases, including where a recapture is linked to multiple releases or multiple recaptures are linked to a single release with equal probability. The tag-linking process produces a table containing all links that were made, including ambiguous links, their scores, the number of tags linked and the occurrence of mismatches. The table also includes the linked 'Akeys', i.e. the unique row identifiers in the recaptures and releases datasets. This new approach uses more of the available data, increases the level of transparency and provides an index of the level of confidence in all linked mark-recapture data.

4.2 The Working Group welcomed this approach and its greater transparency about the tag-linking process. It noted that this algorithm is the first step in linking tag releases and recaptures, and that, where this was not able to link a recapture to a single release event, other information, such as the release and recapture locations, could subsequently be used to select likely links.

4.3 The Working Group recommended that the new approach outlined in WG-SAM-2019/07 be routinely implemented by the Secretariat and requested that the Secretariat provide the links from the currently implemented approach and the new approach to help data users to compare the differences between approaches. The Working Group agreed that the greater transparency and inclusion of data-quality metrics would provide the basis to improve the new algorithm over time in a collaborative process between the Secretariat and data users.

4.4 The Working Group requested that the Secretariat:

(i) report each year to WG-FSA a summary of the linking process. This report should include, inter alia, how many tags have been successfully or unsuccessfully linked and what reasons led to unsuccessful links, and how many tags have been released with missing data or inappropriate values

(ii) provide the data link output from the previous year in extracts to data users to support data comparisons between years

(iii) provide the details of all the fish included in an ambiguous link where one of the links includes the area for which the data has been requested

(iv) provide metadata in association with tagging data on known issues to allow users to undertake appropriate analyses

(v) investigate whether releases from the early years of the fishery in Subarea 88.1 and small-scale research units (SSRUs) 882A–B, previously submitted by New Zealand but not entered into the CCAMLR database, can now be included in the tag-linking process

(vi) identify situations where fish may have been released and recaptured multiple times and are therefore likely to have ambiguous links.

Catch estimation

4.5 WG-SAM-2019/14 provided a description of the potential effects of operating conditions on the estimation of catch weights that sought to address concern from SC-CAMLR-XXXVII on discrepancies in reported catches (C2) and landings (*Dissostichus* Catch Document (DCD)) (SC-CAMLR-XXXVII, paragraphs 12.3 to 12.5). The paper highlighted that the instructions provided on some vessels may have resulted in the underestimation of catches as reported on the C2 forms.

4.6 The Working Group thanked Ukraine for the transparency and requested that Ukraine work with the Secretariat to provide further details of the potential underestimation of catches (including by vessel, year and area) in order that the implications of this on the provision of management advice can be reviewed by WG-FSA. The Working Group also agreed that the potential underestimation of catches be considered by the Standing Committee on Implementation and Compliance (SCIC).

4.7 The Working Group recommended that in the interim of a decision being made on how the underestimation of catches is addressed, including how this data is flagged in the CCAMLR database, data extracts from the CCAMLR Secretariat should include a reference to WG-SAM-2019/14 linked to the data in question.

Fishery Reports

4.8 WG-SAM-2019/35 presented a new Fishery Report format that has been developed by the CCAMLR Secretariat, using R Markdown. Many of the data summaries can be automatically generated and formatted into a publication-ready format for Fishery Reports.

4.9 The Working Group welcomed this new format, its greater flexibility and its potential as a means to increase consistency across Fishery Reports. It noted that some modifications were necessary, such as the inclusion of a table of contents, stock status summary and consideration of environmental effects. The Working Group suggested that the Fishery Reports have the content as given in Appendix D and requested further review by WG-FSA.

4.10 The Working Group agreed that in the future, Fishery Reports could be part of a set of documents designed to inform a broad range of audience, from the general public to stock assessment scientists. It noted that a hierarchical approach, whereby a simple and concise 'Fishery Summary' would link to three detailed documents (namely a Fishery Report, a Species Description and a Stock Assessment Annex) to communicate fishing and research activities in the Convention Area (Appendix D).

4.11 The Working Group encouraged Members providing integrated toothfish assessments to WG-FSA this year to develop the Stock Assessment Annexes for those stocks (WG-FSA-2018 report, paragraphs 2.32 and 2.33).

4.12 The Working Group agreed that the Fishery Summary should include a figure of the region for which the Fishery Report applies, the species name, a visual representation of the species, a graphic summary of the catch time series, and a summary table detailing: the status of the fishery, the wider environmental consideration (e.g. seabirds, vulnerable marine ecosystem (VME) triggers), the type of fishery (e.g. exploratory, Conservation Measure (CM) 24-01), the vessel types and gears involved. The Fishery Summary would also include links and references to the relevant Fishery Report, the Species Description and the Stock Assessment Annex.

4.13 The Working Group requested that the Secretariat implement this hierarchical structure for Fishery Reports and present this at WG-FSA-2019.

Data Services Advisory Group (DSAG)

5.1 The Data Services Advisory Group (DSAG) Co-convener, Mr Dunn, provided an update on recent developments in the DSAG, detailing how the group has been working with the Secretariat on the development of plans to implement and improve data access and documentation procedures. Mr Dunn informed the Working Group about a virtual meeting of the DSAG, proposed for August 2019, where interested parties could discuss these developments. He encouraged DSAG members to participate. The CCAMLR Science Manager, Dr Reid, further summarised the developments in the Secretariat, including investment in resources and infrastructure.

5.2 The Working Group welcomed the progress and collaboration between DSAG and the Secretariat, thanking both for their engagement. The Working Group supported the proposed virtual DSAG meeting in August 2019, and further encouraged participants to visit the DSAG e-group since the Secretariat has recently introduced a standardised data request submission form.

Review of research plan proposals and results

Research standardisation

6.1 The Working Group recalled the discussions at WG-FSA-2018 regarding research standardisation and ways to control or quantify the impact of gear on conclusions drawn from research data, and best practice for developing and presenting analyses (WG-FSA-2018 report, paragraphs 4.27, 4.29 and 4.30).

6.2 WG-SAM-2019/34 summarised two alternative approaches to standardisation of data from research conducted by longline fishing vessels, derived from the discussions at WG-FSA (WG-FSA-2017 report, paragraph 4.20; WG-FSA-2018 report, paragraphs 4.27 to 4.30) and the Scientific Committee (SC-CAMLR-XXXVII, paragraphs 3.138 to 3.144), namely:

(i) using standardised longline gear for multi-Member research programs on *D. mawsoni* in East Antarctica

(ii) using different longline types and post-hoc analyses to estimate the impact of gear on the results of research.

6.3 Dr Kasatkina also presented an overview of multinational trawl survey designs used in the International Council for the Exploration of the Sea (ICES) to illustrate the need for consideration of gear effects in designing research surveys. She highlighted that the trawl fishing process and fishing gears are so complex that catches depend on many factors (in particular, behaviour and distribution of fish, and their influence on catchability properties of fishing gear, team experience, etc.), which cannot be addressed using data standardisation. She further noted that, in her opinion, the best way to address this situation is to use standard fishing gear for trawl surveys, especially those involving several vessels. She noted that the use of standard trawl gears accompanied by standard procedures and survey design are the basis for international surveys in the ICES areas. She stressed that the ICES manuals for multivessel surveys do not include requirements for intercalibration between participating vessels (ICES, 2017a, 2017b).

6.4 Dr Kasatkina noted that, in her opinion, methodical aspects of the implementation of the research program in Division 58.4.1, such as follows: lack of standardised design of longline surveys (concentration of longline settings in local areas of research blocks, variation of longline gear types and fishing efforts in research blocks by years), impact of fishing longline gear on length and age composition, proportion of mature fish and results of tag recapture (WG-FSA-16/13 Rev. 1; WG-FSA-17/15; WG-FSA-17/16; SC-CAMLR-XXXVII/BG/23), do not provide adequate data for achieving objectives and goals of the research activity on *D. mawsoni* in East Antarctica (Divisions 58.4.1 and 58.4.2) between the 2011/12 and 2017/18 fishing seasons. She proposed the use of standardised fisheries-dependent survey design and standardised longline gear for multi-Member research activity in this region. She also noted that there still is insufficient understanding of longline gear as a tool for research activity including the 'swept area' or sampling volume of longlines, catchability and selectivity properties, and hence catch rates from longlines cannot be used as an absolute measure of abundance.

6.5 The Working Group noted that in ICES trawl surveys, which are used as the basis of CPUE time series, while there is a single type of gear specified, the actual designs of the

deployed nets vary across the survey area to account for differences in sea-floor characteristics, and to maintain important time series that pre-date the multinational survey. It further noted that despite using standardised gear, vessel effects remained an important source of variation in these surveys, and hence the ICES survey designs include substantial overlap in survey hauls between vessels and nations to allow statistical standardisation of the results prior to conclusions being drawn on stock abundance (e.g. Walker et al., 2017).

6.6 WG-SAM-2019/25 described an exploration of the main sources of variation in CPUE analyses using data from the exploratory longline fishery for *D. mawsoni* in the Ross Sea. The Working Group noted that according to generalised linear model (GLM) analyses, the total number of hooks is the preferred effort measure when comparing CPUE from different types of longline (autoline, trotline, Spanish line). However, the Working Group noted that the effect of effort measure was sufficiently small that it would not impact on trend analyses for the purposes of setting catch limits in data-limited exploratory fisheries.

6.7 The Working Group also noted that vessel identity was the largest driver of variations in CPUE. Excluding trips by vessels with only one year of fishing reduced the size of the vessel effect, however, it remained the most important explanatory variable in all models, with effect size three times higher than the gear effect.

6.8 Dr Kasatkina noted with concern the large 'vessel effect' which, in her opinion, makes the research data unpredictable. She noted the need to minimise the effect of the vessel using standardised gear and standardisation of all aspects of vessel activity (catch rates, calculation of conversion factors, etc.). She noted that while the method to standardise for vessel effects on CPUE was well established, in her view, analysis of the impacts on other variables still needed further development, otherwise standardised CPUE will be dominated by vessel effects. Dr Kasatkina further noted that CCAMLR should continue to work to understand and standardise, where possible, the impacts of vessel effects on data.

6.9 To assist in future quality checking of data, the Working Group recommended the Secretariat develop an appropriately documented new reporting field in the C2 form for the number of droplines per line when using trotline.

6.10 The Working Group noted that the Coalition of Legal Toothfish Operators (COLTO) would be hosting an industry–science data management workshop to achieve best practices within CCAMLR (SC-CAMLR-XXXVII, paragraph 3.45; SC CIRC 19/29) and that one of the aims of this workshop was to provide a multi-stakeholder review of the current data reporting specifications on the C2 form and that this would include consideration of a potential revision of the C2 form.

6.11 The Working Group agreed that there were many potential reasons why vessel effects would be important in explaining the variation observed in CPUE, including fishing strategy, vessel design, crew and skipper experience and behaviour, data collection equipment and observation error. It noted that all these factors would be impossible to control a priori in any multivessel research activity. It therefore recommended that toothfish research fishing is conducted with a high level of spatial and temporal overlap between vessels and gear types to allow for a meaningful standardisation of variables such as catch rates, mean length or sex ratio.

6.12 The Working Group noted that the design of research activities, and the likely impacts of gear and vessel effects, depend on the objectives of this research. The Working Group

recalled the WG-FSA-2018 report, paragraph 4.29, which described the process for approaching standardisation analyses. To assist with the design and evaluation of research plans, the Working Group developed a table to indicate which factors were likely to be important in the design of data collection and analysis of key datasets (Table 1).

6.13 The Working Group recalled that CPUE is influenced by many factors, highlighting the rationale for why unstandardised CPUE data are not used in CCAMLR stock assessments when other less confounded indices are available. The table highlighted that a number of factors need to be considered in standardisation for questions related to CPUE or age structure, but that few variables need to be standardised for questions related to tag data or distribution. For most types of fisheries-dependent studies, standardising for effects related to space, time and vessel were most important. It further highlighted that power analysis was a key step in determining the likelihood success of all research activities.

6.14 WG-SAM-2019/37 described an analysis of CPUE from the exploratory longline fishery for *D. mawsoni* in Subarea 48.6. The Working Group noted that this analysis indicated that overall CPUE has been increasing in this subarea. However, it also noted that CPUE analyses and tag-recapture analyses at the individual research block scale were still required to ensure that fishing was not resulting in localised depletion, and to enable the setting of research catch limits.

6.15 WG-SAM-2019/06 described guidelines for assessing research from fishing vessels that is directed at the Research and Monitoring Plan (RMP) for the Ross Sea region marine protected area (MPA).

6.16 The Working Group agreed that any research fishing proposed in MPA zones should ensure it maximises scientific outputs and that robust scientific conclusions can be drawn from those outputs. The Working Group recalled the conclusions of the WG-SAM-2018 report, paragraph 6.45 and the WS-SM-2018 report, paragraph 6.4 and recommended to the Scientific Committee that research proposals should:

(i) identify which priority research elements are addressed

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

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

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

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

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

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

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

6.17 The Working Group further recommended to the Scientific Committee that research proposals should include design components, including:

(i) a clear rationale and approach for the definition of experimental strata

(ii) well-designed statistical approaches to standardise the results to control for variation due to operational effects (e.g. catch-rate standardisation)

(iii) removing the effects of vessel choice in fishing location through randomisation of survey stations locations

(iv) the use of power analyses and simulations to ensure robust statistical comparisons

(v) ensuring that the proposed data collection requirements can be implemented by including the appropriate scientific expertise, numbers of people sampling, and/or use of scientific electronic monitoring.

6.18 The Working Group noted that Mr Dunn had provided an R script that could assist with evaluating the power of a survey design (included as an appendix in WG-SAM-2019/06). The Working Group recommended that proponents of research in MPAs (and for research plans on general) use statistical power analyses to assess the likelihood of their designs achieving their objectives and encouraged the use of the provided code.

6.19 The Working Group noted that research in closed areas is notified under CM 24-01, which includes requirements for research plans in Annex 24-01/B. It noted that this annex had not been reviewed for several years, and requested the Scientific Committee consider if the annex should be updated to include the requirements for research within MPAs. It also noted that research targeting toothfish should not undermine the other objectives that MPAs are designed to achieve for CCAMLR.

6.20 WG-SAM-2019/09 described preliminary results from statistical modelling of grenadier by-catch by longlines in research block 486_2. The Working Group noted that this analysis indicated that despite using a large number of zero-inflated distribution models, none of the models trialled was able to predict zero catches satisfactorily. The Working Group noted that there was spatial structure apparent in the distribution of zero catches of grenadiers and recommended further development of these models to include spatial effects.

Proposals and research results for toothfish from Area 48

Subarea 48.6

6.21 The Working Group considered papers on the results of research from Subarea 48.6 by Japan, South Africa and Spain. WG-SAM-2019/15 provided an analysis of the sea-ice concentration in research blocks 2, 3, 4 and 5 of Subarea 48.6. The paper noted that lower sea-surface temperature (SST) anomalies corresponded with higher sea-ice concentration in 2019 both in research blocks 486_4 and 486_5. The paper noted that it may be possible to predict future research vessel accessibility into research blocks 486_4 and 486_5 using SST from the HYCOM model.

6.22 WG-SAM-2019/16 described an oceanographic study of Subarea 48.6 using SST, sea-ice concentration, temperature-at-depth profiles, current and wind vectors. The paper noted that lower SST corresponded to the higher sea-ice concentration and was related to the patterns in wind vectors.

6.23 The Working Group noted that both papers observed considerable variability in anomalies especially in more recent years, and that this could be tied to global climatic change and prevalent climate modes in addition to local conditions. The Working Group noted that Antarctic region trends in climate variables are described in WG-EMM-2019/39, and suggested exploring whether prevalent climate mode was a factor in the accessibility of the southern research blocks.

6.24 WG-SAM-2019/36 presented updated biological parameters of *D. mawsoni* in Subarea 48.6 from research surveys, including an updated length–weight relationship, ALK, von Bertalanffy growth curves and maturity ogives. The paper noted that due to insufficient ageing of otoliths, annual ALKs were not yet available.

6.25 The Working Group noted that the observations of age at length for some of the data was unusual, and that the age estimates may need to be verified and checked. Dr T. Okuda (Japan) noted that not all the readings had been made by two different readers. He noted that they would investigate these data to confirm or update these age readings.

6.26 The Working Group noted that diagnostic plots of the fits for length weight, growth and maturity ogives may help identify where there were unusual patterns of residuals. The Working Group recommended that residuals from fits be produced, and that plotting residuals by age, year of sampling or reader may provide an insight into whether there were unusual patterns that would need additional investigation.

6.27 The Working Group reviewed the research proposal for Subarea 48.6 by Japan, South Africa and Spain given in WG-SAM-2019/13 Rev. 1. The research program has seven main objectives, including an assessment of abundance, growth, population structure and ecological traits of *D. mawsoni*; by-catch species distribution; knowledge about Antarctic marine ecosystems; and effects of depredation.

6.28 The Working Group noted that this research program was initiated in 2018/19, and comprised three years of on-water research for the seasons 2019, 2020 and 2021. The research proposal noted that some off-water analyses would be completed in 2022 to meet the research program objectives.

6.29 The Working Group reviewed the research proposal as an ongoing research proposal and summarised its advice for WG-FSA-2019 in Table 2.

6.30 The Working Group reviewed progress against the 19 specific and six additional research milestones as described in WG-SAM-2019/13 Rev. 1, Appendix 1, Table 1. The table provided descriptions of the research program milestones and the achievements and reports for those milestones.

6.31 The Working Group noted the considerable progress against the milestones that has been provided by Japan, South Africa and Spain. The Working Group agreed that, in reviewing the results of research against milestones 1, 2, 3, 6, 7, 9, 10, 11, 12 and 18, these milestones had been achieved.

6.32 The Working Group noted partial progress against milestones 5 and 19 had been presented and agreed that the work currently being undertaken was likely to lead to the achievement of these milestones and encouraged the proponents of the research proposal to continue their work to complete these milestones.

6.33 The Working Group noted that additional work would be required to meet milestones 4, 8, 13, 14, 15, 16 and 17. Specifically, additional otoliths would need to be read to provide data for annual ALKs (milestones 4 and 8); the research proposal would need to specify how information from this proposal or additional research would allow testing of the stock hypotheses (13); vessel calibration studies should be developed, noting that the number of tag recaptures obtained from the current research would not allow this to be evaluated (14); that methods of IUU estimation require additional research (15); reports on the tagging performance (16); and development of preliminary stock status, given the tag performance.

Subarea 48.1

6.34 WG-SAM-2019/33 presented the results of the longline survey conducted by Ukraine in Subarea 48.1 as set out in WG-FSA-18/20 Rev. 1. The survey had been restricted by ice conditions and only deployed and successfully retrieved seven sets (of the planned 36) in research block 481_1, due to an inability to access research block 481_2; two additional lines, comprising 25% of the hooks deployed, had also been lost under ice and not retrieved.

6.35 The authors presented the preliminary survey results on length distributions, maturity and by-catch, which will be updated and supplemented with further analysis at WG-FSA-2019. Otoliths from the survey had yet to be read and microchemistry and genetic samples have been sent to collaborating organisations in order to establish potential biological links of the toothfish with other regions in Area 48 as part of the research requested by the Workshop for the Development of a *Dissostichus mawsoni* Population Hypothesis for Area 48 (WS-DmPH).

6.36 The importance of collecting information on the toothfish stock characteristics in this area was highlighted by the Working Group and it noted that the survey had provided a valuable dataset, despite the difficulties it had in collecting it. The Working Group noted the high percentage of full stomachs in the sampled catch, with a substantial amount of digested material and suggested collecting samples for fatty acid analysis. The authors noted that in the next research proposal stomachs were to be collected and returned for more detailed analysis.

6.37 A large range of sizes was observed with a bimodal distribution. The Working Group suggested separating the length distribution by depth to determine the local stock structure.

6.38 The Working Group noted that the tag-overlap statistic for the survey was lower than the 60% threshold specified by CM 41-01, while the number of fish tagged was greater than the 30 minimum for the threshold to apply and recommend it be reviewed by SCIC. The low overlap percentage resulted from a low number of large fish in the tagged fish length distribution compared to the catch.

6.39 The Working Group noted that the research report indicated that the observers were responsible for meeting the survey objectives. It reiterated observers are responsible for CCAMLR Scheme of International Scientific Observation (SISO) sampling and that it is the Members which have responsibility for completing the survey objectives.

6.40 The presence of ice in large concentrations had previously been noted by the Working Group as a risk to completion of its objectives (WG-FSA-2018 report, paragraphs 4.48 to 4.52), and it was noted that the subsequent confirmation of this advice was beneficial. Procedures to review the potential for completing research in the ice-restricted areas should be routine within survey submissions.

6.41 The Working Group noted that the risk remains to the completion of objectives if the survey continues. It recommended that the authors review their program aims to ensure focus on objectives that can be completed in a restricted time and area. The authors noted that a review of the ice conditions in the region indicated that conducting the survey in February should allow for better access to the area and that this would be set out in a revised proposal to WG-FSA-2019.

6.42 The Working Group noted that SC-CAMLR-XXXVII (SC-CAMLR-XXXVII, paragraph 3.122) had advised that this research program be conducted for one year as a trial and that further research would require a new submission, as presented in WG-SAM-2019/28.

6.43 WG-SAM-2019/28 presented a proposal to continue the research in Subarea 48.1. The objectives were the same as the previous proposal, collection of data on stock structure, genetic samples and conducting plankton sampling. The vessel intended to start earlier to take advantage of less ice in the area and to conduct research in research blocks 481_1 and 481_2 only. The authors indicated that the plan was intended to collect data for one further year only, however, the research analysis and reporting would continue after the on-water activities were completed.

6.44 The Working Group reviewed the research proposal as an ongoing research proposal and summarised its advice for WG-FSA-2019 in Table 2.

Subarea 48.2

6.45 WG-SAM-2019/29 presented the results of the fifth year the longline survey was conducted by the Ukrainian vessel *Simeiz* in Subarea 48.2 in March–April 2019, as set out in WG-FSA-18/49. Significant reductions were noted in the CPUE of *D. mawsoni* in the survey area compared with 2018. Data on the CPUE of the target and main by-catch species, biological characteristics of toothfish and by-catch and seabird and marine mammal observations were presented. The authors noted there was no plan to continue fishing activities in 2019/20, but to instead focus on delivery of research objectives off the water.

6.46 The Working Group noted that the analysis of the work was ongoing and that following this preliminary report a more detailed research report on the survey in this area would be presented to WG-FSA-2019. It requested that the update include a time series summary of the CPUE within each research block in order to determine the local dynamics.

6.47 The Working Group recalled the discussion on the differences between C2 catch records and Catch Documentation Scheme for *Dissostichus* spp. (CDS) landings (paragraphs 4.5 to 4.7 and SC-CAMLR-XXXVII, paragraphs 12.3 and 12.4) that indicated that there may have been underestimation of the catch by the vessel taking part in this survey. Consequently, these differences should be considered in the analysis of trends in the CPUE from this research. The authors of WG-SAM-2019/29 reported that in 2019 there was no discrepancy between the reported catch and the verified landings in the CDS.

6.48 The Working Group noted that differences between C2 catch records and CDS landings provide a very useful means of highlighting where there may have been issues with catch data reporting that have the potential to impact the advice provided on catch limits. It welcomed the recommendation of the Scientific Committee that this information be routinely reported (SC-CAMLR-XXXVII, paragraph 3.39).

6.49 The Working Group noted the increase in the catch of grenadier through the survey time series and asked the survey authors to investigate what factors this resulted from including the survey design. The Working Group further requested a figure showing all fishing locations for the five years of the survey by year for WG-FSA, so that it would be better able to evaluate causes for the change in toothfish and grenadier CPUE.

6.50 The Working Group noted that the changes in toothfish CPUE were not a result of the gear type design as it had been consistent during the five years, therefore the variation resulted from changes in the underlying stock. The short survey by Chile in 2017 had not been included in the analysis. The survey had been of such limited effort that there could be no valid comparison between gears.

Subareas 48.2 and 48.4

6.51 Dr Darby noted that that the on-water activities of the UK research survey in the Subareas 48.2 and 48.4 survey, as described in WG-FSA-18/52, were completed in 2019 and that the survey analysis was now being conducted. A first report of the analysis would be presented to WG-FSA-2019. Further analyses of the results of the time series would be presented to WG-FSA as outlined in the timeline presented in WG-FSA-18/52.

Proposals and research results for toothfish from Subarea 58.4

Divisions 58.4.1 and 58.4.2

6.52 The Working Group considered WG-SAM-2019/20, which described the preliminary results of a modelling study of egg and larval transport of *D. mawsoni* in the East Antarctic region. The Working Group thanked the authors for this large body of work and noted that it could be a useful tool to assess different stock hypotheses including those developed at WS-DmPH as well as having potential for assessing larval transport patterns under different climate modes. The Working Group also noted that the model could be used to investigate the regional transport of krill or be coupled with microchemistry studies for toothfish connectivity.

6.53 The Working Group noted that a consistent trend in the model for particles to move onshore from the slope towards the shelf may suggest that there is a consistent requirement for adult fish to migrate and spawn offshore to enable eggs and larvae to return to shelf areas. The Working Group noted that bathymetry data are a key input to the model but the quality of these data varies from region to region.

6.54 WG-SAM-2019/26 provided an update of the second season of multi-Member toothfish research in Divisions 58.4.1 and 58.4.2. The Working Group recalled that only Division 58.4.2 was open for fishing in 2018/19. A vessel from Australia and one from France undertook research fishing in Division 58.4.2 during the 2018/19 season.

6.55 The Working Group agreed that the loss of a season's data from Division 58.4.1 has resulted in a break in the time series of the data collected in the division. This could cause a delay to the further development of a stock assessment and the ability of Scientific Committee to provide advice to the Commission for this division.

6.56 WG-SAM-2019/05 provided details for the continuation of a multi-Member research program on *D. mawsoni* in the exploratory fishery in East Antarctica (Divisions 58.4.1 and 58.4.2) from 2018/19 to 2021/22. Changes had been made to the research plan, including operational details and the addition of the larval and egg transport study (paragraphs 6.52 and 6.53) in the milestones. Research blocks will again be allocated between Members to ensure overlap between fishing gear types and vessels to enable further assessment of gear and vessel effects.

6.57 The Working Group recalled that the proposal had been thoroughly reviewed over the last three years by WG-SAM and WG-FSA and had achieved all research milestones as noted by the Scientific Committee in 2018 (SC-CAMLR-XXXVII, paragraph 3.138).

6.58 The Working Group considered WG-SAM-2019/19, a proposal by Russia for a three-year program of toothfish research within Divisions 58.4.1 and 58.4.2 within the same research blocks as the multi-Member research proposal. The stated objectives of the research are the same as for the multi-Member proposal but participation is restricted to vessels using autolines only, and includes three vessels from Russia. Russia invited other Members to participate in this research using vessels with the same autoline gear specifications. The objective is to collect data using a single standardised fishing gear using a random stratified design to allocate effort in research blocks and depth strata. The proposed catch limits for each research block are those agreed by the Scientific Committee in 2018, noting that research was not conducted in Division 58.4.1 in 2018/19. The catch limits proposed in the proposal are the same as those agreed for research in this division in 2018. The Working Group noted that these are based on data obtained from the research conducted to date within the research blocks under the multi-Member research effort.

6.59 The Working Group recalled its previous advice and that of WG-FSA, the Scientific Committee and the CCAMLR Performance Review that proponents of new research should seek to collaborate with Members who are currently participating in established research programs within the same area. It was noted that other Members were invited to participate in the Russian research but that it was restricted to vessels using autoline gear and that no approach had been made to Members prior to the submission of the proposal to WG-SAM.

6.60 The Working Group noted that Russia had notified three autoline vessels to participate in the research in Division 58.4.1 but that there were differences among the types of autoline gears used by each vessel. Two vessels (*Palmer* and *Volk Arktiki*) had notified to use a Mustad integrated weighted autoline system whilst the third (*Sparta*) used a Mustad system without an integrated weighted line. The Working Group also noted that tagging survival and detection statistics among vessels in the Ross Sea varied widely among autoline vessels, suggesting that using autoline vessels alone does not guarantee consistent performance.

6.61 The Working Group sought clarity from the proponents as to why there is a need to adopt a different approach to research within Division 58.4.1 and what the scientific basis for treating this region differently to others within the Convention Area is. The Working Group noted that multi-Member research is undertaken across the Convention Area by vessels using different fishing gears that has been used to set catch limits and develop integrated stock assessments.

6.62 Dr Kasatkina indicated that the issue of gear standardisation was a problem for data-limited fisheries across the Convention Area and that this issue should be addressed by conducting research using standardised gear that is appropriate for the research and region. This would provide improved data for estimating abundance, population structure, productivity indices and distribution of toothfish and by-catch.

6.63 The Working Group noted that CCAMLR has never specified the need for a prescribed 'standard gear' for research. It was noted that where long-term multinational 'standardised' trawl surveys are conducted elsewhere in the world, gear differs between participants reflecting local conditions.

6.64 The Working Group noted that the proposal from Russia provides details of how data will be collected from research fishing activities but there is considerable uncertainty and a lack of clarity as to which analyses will subsequently be undertaken and by whom. The Working Group also noted that there is no indication as to whether or not data collected in recent seasons as part of the multi-Member research in these divisions will be integrated into any subsequent analyses.

6.65 The Working Group requested that the proponents provide additional information on the fishable seabed area within each research block, and the number of stations that will be sampled by the survey and how the proposed catch limits are related to the survey design. The Working Group also noted that the survey design does not address temporal and spatial effects and that there is a lack of information as to how the research will be implemented, particularly if other Members' vessels join the research program.

6.66 The Working Group noted that in order to increase its research fishing activities within the Convention Area, France has invested heavily to increase its research capacity (taking on an additional 3.5 staff) in order to achieve its research objectives. The Working Group noted that the Russian program is very ambitious, but it is not clear whether the capacity exists to undertake subsequent analyses (WG-FSA-2018 report, paragraph 4.167).

6.67 The Working Group recalled that a preliminary integrated stock assessment had been developed for Division 58.4.1 that had been reviewed by the WG-FSA-2018 (WG-FSA-2018 report, paragraph 4.108). It further noted that such an assessment relies on tag-recapture data and not standardised CPUE data and therefore the tagging performance of vessels undertaking research is an important consideration when assessing the likely success of a research program (WG-FSA-2017 report, paragraphs 3.69 to 3.71).

6.68 The Working Group highlighted additional issues with the research proposal for which greater clarity was required, including the provision of details of how existing data will be used within the planned research program. The Working Group requested more information on the sampling regime for by-catch and otolith collection which is restricted in the proposal to fish less than 150 cm in length, noting a large proportion of historical catch has been larger than this. The Working Group also requested that additional information is provided to address concerns that it will be difficult to conduct research in prescribed fine-scale rectangles when ice conditions are unpredictable and likely to impact on access.

6.69 The Working Group evaluated the research proposal against the standard criteria and format for research proposals as shown in Table 3.

6.70 The Working Group noted that a disruption to a survey time series would have a detrimental effect on the ability to provide advice to the Scientific Committee and the Commission. In order to avoid this disruption, any new proposals should be integrated within existing research in the area.

6.71 The Working Group recommended that the proponents evaluate the likelihood of success of the research both as described in the proposal where it is restricted to the participation of vessels from Russia, but also with the addition of other Members' vessels. In particular, further clarity is required on the distribution of effort within the fine-scale rectangles.

6.72 During the course of the meeting, Dr Kasatkina agreed to work intersessionally to develop a joint research proposal with the existing research proponents of Divisions 58.4.1 and 58.4.2 for consideration by WG-FSA-2019. This proposal would aim to address many of the issues highlighted in paragraphs 6.64 to 6.69. The Working Group welcomed this development and looked forward to seeing the outcomes of these intersessional discussions.

Division 58.4.4b

6.73 Following the discussions of WG-FSA-18 (WG-FSA-2018 report, paragraphs 4.132 and 4.134), WG-SAM-2019/01 presented an overview of the rate of killer whale (*Orcinus orca*) interactions, the estimated amount of depredated fish and new data on numbers and movements of killer whales using photo-identification for Division 58.4.4b. The paper also highlighted movements of individually identified killer whales observed between Division 58.4.4 and Subarea 58.6.

6.74 The Working Group noted that the depredation rates over time in research blocks 5844b_1 and 5844b_2 were 1.7% and 0% respectively. Further, the Working Group agreed that using the assumption that any killer whale observed near the vessel was interacting with the gear was a conservative one. The Working Group also agreed with the recommendation of the paper that photos should be taken when any killer whales are observed near the vessel to assist in the understanding of killer whale ecology and depredation behaviour in Area 58. It also agreed the best-practice action is to buoy off the line and return to haul once killer whales have left the area, in order to prevent learning and naive groups starting to interact.

6.75 WG-SAM-2019/08 presented an updated research plan for research blocks 5844b_1 and 5844b_2, proposing to continue the current research operation with updated research design to account for comments made by WG-SAM-18 and results presented at WG-FSA-18 and SC-CAMLR-XXXVII, Annex 12. The paper also highlighted the addition of one new vessel, the *Cap Kersaint*, to increase on-water capacity and that fishing for this season was still underway.

6.76 The Working Group noted that all milestones due for WG-SAM-2019 had been achieved. Upon reviewing the future milestones, the Working Group recommended that the milestone schedule be amended to deliver updated growth, maturity and ALKs to future WG-FSA meetings only and not require these to be reviewed by WG-SAM unless methodological issues need review. Additionally, it recommended separating the CASAL milestone into two; the first outlining CASAL developments which will be presented to future

WG-SAM meetings, and the second outlining CASAL evaluation which will be presented to WG-FSA meetings. The Working Group also suggested incorporating the calculation of harvest rate under varying scenarios of IUU and depredation.

6.77 The Working Group also noted that the two research blocks in Division 58.4.4b represent a small proportion of the Division 58.4.4 population, and consideration should be given to how the populations in these research blocks relate to the population in Division 58.4.4 more broadly and how to develop a stock hypothesis.

6.78 The Working Group noted that while the notified vessels have experience in tagging in other CCAMLR fisheries, tag survivability and detection rate estimates are not yet available for the vessels fishing in this area and it recommended that these be calculated for the vessels from France which have fished in Crozet and Kerguelen.

6.79 The Working Group reviewed the research proposal as an ongoing research proposal and summarised its advice for WG-FSA-2019 in Table 3.

Review of research proposals and results for toothfish from Area 88

Subarea 88.1

6.80 WG-SAM-2019/03 described the results from the 2019 Ross Sea shelf survey and the notification for the survey in 2020. The objectives of the survey included monitoring the abundance and age structure of sub-adult toothfish in the south of SSRUs 881J and 881L in the southern Ross Sea using standardised gear in a standardised approach, and monitoring trends in large sub-adult and adult toothfish in two areas situated in SSRU 881M which are of importance to mammalian toothfish predators.

6.81 The Working Group noted the importance of this time series of surveys for the Ross Sea region stock assessment in delivering a long-term time series of recruitment.

6.82 The Working Group reviewed the research proposal as an ongoing research proposal and summarised its advice for WG-FSA-2019 in Table 4.

6.83 The Working Group recalled the advice by the Commission in 2018 (CCAMLR-XXXVII, paragraph 5.30) that all continuing research in closed areas shall only be reviewed annually at WG-FSA and continuing research in exploratory fisheries be reviewed every second year at WG-FSA. The Working Group therefore recommended that the survey results paper be referred to WG-FSA-2019.

6.84 WG-SAM-2019/17 presented a proposal for a research program from 2019/20 to 2027/28 to investigate the life cycle, distribution and movement, biological parameters and stock structure of *Dissostichus* spp. in the eastern part of the Ross Sea over the shelf and continental slope in the Special Research Zone (SRZ).

6.85 The Working Group noted that the objectives and methods in this proposal were the same as in WG-FSA-18/33 Rev. 1 and recalled its discussion and advice from the WG-FSA-2018 report, paragraphs 4.155 to 4.168. It expressed concerns that this advice had not been addressed in this proposal and noted that:

(i) The survey design, in which vessels fish in separate areas, would not allow for vessel effects to be removed from the estimation of the monitored population characteristics. The Working Group recommended that overlapping sampling effort by each vessel would allow vessel effects to be disentangled, such as effective tagging survival and tag detection rates.

(ii) The systematic design of the survey in the first year would provide information on the distribution of the stock within the SRZ for the subsequent stratification of the research stations which is planned as part of this research proposal. However, the Working Group considered that there was sufficient information from the commercial fishery already available to allow for the survey to be stratified from the first year onwards. It also noted that using fixed stations can be impacted by high sea-ice concentrations and recommended that a more flexible random stratified design be considered.

(iii) A vessel with negligible recaptures of tags, and a vessel with unknown tagging performance were proposed for delivering the research objectives of this proposal based on information available in WG-FSA-17/36. The analysis of tagging performance will be updated for WG-FSA-2019.

(iv) Given the expected catch rates and the number of haul stations, it is unlikely that the survey could be completed within the proposed catch limits. Errors in the calculation of catch limits for this proposal need to be corrected.

(v) There are proposed sampling locations that are outside the SRZ and using geographic reference data for the SRZ from the CCAMLR geographic information system (GIS) would assist in presenting this information in a consistent projection.

(vi) The proponents should undertake a power analysis to determine the required number of survey stations given the research objectives (see e.g. WG-SAM-18/06).

6.86 The Working Group noted that the proposed survey design and methods in WG-SAM-2019/17 are unlikely to achieve the objectives of this research plan. However, it noted the high importance of the area and science within the SRZ (paragraphs 6.16 and 6.17), and that the Scientific Committee had identified that there was a high priority for research within this area. It encouraged the proponents to submit a revised version addressing the issues outlined in the paragraph above.

6.87 The Working Group evaluated the research proposal in WG-SAM-2019/17 against the criteria set out in the WG-FSA-2017 report, paragraph 4.7 (Table 4).

Subareas 88.2 and 88.3

6.88 WG-SAM-2019/11 provided a progress report on the joint research survey for *D. mawsoni* in Subarea 88.3 by the Republic of Korea (Korea) and New Zealand in 2018/19. The survey was undertaken by one Korean vessel in seven research blocks in SSRUs 883A–D. As a result of extreme ice conditions covering the southern part of Subarea 88.3, New Zealand was not able to access the area to conduct its part of the survey. The total survey catch was

63 840 kg, and catch rates showed regional differences among the research blocks, with similar CPUEs in research blocks 883_1, 883_3 and 883_4, and lower CPUEs in research blocks 883_5, 883_8 and 883_9.

6.89 The Working Group noted that there were four tags recaptured, which represents the first tag recaptures in Subarea 88.3 for *D. mawsoni*.

6.90 Dr Kasatkina noted that the two vessels that notified to undertake the research had different longline configurations, and that this may impact CPUE patterns between different research blocks. Dr S.-G. Choi (Korea) informed the Working Group that efforts to standardise between fishing gears would take place in research block 883_3 in the coming fishing season though spatial overlap of vessels with different gear-types, random station allocation and with scientific electronic monitoring systems on each vessel.

6.91 The Working Group also noted differences in the size composition of *D. mawsoni* in different research blocks throughout the region, and that northern and southern regions of the survey area have different size structures.

6.92 WG-SAM-2019/02 provided details for an integrated survey for *D. mawsoni* in Subarea 88.3 for the 2019/20 fishing season by Korea, New Zealand and Ukraine. The Working Group noted that this research was entering the third and final year of a joint research proposal by Korea and New Zealand, endorsed in 2017/18, and this proposal was designed to build on Korea's previous research by continuing to focus on research blocks where tagged fish have previously been released on the slope, while also prospecting two northern seamount complexes and two areas on the continental shelf, where no research has occurred.

6.93 The Working Group noted that WG-SAM-2019/02 was developed following a proposal from the Ukraine to join the research plan in 2018. The Scientific Committee requested an integrated proposal be developed for all three Members (SC-CAMLR-XXXVII, paragraph 3.191). The Working Group noted that the objectives of the integrated proposal were unchanged from the original proposal, and included secondary objectives to improve understanding of stock structure in Subarea 88.3, carry out calibration trials among the vessels, collect data on the spatial and depth distributions of by-catch species and to trial scientific electronic monitoring technologies.

6.94 The Working Group noted the intention to undertake gear calibration experiments with spatial overlap of vessels to take place in research block 883_3 and scientific electronic monitoring on all vessels engaged in the research. It was further noted that an additional milestone was added to account for off-water research activity. The Working Group agreed that a full review of this survey be undertaken after the 2019/20 season, and that a new proposal will be required for the 2020/21 fishing season.

6.95 The Working Group noted recent environmental changes that have taken place adjacent to research block 883_2, where there have been recent significant calving events of the Pine Island glacier that may result in future logistic problems in relation to access to this research block.

6.96 The Working Group recommended that details and catch limits be specified in research blocks following the specific nomenclature set out in SC-CAMLR-XXXVII, Table 1.

6.97 The Working Group reviewed the research proposal and summarised its advice for WG-FSA-2019 in Table 4.

Review of research proposals and results for other species

Icefish trawl survey proposal

6.98 WG-SAM-2019/29 presented a draft proposal to WG-SAM for feedback, to conduct a local survey of mackerel icefish (*Champsocephalus gunnari*) by midwater trawl in Subarea 48.2. The proposal indicated a research area on the shelf and slope west of the South Orkney Islands in February–April 2020. The survey would be conducted as a limited effort series (37 trawl stations) with a precautionary catch limit of 70 tonnes.

6.99 The Working Group noted that discussions on the design of surveys for icefish in Subarea 48.2 had occurred at length at WG-SAM and WG-FSA during the previous few years in relation to the Chilean survey in the region. Icefish are both demersal and pelagic and catches in the water column can be highly variable. A purely pelagic trawl survey would not provide information on the total stock in the area and consequently the utility of such a survey in the determination of stock abundance was not considered appropriate. The design and the methodology to be applied during the survey was not clear, in particular whether the survey was a multibeam acoustic survey in which species aggregations were targeted for identification or whether the survey was purely a grid of survey stations at which a trawl would be deployed.

6.100 The authors thanked the Working Group for its comments and noted that they would review the feedback and revisit the proposal at a future meeting.

Crab research results and proposals

6.101 WG-SAM-2019/31 reported on the outcomes of the first year of research fishing for Lithodidae (Anomura, Decapoda) in the Amundsen and Bellingshausen Seas in 2019. The activities took place in March 2019 and two species were caught: *Paralomis birsteini* and *Neolithodes yaldwini*. Results included length–weight relationships, length distributions, sex ratios and reproductive state, and samples were collected for histological, genetic, isotope and parasite studies. By-catch of *D. mawsoni*, Whitson's grenadier (*Macrourus whitsoni*) and *Chionobathyscus dewitti* was reported, for which length and weight were taken. Otoliths were sampled from 12 of the 17 by-caught toothfish, and two toothfish were tagged and released. The authors informed the Working Group that due to the short time between the end of the Commission meeting in 2018 and the start of the 2018/19 season, video cameras were not available to the vessels in time, but that these would be deployed in the following year together with salinity-temperature-depth probes. The authors invited suggestions for which video camera equipment would be most suitable to withstand the pressure at depths fished.

6.102 The Working Group noted that the locations for some of the pots set deviated from those in the initial proposal, due to operational constraints with environmental conditions and sea-ice. It further noted that some of the toothfish caught in Subarea 88.3 were small (<70 cm), which for a region where information is limited and efforts are under way to improve

knowledge of local toothfish stocks (paragraphs 6.88 to 6.97) is important information, and welcomed the collection of otoliths. The authors informed the Working Group that more detailed by-catch analyses would be presented at WG-FSA-2019.

6.103 The Working Group recalled previous research (WG-FSA-96/35; Watters and Hobday, 1998) that showed allometric relationships between carapace length and chela size can be used to determine size at sexual maturity, and such additional information on allometric measurements would bring additional benefit to this research investigating the life history of these species. The Working Group recalled that WG-FSA had noted (WG-FSA-2018 report, paragraph 4.210) the opportunity of this program to test two concurrent scientific hypotheses, whether Lithodidae were endemic or invasive species to this region, and noted that collecting environmental data would be fundamental to resolving this question.

6.104 The Working Group wished to highlight this research to WG-EMM-2019 and WG-FSA-2019, as approximately 45 pots were lost during operations as well as a further 30 damaged, and there was some concern about the potential to impact seabed communities in this area.

6.105 The Working Group requested that the proposed catch limits be reviewed by WG-FSA to reflect the actual catch rates from 2019 together with the proposed effort.

6.106 The Working Group requested that the reporting forms specified by the Scientific Committee (SC-CAMLR-XXXVII, paragraph 4.3) be considered by WG-FSA-2019 to ensure they are consistent with the recent reviews of the trawl and longline data reporting forms.

6.107 WG-SAM-2019/18 provided a proposal to continue the investigation on species composition, biology, life cycle, distribution, and structure of Lithodidae stocks (Anomura, Decapoda) in Subareas 88.2 and 88.3, to further assess their resource potential. The proposal provided two options, one to continue under CM 24-01, and the other to move to a new fishery under CM 21-01 (paragraphs 8.7 and 8.8).

6.108 The Working Group reviewed the research proposal for Lithodidae by Russia given in WG-SAM-2019/18. The research program has four main objectives, including to improve understanding of species distribution and life history, assess the resource potential and commercial significance, contribute to ecosystem approach to managing fisheries in Subareas 88.2 and 88.3, and contribute to spatial management of fisheries in Area 88.

6.109 The Working Group suggested investigating the possibility of using methods such as the CPUE × seabed area along with available habitat to try and develop an understanding of distribution and relative abundance to provide advice on appropriate precautionary catch limits of this research proposal.

6.110 The Working Group requested that, should the research go ahead, data also be collected on viability of the large percentage of crabs being returned to sea, in line with studies carried out previously and presented in WG-FSA-00/24.

6.111 The Working Group reviewed the research proposal and summarised its advice for WG-FSA-2019 in Table 4.

Future work

WG-SAM workplan

7.1 The Working Group identified strategic work areas for consideration by the Scientific Committee. The Working Group noted that the Strategic Plan was last updated in 2016, and the current five-year work plan should be updated.

7.2 The Working Group requested the Scientific Committee consider the following topics as potential tasks for WG-SAM:

(i) develop ecosystem models for toothfish

(ii) promote interaction between WG-SAM and WG-EMM on methods and survey design

(iii) review new stock assessments developing from research plans

(iv) implementation of recommendations of the CCAMLR Independent Stock Assessment Review for Toothfish

(v) development of integrated assessments at population scale

(vi) management strategy evaluations

(vii) Scientific Committee on Antarctic Research (SCAR) joint symposium on 'role of fish in Antarctic ecosystems'

(viii) uncertainty in linear trend analysis catch limits

(ix) implementing CCAMLR decision rules with F-based assessments

(x) methodologies for spatially explicit risk assessments with regard to krill but also by-catch or protected species

(xi) develop toothfish tagging best practices

(xii) development of current method and alternatives for calibration between vessels for tagging survival and tag detection

(xiii) operating models for CCAMLR fisheries (e.g. krill and toothfish)

(xiv) development of a strategic plan within WG-SAM

(xv) further streamlining of review processes to focus on quantitative methods

(xvi) CASAL 2 development

(xvii) methods for multivessel research designs.

7.3 The Working Group requested that the Scientific Committee consider developing an overarching strategic direction for the work plan to more clearly define the role of the Working Group, noting that cross-links with SG-ASAM and WG-EMM could create opportunities for sharing of scientific expertise on high-priority quantitative work areas.

Research plan timeline

7.4 The Working Group noted that CM 24-01 notification requirements may be confusing and may conflict with the updated review procedure agreed by the Commission (CCAMLR-XXXVII, paragraph 5.30). The Working Group noted that most research plans were being annually reviewed by the Working Group.

7.5 The Working Group noted that a timeline is required for research plans in order to effectively monitor, strategically align and clarify the review process for each research plan.

7.6 The Working Group noted that the three-year restriction of research plans adopted by the Commission in 2018/19 relates to the elements of the research that require an exemption from conservation measures, and that analysis of data and samples collected is able to be completed outside of this time period.

7.7 The Working Group requested that a description of the current review timeline be developed intersessionally by the Scientific Committee Bureau, to clarify the process for proponents and provide an opportunity for the Scientific Committee to review and further streamline the notification and review of research plans.

Other business

Fishing location reporting

8.1 WG-SAM-2019/22 examined the potential for difference between the location of gear on the sea floor and the vessel location as reported on C2 forms for longline sets in exploratory fisheries. All gear types were estimated to achieve similar sink rates and the potential differences in the coordinates between setting and hauling increased with depth and in areas of high current velocities.

8.2 The Working Group noted that while the authors of WG-SAM-2019/22 suggested revising the radius of risk areas around potential VMEs from 1 n mile to 1.5 n miles, further work would be required to examine the effect of other factors, including incorporating the improvements in the vessel positioning systems through time, and the observed sink rates of lines based on the weights of line anchors and on gear positioning on the sea floor relative to the vessel location.

Skate ageing

8.3 The Working Group considered WG-SAM-2019/10 which described a protocol to mark Antarctic starry skate (*Amblyraja georgiana*) chemically in order to validate the thorn ageing method. This protocol represents a simple addition that will complement the aims of the skate tagging program in the Ross Sea in 2020 and 2021 (WG-FSA-2018 report, paragraphs 6.34 to 6.36).

8.4 The Working Group welcomed the offer from Dr Parker to provide the necessary hardware and training to scientists on vessels transiting through New Zealand en route to the

Ross Sea to encourage participation in this program. WG-SAM-2019/10 provided examples of the vendors for injection materials and instructions for how to tag and chemically mark the skates.

Satellite tagging of toothfish outside the Convention Area

8.5 WG-SAM-2019/12 presented the details of a plan for a study on *D. eleginoides* in the southwest Atlantic (FAO Area 41) using satellite tags. The main objectives of the study are to investigate movements of the species and the connectivity between FAO Area 41 and the Convention Area by deploying a total of 50 pop-up satellite archival tags on adult *D. eleginoides* over two years from Korean longline vessels.

8.6 The Working Group welcomed this initiative and its initial results that showed toothfish undertaking regular, extensive vertical movements and noted its potential to improve our understanding of *D. eleginoides* in this area.

New fishery notification

8.7 WG-SAM-2019/21 outlined a proposal from Russia for a new fishery for crabs in Subareas 88.2 and 88.3 in accordance with CM 21-01 based on the recommendations of the Scientific Committee (SC-CAMLR-XXXVII, paragraph 4.3).

8.8 The Working Group noted that the process for the notification for a new fishery had both administrative and scientific components and that the discussion on this fishery in paragraphs 6.102 to 6.111 should form an important part of the process.

Advice to the Scientific Committee

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

(i) consideration of the implications of potential underestimation of catches in exploratory fisheries by WG-FSA and SCIC (paragraph 4.6)

(ii) specification of requirements for research fishing being proposed in MPAs (paragraphs 6.16, 6.17 and 6.19)

(iii) recommendation that the low tag-overlap statistic for the survey in Subarea 48.1 be reviewed by SCIC (paragraph 6.38)

(iv) request for the reporting forms specified by the Scientific Committee for crab research to be made available to WG-FSA-2019 (paragraph 6.106)

(v) request that a description of the current review timeline be developed intersessionally by the Scientific Committee Bureau (paragraph 7.7).

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.

10.2 Dr Parker thanked the hosts for the excellent facilities and stunning venue for the meeting, as well as the support provided by the team from the Muséum national d'Histoire naturelle that had all contributed to such a successful Working Group meeting.

10.3 Dr Péron also thanked all participants and, in particular, Dr Parker for his mentorship that had allowed for a very positive handover of the role of Convener.

10.4 On behalf of the Scientific Committee and the Working Group, Dr Belchier thanked Drs Parker and Péron for their successful co-convening of the meeting. He thanked Dr Parker for his five years of convening the Working Group in a very agreeable and languid style that had delivered much progress in the development of the research in data-limited fisheries.

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Watters, G. and A.J. Hobday. 1998. A new method for estimating the morphometric size at maturity of crabs. *Can. J. Fish. Aquat. Sci.*, 55 (3): 704–714.

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Table 1: Factors that are considered to be important in the design of data collection and analysis of key datasets. * Vessel is a proxy for other factors such as crew, skipper, and other vessel specific operational effects.

Datasets/parameters to be estimated	Influential factors													
		Fishing										Environmental		
	Tag rate	Bait	Depredation	Gear	Hook number	Hook type	Location	Nationality	Soak time	Time	Vessel*	Depth	Temperature	Salinity
Abundance														
CPUE		X	X	X	X	X	X	X	X	X	X	X	X	X
Tags	X						X			X	X			
Life history														
Mortality			X				X			X				
Recruitment		X	X	X	X	X	X	X	X	X	X	X		
Growth							X			X		X	X	
Maturity							X			X		X	X	
Length/weight							X			X		X	X	
Stock structure														
Distribution		X	X	X	X	X	X	X	X	X	X	X	X	X
Age							X			X		X	X	
Size							X			X		X	X	
Genetics							X			X				
Ecosystem														
By-catch		X	X	X	X	X	X	X	X	X	X	X	X	X
Diet							X		X	X		X		
VME				X	X	X	X	X			X	X	X	X

Table 2: Summary of the assessment of the new and underway Area 48 research proposals against the criteria set out in WG-FSA-2017 report, paragraph 4.7. Summary of the rationale behind the scores are in the notes below, and the table should be taken in the context of the details in paragraphs 6.21 to 6.44. TBD indicates that catch limits will be discussed at WG-FSA.

Subarea:		48.1	48.6
Proposal and country/criteria:		WG-SAM-2019/28 Ukraine (year 1 of 1)	WG-SAM-2019/13 Japan, South Africa and Spain (year 2 of 3)
Conservation measure under which proposal submitted		24-01	21-02
(i)	(a) Is the proposed research likely to generate an index of local stock abundance?	N[2]	Y
	(b) Is the proposed research likely to generate estimates of biological parameters relating to productivity?	Y	Y
	(c) Is the proposed research likely to test a hypothesis of relationship of fish in the research area to the overall stock?	Y	Y
(ii)	Is the catch limit for the proposed research plan sufficient to achieve the agreed research objectives and consistent with Article II of the Convention?	TBD	TBD
(iii)	Are the likely impacts from the proposed research to dependent and related species consistent with Article II?	N[1]	N[4]
(iv)	Does the proposed research contain the details needed for WG-SAM, WG-FSA and the Scientific Committee to evaluate the likelihood of success, and relevant milestones specified with the detail necessary to evaluate the likelihood of success of the proposal?	Y	N[3]
(v)	Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs?	Y[5]	Y[5]
(vi)	Has the collective research team demonstrated a thorough understanding of environmental conditions and associated logistics and capacity to carry out the proposed research plan (on the water)?[6]	N[2]	Y
(vii)	Has the collective research team demonstrated experience and sufficient resources and capacity, or identified a reliable mechanism, for analysis of data to achieve the objectives of the research (data and sample analyses)?[6]	N[8]	N[1]
(viii)	Has the research team demonstrated achieving all milestones in previous proposals for this area, or provided a reasonable account of why some milestones were not able to be achieved?	Y[9]	N[7]

Table 2 (continued)

Notes:

1. There is not enough information in the proposal.
2. There are concerns about the repeated accessibility of the fishing grounds due to sea-ice (WG-FSA-2018 report, Figure 5).
3. Not all milestones were sufficiently specified in the proposal (paragraphs 6.30 to 6.33).
4. Requires more data analysis.
5. Based on vessel tagging detection and survival rates in WG-FSA-17/36.
6. Based on milestones not being achieved on the assessment of biological parameters, analyses of by-catch species, seabirds and marine mammals.
7. Based on milestones not being achieved on productivity parameters.
8. There is concern that the vessel did not meet the tag-overlap statistic requirement or the tag-rate requirement.
9. Refer to comments in text under paragraphs 6.73 to 6.79.

Table 3: Summary of the assessment of the new and underway Area 58 research proposals against the criteria set out in WG-FSA-2017 report, paragraph 4.7. Summary of the rationale behind the scores are in the notes below, and the table should be taken in the context of the details in paragraphs 6.52 to 6.78. TBD indicates that catch limits will be discussed at WG-FSA.

Division:	58.4.4b	58.4.1 and 58.4.2	58.4.1 and 58.4.2
Proposal and country/criteria:	WG-SAM-2019/08 France and Japan (year 3 of 5)	WG-SAM-2019/05 Australia, France, Japan, Republic of Korea, Spain (year 2 of 4)	WG-SAM-2019/19 Russia (year 1 of 3)
Conservation measure under which proposal submitted	24-01	21-02	21-02
(i) (a) Is the proposed research likely to generate an index of local stock abundance?	Y	Y	N[1]
(b) Is the proposed research likely to generate estimates of biological parameters relating to productivity?	Y	Y	N[1]
(c) Is the proposed research likely to test a hypothesis of relationship of fish in the research area to the overall stock?	N[8]	Y	N[1]
(ii) Is the catch limit for the proposed research plan sufficient to achieve the agreed research objectives and consistent with Article II of the Convention?	TBD	TBD	TBD
(iii) Are the likely impacts from the proposed research to dependent and related species consistent with Article II?	Y	Y	N[1]
(iv) Does the proposed research contain the details needed for WG-SAM, WG-FSA and the Scientific Committee to evaluate the likelihood of success, and relevant milestones specified with the detail necessary to evaluate the likelihood of success of the proposal?	Y	Y	N[1,4]
(v) Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs?	N[2]	N[3]	N[5]
(vi) Has the collective research team demonstrated a thorough understanding of environmental conditions and associated logistics and capacity to carry out the proposed research plan (on the water)?[7]	Y	Y	N[6]
(vii) Has the collective research team demonstrated experience and sufficient resources and capacity, or identified a reliable mechanism, for analysis of data to achieve the objectives of the research (data and sample analyses)?[7]	Y	Y	N[1]
(viii) Has the research team demonstrated achieving all milestones in previous proposals for this area, or provided a reasonable account of why some milestones were not able to be achieved?	Y	Y	N[7]

(continued)

Table 3 (continued)

Notes:

1. There is not enough information in the proposal.
2. The proposed vessels have multiple years of experience but have unknown calculated effective survival rates.
3. The vessels proposed by Australia and Spain have demonstrated experience and performance in toothfish tagging programs based on the vessel tagging detection and survival rates in WG-FSA-17/36. The vessel proposed by the Republic of Korea has limited tagging experience and unknown calculated effective survival rates. The vessels proposed by France and Japan have tagging experience but unknown effective survival rates.
4. Increased biological sampling rates would be required to achieve objectives.
5. Of the three vessels proposed for this research, two have calculated tag detection and survival statistics, one of which has a negligible tag-survival rate (WG-FSA-17/36). The *Arctic Wolf* has no calculated tag-performance statistics available.
6. The proposed vessels would be new to fishing in that area.
7. Priority should be given to the completion of research programs already in place over new research proposals.
8. Refer to report text.

Table 4: Summary of the assessment of the new and underway Area 88 research proposals against the criteria set out in WG-FSA-2017 report, paragraph 4.7. Summary of the rationale behind the scores are in the notes below, and the table should be taken in the context of the details in paragraphs 6.80 to 6.86. n/a indicates not applicable.

Subarea:	88.1		88.2/3	88.3
Proposal and country/criteria:	WG-SAM-2019/17 Russia (year 1 of 9)	WG-SAM-2019/03 New Zealand (year 3 of 5)	WG-SAM-2019/18 Russia (year 1 of 3)	WG-SAM-2019/02 Republic of Korea, New Zealand and Ukraine (year 3 of 3)
Conservation measure under which proposal submitted	24-01	24-01	24-01	24-01
(i) (a) Is the proposed research likely to generate an index of local stock abundance?	Y	Y	N[5]	Y
(b) Is the proposed research likely to generate estimates of biological parameters relating to productivity?	Y	Y	Y	Y[2]
(c) Is the proposed research likely to test a hypothesis of relationship of fish in the research area to the overall stock?	Y	Y	N[6]	Y
(ii) Is the catch limit for the proposed research plan sufficient to achieve the agreed research objectives and consistent with Article II of the Convention?	TBD	TBD	TBD	TBD
(iii) Are the likely impacts from the proposed research to dependent and related species consistent with Article II?	Y	Y	N[7]	Y
(iv) Does the proposed research contain the details needed for WG-SAM, WG-FSA and the Scientific Committee to evaluate the likelihood of success, and relevant milestones specified with the detail necessary to evaluate the likelihood of success of the proposal?	N[8]	Y	Y[9]	Y
(v) Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs?	N[10]	Y[1]	N[11]	N[3]
(vi) Has the collective research team demonstrated a thorough understanding of environmental conditions and associated logistics and capacity to carry out the proposed research plan (on the water)?	Y	Y	Y[7]	Y
(vii) Has the collective research team demonstrated experience and sufficient resources and capacity, or identified a reliable mechanism, for analysis of data to achieve the objectives of the research (data and sample analyses)?[5]	Y	Y	Y	Y
(viii) Has the research team demonstrated achieving all milestones in previous proposals for this area, or provided a reasonable account of why some milestones were not able to be achieved?	N[12]	Y	Y	N[4]

(continued)

Table 4 (continued)

Notes:

1. Based on vessel tagging detection and survival rates in WG-FSA-17/36.
2. Aging data still to be provided.
3. Tagging statistics are not available for the vessels proposed by the Republic of Korea or Ukraine, but they are part of the experimental design.
4. Milestones have been delayed due to the New Zealand vessel not fishing in 2017/18 or 2018/19 due to ice conditions.
5. There is no information available on the distribution of the target species within CCAMLR data, and therefore no relation to the overall stock is possible from this limited area survey.
6. Alternative hypotheses exist for estimating crab populations in the Southern Ocean
7. The proponent has not addressed the potential environmental impact of a large amount of lost gear.
8. The Working Group recommended a review after one year of the research program.
9. Additional information is needed on biological parameters and the potential for high discard mortality.
10. Of the four vessels proposed for this research three have calculated tag detection and survival statistics, and one of these vessels has a negligible tag survival rate (WG-FSA-17/36).
11. Of the two vessels proposed for this research only one has calculated tag detection and survival statistics (WG-FSA-17/36).
12. Analyses are pending for this region.

Appendix A

List of Participants

Working Group on Statistics, Assessments and Modelling
(Concarneau, France, 17 to 21 June 2019)

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Appendix B

Agenda

Working Group on Statistics, Assessments and Modelling
(Concarneau, France, 17 to 21 June 2019)

1. Introduction

2. Opening of the meeting

    2.1 Adoption of the agenda and organisation of the meeting

3. Assessments to estimate sustainable yield

4. Cross-cutting issues in longline fisheries affecting data quality

    4.1 Tagging
    4.2 Generic

5. Data Services Advisory Group (DSAG)

6. Review of research plan proposals and results

    6.1 Proposals and research results from Area 48

        6.1.1 Subarea 48.6
        6.1.2 Subareas 48.1 and 48.2

    6.2 Proposals and research results from Subarea 58.4

        6.2.1 Divisions 58.4.1 and 58.4.2
        6.2.2 Division 58.4.4

    6.3 Review of research proposals and results for Area 88

        6.3.1 Subarea 88.1
        6.3.2 Subareas 88.2 and 88.3

7. Future work

8. Other business

9. Advice to the Scientific Committee

10. Adoption of report and close of meeting.

Appendix C

List of Documents

Working Group on Statistics, Assessments and Modelling
(Concarneau, France, 17 to 21 June 2019)

WG-SAM-2019/01	Update report on marine mammal interactions in Division58.4.4 N. Gasco, P. Tixier, T. Okuda, C. Péron and F. Massiot-Granier
WG-SAM-2019/02	Integrated research proposal for *Dissostichus* spp. in Subarea 88.3 by the Republic of Korea, New Zealand and Ukraine Delegations of the Republic of Korea, New Zealand and Ukraine
WG-SAM-2019/03	2019 Ross Sea shelf survey results and notification for research in 2020 S. Parker and C. Jones
WG-SAM-2019/04	A preliminary model-based approach for estimating natural mortality of Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea Region B. Moore, S. Mormede, S. Parker and A. Dunn
WG-SAM-2019/05	Continuation of multi-Member research on the *Dissostichus mawsoni* 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-2019/06	Fisheries research within the Ross Sea region Marine Protected Area S. Parker and A. Dunn
WG-SAM-2019/07	Tag linking – revised algorithm (2019) Secretariat
WG-SAM-2019/08	Revised proposal for the ongoing research plan on Patagonian toothfish (*Dissostichus eleginoides*) in Division 58.4.4b (2016/17–2020/21) Delegations of Japan and France
WG-SAM-2019/09	Statistical modelling of by-catch patterns: a preliminary case study using research fisheries in Subarea 48.6 K. Sawada and T. Okuda

WG-SAM-2019/10	Chemical marking protocols for Antarctic starry skate age validation M. Francis and S. Parker
WG-SAM-2019/11	Progress report on the joint research for *Dissostichus* spp. in Subarea 88.3 by the Republic of Korea and New Zealand in 2018/19 Delegations of the Republic of Korea and New Zealand
WG-SAM-2019/12	Patagonian toothfish tagging study plan in the southwest Atlantic (FAO Area 41) C.H. Lam, K.J. Park, J. Lee and S.-G. Choi
WG-SAM-2019/13 Rev. 1	Proposed continuation of a multi-Member longline survey on Antarctic toothfish (*Dissostichus mawsoni*) in Statistical Subarea 48.6 in 2019/20 by Japan, South Africa and Spain Delegations of Japan, South Africa and Spain
WG-SAM-2019/14	The factors causing impact on the toothfish catch estimation on board of fishing vessels K. Demianenko, P. Zabroda, I. Slypko, L. Pshenichnov, A. Bazhan, O. Diripasko and D. Marichev
WG-SAM-2019/15	Analysis of the sea-ice concentration (SIC) in Subarea 48.6, research blocks 2, 3, 4 and 5 with sea-surface temperature (SST) and statistical models T. Namba, R. Sarralde, H. Pehlke, K. Teschke, T. Brey, S. Hain, T. Ichii, T. Okuda, S. Somhlaba and J. Pompert
WG-SAM-2019/16	Oceanographic study of the Subarea 48.6 with sea-surface temperature (SST) anomaly and vertical profile of sea temperature (PST) T. Namba, R. Sarralde, T. Ichii, T. Okuda, S. Somhlaba and J. Pompert
WG-SAM-2019/17	Research program to examine the life- cycle and resource potential of *Dissostichus* spp. in the Special Research Zone within the Ross Sea region marine protected area (RSRMPA) in 2019–2027 Delegation of the Russian Federation
WG-SAM-2019/18	Continuation of the research program on study of life cycle, species compositions, biology and resource potential of craboids (Anomura, Decapoda) in the Pacific Ocean Antarctic Area from 2019/20 to 2020/21 by Russian Federation Delegation of the Russian Federation

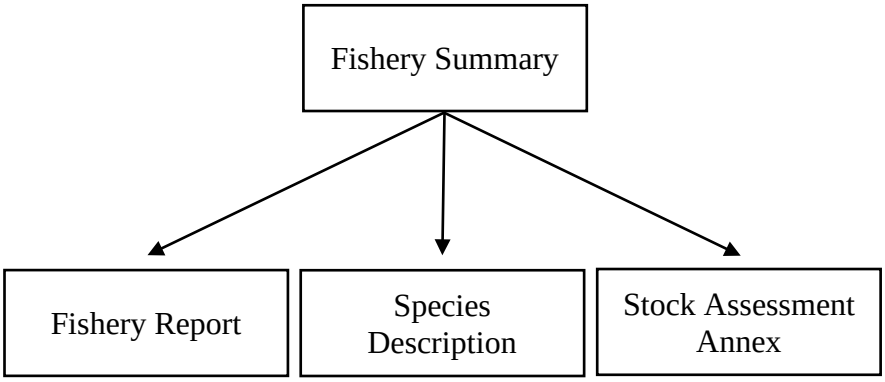
WG-SAM-2019/19	Research program on *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2 from 2019/20 to 2021/22 Delegation of the Russian Federation
WG-SAM-2019/20	Modelling egg and larval transport of Antarctic Toothfish (*Dissostichus mawsoni*) in the East Antarctic region: Plan M. Mori, K. Mizobata, T. Okuda and T. Ichii
WG-SAM-2019/21	Proposal on establishment of a new fishery for craboids (Anomura, Decapoda) in the Subareas 88.2 and 88.3 Delegation of the Russian Federation
WG-SAM-2019/22	On acceptable scattering of longlines geo-referencing in the toothfish fishery in the CAMLR Convention Area O. Krasnoborodko
WG-SAM-2019/23	Information about methods for finding lost longlines P. Zabroda and L. Pshenichnov
WG-SAM-2019/24	A preliminary proposal to conduct a local survey of the *Champsocephalus gunnari* by the midwater trawl in the Statistical Subarea 48.2 Delegation of Ukraine
WG-SAM-2019/25	Exploration of CPUE standardisation variances in the Ross Sea (Subareas 88.1 and 88.2A South of 70°s) Antarctic toothfish (*Dissostichus mawsoni*) exploratory longline fishery D. Maschette, S. Wotherspoon and P. Ziegler
WG-SAM-2019/26	Report on joint exploratory fishing in Divisions 58.4.1 and 58.4.2 between the 2011/12 and 2018/19 fishing seasons Delegation of Australia
WG-SAM-2019/27	Planned updates for the integrated stock assessment for the Heard Island and McDonald Islands Patagonian toothfish (*Dissostichus eleginoides*) fishery in Division 58.5.2 P. Ziegler and J. Dell
WG-SAM-2019/28	Ukraine proposes to continue a scientific survey of *Dissostichus* spp. by bottom longline in the eastern part of Subarea 48.1 in a season 2019/20 Delegation of Ukraine
WG-SAM-2019/29	The preliminary report on the survey in Subarea 48.2 in 2019 Delegation of Ukraine

WG-SAM-2019/30	Revised CASAL model for *D. eleginoides* with updated biological parameters at Division 58.4.4b T. Okuda and F. Massiot-Granier
WG-SAM-2019/31	Report on implementation of research program for study of species composition, biology and resource potential of craboids (Anomura, Decapoda) in the Antarctic Pacific in 2019 Delegation of the Russian Federation
WG-SAM-2019/32	An exploration of the biological data used in the CCAMLR Subarea 48.3 Patagonian toothfish stock assessments E. MacLeod, K. Bradley, T. Earl, M. Söffker and C. Darby
WG-SAM-2019/33	Informational report on research fishing for *Dissostichus* spp. in Subarea 48.1 by Ukraine in 2019 P. Zabroda, L. Pshenichnov and K. Demianenko
WG-SAM-2019/34	Proposals on standardization of toothfish resource research S. Kasatkina
WG-SAM-2019/35	Updates to Fishery Reports – A prototype based on the 'Exploratory fishery for *Dissostichus mawsoni* in Subarea 48.6' Fishery Report Secretariat
WG-SAM-2019/36	Updated biological parameters of *Dissostichus mawsoni* at Subarea 48.6 T. Okuda and R. Sarralde Vizuete
WG-SAM-2019/37	A development of catch per unit effort (CPUE) trends that may be useful in stock assessment for *Dissostichus mawsoni* in Subarea 48.6 S. Somhlaba, K. Leach, M. Bergh, T. Okuda, T, IIchi, R. Sarralde and T. Namba

Appendix D

Fishery Report structure

Hierarchical structure of the future set of documents to communicate CCAMLR fisheries activities.



Fishery Summary

Map of the region
Image of organism with species name
Plot of time-series of catch and catch limits
Summary table:

- Stock status
- Conservation measures in force (with links)
- Wider environmental considerations (e.g. seabirds, vulnerable marine ecosystem (VME))
- Type of fishery (e.g. exploratory, Conservation Measure (CM) 24-01)
- Vessel type and gears involved

Links to relevant Fishery Report, Species Description and Stock Assessment Annex

Fishery Report

Title
Picture of organism
Map

Table of contents

Sections:

1. **Introduction to the fishery**
   History, conservation measures currently in force, active vessels, timeline of spatial management (e.g. changes, additions/removal of research blocks)
2. **Reported catch**
   Season and value of peak catch, catch table, catch limits
   By-catch
   Vulnerable marine ecosystems (VMEs)
   Incidental mortality of seabirds and marine mammals
3. **Illegal, unreported and unregulated (IUU) fishing**
4. **Data collection**
   CCAMLR Scheme of International Scientific Observation (SISO)
   What is collected and under which conservation measure
   Length-frequency distributions
   Tagging
   CCAMLR Ecosystem Monitoring Program (CEMP)
5. **Research**
   Research plans, advice by the Scientific Committee, status of the science (full assessment or other approach), climate change
6. **Stock status**
   Catch vs limit/SSB/year-class strength (YCS)/exploitation time-series plots
   Summary of current status (%B_0, current biomass, expected biomass at the end of the projection period)
   Assessment method (integrated model, trend analysis, etc.)
   Year of last assessment, year of next assessment
7. **Environmental variability**
   Changes in biological parameters and productivity assumptions and potential impact on management advice

Species Summary

Image of organism
Map of reported catch in the Convention Area
Life-history description
Parameter estimates
Relevant conservation measures

Stock Assessment Annex

Structure to be determined by e-group intersessionally (WG-FSA-2018 report, paragraph 2.33).