

Report of the Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2018)

Contents

| | Page |
|---|------------|
| Opening of the meeting | 321 |
| Review of data available | 321 |
| Illegal, unreported and unregulated (IUU) fishing activity | 321 |
| Catches in the current season | 322 |
| Data management..... | 323 |
| Data Management Group | 323 |
| C2 form design | 323 |
| Procedures for the use of catch and effort data in fishery management..... | 325 |
| Fishery Report updates | 326 |
| Review of updated stock assessments and provision of management advice (all fisheries) | 327 |
| <i>Champscephalus gunnari</i> | 328 |
| <i>C. gunnari</i> in Subarea 48.3 | 328 |
| <i>C. gunnari</i> in Division 58.5.1 | 328 |
| <i>C. gunnari</i> in Division 58.5.2 | 329 |
| Management advice | 329 |
| <i>Dissostichus</i> spp. | 329 |
| <i>Dissostichus</i> spp. in Subarea 48.4 | 331 |
| Management advice | 331 |
| Research to inform current or future assessments in ‘data-poor’ fisheries (e.g. new fisheries, activities in closed areas, areas with zero catch limits and in Subareas 48.6 and 58.4) notified under Conservation Measures 21-01, 21-02 and 24-01 | 331 |
| Generic issues | 331 |
| Trend analysis and setting catch limits | 331 |
| Tagging performance | 332 |
| Transitioning from area biomass estimates to integrated stock assessments | 333 |
| Process for reviewing research proposals | 334 |
| Review of requirements for plans in CM 21-02 | 335 |
| Management area research reviews and management advice | 335 |
| Research standardisation | 335 |
| <i>Dissostichus</i> spp. in Area 48 | 337 |
| Subarea 48.1 | 337 |
| Subareas 48.2 and 48.4 | 339 |
| Subarea 48.5 | 341 |
| Subarea 48.6 | 341 |
| <i>Dissostichus</i> spp. in Area 58 | 344 |
| Management advice | 348 |
| Division 58.4.3a..... | 348 |
| Management advice | 349 |
| Division 58.4.4b | 349 |
| Management advice | 350 |

| | |
|--|------------|
| <i>D. mawsoni</i> in Area 88 | 350 |
| Capacity | 350 |
| Winter survey | 350 |
| Shelf survey | 351 |
| Fishery monitoring | 351 |
| SRZ survey | 352 |
| The CCAMLR scholarship recipient | 354 |
| Subarea 88.2 | 354 |
| Subarea 88.2 stock assessment | 355 |
| Subarea 88.3 | 356 |
| Ukraine | 356 |
| Korea and New Zealand | 357 |
| Other fisheries research | 358 |
| Crabs | 358 |
| Toothfish genetics | 360 |
| Acoustic data collection | 360 |
| Toothfish fisheries adjacent to the Convention Area | 360 |
| Research on non-target species | 361 |
| Zooplankton data collection | 362 |
| Oceanographic data collection | 362 |
| Scheme of International Scientific Observation (SISO) | 363 |
| SISO developments | 363 |
| Observer training application | 364 |
| Non-target catch and ecosystem impacts of fishing | 364 |
| Fish by-catch | 364 |
| Status and trends in finfish by-catch | 368 |
| Risk assessment methods for finfish by-catch | 371 |
| Incidental mortality of seabirds and marine mammals | 372 |
| Invertebrate by-catch and VMEs | 374 |
| Marine debris | 375 |
| Future work | 376 |
| Organisation of intersessional activities | 376 |
| Notifications of other scientific research | 376 |
| Other business | 377 |
| Weddell Sea MPA (WSMPA) Proposal | 377 |
| Catch and effort mapping | 377 |
| Weird leech | 378 |
| Otolith library | 378 |
| Whale depredation research | 378 |
| Advice to the Scientific Committee | 378 |
| Close of the meeting | 381 |
| References | 381 |

| | |
|--|-----|
| Tables | 383 |
| Figures | 397 |
| Appendix A: List of Participants | 402 |
| Appendix B: Agenda..... | 408 |
| Appendix C: List of Documents | 410 |
| Appendix D: Using catch data in fishery monitoring and closure forecasting in the Ross Sea toothfish fisheries | 419 |
| Appendix E: Vessel tagging procedures survey | 421 |

**Report of the Working Group
on Fish Stock Assessment**
(Hobart, Australia, 8 to 19 October 2018)

Opening of the meeting

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 8 to 19 October 2018. The Convener, Dr D. Welsford (Australia), opened the meeting and welcomed participants to Hobart (Appendix A). He encouraged all participants to engage in discussion in the Working Group and urged participants to ensure that the discussions were based on science and where there were alternative views, that these should be reflected as testable scientific hypotheses.

1.2 Dr D. Agnew (Executive Secretary) welcomed all participants to the CCAMLR Secretariat. He looked forward to seeing the outcomes of the meeting being presented to the Scientific Committee and Commission and hoped that everyone would also have an opportunity to enjoy the spring weather in Hobart.

1.3 The Working Group reviewed and adopted the agenda (Appendix B).

1.4 Documents submitted to the meeting are listed in Appendix C. The Working Group thanked all authors for their valuable contributions to the work presented to the meeting.

1.5 In this report, paragraphs dealing with advice to the Scientific Committee and other working groups have been highlighted. These paragraphs are listed under Item 9. In addition, the information used in developing assessments and other aspects of the Working Group's work is included in the Fishery Reports (www.ccamlr.org/node/75667).

1.6 The report was prepared by M. Belchier (UK), C. Darby (UK), K. Demianenko (Ukraine), M. Doyle (Secretariat), A. Dunn (New Zealand), J. Fenaughty (New Zealand), I. Forster (Secretariat), N. Gasco (France), E. Grilly (Secretariat), P. Hollyman (UK), C. Jones (USA), D. Maschette (Australia), S. Mormede (New Zealand), S. Parker (New Zealand), C. Péron (France), K. Reid (Secretariat), G. Robson (UK), R. Sarralde (Spain), S. Somhlaba (South Africa), S. Thanassekos (Secretariat) and P. Ziegler (Australia).

Review of data available

Illegal, unreported and unregulated (IUU) fishing activity

2.1 The Secretariat presented an update on illegal, unreported and unregulated (IUU) fishing activity and trends in 2017/18 (CCAMLR-XXXVII/12) and highlighted that there were no reports of IUU vessel sightings in the Convention Area in 2017/18 and there were only three reports of gear recovered by Members. The Working Group agreed that, while the trend in IUU vessel sightings in the Convention Area (Figure 1) is a very welcome indication of a decline in IUU fishing activity, it noted that, with the information currently provided to the Secretariat, it is not possible to be definitive as the trend is not corrected for changes in surveillance effort.

2.2 With respect to the three reports of unidentified gear reported by Members, the Working Group noted that:

- (i) the gillnet recovered from research block 486_3 was from the same location as previously recovered gillnet and may be the legacy of previous IUU fishing, rather than reflecting ongoing IUU fishing in 2017/18
- (ii) the Spanish longline reported in Division 58.4.2 was described as having encrusting organisms attached which is potentially consistent with it being lost in the 2008–2010 period when Spanish longline gear was last used in the regulated fishery in the division
- (iii) the description of the state of the gear recovered in Subarea 88.1 in November 2017 indicated that it had been deployed within five days of the recovery suggesting that fishing had occurred immediately prior to the start of the fishing season.

2.3 The Working Group highlighted that fishing prior to the start of the fishing season would negatively affect the ability to manage the fishery sustainably and would also have a negative impact on the collection of data required for the assessment for this fishery and considered that the particular circumstances of this gear recovered should be considered by the Standing Committee on Implementation and Compliance (SCIC).

2.4 The Working Group also considered an analysis of IUU fishing activities in Division 58.4.1 during 2013/14 and in Division 58.4.3b during 2014/15 (paragraphs 4.93 to 4.97).

Catches in the current season

2.5 The Secretariat presented SC-CAMLR-XXXVII/BG/01 Rev. 2 that provided an update on catches in 2017/18 up to 30 September 2018. This paper also included a map of the Convention Area showing all areas for which a catch limit is in place.

2.6 The Working Group noted a number of areas/subareas where the proportion of the catch limit taken was low or zero (SC-CAMLR-XXXVII/BG/01 Rev. 2, Table 3) and requested an indication from Members of intention to fish in the periods between WG-FSA and the end of the season which would assist in the provision of advice and the review of ongoing research fishing.

2.7 The Working Group thanked the Secretariat for this update and noted that while closure notices were issued for fisheries in Subareas 88.1 and 88.2, the Secretariat had worked collaboratively with Members and vessels engaged in fisheries in other areas to ensure that the catch limits were not exceeded without the necessity of issuing a closure notice.

2.8 The Working Group requested that SC-CAMLR-XXXVII/BG/01 Rev. 1, Figure 1, be revised to indicate those areas where catch limits are set using an integrated assessment and to show existing and proposed research blocks (the revised figure is included as Figure 2 of this report).

Data management

2.9 The Executive Secretary described the proposed Secretariat Strategic Plan (CCAMLR-XXXVII/06) in which data management was identified as a key theme. He explained that to strengthen data management across the entire Secretariat, the staffing strategy accompanying the Strategic Plan included the recruitment of three new data management related positions (one each in the Science, Fishery Monitoring and Compliance and Information Systems and Data Services (ISDS) sections).

2.10 Mr T. Jones (Secretariat) provided an update on the project to develop a CCAMLR data warehouse that would consist of a set of database tables that have had a rigorous process around how they have been produced from source data, would have a stable, well-defined database infrastructure and would provide consistent, quality-assured and well-documented data. He indicated that the first phase of the project would focus on catch and effort, tagging and recapture data and length data, and would be overseen by a steering committee including section managers in the Secretariat and representatives from the Data Management Group (DMG). The Working Group was informed that elements of the data warehouse will be available by WG-FSA-19.

Data Management Group

2.11 The Working Group discussed the role on the DMG in progressing data-related issues. To support the work of the DMG, the Working Group developed a summary of its priorities for consideration by the DMG (Table 1). The Working Group further considered how engagement from the Working Group with the DMG could be improved and asked the Scientific Committee to consider ways in which continuity and information exchange between the DMG and the Scientific Committee working groups could be enhanced. The Working Group recalled that the membership of the DMG was by nomination by Scientific Committee Representatives and requested that the DMG e-group be visible to all authorised users of the CCAMLR website.

C2 form design

2.12 The Working Group noted the following issues with the current C2 form that were highlighted in WG-FSA-18/29:

- (i) only one conversion factor per processing type per species, and three conversion factors per haul can be reported. This can be insufficient for fisheries where both *Dissostichus* spp. are caught, or for vessels which use separate conversion factors for different fish size classes
- (ii) the inclusion of processed weight would improve evaluation of how green weights are calculated using reported conversion factors
- (iii) fate descriptions do not include ‘retained for later discard’. This can cause issues with reconciling landed catch as the fate can only be currently reported as retained
- (iv) the form requires modification by the vessel if more than six species are landed from a single haul, which increases the complexity of the form.

2.13 The Working Group agreed that resolving the highlighted issues would improve data quality and assist in reconciliation between landings reported in the Catch Documentation Scheme for *Dissostichus* spp. (CDS) data by product type.

2.14 The Working Group agreed that potential modifications to the C2 form may allow vessels to submit a single catch report using a new C2 form, rather than the current requirements of submitting a catch and effort report aggregated by time (either daily, five-daily or 10-daily) and haul-by-haul data (C2 form) at different reporting frequencies. The submission of a single form would reduce reporting complexity for vessels, avoid transcription errors and result in higher-resolution data being available sooner for many fisheries.

2.15 The Working Group reflected that prior to any modifications to the C2 form it was important to understand how vessels and Members completed the current forms operationally to ensure that any additional issues could be identified and to allow for ease of data transfer between vessel systems and any updates to the C2 form.

2.16 The Working Group emphasised the importance of clear instructions to vessels on how to complete both the C2 and catch and effort forms, to ensure consistency of data reported between vessels.

2.17 The Working Group recognised that in addition to considerations of the C2 form, several other vessel operational issues had been raised in recent years e.g. data collection, e-monitoring, tagging performance and by-catch reporting, and noted that a workshop focussed on these issues, attended by a range of stakeholders including those who complete catch reporting forms on the vessels, would be beneficial.

2.18 The Working Group therefore recommended:

- (i) the Secretariat initiate a consultation with all Members on how vessels record catch data, and if any issues are encountered using the current C forms, with deadline for comments by 15 March 2019
- (ii) following the results of the consultation, the Secretariat will undertake a revision of the C2 form and present this through the Data Forms e-group for consideration and potential trial by Members. Results from this process will be presented to WG-FSA-19
- (iii) the development of a commercial data manual by the Secretariat with clear instructions on how to achieve vessel reporting requirements using CCAMLR forms
- (iv) the formation of a list of fishery data coordinators (analogous to the Scheme of International Scientific Observation (SISO) technical coordinators) to facilitate easier communication between the Secretariat and Members on vessel data issues
- (v) the Scientific Committee consider holding a focussed fishing data workshop, similar to the SISO Workshop in 2017 (SC-CAMLR-XXXVI/08) attended by a range of stakeholders including those who complete catch reporting forms on the vessels, to review fishery data submission issues that have been raised in working groups

- (vi) the same introduction schedule as agreed for new observer forms be applied to any new fishery data forms to allow adequate time for training and testing
- (vii) clarification be provided by SCIC on how hauls that are incomplete at the end of a reporting period should be recorded in C forms.

Procedures for the use of catch and effort data in fishery management

2.19 The Working Group noted the proposal from the Secretariat on a revised approach for catch and effort monitoring, and the calculation of closure dates for the 2018/19 season in the Ross Sea (WG-FSA-18/07). The paper described a two-stage decision process that uses all available data to manage exploratory longlining in a way that provides timely updates to Members and issues closure notices according to the catch limits in place.

2.20 The Working Group agreed that the approach described in WG-FSA-18/07 would accommodate situations where the catch limit in place might be exceeded prior to sufficient catch and effort data becoming available from the fishery with which the Secretariat can advise a closure date in accordance with Conservation Measure (CM) 31-02, paragraph 2. In addition, the Working Group noted that the within season forecast process described in WG-FSA-18/07 had been used in 2017/18 to close the fishery in Subarea 88.1 south of 70°S where the catch reached 99% of the catch limit.

2.21 The Working Group recalled that the overall catch limit in CM 41-09 was based on the Ross Sea region stock assessment and that the separate area catch limits in that conservation measure are designed to create a spatial distribution of the fishery relative the distribution of the stock in the assessed area. The Working Group requested that the Scientific Committee consider the proposed amendment to CM 41-09, described in WG-FSA-18/07, as a means to achieve the aim of not exceeding the overall catch limit and the required distribution of fishing effort in a way that balances the impact of both under- and over-runs in the area north of 70°S.

2.22 The Working Group agreed that where the total potential catch of the vessels in a fishery exceeds the catch available, then this over-capacity has the potential to compromise any forecasting approach. In a management framework where such situations arise, there is the potential for this to cause a change in the behaviour of the fishery that could potentially impact on the time series of data used in assessments.

2.23 The Working Group noted that testing the algorithm for early season closure, using historic catch data for vessels in the area of the fishery immediately prior to the start of the fishery, was restricted by the requirement of CM 10-04, Annex 10-04/B, paragraph 3.6 to de-identify vessels in the vessel monitoring system (VMS) data. The Working Group agreed that this requirement may unintentionally restrict scientific analyses and requested that the ongoing need for this requirement be reviewed by the Commission (Appendix D).

2.24 The Working Group agreed that for the purpose of CM 23-07, paragraph 1, any vessel that is licenced and notified to participate in an exploratory fishery, and is in the area of that fishery during the period that the fishery is open, should be considered to be a ‘operating in an exploratory fishery’ regardless of whether it is actively deploying or retrieving fishing gear. This clarification would provide vessels and the Secretariat with a greater degree of certainty on when to expect catch and effort data.

2.25 The Working Group also noted that the notification of vessel movements in CM 10-04, Annex 10-04/A, was required for movements between areas, subareas or divisions, rather than at the scale of the individual fishery areas and this meant that a vessel fishing in small-scale research unit (SSRU) 882A could move to SSRU 882H without requiring a vessel movement notification despite moving between areas where the catch limits are specified in different conservation measures. The Working Group noted that there was a proposal before the Commission to redefine the longitude of the boundary between Subareas 88.1 and 88.2 and this realignment would alleviate confusion over vessel movement reporting.

2.26 The Working Group recommended that the procedure outlined in Appendix D be used to manage the catch limits in the Ross Sea region exploratory fishery and other exploratory fisheries as appropriate. The Scientific Committee should review the application of these rules in the Ross Sea region exploratory fishery in 2019 and adjust them as necessary.

2.27 If the application of the pre-season closure process results in the northern area in the Ross Sea region exploratory fishery not being opened in a given season, then a process for managing the catch limit in the subsequent period would need to achieve the average spatial distribution of catch over a 3–5 year period.

Fishery Report updates

2.28 The Working Group noted that changes in productivity parameters may impact on assessments and management advice, and these changes may be related to long-term environmental change, shorter-term variability, or potential effects of fishing.

2.29 The Working Group recommended that Members developing updated management advice present any changes in productivity parameters used in their analyses and evaluate how these may impact the advice. The Working Group encouraged Members to collaborate to develop methods to assess changes over time, that can be used to evaluate the importance of observed changes on resulting advice using sensitivity analyses and simulations.

2.30 The Working Group recommended that WG-FSA-19 update CCAMLR's Fishery Reports to include a section on changes in model parameters and productivity assumptions, and that this section consider the impact of observed changes in biological parameters on management advice.

2.31 The Working Group recommended that key parameters could be presented in a table or as figures either in annual or five-yearly periods (see Table 2). The spatial distribution of catch and effort may also be considered, to assess if there have been distributional changes in population locations. For example, this may be shown as a plot of mean catch-per-unit-effort (CPUE) and latitude over time (see Figure 3).

2.32 The Working Group welcomed the Secretariat's intent to transform the way Fishery Reports will be published, into standardised and automated webpages. The Working Group recalled that the CCAMLR Independent Stock Assessment Review for Toothfish (Annex 5) indicated the need for standardised summaries across assessments to ease their comparison, and that such an approach would be beneficial to implement in Fishery Reports.

2.33 The Working Group recommended the establishment of an e-group to develop a standard format for Fishery Reports Stock Assessment Appendices so that they contain easily accessible summary information similar to Stock Annexes used in International Council for the Exploration of the Sea (ICES), summarising the background information leading to stock assessments. The Working Group requested that the e-group initially focusing on the toothfish fisheries to be assessed at WG-FSA-19, so that those Fishery Reports can be updated accordingly (paragraph 3.6).

Review of updated stock assessments and provision of management advice (all fisheries)

3.1 An independent CCAMLR Stock Assessment Review was held in June 2018. The primary objective for the expert group was to provide advice to the Scientific Committee and its working groups on the adequacy of the modelling approaches and methods used in CCAMLR's integrated toothfish stock assessments relative to international best practices, and to suggest improvements to the assessment methods where appropriate (SC-CAMLR-XXXVI, Annex 9). The Stock Assessment Review (Annex 5) concluded that the CCAMLR approach to stock assessment is appropriate for the precautionary management of the toothfish stocks and consistent with CCAMLR's approach to management. The CCAMLR stock assessments use a single modelling framework across stocks, based on surveys, catch, and a comprehensive annual tagging program across the fisheries, and the applied uncertainty in parameters and assumptions. The review highlighted the importance of the tagging data and long-term standardised surveys to index recruitment and noted that CCAMLR was leading in the development of tag-based integrated assessments. It further noted the need to reduce the differences in tag-survival and tag-detection rates between vessels, and to investigate statistics and methodologies to account for the variation in spatial distribution of fishing between years. The report also recommended future generic and assessment-specific work.

3.2 The Working Group thanked the Convener, Dr C. Reiss (USA), the expert group and the participants for the thorough review. It noted that valuable lessons were learned with regard to preparing for reviews and, in particular, the need for standardised documentation of inputs to, and outputs from, stock assessments. The Working Group further noted that topic-specific workshops with invited experts were a useful process to progress CCAMLR's work program, including how to best conduct assessments and provide catch advice in data-poor fisheries.

3.3 The Working Group recommended that the report of the independent Stock Assessment Review be made publicly available, for example, as an appendix to the WG-FSA-18 report.

3.4 The Working Group noted that such a publicly available report could include in an appendix a list of the papers and the presentations presented to the review panel that could be made available upon request to the Secretariat under the same process as for CCAMLR working group papers. The Working Group requested that the Secretariat work with the Members that presented assessments to facilitate this.

3.5 In particular, WG-FSA noted the expert group's conclusions that:

- (i) CCAMLR's approach, using a single modelling framework (CASAL) across stocks, based on surveys, catch and a comprehensive annual tagging program across fisheries, is appropriate for the management of these stocks

- (ii) in fisheries managed for low overall exploitation rate, like toothfish, tagging data are essential because they provide an absolute index of abundance that is generally not provided by other types of data typically used to assess stock status
- (iii) CCAMLR's approach with tagging studies makes it a leader in this area, and this knowledge is of interest to the broader stock assessment community
- (iv) overall, CCAMLR applies assumptions in the stock assessments in a precautionary manner, when there is uncertainty in parameters and assumptions. Management of the fisheries is consistent with CCAMLR's precautionary approach and Article II
- (v) in most instances examined, appropriate practices are being followed and the assessments continue to adapt to new standards. Differences in standards, when they occurred, were within the scope of standards in the assessment field, but were also consistent with management strategies of CCAMLR
- (vi) the expert group was presented with many instances where the assessment scientists considered spatial structure in fishing and population dynamics, indicating a high level of understanding of the importance of this component to the assessment of these fisheries in the future.

3.6 The expert group made a number of recommendations which WG-FSA agreed should continue to be evaluated in future research and presented to the appropriate working group. The expert group recommendations and the target group, priorities and timelines suggested by WG-FSA are presented in Table 3. The Working Group further recommended that an intersessional e-group be created to develop a standardised format for a stock assessment annex to be added to the Fishery Reports.

Champscephalus gunnari

C. gunnari in Subarea 48.3

3.7 The fishery for mackerel icefish (*Champscephalus gunnari*) in Subarea 48.3 operated in accordance with CM 42-01 and associated measures. In 2017/18, the catch limit for *C. gunnari* was 4 733 tonnes. At the time of the meeting, no fishing had taken place in Subarea 48.3; vessels were expected to start fishing in October. Details of this fishery and the stock assessment of *C. gunnari* are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.8 The Working Group agreed that the catch limit for *C. gunnari* in Subarea 48.3 of 3 269 tonnes, for 2018/19, in Conservation Measure 42-01 remain in place.

C. gunnari in Division 58.5.1

3.9 No papers were tabled under this item, and the Working Group provided no new management advice for this fishery.

C. gunnari in Division 58.5.2

3.10 The fishery for *C. gunnari* in Division 58.5.2 operated in accordance with CM 42-02 and associated measures. In 2017/18, the catch limit for *C. gunnari* was 561 tonnes. Fishing was conducted by one vessel and the total reported catch up to 28 September 2018 was 523 tonnes. Details of this fishery and the stock assessment of *C. gunnari* are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.11 The results of a random stratified trawl survey in Division 58.5.2 undertaken in April 2018 were summarised in WG-FSA-18/55. Sampling protocols, such as the design and the duration of the hauls, were similar to recent surveys, but with a new set of randomly selected station points. As in previous years, toothfish and skates were also tagged during the survey.

3.12 Based on data gathered during the survey, an assessment for *C. gunnari* using the generalised yield model (GYM) was presented in WG-FSA-18/56. The one-sided bootstrap lower 95% confidence bound of total biomass of age 1+ to 3+ fish from the 2018 survey and fixed model parameters was estimated at 2 964 tonnes. Estimates of yield indicate that a catch limit of 443 tonnes of *C. gunnari* in 2018/19 and 320 tonnes in 2019/20 would satisfy the CCAMLR decision rules.

3.13 The Working Group also suggested further investigations to understand why the projected biomass estimate for this stock was above their respective 95% confidence interval in some years. The Working Group noted that the biomass estimate was consistent with that of the previous year and thanked Drs T. Earl (UK) and R. Sinegre (France) and Mr Maschette for developing diagnostic plots.

3.14 The Working Group recommended that the diagnostic plots be included in the annual fishery reports for icefish and that Members continue to work to standardise the information presented in the assessment papers and fishery reports.

Management advice

3.15 The Working Group recommended that the catch limit for *C. gunnari* should be set in 2018/19 at 443 tonnes and at 320 tonnes in 2019/20 in Division 58.5.2.

Dissostichus spp.

3.16 WG-FSA-18/02 presented a review of variability in the Patagonian toothfish (*Dissostichus eleginoides*) biological parameters in longline fishery catches in Subarea 48.3. Analysis was based on WG-FSA reports, documents and Fishery Reports. The authors noted declines in the length and weight at first maturity of females and males, increases in the proportion of immature fish and a reduced number of large spawning fish in historic catches from 1985 to 2004. The authors also noted that despite an increase in fishing depth from 2002 to 2004, young fish remained predominant in catches in Subarea 48.3. The authors further noted that unstandardised length frequency of toothfish in the catches in South Georgia for the period 2008–2017 showed an apparent decline in the mean length of fish in the catch in the more recent years (Fishery Report 2017).

3.17 The authors of the paper advocated that the *D. eleginoides* population in Subarea 48.3, which has been fished for more than 40 years, requires protection via the imposition of restrictions on fishing and changes to conservation measures, because CCAMLR's precautionary approach to the management of this resource has not been likely effective and asked if the changes discussed in WG-FSA-18/02 were consistent with the CCAMLR precautionary approach to stock management. As a consequence, the authors proposed a range of management changes for the *D. eleginoides* in this subarea, namely a minimum size limit of 90 cm in catch, restricting fishing to depths greater than 1 000 m, a reduction in the catch limit to 500 tonnes in depth ranges from 1 000 to 2 250 m and a closure of the fishery from 2020 onwards until a review has taken place based on international surveys.

3.18 The Working Group noted that the exclusive use of unstandardised catch length distribution data to make assumptions about the state of the stock, in isolation from other information, was not an appropriate approach for determining the general status of a stock. In particular, the Working Group considered that the authors have apparently misunderstood that the CCAMLR decision rule accounts for expected catch-at-length in the fishery, such that the long-term objective is likely to be achieved even if a proportion of the catch are juveniles.

3.19 The Working Group noted that *D. eleginoides* stocks in this area are characterised by maturing fish (60–90 cm in length) throughout the depth profile. Larger fish are increasingly caught at depth, but the immature length ranges are also present in the catches. Moving fishing to deeper waters does not reduce the proportional abundance of the maturing fish substantially. The Working Group further noted that the analyses of maturity trends presented in the paper were collected over a short historic time period and had not been standardised for effects such as sample size, sampling location and time, length distribution and depth which are key processes that will impact on the interpretation of these data. The Working Group noted that standardisation carried out by the UK showed no trend, and recommended such standardisation be presented in 2019 to WG-FSA.

3.20 The Working Group noted that *D. eleginoides* in Subarea 48.3 was assessed biennially with an integrated stock assessment. This assessment is reviewed by WG-FSA and additionally in 2018, was reviewed by an independent expert review panel (Annex 5). The review panel considered that the assessment was appropriate for the precautionary management of the stock and consistent with CCAMLR's approach to management. The assessment showed that fits to the observations which incorporated information on catch at length data, including changes over time, were adequate. The conclusions drawn from the information presented in WG-FSA-18/02 were therefore not consistent with the results of the agreed CCAMLR assessment which uses all available information.

3.21 The Working Group noted that 2018 was an intersessional year for the biennial integrated stock assessment in Subarea 48.3. It recalled advice from the Commission for a biennial assessment in this area unless WG-SAM recommended new methods for use in the stock assessment, parameters in the stock assessment were revised significantly, or a large IUU catch occurred (not included in the assessment) (CCAMLR-XXVI, paragraph 4.57). The Working Group concluded that a biennial assessment was still appropriate in this instance.

3.22 On the basis of these discussions, the Working Group agreed that its management advice for *D. eleginoides* in Subarea 48.3 remains unchanged for 2018/19.

Dissostichus spp. in Subarea 48.4

3.23 The fishery for Antarctic toothfish (*D. mawsoni*) in Subarea 48.4 operated in accordance with CM 41-03 and associated measures. The catch limit for *D. mawsoni* in Subarea 48.4 in 2017/18 was 37 tonnes of which 20 tonnes were taken in the fishery. An additional 18 tonnes were allocated as an upper catch limit for the effort-limited research survey to the south of the fishery outlined in WG-FSA-16/40 Rev. 1, of which 5 tonnes were taken (www.ccamlr.org/node/75667).

3.24 WG-FSA-18/26 presented an annual tag-recapture biomass estimate for the area that was conducted following the agreed procedure from SC-CAMLR-XXXV, Annex 7, paragraphs 3.29 to 3.31. The Chapman biomass estimate in 2018 was 982 tonnes and applying a harvest rate of 0.038 resulted in a yield of 37 tonnes, unchanged from 2017.

3.25 The Working Group noted that the confidence intervals were calculated analytically and that bootstrapping to estimate uncertainty could be used to better describe the variability in the data, especially with low numbers of recaptures. The Working Group noted that vessel and gear effects were likely to have a small effect on the Chapman estimate, with similar effective tagging survival and tag detection rates between vessels and similar catch length frequencies across different gear types.

3.26 The Working Group further noted that CPUE by vessel was showing a decreasing trend over time, which the authors attributed to vessels starting fishing later in the season. The Working Group noted the duration of fishing had also changed and suggested further analyses be conducted to assess the effects of changes of the timing of the fishery on CPUE.

Management advice

3.27 The Working Group recommended that the catch limit for *D. mawsoni* in Subarea 48.4 be set at 37 tonnes for 2019/20 based on the results of this assessment, and that a stock hypothesis continue to be developed for that area.

Research to inform current or future assessments in ‘data-poor’ fisheries (e.g. new fisheries, activities in closed areas, areas with zero catch limits and in Subareas 48.6 and 58.4) notified under Conservation Measures 21-01, 21-02 and 24-01

Generic issues

Trend analysis and setting catch limits

4.1 WG-FSA-18/12 updated the estimates of local biomass with uncertainty for *D. mawsoni* and *D. eleginoides* in research blocks in Subareas 48.6 and 58.4 as agreed by the Scientific Committee (SC-CAMLR-XXXV, Annex 5, paragraph 2.28).

4.2 The Working Group recalled the advice of WG-SAM-18 (Annex 6, paragraphs 4.1 to 4.7) to use the linear trend method for the estimates of local biomass in research blocks in Subareas 48.6 and 58.4. The trend analysis decision rules developed by WG-FSA-17 (SC-CAMLR-XXXVI, Annex 7, paragraphs 4.28 to 4.33) were applied to provide catch limits for 2018/19. The only research blocks in which there were adequate tag recaptures were 486_2,

486_3 and 486_4. However, as the trend in all three of these research blocks was declining, the revised catch limit is determined as 0.8 times the existing catch limit. The revised catch limits for all but one of the research blocks was determined by the requirement that the absolute change in the existing catch limit should not exceed 20%.

4.3 The Working Group recommended updating the decision rules to account for situations when CPUE data were declining, but the tag-recapture data were not adequate to inform a trend. The revised decision rules are given in Figure 4.

4.4 The Working Group recommended that the trend analysis be based on data from the past five years only, so that the method would be responsive to recent trends in the biomass indices. The Working Group welcomed the use of the inverse variance weighting in the regression as an appropriate method to account for the different levels of uncertainty in the biomass estimates used in the regression analyses, although the Working Group noted that the effect of using this regression method had little impact on the resulting catch limits.

4.5 The Working Group recommended that catch limits for the research blocks be as determined using this method, and these are given in Table 4.

4.6 The Working Group noted that while the method is suitable for providing interim management advice, further work was required to fully account for the uncertainty in the estimates of mean trend. The Working Group noted that the linear trend method was likely to be precautionary, however, it also noted that additional simulation and evaluation of the method were required in order to fully test it against the CCAMLR decision rules.

4.7 The Working Group noted that the method was considered an interim measure for the calculation of precautionary catch limits in research blocks. The Working Group noted that other methods could replace the linear trend method in each area as the research programs in those areas progressed.

4.8 The Working Group recommended that research plans provided for research blocks by Members include additional milestones for undertaking further method development and simulation analyses to ensure the removals under these research plans are consistent with Article II.

Tagging performance

4.9 WG-FSA-18/48 Rev. 1 presented on improvements to the tagging procedure on the Spanish FV *Tronio* using a cradle to lift and lower toothfish that are tagged and released. The method was trialled in 2017/18. The modifications were trialled to optimise the handling of the cradle, achieve rapid retrieval to minimise hauling downtime, minimise handling and time out of the water of the fish and use the cradle to release the fish. The authors reported that the modification achieved most of these objectives, with room for some further suggested alteration to further improve the system.

4.10 The authors noted that they observed reduced instances and severity of injury to the mouth of the toothfish when using the cradle, particularly for fish longer than 115 cm in length. They reported that the use of the cradle and winch did not affect the hauling rate of toothfish and had little impact on the efficiency of the vessel's fishing operations.

4.11 The Working Group welcomed the paper and noted that the improvements would likely result in a higher likelihood of survival of released toothfish and encouraged further development of the procedure. The Working Group requested that the authors make the plans and design of the cradle available to other Members so that they could consider the use of the cradle on other vessels.

4.12 The Working Group recalled the advice from WG-SAM to request vessels to record the use, characteristics and water flow of holding tanks for toothfish as a part of the tagging procedure as this may assist in understanding variability between vessels.

4.13 The Working Group recalled that there can be a high level of variability between vessels in the rates of tagged fish survival and tag detection, and recommended that the procedure used on vessels for tagging fish and for recording tagged fish be documented by observers so that a more complete understanding of the variability of effective tag survival and tag detection between vessels can be documented.

4.14 The Working Group noted the request by the Scientific Committee to develop a tagging pro forma for the purposes of collecting information describing the mechanisms used to train people tagging toothfish, the tagging facilities on board vessels, and the actual practices used on board, so that tagging effectiveness by vessels can be comprehensively reviewed (SC-CAMLR-XXXVI, paragraphs 3.127 to 3.130).

4.15 The Working Group considered that ongoing collection of data describing tagging practices could be useful in future analyses to understand the differences in tagging performance between vessels and may also be useful for improving future training materials for the people that are using them.

4.16 Noting the discussion from the Commission regarding alternatives to vessels supplying tagging information (CCAMLR-XXXVI, paragraphs 5.38 and 5.39), the Working Group developed a survey form intended for use by SISO observers to collect information about tagging facilities and practices on board toothfish longline vessels (Appendix E).

4.17 The Working Group recommended:

- (i) the Secretariat circulate the survey form to Members' observer technical coordinators and lodge a copy of the form on the SISO section of the CCAMLR website for use by observers in exploratory fisheries and for toothfish research conducted under CM 24-01 in the 2018/19 season (Appendix E)
- (ii) the Observer Scheme Program Coordinator at the Secretariat collate data collected through the survey, liaising directly with observer technical coordinators and observers if any responses describing the tagging procedures require clarification
- (iii) the Secretariat present the results of the survey at WG-FSA-19 for consideration.

Transitioning from area biomass estimates to integrated stock assessments

4.18 The Working Group considered the general issues arising from WG-FSA-18/37, 18/58 Rev. 1, 18/66 and 18/72 on transitioning from area biomass estimates to integrated stock

assessments. The Working Group noted that in progressing from research in research blocks and developing advice using integrated assessments, research would need to:

- (i) consider different assumptions of stock structure and how these impacted the advice
- (ii) develop simulations and analyses that evaluated different assumptions and their impact on the advice
- (iii) develop methods that incorporate changes in spatial overlap of tag releases and recaptures to evaluate spatial and temporal bias in the interpretation of tag-recapture biomass estimates
- (iv) incorporate the individual vessel effects into the analyses to account for different vessel-specific CPUE, gear, tag-release survival and tag-detection rates, or other confounding factors
- (v) develop or continue to develop toothfish habitat models that extrapolate from fished areas within research blocks to account for the stock that may be outside the research blocks, including methods to validate the estimates from habitat models for extrapolated areas
- (vi) provide estimates of biological parameters (for example, age structure, maturity, and growth rates) and validated age data that can be used in analyses and integrated assessments
- (vii) undertake sensitivity analyses of current and historical IUU catch to account for uncertainty in catch histories
- (viii) develop intermediate assessment methods to facilitate the transition from CPUE by seabed area and Chapman estimates to integrated assessment methods, noting that WG-FSA-18/58 Rev. 1 includes examples of each step
- (ix) develop methods to fully include uncertainty within the estimates used to develop advice.

4.19 The Working Group noted the previous discussion on the revision of the regulatory framework (CCAMLR-XXXIV/17 Rev. 1), and requested that the Scientific Committee and the Commission clarify the objectives, priorities and definitions of data-poor exploratory fisheries.

Process for reviewing research proposals

4.20 The Working Group recalled the advice from the Scientific Committee (SC-CAMLR-XXXVI, paragraph 3.74) that WG-SAM and WG-FSA should evaluate and provide comment on proposals submitted by the submission deadlines for these meetings. The submitted proposals, together with comments by the working groups, should then be forwarded to the Scientific Committee for consideration.

Review of requirements for plans in CM 21-02

4.21 The Working Group noted that currently CM 21-02 requires a data collection plan, a fishery operation plan and a research plan for notifications for exploratory fisheries in areas included in paragraph 6(iii). The Working Group recommended that the Scientific Committee review the need for the data collection plan and the fishery operation plan for such notifications as all of the information requested in these plans was now provided in the research plan.

Management area research reviews and management advice

4.22 The Working Group reviewed research plans involving toothfish, using the summary table format with the criteria set out in WG-FSA-17 (SC-CAMLR-XXXVI, Annex 7, paragraph 4.7), and using the recommendations from WG-SAM-18 (Annex 6, paragraphs 6.1 to 6.3).

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

4.24 The Working Group noted that a considerable amount of the time of WG-SAM and WG-FSA was spent reviewing research proposals for research fisheries limiting their ability to address other priorities, and that there were examples of research plans that were successfully delivering on their on- and off-water milestones which could be used as examples to emulate in developing research plans.

4.25 The Working Group noted advice on how to prepare research plans has been extensively progressed by WG-SAM and WG-FSA since 2011 and therefore asked that the Scientific Committee consider whether, given this progress, research plans still need to be reviewed twice each year or if a single review in WG-FSA would be sufficient (Annex 6, paragraphs 7.1 and 7.2) and advise the Commission accordingly.

4.26 The Working Group noted the advice from WG-SAM that recognised the potential for differences in the interpretation of the need for an exemption from conservation measures under CM 24-01 for different research fishing activities. The Working Group requested that the Scientific Committee review the objectives and provisions of CM 24-01 and provide clear guidance to Members on appropriate criteria for the application of this measure.

Research standardisation

4.27 Whilst reviewing a number of research plans the Working Group recalled previous discussions about gear selectivity and standardisation of effort between different types of longlines (SC-CAMLR-XXXVI, Annex 7, paragraphs 4.19 and 4.20). The Working Group recalled that the effect of gear type will depend on the research question asked, for example questions regarding stock hypotheses such as life stages in areas, biological parameters or spatial distributions may not be affected by gears, whereas catch rate analyses or tag-release performance may be.

4.28 Dr S. Kasatkina (Russia) noted that at present a variety of evidence regarding the longline type impact on catch rate, the size and species structure of the catches, mark-recapture results were revealed by documents of CCAMLR Working Groups (Kasatkina 2016, 2017; Yates et al., 2017; Eleaume et al., 2018). Dr Kasatkina expressed the need to clarify the potential effects of different types of longlines on outcomes from multivessel research with focus to their efficiency including the quality of the results obtained and the achievement of the objectives.

4.29 The Working Group noted that the standardisation of a parameter adjusts for, and removes the impact of, confounding factors other than that of interest, and recommended that it should include the following steps:

- (i) define the question or hypothesis
- (ii) data exploration, such as:
 - (a) visualising the data, e.g. with bi-plots for potential factors and mapping for spatial and temporal overlap
 - (b) summarising any decisions in relation to data cleaning
 - (c) summarising the data, such as number of hauls by year and area
- (iii) model exploration, such as:
 - (a) considering appropriate model and error structures based on the data exploration taking into account the question asked and data complexity
 - (b) exploring alternative models in a stepwise manner for candidate explanatory factors and complexity in statistical approaches (e.g. GLM, GAM, GLMM or GAMM), avoiding over-parameterisation of the models
 - (c) showing stepwise comparisons from initial and final models
 - (d) presenting diagnostic table and plots, showing the fit and predictive ability of the model.

4.30 The Working Group also recalled its advice (SC-CAMLR-XXXVI, Annex 7, paragraph 4.20) that Members develop methods towards the following issues regarding the characteristics of different gears:

- (i) design-based versus model-based approaches to gear standardisation
- (ii) performance of tag releases and recaptures associated with gear type
- (iii) approaches to consolidate effort between different gear types for the evaluation of CPUE, length distribution, species composition and other parameters
- (iv) characterisations of gear types, such as bait types or hook types and line length and number of hooks.

Dissostichus spp. in Area 48

4.31 The Working Group noted SC-CAMLR-XXXVII/01, the report of the Co-conveners of the CCAMLR Workshop for the Development of a *D. mawsoni* Population Hypothesis for Area 48 held from 19 to 21 February 2018 in Berlin, Germany. The Working Group thanked the Co-conveners, Drs Darby and Jones, and all participants for their valuable contributions to the Workshop and, in particular, Dr M. Söffker (EU) for her major contribution in preparing WG-SAM-18/33 Rev. 1 synthesising extensive background information and including summaries of available data, developed through the Development of a *D. mawsoni* Population Hypothesis for Area 48 e-group.

4.32 The main outputs of the Workshop were three alternative stock hypotheses which are provided in WG-SAM-18/33 Rev. 1. The Working Group noted that some of the outcomes from the Workshop had already been incorporated in the current work of research plans.

4.33 The Working Group noted that there is little information on early life stages and stock connectivity of toothfish available at the moment, and that climate change in particular is likely to affect the early life stages of toothfish. Data on early-life stages could be collected, for example through targeted plankton sampling.

4.34 The Working Group noted there were a number of research plans across different subareas in Area 48 and Subarea 88.3, and that these research plans provide the opportunity to examine the stock connectivity of *D. mawsoni* populations between those subareas.

4.35 The Working Group noted that scientific activities outside CCAMLR, for example through the Scientific Committee on Antarctic Research (SCAR) and the Southern Ocean Observing System (SOOS), could assist in developing and testing the alternative stock hypotheses.

4.36 Dr Kasatkina noted that in her view the fragmented nature of available biological data at all stages of *D. mawsoni* life cycle were revealed by the Workshop. The latter is especially important considering interannual variability in environmental conditions in Subareas 48.5 and 48.6.

4.37 At the time of adoption, Dr Kasatkina proposed that conducting a large-scale multivessel toothfish survey in Area 48 would collect sufficient data to develop a population hypothesis for toothfish (*D. mawsoni*) and facilitate a stock assessment in Area 48.

4.38 The Working Group recommended that future research in the region should address the data gaps highlighted at the Workshop for the Development of a *D. mawsoni* Population Hypothesis for Area 48 (WS-DmPH-18) to further develop and test stock hypotheses in Area 48. The Working Group also recommended that considerations of climate change, which is likely to affect the early life stages of toothfish, be included in such work.

Subarea 48.1

4.39 WG-FSA-18/45 presented an analysis of the spatial distribution and population structure of juvenile *D. mawsoni* that had been sampled on random stratified bottom trawl surveys from 2001 to 2007 around the South Shetland Islands in Subarea 48.1.

4.40 The Working Group noted that information on catch locations for *D. mawsoni* from Subarea 48.1 trawl surveys had been provided at WS-DmPH-18, and that this analysis was undertaken to fill in data gaps identified at WS-DmPH-18. Specifically, juvenile development stages and durations, growth changes with latitude, condition indices, and age and growth of *D. mawsoni* in Subarea 48.1. The Working Group agreed that this information will contribute to evaluating the alternative stock hypotheses developed at WS-DmPH-18.

4.41 WG-FSA-18/20 presented a research proposal by Ukraine to carry out a scientific survey of *Dissostichus* spp. by bottom longline in the eastern part of Subarea 48.1 under CM 24-01. Revision 1, submitted during the meeting at the request of the Working Group, contained an additional map showing the proposed fishing locations based on the coordinates presented in WG-FSA-18/20 Rev. 1, Table 1, and a reformatted table of the proposed research milestones.

4.42 The Working Group noted that this proposal, on request by WG-SAM-18, now incorporated information that simplified the evaluation of the proposal against the criteria set out in Table 5, and information to take account of CM 24-05. The Working Group also welcomed the trial of monitoring the hauling and tag and release processes using video cameras.

4.43 The Working Group noted that Ukraine has proposed to conduct research in Subareas 48.1 (WG-FSA-18/20 Rev. 1), 48.2 (WG-FSA-18/49) and 88.3 (WG-FSA-18/16 Rev. 1). The Working Group noted the large amount of data and sample analysis activity that would be required to achieve all research objectives, including ageing the required number of otoliths across multiple subareas. It was noted that an overarching strategy or scheme of prioritisation for research undertaken by Ukraine would assist the Working Group to provide advice on whether the respective research plans are likely to achieve the objectives. The Working Group also recalled the advice from SC-CAMLR-XXXVI, paragraph 3.64, that priority should be given to the completion of research programs already in place over new research proposals.

4.44 The Working Group noted that the survey design focuses only on a relatively narrow range of fishing depth and recommended that it should also include hauls from shallower and deeper habitat to achieve the objective of determining distribution and abundance of *D. mawsoni* in the area.

4.45 The Working Group noted that plankton sampling in the upper layer of the investigated area and measurements of oceanographic parameters was planned during the survey to confirm the hypothesis of the distribution of *D. mawsoni* larvae in Subareas 48.1 and 48.2. The Working Group noted that the sampling was not designed to test a particular stock hypothesis and may not achieve its objective to collect eggs and larvae since toothfish spawn in winter during August–September while the survey was planned to be completed in the austral summer. The Working Group also noted that the ocean circulation patterns in this area are complex, and obtaining new oceanographic and biological data will provide a better understanding of the ecosystem structure in this area.

4.46 The Working Group also noted that several expeditions with research ice breakers had been carried out in the area proposed by Ukraine, including the CCAMLR krill survey with RV *Polarstern* in March and April 2018. This meant that data and information on several biological and environmental parameters were already available.

4.47 The Working Group noted that, if possible, more than 10 specimens of any by-catch species should be collected and analysed to achieve the objective of evaluating the by-catch distribution and trophic relationships and ecosystem function.

4.48 WG-FSA-18/01 provided an analysis of ice condition in the research area proposed by Ukraine in WG-FSA-18/20 Rev. 1, using the modelling method presented in WG-SAM-18/01. The results indicated that the mean sea-ice concentrations range from 50% to 100% and mean repeated accessibility was between 0% and 60%, especially in the southern parts between 64°S and 65°S of the proposed research area from January to April when the survey was planned to be carried out.

4.49 The Working Group noted that while fishing vessels may be able to navigate through waters with 60% sea-ice concentration, fishing activities were usually limited to a maximum of 20% sea-ice concentration.

4.50 Based on the results of this sea-ice model, the Working Group noted that the proposed sampling locations in the central and southern part of the research area had a likelihood of below 50% to be accessible for fishing at least twice within the three-year time span proposed in the Ukrainian proposal (Figure 5).

4.51 The Working Group noted that an important aspect of the Ukrainian research plan was to repeatedly access the research area, and it was concerned that the objectives of the research plan may not be achievable due to high sea-ice concentration in some proposed sampling areas.

4.52 Dr Demianenko welcomed the presented sea-ice analysis, noting that it provides important information for the successful realisation of the research plan. However, he noted that the preference of the Ukrainian research team was to test the real sea-ice conditions during the first year of the research plan, in particular in the southern area (research block 3), which has the highest sea-ice concentration. The research plan could then be modified for the subsequent years depending on the actual sea-ice conditions. The Ukrainian research team considers that it would be very useful to collect different types of data in this area which has not been observed regularly. Dr Demianenko noted that Ukraine would be happy to take into account the discussions and advice of WG-FSA, to make sure that this research plan in Subarea 48.1 could be realised.

4.53 Dr Demianenko noted that the area of research block 3 as shown in Figure 10 in WG-FSA-18/20 Rev. 1 could be excluded from the research proposal for Subarea 48.1 to increase the likelihood for completing the 3-year research plan. The research plan would remain the same for research blocks 1 and 2.

4.54 The Working Group evaluated the research proposal in WG-FSA-18/20 Rev. 1 against the criteria set out in SC-CAMLR-XXXVI, Annex 7, paragraph 4.7 (Table 5).

Subareas 48.2 and 48.4

4.55 WG-FSA-18/49 provided a progress report on the research from 2014/15 to 2017/18 for *Dissostichus* spp. in Subarea 48.2 by Ukraine and a notification to continue research in 2018/19, the final year of a two-year research plan extension.

4.56 The Working Group noted that a number of recommendations by WG-SAM-18 (Annex 6, paragraph 6.17) had not been addressed completely, namely:

- (i) detailed studies of by-catch species, seabirds and mammals observed during the research as indicated in the original proposal

- (ii) specific recommendations on reporting (SC-CAMLR-XXXVI, Annex 7, paragraphs 4.45 to 4.49) from this research plan
- (iii) length-frequency data in research reports should be catch-weighted if not every fish is measured from the catch
- (iv) that the CCAMLR geographic information system (GIS) could be used to present maps of sampling stations.

4.57 The Working Group expressed concerns that the number of sampling stations in the southern research blocks had continuously increased over the last three years, while the catch rates had declined over the same period. The Working Group noted that Ukraine had increased the number of sampling stations to increase the likelihood to recapture tagged toothfish and increase the information from the southern part of the research area.

4.58 The Working Group welcomed that a number of fish had been aged, and the number of aged fish has increased in recent years. However, it noted that the number of aged fish per year was still too small to estimate robust age-length keys (ALKs) for an assessment, and that the current sampling protocol would not provide sufficient otoliths to achieve robust ALKs.

4.59 The Working Group welcomed efforts of the Ukrainian research team to collect additional data on the hydrobiology and oceanography from the research area and noted that this could be useful for broader assessments of structure, status and trends of the ecosystem in this region (paragraphs 4.235 to 4.240 and WG-FSA-18/04 and 18/19).

4.60 The Working Group evaluated the research proposal in WG-FSA-18/49 against the criteria set out in WG-FSA-17 (SC-CAMLR-XXXVI, Annex 5, paragraph 4.7) (Table 5). The Working Group noted that Ukraine had other research plans proposed (in Subareas 48.1 and 88.3) and recommended that this existing research plan should have priority over new proposals. However, the Working Group noted that 2018/19 was the final year of this research plan and that there was a large amount of research outstanding to achieve the objectives of the research plan. It expressed concerns that the intended development of an integrated stock assessment for this area next year may not be achievable.

4.61 The Working Group recommended that the existing 75 tonne catch limit be applied as the precautionary catch limit for the research proposed by Ukraine in Subarea 48.2.

4.62 WG-FSA-18/35 presented results from the second year of a three-year survey by the UK into the connectivity of toothfish species in Subareas 48.2 and 48.4. The focus for the second year was to further investigate availability of fishable grounds, update information for toothfish species and non-target species in this region, continue temperature data collection on longlines, focus on vulnerable marine ecosystem (VME) indicator species information and review survey station locations.

4.63 The Working Group noted that the deployment of satellite tags and benthic cameras had been delayed, and that no ageing had been done yet but that otolith reader training was in progress.

4.64 WG-FSA-18/31 provided an outline for the third year of the three-year longline survey by the UK to determine toothfish population connectivity between Subareas 48.2 and 48.4.

4.65 The Working Group noted that the survey design in WG-FSA-18/31 had been adjusted to provide a greater spatial overlap between the fishing activities of the two vessels that are part of the proposal, by allocating stations to vessels *a priori* randomly, however, adjusting station allocations where necessary to minimise travel between stations.

4.66 The Working Group welcomed that plan for the refinement of the stock hypothesis in Area 48, which is scheduled as part of this research plan for 2020 and 2021, to combine information on tag recaptures, genetic stock connectivity, otolith microchemistry and environmental measurements.

4.67 The Working Group evaluated the research proposal in WG-FSA-18/31 against the criteria set out in WG-FSA-17 (SC-CAMLR-XXXVI, Annex 7, paragraph 4.7) (Table 5).

4.68 The Working Group recommended that the existing catch limits of 18 tonnes for hauls in Subarea 48.4 and 23 tonnes for hauls in Subarea 48.2 be applied as the precautionary catch limit for the research proposed by the UK.

4.69 The Working Group welcomed the overall summary report of the activities conducted independently within Subarea 48.2 by Ukraine and the UK (WG-FSA-18/52). The report provides an area overview of the research and objectives of the independent research programs, as outlined in the proposal submitted by Ukraine in WG-FSA-18/49, and the UK in WG-FSA-18/31.

Subarea 48.5

4.70 WG-FSA-18/06 reported biological data on a few sub-adult *D. mawsoni* collected by research bottom trawling carried out by the RV *Polarstern* in the southern Weddell Sea (Subarea 48.5). The Working Group thanked the authors for providing this information on request by WS-DmPH-18 and noted that more information from research cruises by the RV *Polarstern* is available and will be tabled to future WG-FSA meetings which can address some of the identified data gaps.

Subarea 48.6

4.71 WG-FSA-18/72 provided an annual report of research fishing operations in Subarea 48.6 in 2017/18. As the research operation was still in progress at the time of the WG-FSA-18 meeting, the reported data was incomplete.

4.72 The Working Group noted that catch rates had declined in research block 486_3 between 2013 and 2016 but then stabilised over the last three years. Fishing effort had been concentrated on two small areas within the research block. The Working Group also noted that IUU vessels had been active in this research block until last year. The Working Group noted that standardised catch rates show a similar trend to the nominal CPUE as described above.

4.73 The Working Group noted that research block 486_5 had only been fished in three seasons, including 2017/18, and that high sea-ice concentration had prevented fishing in the other seasons. Catch rates had been high in this research block in all fished seasons, possibly as

the result of large toothfish being caught in this area. Prior to this fishing season, there had only been two within-season recaptures. Dr T. Okuda (Japan) notified the meeting that there have been six recaptures in the 2017/18 season, one which had been released in 2011 and five which had been released in 2017. These recaptures will contribute to the stock assessment and to further develop the stock hypothesis for the area.

4.74 The Working Group requested that the Scientific Committee consider the viability of future research in research block 486_5 which is inaccessible due to sea-ice in many years in evaluating the research proposed in this block.

4.75 The Working Group noted that there was no report of ageing which was a milestone of this research plan for this year. Mr Somhlaba informed the Working Group that South Africa had conducted some otolith ageing but had not yet validated these age readings. Ongoing otolith ageing and validation was being performed using the reference collection from New Zealand and otolith microchemistry work was being done in collaboration with China.

4.76 The Working Group noted that estimating population productivity parameters is crucial for the development of a stock assessment and was a milestone for this research plan. The Working Group noted that while sufficient data had been collected to estimate maturity ogives in this subarea, no such estimation had been conducted recently.

4.77 The Working Group noted that five pop-up satellite archival tags (PSATs) had been released from the *Shinsei Maru No. 3* in July 2018, but no data had been recovered from these tags. The PSATs had been programmed to pop-off after one month, and as a result, they may have been trapped under sea-ice during winter or fish may have moved deeper than the maximum depth tolerated by the PSATs, preventing the transmission of data.

4.78 WG-FSA-18/75 presented an analysis of the microchemistry of *D. mawsoni* otoliths collected in research blocks 486_2, 486_3 and 486_4. The analysis showed no significant differences in the chemistry within either the nucleus or edge sections, but differences between the nucleus and edge sections. Based on these results, the authors concluded that while the *D. mawsoni* specimens may have the same hatching grounds and that the habitat was consistent between the three research blocks, the habitat may change with ontogeny between hatching ground and the area that the fish were captured. The ongoing analysis further indicated there was a significant difference in trace elements of *D. mawsoni* otoliths between Subareas 48.6 and 88.1.

4.79 The Working Group noted that the uptake of the investigated trace elements is species-specific and may change with fish age and water temperature, and that other biological processes may have contributed to the observed differences between nucleus and edge other than ontogenetic movement.

4.80 The Working Group noted that analysing the microchemistry across the entire otolith, combined with information from ageing, tag-recaptures and genetic analysis, may help to provide further insights into the stock structure and connectivity in Area 48. The Working Group noted that there was an international collaboration in place between South Africa, New Zealand, the Republic of Korea and China to address this issue, and encouraged this international collaboration to be extended to Japan and other Members.

4.81 WG-FSA-18/66 outlined the early developments of stock assessment work that has been conducted in Subarea 48.6 since 2012, possible methods for assessing the stocks given the amount of information that has been collected, experiences in progressing data-poor assessments into integrated assessments from other areas of the Convention Area, and uncertainties introduced by IUU activities that have taken place in this subarea.

4.82 WG-FSA-18/72 provided the preliminary results of an integrated stock assessment for research block 486_2 using CASAL. The model fitted a single-sex age-structure population model to tag-release data, catch-at-age and catch rates from 2012 to 2017, assuming catch data from 2006 to 2017 but not considering IUU removals.

4.83 The Working Group noted that the model needed careful consideration of data weighting since the maximum posterior density (MPD) estimate for B_0 showed a strong conflict between tagging data and catch-at-age. Tagging data indicated a low B_0 while catch-at-age data indicated a very large B_0 . As a consequence, the MPD model fit was poor for tagging data, with higher numbers of observed than expected recaptures for all release years.

4.84 The assessment model assumed a closed population in research block 486_2. The Working Group noted that given the stock hypotheses in Area 48, this assumption was unrealistic. In addition, using a dome-shaped selectivity function was likely to inflate the estimate of B_0 in this case, and tag-recaptures with a time of liberty of longer than one year should be used in the model.

4.85 The Working Group recommended that the assessment model for Subarea 48.6 be further developed and presented to WG-FSA-19 to address issues on data weighting and stock hypotheses and to consider different levels of IUU catches in sensitivity runs.

4.86 WG-FSA-18/34 provided a proposal for the continuation of a multi-Member longline survey on *D. mawsoni* in Subarea 48.6 in 2018/19 by Japan, South Africa and Spain. A collaborative research plan has been undertaken by Japan and South Africa since 2013, but based on the recommendation by WG-SAM-18 (Annex 6, paragraph 6.29), Spain has joined this research plan. Data and investigations about the population structure and various demographic parameters of *D. mawsoni* using trotline by the Japanese and South African vessels and Spanish longline by the Spanish vessel, established tagging techniques, pop-up tags and genetic analysis are planned to provide the basis for the development of spatial population models and assessments by 2021/22.

4.87 The Working Group noted that this is a continuation of an existing research plan (WG-FSA-16/32 Rev. 1 and WG-FSA-17/10) with a scheduled end date of 2021. Some of its milestones in the plan have not been reported in the annual progress report for the 2016/17 and 2017/18 fishing seasons, including the estimation of growth, population structure and reproduction.

4.88 The Working Group noted that original milestones have been delayed and extended in WG-FSA-18/34, with now 2022 as the final year of the research plan.

4.89 The Working Group also noted that milestones focused on data collection instead of outcomes from data analyses, with little information provided on planned data analyses. The Working Group recommended that the research plan provide more details on:

- (i) the milestones to estimate natural mortality using tagging data which is a complex task and difficult to achieve

- (ii) how video data will be analysed to evaluate the impact of different fishing gear types on the benthic habitat
- (iii) how the addition of Spanish line to this research plan would affect catch rates and the tagging program
- (iv) analyses to evaluate the likelihood of achieving the milestones (e.g. given the spatial and temporal overlap of vessels, what is the likelihood to estimate the vessel tagging performance in Subarea 48.6).

4.90 The Working Group noted that there are three stock hypotheses developed by WS-DmPH-18 which should be incorporated into this research plan.

4.91 The Working Group evaluated the research proposal in WG-FSA-18/34 against the criteria set out in WG-FSA-17 (SC-CAMLR-XXXVI, Annex 7, paragraph 4.7) (Table 5).

4.92 The Working Group noted that catch limits were calculated for Subarea 48.6 using the trend analysis rules (paragraphs 4.1 to 4.5) and recommended they be applied as shown in Table 4.

Dissostichus spp. in Area 58

4.93 The Working Group reviewed WG-FSA-18/60 on analyses of data of IUU fishing activities in Division 58.4.1 during the 2013/14 season and Division 58.4.3b during the 2014/15 season. This analysis had been conducted upon request from SC-CAMLR-XXXVI (Annex 7, paragraph 2.16) based on data from Division 58.4.1 provided by Spain following Operation Sparrow 2, and data from Division 58.4.3b collected by a non-governmental organisation (NGO) vessel from five recovered IUU gillnets.

4.94 The paper concluded that the daily catch rates of IUU vessels using gillnets were similar to those of authorised fishing vessels using longlines, total removals by IUU vessels during the 2013/14 season were much higher than those of an authorised vessel fishing (up to seven times) in the same season in Division 58.4.1, that IUU removals may have impacted on research in this area, and that the presence of authorised vessels did not seem to deter IUU fishing.

4.95 The Working Group noted that the IUU catch concentrated outside research blocks in an area east of research block 5841_2 but also overlapped with research blocks 5841_2 and 5841_3 and 5841_4.

4.96 The Working Group noted that given the similarity in daily catch rates between IUU vessels and authorised vessels, there was the potential to estimate total IUU removals across the CAMLR Convention Area given existing sightings of IUU vessels. The Working Group recommended that the Scientific Committee develop a workplan to provide these estimates.

4.97 The Working Group noted the proximity of the FV *Tronio* to one of the IUU vessels for a number of days and requested that the Scientific Committee and SCIC evaluate if authorised vessels are an effective deterrent to IUU vessels. In addition, the Working Group requested the Scientific Committee provide advice on data collection protocols to report effort, catch and biological data for IUU fishing gears recovered in the future.

4.98 The Working Group considered WG-FSA-18/22, which reported the results from five PSATs which provided data out of 13 deployed on *D. mawsoni* between 2014 and 2017 from a study in the Mawson Sea in Division 58.4.1. All tagged fish were recovered within a distance of 183 km between release and recapture site and remained in a depth range between 326 and 1 824 m for the majority of time at liberty. Based on data from an entire year at liberty, one tagged toothfish showed a distinctive behaviour during the month of September when it ascended to depths around 500 m and a number of short vertical ascents and descents returning to the same depth that could be related to spawning behaviour. Dr S.-G. Choi (Republic of Korea) informed the Working Group on a plan to deploy 10 MiniPATs on *D. mawsoni* in Division 58.4.1 during the 2018/19 season and to deploy 50 PSATs on *D. eleginoides* in FAO Area 41 to better understand stock structure in that area.

4.99 The Working Group noted that the vertical movement could be associated with spawning behaviour due to the time of year it occurred, as the behaviour pattern has been noted in other perciform fishes, however, it could also be associated with feeding behaviours targeting species that aggregate at that time of year such as Antarctic silverfish (*Pleuragramma antarctica*). The Working Group note that depending on the questions to be addressed by the research, the use of magnetometers could help to estimate the tag location during deployment, and accelerometers can indicate changes in speed during vertical movements. The Working Group recommended analyses to identify temporal patterns (such as biological rhythms), especially in association with other environmental factors, could help to understand the fish behaviour recorded by the tags.

4.100 WG-FSA-18/24 presented an analysis on diet composition and feeding strategy of *D. mawsoni* collected from longlines in Areas 58 and 88 between 2014 and 2018. The results indicated that *D. mawsoni* is an opportunistic predator that feeds mainly on other fishes from all size classes with a narrow trophic niche width. Small quantities of other preys as molluscs, crustaceans, anthozoans, echinoderms, eggs, birds and mammals have also been found. Macrourids were the main fish in the diet in Area 58 while macrourids and the icefish *Chionobathyscus dewitti* were found in similar proportions in Area 88. Ontogenetic changes were observed where small size classes of *D. mawsoni* seem to feed mainly on *C. dewitti* while large size fish feed more on macrourids, however, this may be confounded by spatial distribution of samples collected.

4.101 The Working Group noted that because toothfish are generalists, a time series of toothfish diet composition could be used as a monitoring index for the effects of climate change on species distributions. The Working Group encouraged continuing this work to investigate potential differences between subareas or with depth, and to integrate these analyses with genetic studies, as presented in a companion paper (WG-FSA-17/P03).

4.102 The Working Group considered WG-SAM-18/65 which analysed the reproductive ecology of *D. mawsoni* in Areas 58 and 88 from gonad samples collected in 2016 and 2017 using histological analysis. The average gonadosomatic index of the fish in Area 58 was higher than in Area 88. Maturity in females was between 120 and 130 cm and all females were mature at a size of 170–180 cm. The authors hypothesised that the main spawning season starts in the month of May and suggested sampling all year around to test this hypothesis.

4.103 The Working Group noted the importance of validating the macroscopic stage data with histological analysis, especially in samples collected during non-spawning seasons. The Working Group noted that there are many fishery observations of maturity stage,

gonadosomatic index (GSI), and sex available for several years and areas and recommended that these observer biological sampling data be requested from the Secretariat to be integrated into these analyses to derive maturity ogives and other biological parameters for each stock sampled.

4.104 WG-FSA-18/54 Rev. 1 described the progress in age determination of otoliths from *D. mawsoni* collected in Division 58.4.1, including a comparison of otolith readings from four age readers from Spain and two from Australia. The results showed that the agreement on ages varied among readers, that some reader comparisons indicated a bias between readers in either young or old fish, and that the overall coefficient of variation (CV) was typically >9%, which was likely a result of small sample sizes in the comparisons.

4.105 The Working Group welcomed the progress in age validation. The Working Group noted that the CV threshold used for acceptable reference set reads in the Ross Sea was 5%, and that further development and testing was needed to improve the CVs in the comparisons with reference sets. The Working Group noted that the goal of the age determinations was to provide an unbiased ALK for use in assessment and that the tests for bias and changes in reader performance through time were important as the uncertainty in age is included in the integrated assessment models.

4.106 The Working Group also noted that the preparations and viewing configurations used by the readers (e.g. bake and embed, thin sections, monitor viewing, dissecting scope and optical quality) can affect the precision of reading and should be considered in comparisons.

4.107 WG-FSA-18/58 Rev. 1 presented the results from the final year of the multi-Member research plan by Australia, France, Japan, Republic of Korea and Spain in Divisions 58.4.1 and 58.4.2. The Working Group noted that a summary on fishing activities, presented in a standardised report format using R markdown, had already been presented in WG-SAM-18/17. The Working Group noted that all the comments raised by review at WG-SAM had been addressed and noted the development of case-control tagging performance statistics, improvements to a habitat model presented in WG-FSA-17/16, and progress in developing a CASAL model for *D. mawsoni* in these divisions (paragraph 4.18).

4.108 The Working Group noted that structured fishing in the research blocks in addition to that provided by the initial catch allocation among Members could be used to support data collection for case-control comparisons of effective tagging survival and tag-detection rates to improve the development of the stock assessment as presented in WG-FSA-18/58 Rev. 1.

4.109 SC-CAMLR-XXXVII/BG/23 questioned the performance of the multi-Member research plan by Australia, France, Japan, Republic of Korea and Spain in Division 58.4.1 arguing that the different gear types of longline gear and configurations used by the different vessels prevented data collected on CPUE, size composition, or mark-recapture results from being summarised and used as a time series to estimate abundance. The paper indicated that the effect of longline gear type is reflected in length composition, age composition, ratio of mature fish and mark-recapture results should be summarised and used as a time series to understand abundance (Kasatkina, 2017, 2016; WG-FSA-17/16).

4.110 The authors emphasised that understanding abundance dynamics and trends requires separating the effect of gear type from the spatial and temporal variability of toothfish compositions. Dr Kasatkina noted that it is necessary to develop approaches for summarising

data obtained with different fishing gears and that the methodology should provide an opportunity to assess the quality of the results based on the application of diagnostics to determine the effectiveness of the methods and models used. Dr Kasatkina noted that an alternative approach for implementation of a multivessel program is to use standardised gear.

4.111 The Working Group noted that a number of standardisation methods exist and are used routinely within CCAMLR working groups to control for the potential effects of gear type, vessel, area, depth and other variables associated with the variable of interest (e.g. catch rate, fish size) as presented in WG-FSA-17/07 and 17/16 (paragraphs 4.27 to 4.30 standardisation discussion). Methods have also been developed to standardise differences in tagging programs, such as the case-control analysis (WG-SAM-14/30), and these data have been used in integrated stock assessments.

4.112 The Working Group noted that these types of standardisation analyses apply to research in many areas and are not specific to Division 58.4.1. Some of these standardisation methods have been applied to Division 58.4.1, including standardisation of catch rates, mean length, the proportion of mature females and sex ratio (WG-FSA-17/16), trends in by-catch abundance (WG-FSA-17/23, WG-FSA-18/28), vessel effective tagging survival and detection rates (WG-FSA-18/58 Rev. 1).

4.113 The Working Group encouraged additional analyses of the potential for gear type to affect indices of by-catch composition, or effective tagging survival and detection rates, and recalled previous advice that the appropriate analysis will depend on asking clear questions, developing hypotheses to test, and conducting an appropriate analysis and diagnostics (paragraphs 4.43 to 4.46) (SC-CAMLR-XXXV, Annex 7, paragraphs 3.90 and 3.91).

4.114 WG-FSA-18/59 presented a new four-year research proposal by Australia, France, Japan, Republic of Korea and Spain in Divisions 58.4.1 and 58.4.2. Based on the outcomes of a review of the locations of research blocks (WG-SAM-18/17), the new research plan proposed to retain the research blocks in their same locations as the previous research plans, but to remove a fine-scale research grid from research block 5841_2.

4.115 Dr Kasatkina expressed concern about the calculation of the catch limit for the researches in Division 58.4.1, given that a different gear types have been used in the research blocks in different years, there is also a low level of tag recapture in this area. Analysis of the impact of gear type in the regression technique used to set research block catch limits and the sensitivity to the level of tag recapture, has not been performed and this uncertainty may impact the precautionary catch limit advice to the Scientific Commission.

4.116 The Working Group noted that the fine-scale research grid had originally been designed around the locations of depletion experiments conducted by Spain in 2015 to recapture tagged fish that had been released as part of that experiment. While the fine-scale grid may be useful for inter-vessel comparisons, data from such a small area could create a bias in the biomass estimates using tag-recapture data. The Working Group therefore supported the removal of the grid in the research proposal.

4.117 The Working Group noted that the habitat model for *D. mawsoni* in this area, including a standardisation of catch rates, will be updated as part of this research plan, and that more detailed sampling of VME by-catch was part of the data collection plan.

4.118 The Working Group evaluated the research proposal in WG-FSA-18/59 against the criteria set out in SC-CAMLR-XXXVI, Annex 7, paragraph 4.7 (Table 6).

Management advice

4.119 The Working Group noted that the catch limits for Division 58.4.1 and 58.4.2 were calculated using the updated trend analysis rules and recommended they be applied as shown in Table 4.

Division 58.4.3a

4.120 WG-FSA-18/50 presented the 2017/18 results of the research plan by France and Japan in Division 58.4.3a. Only the *Mascareignes III* fished in that season, taking 2.5 tonnes of the 38 tonne catch limit in 16 sets with three recaptures of tagged fish. The other fishing vessel, the *Shinsei Maru No. 3* did not participate in the research due to engine failure.

4.121 The Working Group noted that the research results had been reported only for the current season. Since fishing activities by the Japanese vessel were still in progress at the time of the last WG-FSA meeting, these activities had not been reported to WG-FSA-17 and were not part of this report either. The Working Group therefore recommended that these research reports include data from more than one season.

4.122 The Working Group expressed concern about the lack of progress in this research plan and failing milestone achievements, including no new age readings since 2015, no update on the estimation of biological parameters, and no further development of a preliminary CASAL stock assessment. The Working Group noted that there is no stock hypothesis developed for this area and recommended some further work towards this objective.

4.123 The Working Group noted that due to the lack of significant catch taken for many years, the number of releases and recaptured fish over time has degraded such that only two fish in 2017 and three fish in 2018 were recaptured. The Working Group noted that these numbers of tag-recaptures could be too small to develop a stock assessment in such a way that it could be used to provide catch management advice using the CCAMLR decision rules.

4.124 The Working Group noted the high level of by-catch in this Division, with 70% of the total catch weight being by-catch (including weight of individuals discarded and estimated weight of individuals released or lost at the surface). The Working Group also noted that 320 of 1 570 skates caught (20%) were reported as lost at the surface.

4.125 WG-FSA-18/61 presented a proposal to continue research in Division 58.4.3a by Japan and France in 2018/19. The Working Group noted that there had been no clear start or end date of this research plan, the presentation of future milestones lacked due dates and that some milestones had been simply delayed as few data were being collected to conduct required analyses. The Working Group also noted that if a large number of tags were not released in the upcoming year, then there would be little prospect of any tag-recaptures by 2020/21.

Management advice

4.126 The Working Group evaluated the research proposal in WG-FSA-18/61 against the criteria set out in SC-CAMLR-XXXVI, Annex 7, paragraph 4.7 (Table 6).

4.127 The Working Group noted that the catch limits in Division 58.4.3a were calculated using the updated trend analysis rules and recommended they be applied as shown in Table 4.

4.128 The Working Group requested that the Scientific Committee consider the prospect of this research plan being successful given the low catches and hence low numbers of fish being tagged since 2014, low numbers of recaptures, low catch yielding low numbers of otoliths available for ageing and ageing not being progressed, and the high proportion of by-catch.

Division 58.4.4b

4.129 WG-FSA-18/67 presented the 2017/18 results of the research plan by France and Japan in Division 58.4.4b. Only the *Ile Bourbon* fished in that season, taking 1.6 tonnes of the 28 tonne catch limit in 18 sets with no recaptures of tagged fish (three recaptures of tagged fish occurred but were not included at the time of the data extract). Similar to Division 58.4.3a, the other fishing vessel, the *Shinsei Maru No. 3* did not participate in the research due to engine failure.

4.130 The Working Group noted low catch rates with a declining trend in CPUE in research block 5844b_2 and suggested further work to standardise this time series for spatial and vessel effects.

4.131 The Working Group also noted that despite an extensive dataset of length, weight, maturity data and otolith samples that have been taken, model parameters related to productivity have not been updated since 2015.

4.132 The Working Group discussed the reported decline in killer whale sightings and depredation recalling its comments from 2016 (SC-CAMLR-XXXV, Annex 7, paragraph 4.138). No recent work has been reported to quantify depredation or develop photographic reference sets.

4.133 The Working Group expressed concern that the research plan is in a closed area, the spatial fishing grid pattern of the proposal is not being implemented, a tag-recapture time series to estimate stock abundance is not being developed, and some milestones are not achieved.

4.134 In discussion of the revised research proposal (WG-FSA-18/44), the Working Group noted that the research plan in this area has been in place since 2010 but that many of the milestones have been delayed either due to lack of catch and tagging data, or lack of processing and analysis of collected samples and data. The Working Group further noted that some milestones in the progress table (e.g. killer whale depredation) had no completion date, but that experts in the field of photo ID (e.g. in Australia, France and USA) would be available to assist in this.

Management advice

4.135 The Working Group evaluated the research proposal in WG-FSA-18/44 against the criteria set out in SC-CAMLR-XXXVI, Annex 7, paragraph 4.7 (Table 6).

4.136 The Working Group noted that the catch limits for research in Division 58.4.4b were calculated using the updated trend analysis rules and recommended they be applied as shown in Table 4.

4.137 The Working Group noted that this is a closed area and requested that the Scientific Committee consider the viability of this research plan and the sustainability of this stock given: (i) that proposed research designs have not been implemented, (ii) low and declining catch rates, (iii) low numbers of historical tag recaptures, (iv) low expected numbers of future recaptures due to low catches, and (v) limited milestone achievement.

4.138 Dr Kasatkina expressed concern about the calculation of the catch limit for the researches in Division 58.4.1, given that different gear types have been used in the research blocks in different years, there is also a low level of tag recapture in this area. Analysis of the impact of gear type in the regression technique used to set research block catch limits and the sensitivity to the level of tag recapture, has not been performed in this area and this uncertainty may impact the precautionary catch limit advice to the Scientific Commission.

D. mawsoni in Area 88

Capacity

4.139 WG-FSA-18/15 updated the metrics of capacity and capacity utilisation presented in WG-SAM-14/19 and WG-FSA-15/09 to monitor trends in capacity in exploratory toothfish fisheries in Subareas 88.1 and 88.2. The updated metrics showed a high CPUE in the Ross Sea fishery in 2016/17 and highlighted that the indices from 2017/18 should be interpreted in the context of the changes in the spatial distribution of the fisheries resulting from CM 41-09 and CM 41-10 in 2017/18.

4.140 The Working Group noted that the uncertainty associated with the closure of the northern Ross Sea in 2017/18 arose directly as a result of a large number of vessels notifying to fish in Subarea 88.1, although some moved straight through to the southern area without fishing in the north (WG-FSA-18/07, see also paragraphs 2.19 to 2.25).

Winter survey

4.141 WG-FSA-18/40 presented a proposal for a winter survey in the north of Subareas 88.1 and SSRUs 882A–B; previously presented as WG-SAM-18/09 which describes the research objectives.

4.142 The Working Group noted that WG-SAM had requested the addition of a milestone table which was included in the revised report.

4.143 The Working Group recommended that the survey catch should be taken from the Ross Sea north area.

4.144 The Working Group requested that the Scientific Committee consider whether to allocate the catch from the Ross Sea northern catch limit of the next season and then adjust the catch limit of that season by the actual catch taken during the survey.

4.145 The Working Group noted that the catch limit had been based on the previous survey catch rates in the area and the number of research blocks and number of stations within research blocks planned for the research to obtain information on catch composition and biological parameters over a broad spatial distribution. The Working Group noted that power analyses could be performed to determine the samples necessary to estimate key parameters from the survey.

4.146 The milestone table was reviewed by WG-FSA which then evaluated the research proposal in WG-FSA-18/40 against the criteria set out in SC-CAMLR-XXXVI, Annex 7, paragraph 4.7 (Table 7).

Shelf survey

4.147 WG-FSA-18/41 presented a proposal for a continuation of the Ross Sea shelf survey. The Working Group noted that the survey contributes information on the relative magnitude of recruitment year classes in the toothfish stock assessment of the Ross Sea Region.

4.148 The Working Group noted that the Independent Review Panel (Annex 5) had commented on the importance of developing time series of standardised surveys such as this one which contribute to reducing the uncertainty of recruitment estimation in assessments (Table 3).

4.149 Dr Kasatkina noted that the catch for the next year survey should be derived from the special research zone (SRZ) rather than being allocated from the Olympic fishery catch allocation in the Area south of 70°S outside the marine protected area (MPA) (CCAMLR-XXXVI, paragraphs 8.25 and 8.26).

4.150 The Working Group noted that the Commission had agreed in 2017 on the basis of advice from the Scientific Committee (SC-CAMLR-XXXVI, paragraphs 3.138 and 3.139) that the catch should be allocated from the total catch limit (CCAMLR-XXXVI, paragraphs 5.35 and 5.36). Consequently, in the absence of a scientific rationale for changing the previous advice the Working Group recommended that the survey catch be allocated from total stock catch limit.

4.151 The Working Group evaluated the research proposal in WG-FSA-18/41 against the criteria set out in SC-CAMLR-XXXVI, Annex 7, paragraph 4.7 (Table 7).

Fishery monitoring

4.152 WG-FSA-18/46 summarised the toothfish fishery in the Ross Sea region (Subarea 88.1 and SSRUs 882A–B) together with biological characteristics of the catch of Antarctic toothfish through the 2017/18 season.

4.153 The Working Group noted that despite 2017/18 being the first year of implementation of the Ross Sea region MPA (RSRMPA), most of the fishing effort was carried out in the historically fished areas. There was a small amount of effort in the northern area of SSRU 882A, which was opened to the exploratory fishery for the first time with the introduction of the RSRMPA.

4.154 The Working Group noted that the annual review would form an important source of information in monitoring the changes in behaviour of the fleets and catch rates required to provide advice on the impact of the MPA measures.

SRZ survey

4.155 WG-FSA-18/33 Rev. 1 presented a proposal for a research survey to be conducted by four vessels within the SRZ of the RSRMPA. The proposal was previously considered by WG-SAM (WG-SAM-18/07).

4.156 The research program has the objectives of investigating 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 within SSRU 882A.

4.157 Dr Kasatkina noted that the proposal includes research considered a priority within the research and monitoring plan for the RSRMPA and that the proposal would provide information on regional catch rates and migration, and toothfish and by-catch species diet studies and biological parameters.

4.158 The Working Group welcomed the link of the outcomes of this research with the topics from the research monitoring plan (RMP) (SC-CAMLR-XXXVI/20) presented in the proposal, and also noted recommendations from WG-SAM and Workshop on Spatial Management (WS-SM-18) regarding guidelines for fisheries research conducted in the MPA (Annex 6, paragraphs 6.45 to 6.47 and Annex 7, paragraph 6.2).

4.159 WG-FSA noted that WG-SAM-18 had requested further information on:

- (i) the rationale for the change to the catch limits in the revised proposal
- (ii) the alternative stock hypothesis that the proposal is trying to test
- (iii) why a CASAL assessment or Chapman biomass estimate is required for a subregion within the Ross Sea, when there is an assessment conducted for the wider area
- (iv) how the research can be conducted without interaction with the SRZ Olympic fishery.

4.160 In response to the WG-SAM questions the proponents noted that:

- (i) The derivation of the catch limits was outlined as being based on an analysis of the Russian research survey conducted within the area in 2011

- (ii) The survey will monitor the dynamics of the trends in local biomass within the SRZ resulting from the changes to fishing pressure resulting from the MPA.
- (iii) The survey objectives were changed to provision of standardised data on length and age structure to the current CASAL assessment; similar to that provided by the Ross Sea shelf survey. It will allow monitoring of the local dynamics of the toothfish in this area which represents a link between Subareas 88.1 and 88.2. The survey would also provide local biomass trends within the surveyed part of the SRZ to compare with trends in the open areas outside the MPA.
- (iv) The proponents advocated reducing interactions with the Olympic fishery by conducting the survey after the Olympic fishery in the SRZ had been closed.

4.161 The Working Group noted that, while the SRZ general objectives are outlined within CM 91-05, there is no mechanism to separate effects of the Olympic fishery and structured research plans and asked the Scientific Committee to consider how this can be achieved.

4.162 The Working Group expressed concerns that a vessel with negligible recaptures of tags was considered for delivering the research objectives of this proposal.

4.163 The Working Group noted that the current design of the survey, in which four vessels fish in four 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.

4.164 The Working Group recalled that WG-FSA-17 and WG-SAM-18 had noted that a systematic survey design was a suitable approach to develop time series of monitoring information from the SRZ, although systematic designs used on fixed stations can be impacted by high sea-ice concentrations, which is a particular problem in this area. The Working Group therefore recommended that a more flexible random stratified design be considered.

4.165 However, the Working Group also noted that the systematic design of the survey 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.

4.166 Dr Kasatkina, noted that the vessel gears would be standardised, as far as possible, by using autolines with 5 000 hooks per line set on 6 km lines with hook spacing of 1.2 m and that, subsequent to a review of the results from the first year of the survey, the survey stratification would be designed with input from WG-FSA and WG-SAM to ensure a survey distribution, by vessel, which permitted testing of vessel effects.

4.167 The Working Group discussed past research by Russia noting that previous surveys had not completed the research program and also outstanding analyses in other areas were yet to be completed.

4.168 The Working Group evaluated the research proposal in WG-FSA-18/31 against the criteria set out in SC-CAMLR-XXXVI, Annex 7, paragraph 4.7 (Table 7).

The CCAMLR scholarship recipient

4.169 Dr D. Di Blasi (Italy), a recipient of the 2018 CCAMLR scholarship, summarised plans for research on *D. mawsoni* in the Ross Sea region (WG-FSA-18/62). The research intends to further develop a non-extractive technique for collecting time series of abundance and investigating size distribution of *D. mawsoni* in areas or seasons not accessible to fishing vessels using baited underwater video cameras deployed through the sea-ice in the Ross Sea.

4.170 The Working Group noted that the research design had previously been presented at WG-EMM-18, which had also provided feedback on developing the experimental design. The Working Group discussed the use of different lighting colours and switching the lights on and off to examine whether lights act as a deterrent, as well as considering examination of fish behaviour in response to guarding the bait.

4.171 The Working Group encouraged future feedback to WG-FSA on the results as non-extractive sampling is of particular interest in monitoring within an MPA.

Subarea 88.2

4.172 WG-FSA-18/36 presented a review of the fishery in the Amundsen Sea region in which the toothfish fishery has operated since 2003. In 2015, a research plan was developed to estimate the toothfish biomass in the area.

4.173 The Working Group noted that few age data are currently available from otoliths collected after 2014 and recommended that further ageing of toothfish be made a priority by Members who have collected otoliths in this area (SC-CAMLR-XXXVI, Annex 7, Table 1) to develop annual ALKs. The Working Group noted previous attempts to encourage the provision of data for this region from the Members fishing there; particularly ageing. Dr Ziegler informed the Working Group that Australia had aged some otoliths from 2015 (WG-FSA-17/15) and just recently finished ageing otoliths collected in 2017.

4.174 The Working Group noted that the current research plan and catch limit distribution by area had advanced the information required for the assessment of the stock, but further development of the stock assessment is needed and relies heavily on adequate mark-recapture and ageing data. A requirement for research plans with milestones as part of the notification for conducting fishing in the area would encourage vessel coordination, and the submission of data for the assessment process and submission of advice to the Scientific Committee.

4.175 The Working Group discussed the distribution of fishing effort in the south of Subarea 88.2 across the four research blocks, noting that effort in research blocks 2 and 3 had been consistent recently and that tag recaptures in research block 2 had contributed to local population abundance estimates. However, the allocation of a catch limit to the whole area, and not individual blocks, has resulted also in the majority of the catch being taken in research blocks 2 and 3 and not distributed across all blocks because some areas are not accessible until after the catch limit has been reached in other areas.

4.176 The Working Group recommended that in the south of Subarea 88.2 individual catch limits be applied to each research block.

4.177 The Working Group reviewed the application of the data-limited trend analysis rules (SC-CAMLR-XXXVI, Annex 7 paragraph 4.33) to this region, as applied to the offshore area SSRU 882H and the four inshore research blocks independently.

4.178 The Working Group recommended that the trend analysis rules should be applied independently for each research block in the southern Subarea 88.2 and SSRU 882H consistent with its advice for other areas, based on the analysis presented in WG-FSA-18/36.

4.179 The Working Group noted the development within WG-FSA-18/36 of a sensitivity analysis for the Chapman population estimation process by application of effective tag release and recaptures (to account for different levels of tag survival and tag detection by individual vessels; see WG-SAM-14/30). Using effective tag releases and tag recaptures for the area resulted in a substantial reduction in the Chapman estimated population abundance (11 759 tonnes reduced to 4 419 tonnes); the lower value was more consistent with the CPUE by seabed area estimates.

4.180 Adequate numbers of recaptures were available from research block 882_2 and SSRU 882H for the Chapman method to be used in the trend analysis rule. When applying this rule for research block 882_2, the recommended catch limits were the same when using all or only the effective tag survival and detection rate. However, for SSRU 882H, the recommended catch limits increase to 240 tonnes when using all tag recaptures, while they decrease to 177 tonnes when using only effective tag recaptures.

4.181 The Working Group agreed that further evaluation was required concerning the application of the effective tagging weighting within the Chapman method as, although its application within CASAL assessments has been reviewed and agreed by WG-SAM, WG-FSA, the Scientific Committee and the Independent Review Panel, its application within the Chapman method has not been reviewed.

4.182 The Working Group recommended a review of the application of the effective Chapman biomass calculation method in research blocks in the subsequent application of the trend analysis approach.

4.183 The Chapman estimates for SSRU 882H used the same R code (BERT package) to derive the estimates using a single year at liberty, which is consistent with the approach taken in Subarea 48.6 for seamount research blocks (486_2 and 486_3). The results are presented in Table 8.

Subarea 88.2 stock assessment

4.184 WG-FSA-18/37 presented progress towards an integrated stock assessment model for *D. mawsoni* in the Amundsen Sea region, defined here as SSRUs 882C–H. The region is modelled as two areas: the North (SSRU 882H) comprising large mature fish, and the South (SSRUs 882C–G) comprising a mix of large mature fish and small immature fish.

4.185 Two-area stock assessment models were first developed for the region in 2014 and refined in 2015 and 2016. Results showed the need to collect mark-recapture data in the South to inform the estimation of biomass in the South. Simulation work undertaken in 2017 showed that if tag recaptures continued in the south, and were spread among research blocks, a model may be developed for management advice.

4.186 In 2018, the assessment models were fitted to the proportions-at-age in the catch, and the mark-recapture data from the two areas. The results suggest that data from the research plan are starting to inform the model, especially with respect to the size of the population in the south and migration rates between areas.

4.187 The Working Group noted that at this stage the model should only be used as indicative of the current status and trends in the stock due to issues including poor fit to the age data in the south, the lack of year-specific age frequency data to inform these fits, the lack of observed tag recaptures which have moved from north to south, and the limited spatial overlap of fishing effort and available tags in the south.

4.188 While noting the caveats concerning the fit of the model, the Working Group agreed that the current management advice is precautionary considering the yield associated with the fitted model for the southern research blocks is consistent with the proposed catch limit in the fishery.

Subarea 88.3

Ukraine

4.189 The Working Group considered a new research proposal for *Dissostichus* spp. in Subarea 88.3 by Ukraine outlined in WG-FSA-18/16 Rev. 1 (previously presented as WG-SAM-18/12). The proposed research will conduct analysis on the life cycle of *D. mawsoni* by fishing at a range of depths across the area. Associated research included conducting conductivity temperature depth probe (CTD) and plankton sampling, which would be analysed by the University of British Columbia. The vessel had been equipped with full electronic monitoring for monitoring catch and by-catch.

4.190 The Working Group noted that there were insufficient details in the proposal to conduct a full evaluation of the recommendations made by WG-SAM-18 (Annex 6, paragraphs 6.74 to 6.76). Particularly, the Working Group considered that there was uncertainty around:

- (i) the process by which the Ukrainian proposal could be integrated with the existing research proposals from the Republic of Korea and New Zealand
- (ii) standardisation of the research results given the proposed research blocks were not overlapping to allow calibration between vessels
- (iii) what the added value of an additional vessel would bring to the research, particularly given that Ukraine was committed to delivering many milestones across a number of proposals.

4.191 WG-FSA recommended that Ukraine should continue efforts to coordinate its research efforts with Korea and New Zealand.

4.192 Dr Demianenko noted that Ukraine considered that the proposal would add value to the New Zealand and Korean research by enabling better coverage of the area and provide valuable oceanic and plankton data for the region.

4.193 The Working Group evaluated the research proposal in WG-FSA-18/16 Rev. 1 against the criteria set out in SC-CAMLR-XXXVI, Annex 7, paragraph 4.7 (Table 7).

Korea and New Zealand

4.194 WG-FSA-18/42 presented a proposal by Korea and New Zealand for an additional three years of research, in Subarea 88.3, during 2018, 2019 and 2020, that is designed to continue Korea's previous research. The study would focus on research blocks where tagged fish have previously been released on the slope, whilst also sampling two of the northern seamount complexes and two boxes on the southern shelf, where little or no fishing has occurred to inform stock structure hypotheses.

4.195 The main objective of the proposal is to determine the abundance and distribution of Antarctic toothfish in Subarea 88.3. Secondary objectives are to improve the understanding of stock structure of toothfish in this area, to carry out calibration trials between the two vessels, to collect data on the spatial and depth distributions of by-catch species, and to trial electronic monitoring using video cameras.

4.196 The Working Group noted that:

- (i) the New Zealand vessel did not complete the survey because the vessel could not access the southern research blocks due to heavy sea-ice conditions and safety considerations and this had delayed the achievement of the milestones
- (ii) no toothfish had been recaptured during the survey and this was likely due to the low catches and ice/weather conditions.

4.197 The Working Group recognised that aggregating length distributions across research blocks can create bimodal length distributions which can impact tag overlap statistics. The Working Group recommended that the tag-size overlap should be considered for each block separately in order to ensure that a representative distribution of fish lengths is tagged (Annex 6, paragraph 6.1).

4.198 The Working Group noted that an agreement on sharing the catch limit had been in place, with unused catch from one of the vessels being made available by the second vessel through Member communication.

4.199 The Working Group evaluated the research proposal in WG-FSA-18/41 against the criteria set out in SC-CAMLR-XXXVI, Annex 7, paragraph 4.7 (Table 7).

4.200 WG-FSA-18/21 presented the results of an analysis of the trophic niche of Antarctic toothfish caught in Subarea 88.3 as inferred from fatty acids and stable isotopes. The data were collected from the muscles of toothfish in Subarea 88.3 of the Pacific Ocean sector, the Ross Sea shelf and the Indian Ocean sector of the Convention Area during 2012–2017.

4.201 The research found significant differences in size distributions of regional toothfish stocks, demonstrating an ontogenetic movement into deeper water from shelf water. The relative fatty acid proportions of the Indian Ocean and Pacific Ocean stocks were similar to each other but differed from those of the Ross Sea Shelf. Isotopic differences between the shelf and slope stocks were detectable in both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values.

4.202 The regional variations in trophic niche were explained by different patterns in resource utilisation, which are partitioned into two prey groups (i.e. feeding on bathypelagic vs. bathydemersal organisms), between regions and toothfish size, reflecting diet shift during ontogenetic migration across the geographic range of Antarctic waters as confirmed by the combined mixing-model calculations of both trophic markers.

4.203 The Working Group noted that differences between regions in the size at which fish move to deeper water may account for some of the variation in recorded trophic niche.

4.204 The Working Group recommended that it would be beneficial to bring together information from tagging movements, diet and genetics studies in a review that would allow design of future research and sampling programs. In addition, regular monitoring could lead to a monitoring tool that could identify responses to climate change or fishing pressure.

Other fisheries research

Crabs

4.205 WG-FSA-18/32 Rev. 1 presented a revised proposal for new research on crabs in Subareas 88.2 and 88.3 to be conducted by two Russian vessels. The proposal was first submitted to WG-SAM as WG-SAM-18/06 where it was presented as a research plan under CM 24-01.

4.206 The objective of the three-year research program is to study the species composition, biology, life cycle, distribution and structure of the crab stocks to assess their fishery potential in the Bellingshausen Sea (Subarea 88.3) and Amundsen Sea (Subarea 88.2). The target species of the research is any lithodids (king crabs).

4.207 The Working Group noted the modification of the sampling design to include biodegradable escape panels and fishing effort stratified across depths, as requested by WG-SAM-18 (Annex 6, paragraph 6.66). The Working Group noted that the spatial and depth distributions of crab species were poorly known in this region and that initial exploration of the distribution of those species might benefit from substantially reducing the number of pots per line set along an isobath from the 120 pots/line proposed.

4.208 Dr Kasatkina recommended to use 120 pots per line for the first season and additionally conduct sets with reducing number of pots per line. Experience from the first season will provide actual data on number of pots per line that would be appropriate.

4.209 The Working Group was unable to evaluate an optimum number of pots per line for use in this research program and requested that the Scientific Committee consider an appropriate level and distribution of effort to conduct this research.

4.210 The Working Group noted that the distribution of crabs in the Southern Ocean was a topic of considerable scientific debate with a recently developed hypothesis suggesting that crabs may have ‘invaded’ the Southern Ocean from lower latitudes as water temperatures have increased with climate change (Smith et al., 2012; Griffiths et al., 2013; Aronson et al., 2015). The Working Group noted that the planned research may provide useful evidence to test the competing hypotheses on crabs as endemic or invasive in this region.

4.211 The Working Group noted that the crab species targeted by this research have not been studied in detail in the Pacific sector of the Convention Area, and key biological parameters such as size distribution, maturity and distribution are unknown. The Working Group recommended that a review of the scientific literature be undertaken to establish whether preliminary estimates of such biological parameters were available for related crab species in the CAMLR Convention Area or in other areas.

4.212 The Working Group noted that the aim of the research is to retain only male specimens that are above the size at sexual maturity. Since there was apparently no information on the size distribution or size at maturity for the species that may be encountered, the Working Group noted that there would be scientific benefits if samples of all catch were retained in order to estimate size at maturity for all species and both sexes. In addition, measuring all crabs would provide information on the size composition of the crab populations with depth and area and inform estimates of the size selectivity of the fishing gear. It was noted that in a previous crab fishery in Subarea 48.3 (Belchier and Peatman, 2012) the retained catch of mature males only made up a small proportion of total catch and this made the fishery commercially unviable.

4.213 The Working Group expressed concerns about the impact of the pots on VMEs. The Working Group noted that assessing the impact of pots on benthic organisms is difficult as few specimens were likely to be brought to the surface. In order to provide information on the footprint of the fishing gear, its impact on the seafloor and the habitats sampled, the Working Group recommended to use deep-water cameras such as those deployed in several CCAMLR toothfish fisheries (e.g. WG-FSA-14/P06) to assess the habitats present where fishing occurred, observed interactions and evaluate the impact of pots on benthic habitats.

4.214 The Working Group noted that tagging and releasing all toothfish caught as by-catch (above the proposed 5 tonne catch limit) could affect other research on *D. mawsoni* in Subareas 88.2 and 88.3. The Working Group noted that toothfish and other fish by-caught in pots were often preyed upon by amphipods and that this may impact on the suitability of toothfish in pots for tagging, and the ability to provide accurate estimates of quantities of by-catch. The Working Group further recommended that only toothfish assessed as suitable for tagging should be tagged and released as part of this research.

4.215 The Working Group noted that WG-SAM had requested that the Scientific Committee provide advice on the status of the proposed research and whether it should be considered as a new fishery under CM 21-01 rather than as a research proposal under CM 24-01. The Working Group recalled that the last crab fishing to take place in the Convention Area was undertaken by Russia in Subarea 48.2 in 2009.

4.216 The Working Group noted that an experimental harvest regime was utilised in previous crab fisheries in Subareas 48.2 (CM 52-02, Annex 52-02/C) and 48.3 (CM 52-01, Annex 52-01/C) that included specific requirements for effort to be placed in a grid of research blocks. It noted that these experimental research blocks were positioned across shallow shelf areas (<200 m) to slope depths in order to collect information on the spatial distribution and stock structure of crabs.

4.217 The Working Group recommended that if the Scientific Committee agreed that the research should proceed, the first season of the research should be considered as a pilot study. Detailed results would be presented to WG-FSA-19 to enable an evaluation of results, a preliminary assessment of the distribution and abundance of crabs in the region and appropriate

design for further research. The Working Group also recommended that the catch and effort data be submitted according to CM 23-05 using the C5 form and that SISO data should be collected using the e-POT(2013) form.

Toothfish genetics

4.218 WG-FSA-18/64 provided an update on the *D. mawsoni* genetic connectivity project (WS-DmPH-18/08). A large number of tissue samples have been made available for this project from nine CCAMLR Members, and DNA was extracted from 761 samples with 551 samples containing sufficient quality and quantity to be sequenced. Results from this project will be presented at WG-FSA-19.

4.219 The Working Group noted that Members willing to get involved in potential future analyses, such as in Subarea 48.6 or the South Pacific Regional Fisheries Management Organisation (SPRFMO) area, were invited to send their samples and relevant biological data to the Australian Antarctic Division (AAD). The Working Group also noted that mechanisms to facilitate the linking of data for fish sampled for DNA could be developed as part of the CCAMLR data warehouse project.

Acoustic data collection

4.220 WG-FSA-18/05 presented analyses of acoustic data obtained during the austral summer of 2018 as a complement to finfish research in Subareas 48.1 (Elephant Island) and 48.2 (South Orkney Islands). The survey documented the spatial distribution of fish and Antarctic krill in the area of study. Concentrations were identified considering their bathymetric distribution, shoal shape, size structure provided by the echosounder, samples obtained with a midwater and bottom trawls and through expert judgment. The Working Group recommended stronger experimental design in future acoustic surveys and to ask SG-ASAM to review future survey designs.

4.221 The Working Group noted that acoustic monitoring is a recognised method to study fish distribution and abundance, particularly in areas closed to fishing or where trawling is banned. However, it noted that despite improved technology, quantitative analyses regarding fish or krill biomass estimates were lacking from WG-FSA-18/05. The Working Group requested that SG-ASAM provide advice on current best practise in the use of multi-frequency acoustic data to assist with the design of acoustic surveys to assess the distribution of fish in the Convention Area.

Toothfish fisheries adjacent to the Convention Area

4.222 WG-FSA-18/39 reported on an exploratory research program for toothfish in the SPRFMO Convention Area in August 2016 and September 2017. Results showed that *D. mawsoni* also spawn north of 60°S and that the sampled size composition was similar to those observed in the northern region of CCAMLR Subareas 88.1 and 88.2.

4.223 The Working Group noted that catches from the SPRFMO exploratory fishery were included into the integrated stock assessment model (CASAL model) implemented for the Ross Sea region in 2017, which was considered precautionary given the stock hypothesis in this region.

4.224 The Working Group reviewed WG-FSA-18/53 Rev. 1 which presented data about eleven *D. eleginoides* recaptures in the SIOFA management area by two Spanish vessels. These tagged fish were released in the CCAMLR management area in Divisions 58.5.1 and 58.5.2 and Subarea 58.6. The years at liberty were between 3 and 10 and 6 out of 10 fish travelled a very long distance exceeding 1 000 km. Spanish vessels have fished occasionally for toothfish and other species in the southwest Indian Ocean.

4.225 The Secretariat recalled ongoing work with the Secretariats of the Southern Indian Ocean Fisheries Agreement (SIOFA) and SPRFMO to operationalise the respective MOUs (www.ccamlr.org/node/74517) including data-sharing protocols, cooperation on tagging programs and toothfish catch reporting.

4.226 The Working Group welcomed this active cooperation between the respective Secretariats, noting that there was a need to increase integration of toothfish research and stock assessment taking account of movement of toothfish across the Convention Area's northern boundary.

4.227 The Working Group noted that most of the fish that travelled long distances were sub-adults, which was similar to findings from Subarea 48.3 (WG-FSA-14/49) and that movement frequency, directions and distances were consistent with previous movement studies conducted in Subareas 48.3 and 58.6 and Divisions 58.5.1 and 58.5.2 (e.g. WG-FSA-15/55, WG-SAM-17/11).

Research on non-target species

4.228 WG-FSA-18/47 presented a comparative morphometric analysis of sagittal otoliths of three Channichthyids (*Pseudochaenichthys georgianus*, *Chaenocephalus aceratus* and *C. gunnari*) collected during a finfish research survey in Subareas 48.1 (Elephant Island) and 48.2 (South Orkney Islands) in 2016. The Working Group noted that a feature common to all the species of icefish studied was significant asymmetry between left and right otoliths.

4.229 WG-FSA-18/74 examined the age determination and precision of age estimation on two myctophid species, *Electrona carlsbergi* and *Protomyctophum bolini* sampled from stomach contents of king (*Aptenodytes patagonicus*) and macaroni (*Eudyptes chrysolophus*) penguins on Marion Island. Results indicated that king penguins fed more on small myctophids. The authors highlighted the importance of ageing validation, particularly those age data being used for stock assessment.

4.230 The Working Group noted that investigating myctophids composition in penguin diet can provide information on ontogenetic changes in their foraging and energetics distribution through life stages and recommended that future diet analyses consider the influence of these factors.

4.231 WG-FSA-18/76 presented results on fatty acids composition of spiny icefish (*Chaenodraco wilsoni*) in the Bransfield Strait (in Subarea 48.1). This species used to be commercially fished and is currently caught as by-catch in the krill fishery.

4.232 The Working Group welcomed the study on a species that has received relatively little attention but is an important species in the regional ecosystem. The spatial variations in fatty acids composition in the study area suggested that *C. wilsoni* do not move much which could have implications for risk-based by-catch management in the krill fishery.

4.233 The Working Group encouraged biological studies on fish caught as by-catch in the krill fishery to progress risk assessment approaches for by-catch species, as discussed for toothfish fisheries under Item 6.

4.234 The Working Group noted that research on myctophids in the CAMLR Convention Area is very important given their key role in the ecosystem. The chair of Scientific Committee indicated that there had been preliminary discussion with SCAR to organise a joint CCAMLR/SCAR symposium focussing on the ‘Role of fish in the Southern Ocean ecosystem’. The Working Group encouraged the development of joint meeting between SCAR and CCAMLR planned for 2020.

Zooplankton data collection

4.235 WG-FSA-18/19 presented preliminary results on mesozooplankton composition and abundances in 53 stations located in the Scotia Sea, Weddell Sea and Amundsen Sea in austral summer 2017/18. Zooplankton data were collected during research fishing from four Ukrainian vessels using vertical tows with fine mesh size (100 µm) set during daylight.

4.236 The Working Group noted that these data provided useful information on components of the pelagic ecosystem in the area and encouraged Members collecting data on zooplankton to make them available to global initiatives such as the *Biogeographic Atlas of the Southern Ocean* and through database web portals such as www.biodiversity.aq.

4.237 The Working Group noted that krill larvae had been identified in the samples and that this information should be brought to the attention of WG-EMM.

Oceanographic data collection

4.238 WG-FSA-18/04 presented a report on oceanographic data collected on longlines and plankton nets using CTD loggers on Ukrainian vessels in SSRUS 881C–I from the Ross Sea and SSRUs 882 D, E and F from the Amundsen Sea and Weddell Sea during the 2017/18 season. Some of these results were presented at WG-SAM (WG-SAM-18/27). Temperature-depth profiles from each region were compared and tables with temporal trends in bottom temperatures were presented.

4.239 The Working Group recalled previous advice from WG-SAM regarding the need for calibration of these compact CTDs to avoid misleading interpretation due to drift in sensors.

4.240 The Working Group recommended that this oceanographic data be made available to established data infrastructures such as SCAR/Scientific Committee on Oceanic Research (SCOR) through the SOOS rather than providing the data to the CCAMLR Secretariat (Annex 6, paragraph 5.12).

Scheme of International Scientific Observation (SISO)

SISO developments

5.1 WG-FSA-18/11 presented a revised SISO observer manual to the Working Group for consideration and observer metrics from an analysis of error rates during the processing of the new observer forms voluntarily trialled by some Members in the 2018 season, as well as overall observer performance in SISO.

5.2 The Working Group thanked SISO observers for their dedication and hard work in the 2017/18 season.

5.3 The Working Group welcomed the reduction in processing errors with the new logbook. The Working Group noted that it was difficult to consider objective measures of observer performance metrics as there is currently no readily available summary of how sampling and reporting requirements have changed throughout the existence of SISO. The Working Group requested that the Secretariat provide WG-FSA-19 with a summary of reporting and sampling requirement changes over time, which would also address one of the WG-FSA priorities for data management (Table 1).

5.4 The Working Group encouraged further intersessional work with Members and the Secretariat on the observer manual and recommended the following elements to guide its structure and content to ensure SISO observer sampling tasks are clear:

- (i) the separation of the single manual into separate manuals for finfish and krill target species
- (ii) the manual content be focussed for use by observers when at sea, rather than a comprehensive document containing all relevant CCAMLR resources (e.g. text of the Scheme of International Scientific Observation, by-catch guides), but that these other resources be made available as annexes that can be downloaded if desired
- (iii) noting that standard SISO sampling requirements exist for new and exploratory *Dissostichus* spp. fisheries (www.ccamlr.org/node/81589), the Working Group further encouraged the development of standard SISO sampling requirements for other species
- (iv) consider the potential addition of sampling requirement annexes for established fisheries
- (v) the Secretariat present the revised observer manuals to WG-EMM-19 for discussion and endorsement.

Observer training application

5.5 WG-FSA-18/30 presented a phone application, developed based on previous work by Mr Gasco for CCAMLR (www.ccamlr.org/node/92048), aimed at improving observer identification skills. The Working Group thanked Mr Gasco for the further development and improvement of the training tool. The Working Group noted that Mr Gasco has developed, and provided CCAMLR with, several guides and tools over many years, which have improved and facilitated the work of SISO, and thanked him for his continual presentation of developments to CCAMLR designed to improve observer performance.

Non-target catch and ecosystem impacts of fishing

Fish by-catch

6.1 WG-FSA-18/14 provided an updated meta-analysis by the Secretariat of target and by-catch reported in all CCAMLR exploratory fisheries (as an update to analyses presented in WG-SAM-15/23 and WG-FSA-15/04 Rev. 1). Analyses of the number of fish belonging to target species divided by the total number of fish caught (the target catch ratio) was used as a simple metric of the relative level of target and by-catch reported for each haul. Analyses were carried out by gear type, vessel and Flag State and the results were broadly consistent with those reported in 2015 where little variation due to gear type or area was observed but apparent reporting differences between Members were evident.

6.2 The Working Group recalled that by-catch reporting is a vessel responsibility and noted that fishing gear and spatial effects on by-catch catch rates are well documented in CCAMLR fisheries. However, differences in reporting of by-catch between Members will mask these effects and make an evaluation of gear and spatial effects within the exploratory fisheries more difficult.

6.3 The Working Group recalled that for those Members reporting low by-catch (high catch ratio) in the 2015 analysis it was noted from responses to COMM CIRC 15/74–SC CIRC 15/44 that the ‘observer has primary responsibility for C2 data collection’. The Working Group noted that there has been no more recent information provided by Members on how by-catch is reported by vessels. The Working Group noted that the catch ratios calculated for Spain in the current analysis were lower (higher by-catch) than those in 2015 suggesting a change in the way that by-catch was reported by this vessel. The Working Group noted that there had been no change in gear configuration used by the *Tronio* over this period so was likely to be a result of improved by-catch reporting.

6.4 The Working Group agreed that, in order to address the apparent inconsistencies in the way in which by-catch is recorded between vessels, it would be useful for the Scientific Committee to further develop clear instructions to vessels on how by-catch should be reported as recommended by the Commission in 2015 (CCAMLR-XXXIV, paragraphs 3.31 to 3.35). It was noted that this could be linked to any redevelopment of the C2 forms (paragraphs 2.12 to 2.18) and associated development of guidelines for C2 form completion.

6.5 The Working Group noted that the voluntary use of electronic monitoring is now widespread across many Members’ vessels and this offered a means by which by-catch reporting could be greatly improved and could allow analyses to be undertaken more frequently.

6.6 The Working Group noted that for some areas it would be possible to develop by-catch profiles similar to those presented at the meeting (e.g. WG-FSA-18/28) which could provide some bounds on the expected composition and catch rates of by-catch within an area. Interpreting such information between areas would be facilitated by the development of standard reporting metrics for by-catch and these would need to include temporal and spatial effects. The Working Group noted that a standard reporting metric, analogous to the way in which tagging performance is evaluated, could be useful in the evaluation of research proposals to assess the performance of vessel by-catch reporting.

6.7 The Working Group noted that the differences in by-catch reporting highlighted in the analyses in the exploratory fisheries meant that it may be difficult to evaluate the level of by-catch removals across a fishery. The Working Group agreed that data on by-catch in CCAMLR fisheries are fundamental to the aims of Article II of the CAMLR Convention and expressed its concern that these data were not being provided in a way that would allow by-catch levels in those fisheries to be addressed. Furthermore, the apparent lack of consistent reporting of by-catch data has implications for the application and compliance with elements of conservation measures that relate to by-catch, such as move-on rules and overall by-catch limits.

6.8 WG-FSA-18/09 provided a summary of the implementation of the by-catch move on rules in CCAMLR exploratory fisheries between 2010 and 2018, based on catch and location data prepared by the Secretariat. The Working Group noted that there had only been a small number of instances where the move-on rules (as detailed in CM 33-03) had been triggered. A post-hoc analysis of C2 data identified a very small number of incidences where the vessels did not move-on as required.

6.9 The Working Group recalled that there were two components to the by-catch move-on rules: a line-specific move-on rule triggered if by-catch of any species exceeds a tonne on a single line and a macrourid-specific cumulative move-on rule. It was noted that the chances of triggering the cumulative move-on rule, based on two consecutive 10-day reporting periods, was likely to be low in exploratory fisheries such as the Ross Sea region toothfish fishery where the catch is taken over an increasingly short period. The Working Group recalled that responsibility for implementing the move-on rules lies with the vessel.

6.10 The Working Group considered whether the current system of by-catch and move-on rules was achieving its objectives noting that it was an effective means of moving a vessel with high by-catch rates away from an area without affecting those vessels that had low by-catch rates. Move-on rules were also likely to move effort away from local regions of high by-catch density.

6.11 The Working Group noted that the catch limits for by-catch within the exploratory fisheries are based on a ratio of by-catch to target species (16%) which was derived from historical *D. eleginoides* catch to by-catch ratio from Division 58.5.2. It was noted that it was unclear whether by-catch limits that are based on a ratio of by-catch to target species are consistent with Article II, and alternative methods for setting by-catch limits may need to be developed and evaluated. These measures may include spatial management measures to reduce the impact on by-catch species in areas where they aggregate.

6.12 The Working Group noted that since the by-catch limits and move-on rules were introduced there have been considerable advances in data-limited risk assessment methods that

should be considered in order to evaluate and revise the current 16% catch limit in exploratory fisheries. Data from fisheries-independent surveys of by-catch species are available for some areas (i.e. macrourids in Subarea 88.1) and this provides a means of assessing the level of risk posed to stocks of by-catch species under current rates of removals. Assessment methods could also include the use of information on changes in species ratios in the commercial catch.

6.13 The Working Group also noted that currently all by-catch limits are specified by weight rather than by number. Data on numbers of by-catch removals are available in the C2 data and this may be a more informative and appropriate measure of by-catch than removals by weight alone. The Working Group noted that there is a need to obtain more information on the dynamics of populations of by-catch species and to consider species groups at a higher taxonomic resolution.

6.14 The Working Group recommended that the Scientific Committee consider the development of a by-catch work plan that could include the development of standardised reporting metrics and risk assessment methods. However, the Working Group noted that unless the inconsistencies in the reporting of by-catch between vessels in exploratory fisheries are addressed, progress on the development of methods for providing management advice on by-catch within exploratory fisheries will remain problematic.

6.15 WG-FSA-18/28 provided a comprehensive report on fish by-catch during exploratory fishing activities undertaken in Divisions 58.4.1 and 58.4.2 from 2012 to 2018. The report presented details of temporal, spatial and bathymetric trends in species composition and CPUE. In addition, new information on the reproductive ecology and sex ratios of the most common by-catch species was presented. The Working Group encouraged Members to produce such studies on by-catch from other exploratory and research fishing activities.

6.16 WG-FSA-18/68, 18/69 and 18/70 reported on the spatial pattern of major by-catch fishes in Subarea 48.6 and Divisions 58.4.3a and 58.4.4b during 2012/13–2016/17. The Working Group noted that the research plan for these areas aims to develop estimates of key biological features of dependant species, and that there is enough information available in Subarea 48.6 to conduct estimates for the most common species listed in WG-FSA-18/70.

6.17 The Working Group noted that there were some inconsistencies between the C2 and observer datasets from Subarea 48.6 and Divisions 58.4.3 and 58.4.4 and asked for further clarification on whether the observer data was scaled-up or represented the sampling period only. The Working Group noted that in Divisions 58.4.3a and 58.4.4b the two vessels conducting research used different gear types and the effect of this on the reported distribution and density of by-catch species should be investigated further.

6.18 WG-FSA-18/25 reported on squaliform shark by-catch data between 2006 and 2016 from within Division 58.5.1. Four species of sharks were reported with *Etmopterus viator* comprising 99% of the total shark catch (by number). Catches of *Somniosus antarcticus*, *Centroscymnus coelolepis* and *Lamna nasus* were also reported. An abundance index (number of sharks per 1 000 hooks) was used to show differences in spatial and bathymetric distributions of these species. Biological data such as length frequency by sex were also presented for *E. viator*. A new identification sheet for sharks in Division 58.5.1 has been developed by Mr Gasco.

6.19 The Working Group thanked the authors for bringing the outcomes of these analyses to the Working Group and presenting this work as there has been little information or discussion in previous years on shark by-catch in this area.

6.20 The Working Group noted that a tagging study for *E. viator* could provide an estimate of biomass in the area if it is possible to release sharks alive and in good condition. The Working Group noted that methods have been developed to evaluate post-release survival for sharks which could be applied to *E. viator*.

6.21 The Working Group noted the presence of few localised hotspots of *E. viator* in the eastern and southeastern part of Division 58.5.1 which would need further investigation. The Working group noted that *E. viator* are small sharks and typically smaller than most toothfish caught by longline and suggested to investigate the effect of size and type of hooks on *E. viator* by-catch rate.

6.22 The Working Group noted that *L. nasus* distribution may be linked to changes in weather or sea temperature. It was also noted that catches of *L. nasus* and sleeper sharks had been reported across the Kerguelen Plateau in Division 58.5.2 as well as *L. nasus* in Subareas 48.3 and 58.7.

6.23 It was noted that *E. viator* was only described as a separate species in 2011, and that in other areas identification of several shark species groups (e.g. *Etmopterus* spp. and *Somniosus* spp.) can be difficult.

6.24 The Working Group requested that the Secretariat update the species codes used in the CCAMLR database as some species of shark (e.g. *S. antarcticus* and *E. viator*) have currently no specific codes for use in data reporting.

6.25 WG-FSA-18/63 presented a data summary of shark by-catch reported throughout the CAMLR Convention Area based on data held at the CCAMLR Secretariat to support discussions requested in CCAMLR-XXXVII/30. Shark by-catch between 1996 and 2017 by statistical subarea, Member and gear type was investigated. The paper noted that whilst there may have been an increase in the trend in shark by-catch over the last 10 years, there were substantial gaps and some inconsistencies throughout the dataset.

6.26 The Working Group noted the debate around the taxonomy of *Somniosus* spp. in the Convention Area (similar to the discussion started during WG-FSA-18/25). It was noted that the great longevity of *S. microcephalus* outlines the particular vulnerability of sleeper sharks to overfishing. It was also noted that species such as *L. nasus* are globally protected by initiatives by the United Nations General Assembly (UNGA), the ‘Convention on the Conservation of Migratory Species of Wild Animals’ (CMS) and the Convention on International Trade in Endangered Species (CITES).

6.27 The Working Group noted that shark species varied in their distribution range, that some have a global distribution and the Southern Ocean is likely to be at the southern limit of their range. It was noted that climate change may have an impact on species ranges, and this could be assessed by analysing changes of their biogeography and of spatial abundance data over time.

6.28 The Working Group noted that changes in by-catch reporting between vessels and over time made interpreting trends in reported shark by-catch difficult (paragraph 5.3). The Working Group noted that the CCAMLR ‘data warehouse’ plan and development and input from the DMG on metadata provision (Table 1) is intended to address these issues.

6.29 The Working Group suggested that the design of fishing gear such as hook size could be investigated for mitigation potential to reduce shark by-catch. The Working Group also discussed the feasibility of releasing large caught sharks (e.g. *Somniosus* spp.) alive, noting that they are sometimes dead upon hauling, wrapped in the longline. The Working Group recalled that when possible all sharks should be released alive in accordance with CM 32-18. It was also discussed that due to the size of *Somniosus* spp. and *L. nasus* it may not feasible to measure and retain them.

6.30 The Working Group noted that future studies aimed at assessing trends in shark abundance in the Southern Ocean should be considered in the context of their global biogeographic distributions. It was also recommended that biological data and genetic samples be collected where possible, as samples of rarer shark species are sought after by shark geneticists and may help resolve the species identity and stock structure of the *Somniosus* spp. caught in the Convention Area.

6.31 To assist in improving the submission of adequate and sufficient data on sharks, the Working Group recommended:

- (i) consider the value of the catch information recorded as numbers in addition to weight and how it could potentially be used or improved toward understanding the status and trends of shark species in the Convention Area
- (ii) to assist in species identification issues, various guides on shark ID should be collated and made available by the Secretariat to all vessels and scientific observers
- (iii) a review of historical records on sharks submitted to the Secretariat should be undertaken to identify errors. Further, the Scientific Committee and Commission, working with the Secretariat, vessel operators and scientific observers, should explore mechanisms to improve the quality of future data collection on sharks
- (iv) exchange of information with regional fisheries management organisations (RFMOs) adjacent to the Convention Area to facilitate the development of biogeographic analysis of present and assumed future distribution of sharks in the Convention Area and adjacent areas and to put CCAMLR fisheries shark by-catch in context.

Status and trends in finfish by-catch

6.32 WG-FSA-18/38 outlined an analysis of previous *Amblyraja georgiana* tagging within Subareas 88.1 and SSRUs 882A–B. The paper provided Chapman biomass estimations for the period 2010 to 2018 (excluding 2012) ranging between 3 257 and 11 685 tonnes with CVs between 0.32 and 0.42. Sustainable exploitation rates were estimated for both a low and a high productivity scenario and suggested that the gammas for *A. georgiana* were 1.6% and 2.8%

respectively. The estimated exploitation rate for *A. georgiana* in Subareas 88.1 and SSRUs 882A–B, based on Chapman estimates, was estimated to be between 0.2% (assuming all released skates survived) and 0.6% (assuming all released skates had 100% mortality).

6.33 The authors suggested performing a second two-year focussed tagging program within this area in the 2019/20 and 2020/21 seasons, broadly consistent with the previous tagging period in 2009 and 2010. They also suggested some additional data collection associated with the tagging, such as tag-releasing skates in all conditions but noting their injuries to estimate associated mortality rates and including an age validation study (see Gallagher and Nolan, 1999) using chemical marking of released skates. The authors further noted a large proportion (50%) of tagged skates should be marked to chemically label thorns for age validation studies (Gallagher and Nolan, 1999). Marking kits could be provided to vessels notifying to fish in the Ross Sea region for the 2019/20 fishery. At recapture, skates would be biologically sampled for disc width, sex and caudal thorns. Caudal thorns could be coordinated to be shipped to National Institute of Water and Atmospheric Research (NIWA) in New Zealand for analysis.

6.34 The Working Group noted that interpretation of ages using thorns in skates was difficult, and that skate vertebrae have also been used to determine ages. The Working Group encouraged further research to compare ageing approaches and ageing validation for skates using thorns and vertebrae.

6.35 The Working Group noted that compared to the previous tagging experiment, the fishery now has a higher proportion of effort in areas where *A. georgiana* occur. However, the Working Group noted that a large portion of this species' distribution was also within the general protection zone (GPZ) of the RSRMPA.

6.36 The Working Group agreed that a second focused tagging program be conducted in 2019/20 and 2020/21 in the Ross Sea region and recommended:

- (i) the skate tag-release program be conducted for a minimum of a two-year period, during which an evaluation is conducted as to the benefit of continuing as an ongoing measure
- (ii) the tagging rate be all live skates up to 15 per line
- (iii) the area of the program be limited to the exploratory fishery in Subareas 88.1 and SSRUs 882A–B
- (iv) the e-longline logbook be updated to include a column with dropdown menus to record skate condition, the guide to the injury assessment (described in WG-FSA-18/38, Figure 6, Figure 6 of this report) be added to the e-longline skate tagging instructions, and the suitability assessment guide in the skate tagging protocols be updated for Subarea 88.1 and SSRUs 882A–B to include the injury assessment
- (v) chemical marking be on a voluntary basis with interested Members working with New Zealand to co-ordinate the methodology (see details in WG-FSA-18/38 Rev. 1)
- (vi) sampling protocols for age structures to be collected will be developed intersessionally in time for the 2019/20 season

(vii) CMs 41-01 and 41-09 be updated this year to include the tagging requirements for this program for the 2019/20 and 2020/21 seasons. Specifically, a new paragraph be added to CM 41-01, Annex 41-01/C after paragraph (v):

'During the 2019/20 and 2020/21 seasons, each longline vessel operating in Subareas 88.1 and SSRUs 882A–B shall tag and release by-caught skates according to the CCAMLR Tagging Protocol, as specified in the conservation measure for that fishery. All tagged skates must be double-tagged and released alive.'

(a) And paragraph (ix) be updated to read:

'Recaptured tagged skates should be identified to the lowest possible taxonomic level and biologically sampled (pelvic length and disc width, weight, sex, gonad stage, and caudal thorns for samples in Subareas 881 and SSRUs 882A–B). Two electronic time-stamped photographs should be taken, one of the whole skate with tag attached and one close-up of the tag detailing the number and colour of the tag.'

(b) And CM 41-09 paragraph 6, a paragraph stating:

'All live skates, irrespective of condition and up to a maximum of 15 per line, shall be tagged following CM 41-01, Annex 41-01/C. Skate, and the species, disc width and injury category should be recorded along with tag numbers.'

(c) Inserted before the following paragraph:

'Unless otherwise specified by scientific observers, all other skates and rays caught alive and with a high probability of survival should be released alive, by vessels, by cutting snoods, and when practical, removing the hooks, and the number should be recorded and reported to the Secretariat.'

(viii) The Secretariat make S-series t-bar tags available for this program and make them available to be ordered.

6.37 WG-FSA-18/73 presented work on the genetics of the skates *A. georgiana* within Subarea 48.3. Previous studies indicated that there may be three *Amblyraja* species in this region, including two morphs of *A. georgiana* (WG-FSA-02/54) and *A. taaf*. This paper examined the genetic relationships between the two species and two morphs and concluded that while there are clear morphological differences between *A. georgiana* and *A. georgiana* sp. anon, at genetic level, location is more indicative of species than morphology. The paper highlighted that a low level of mixing of the *Amblyraja* populations between Subareas 48.3 and 48.4 may occur.

6.38 The Working Group noted that based on these results, to facilitate the work of scientific observers in Subareas 48.3 and 48.4 (see also WG-FSA-18/27), the species identification for *Amblyraja* could be limited to the generic *Amblyraja* spp. code (SRX), as this species seems to have a number of morphotypes.

6.39 WG-FSA-18/27 provided an update on stock status of *A. georgiana* in Subarea 48.3. This is a by-catch species in the longline *D. eleginoides* fishery. The update used a Chapman estimated biomass to explore trends in biomass of this species. The biomass estimates ranged from 73 to 1 664 tonnes with fishery exploitation rates ranging from 0.6 to 3.12% with a mean

of approximately 1%. Based on movement of tag recaptures it is assumed that this area is a single stock. The overall trend of both biomass estimates and exploitation rate is stable across the time series, indicating there is a low impact on this species from the *D. eleginoides* fishery in this area.

6.40 The paper also highlighted that there is large variation in species identification of skates, which was linked to observer experience in this region. Using morphometrics (wingspan to length ratio) allows post-hoc classification of unidentified skates into the two dominant species groups *Amblyraja* spp. and *Bathyraja meridionalis*, and to flag any unusual species identifications. This method can also be used to check observers' identification skills comparing experienced observers with newer observers. The paper further outlined how this method allowed for the reclassification of tag releases and recaptures to validate data used for the Chapman estimates.

6.41 The Working Group noted the relatively large and constant amount of tag recaptures over time in this long-term tagging program. The working group recalled discussion about a designated by-catch workshop and highlighted this may be a good option for exploring the combination of these biomass estimates with skate removals to ensure limits are consistent with Article II.

6.42 The Working Group noted that based on the information around morphology presented in these two papers, region-specific by-catch guides would assist in species identifications better than Convention Area wide by-catch guides.

6.43 WG-FSA-18/10 provided an update on fish by-catch within the krill fishery. The paper highlighted the increase of fish by-catch reported in the C1 data provided by vessels in relation to species identified by observers, noting this season is still incomplete. The paper highlighted that between the improved by-catch reporting and the confidence in SISO species identifications (WG-EMM-18/30), there are now sufficient data available to explore the factors associated with observed by-catch distributions.

6.44 The Working Group noted that there will be a requirement for 100% observer coverage in the krill fishery after 2020, this could result in more data in future. It also noted that some Members had implemented 100% coverage since 2014.

6.45 The Working Group recalled the discussion on WG-FSA-18/14 (paragraphs 6.1 to 6.7) and recommended a similar analysis be undertaken within the krill fishery exploring the effects of Member and gear type on by-catch reporting.

6.46 The Working Group requested that the Scientific Committee note that it is currently not possible to provide an impact assessment for the krill fishery on finfish populations until previous concerns relating to reporting on continuous fishing system trawl vessels are addressed (SC-CAMLR-XXXVII, Annex 7, paragraph 6.2).

Risk assessment methods for finfish by-catch

6.47 The Working Group recalled that in the history of CCAMLR, a range of methods have been used to assess the risk of impact to non-target species within the wider ecosystem. The Working Group discussed (i) how to prioritise the species which should be assessed, and (ii) what is expected to be in these assessments.

6.48 The Working Group noted that Article II requires advice on related species and that some conservation measures are in place for some non-target species. The Working Group also noted that a number of these conservation measures relating to by-catch species may be based on outdated information, or adopted as precautionary measures until information became available, and encouraged Members to provide updates where new data exists.

6.49 Noting CCAMLR's approach to by-catch of (i) avoidance, (ii) mitigation, and (iii) the setting of sustainable by-catch limits if mortality is not preventable, the Working Group requested the Scientific Committee clarify whether region-specific by-catch limits should be considered, and whether the catch limits based on a percentage of by-catch versus target species currently in place satisfy the requirements under Article II.

6.50 The Working Group noted there are a range of methods used in fisheries around the world available for assessing the risk of impact to a species from a fishery where limited data is available such as the SAFE method (Zhou and Griffiths, 2008) and suggested these could be explored as options for the less common and/or data-poor by-catch species. It also considered that trends in by-catch over time could be included in the Fishery Report (paragraphs 2.28 to 2.33).

6.51 The Working Group further noted that effects on a by-catch species are not just by removals but also through changes to the wider ecosystems driven by the removal of target species which can lead to effects such as predation release and consequential changes to species composition.

6.52 The Working Group noted that the Scientific Committee had requested a focus topic on by-catch for WG-FSA-18, however, as by-catch is a significant ongoing issue for CCAMLR it requested the Scientific Committee consider allocating time to the further development of risk assessments for non-target species in the Convention Area.

Incidental mortality of seabirds and marine mammals

6.53 The Secretariat provided an update on incidental mortality of seabirds and marine mammals in CCAMLR fisheries during 2017/18 (WG-FSA-18/13 Rev. 1). The paper summarised incidental mortality associated with fishing activities collected in scientific observer and vessel data during 2017/18 as received by the Secretariat up to 8 October 2018.

6.54 This paper presented incidental mortality numbers for longline fisheries in which seabird mortalities have been reported. The extrapolated total of 87 birds killed is the lowest on record. This reduction has been most noticeable in the French exclusive economic zone (EEZ) fisheries (Division 58.5.1 and Subarea 58.6) where mortalities have shown a 95% reduction over the same period. One marine mammal mortality was observed during longline fishing in Division 58.5.2; a southern elephant seal (*Mirounga leonina*) was recovered entangled in the main line.

6.55 The 11 krill vessels operating in Subareas 48.1, 48.2 and 48.3 reported one seabird mortality and 19 marine mammal mortalities. For some of these cruises the observer data have yet to be received as the observers have not yet returned to their home port.

6.56 The 19 Antarctic fur seals (*Arctocephalus gazella*) caught in 2018 represent a sudden increase as only one mortality has been recorded since 2013. However, as 18 of the 19 mortalities were reported from one vessel, this indicates that this is likely to be a vessel-specific, rather than a fishery-wide issue. As the Secretariat is yet to receive the observer data for the cruises where the mortalities occurred the Working Group requested further details on this incident when they are available.

6.57 The Working Group noted that the relevant conservation measures (CMs 51-01 to 51-03) contain the requirement for a marine mammal exclusion and that the specification for the device is part of the requirement in CM 21-03, Annex 21-03/A. The Working Group noted that an analysis of these designs could provide a better understanding of the operation of mitigation devices and procedures in relation to reported mortalities. The Working Group also noted that there are currently no by-catch limits specified for the krill fishery.

6.58 The Working Group noted that there was considerable interannual variation in reported seabird mortalities by area and that some of this variation was likely a result of interpolation. Large mortality events at a single vessel scale also contributed to this variation.

6.59 The Working Group thanked the Secretariat for the paper and recommended that in future the information in WG-FSA-18/13 Rev. 1, Table 2, include an additional category for observed mortality in addition to the extrapolated mortality and the observed mortality rate, as in some areas observers reported all seabird mortalities from each line.

6.60 The Working Group recalled WG-EMM-18/33 which discussed potential interactions and competition between the krill fishery and krill-dependent predators during fishing operations. The Working Group noted that while reporting of incidental mortality of seals was required, there was no requirement for other marine mammal interactions with gear or fishing vessels to be reported. It was therefore not possible to understand at the scale of the entire Convention Area how marine mammal mortalities relate to the potential overlap between vessels and marine mammal activities.

6.61 WG-FSA-18/57 reported on fishing effort and seabird interactions during the season extension trials in the longline fishery for *D. eleginoides* in Division 58.5.2. The Commission endorsed three trial season extensions for this statistical division (CCAMLR-XXXIV, paragraph 5.68). Australia undertook to report annually on the results of all the trials. This paper presented information on fishing effort and seabird interactions with fishing gear collected during the periods of 1–14 November 2017, 15–30 November 2017, 1–14 April 2018 and 15–30 April 2018. The Working Group noted that the conditions set in WG-FSA-15/48 for the conclusion of the trial season extensions have now been met in all three trials and that a full analysis of all season extension trials, with complete data up until the end of the current fishing season, will be presented to WG-FSA-19.

6.62 The Working Group noted a proposal by Norway to trial the use of a third wire on krill trawl vessels that was approved by the Scientific Committee (SC-CAMLR-XXXV, paragraphs 4.10 and 4.11). The Scientific Committee recommended that a one-season trial be carried out with the proposed design on any krill trawl vessel using a net monitoring cable, and that results of these trials be reported to the Scientific Committee to further evaluate the safety of the use of this cable. The Working Group noted that the time for this exemption had now expired and that no report had been received on the trial.

Invertebrate by-catch and VMEs

6.63 WG-FSA-18/23 provided a report on recent catches of sea pens (*Pennatulacea*) in Division 58.4.4b from research activities in 2018. The Working Group noted the request by WG-SAM to further review information on the locations and amount of catch of 44.49 kg of this taxon described in WG-SAM-18/31 (Annex 6, paragraph 6.43).

6.64 The Working Group noted that further analysis of the weight of the four morphotypes of sea pens from longline sets in Division 58.4.4b, when standardised to 1 000 hooks, did not meet the threshold of VME indicator units as specified in CM 22-07. It was further noted that the spatial distribution of sea pen densities was heterogeneous, with a peak concentration in the eastern part of research block 5844b_2, and a low density over the rest of Division 58.4.4b on Lena Bank.

6.65 Noting that sea pens are relatively small and therefore a light VME indicator taxa in terms of weight, the Working Group agreed that it would be worthwhile reviewing appropriate thresholds for these light taxa and other VME indicator taxa to determine whether the thresholds as set out in CM 22-07 remain appropriate. The Working Group further noted that it would be useful to review the sea pen taxa from previous research cruises in the region, as the large number of sea pens may represent a gear-specific effect between trotlines and autolines.

6.66 The Working Group noted that previously the application of CM 22-07 in research fishing in closed areas, conducted under CM 24-01 was unclear. However, it noted that conservation measure exemptions in accordance with CM 24-01 shall now explicitly be specified in CM 24-05.

6.67 WG-FSA-18/51 provided a preliminary report on invertebrate by-catch in research blocks in Divisions 58.4.1, 58.4.2, 54.4.3a and 58.4.4b for the 2013/14 and 2017/18 seasons. The Working Group noted that more diverse VME communities were shown in research blocks 5841_2–5, whilst research block 5844b_1 and Division 58.4.3a had higher catches, with lower diversity. It was again noted that potential gear effect on VME indicator taxa capture with trotlines only yielding <1% of the total VME indicator taxa catch, although further work is needed to confirm this. The authors suggested that an index of taxonomic diversity and specimen counts could be developed and considered as an indicator of a VME.

6.68 The Working Group welcomed the analysis of VME data in this region, and noted that there may be some difficulty reconciling observer data on line segments with C2 catch and effort data, and that in some cases position errors in line segment data from C2 forms have also been shown to be an issue. The Working Group suggested these could be starting points for refining analyses and developing advice on this topic. The Working Group also noted that using an index of diversity for analysing VME data could be considered further, while bearing in mind that data are often collected at a phylum level, which would underrepresent the true diversity.

6.69 The Working Group recalled WG-EMM-12/51, which proposed a differentiating diversity threshold of VME indicator taxa to trigger VME move-on rules. WG-EMM had recommended that more work on this topic be undertaken to advance scientific advice toward future refinement of CM 22-06 and CM 22-07.

6.70 The Working Group agreed that a greater understanding of the gear efficiency and how repeated sampling can be used over time to detect benthic features, size of habitats and patch distributions for VME communities would be useful, noting that a small number of sets in an area is unlikely to give a reliable estimate of VME community structure and spatial variability. Analysis of all available data sources in aggregate including any available video monitoring data would allow more accurate maps of where communities exist to be developed.

6.71 The Working Group noted that conservation measures relating to VMEs (particularly CM 22-07) have not been reviewed for several years and asked the Scientific Committee to develop a plan to evaluate these measures.

Marine debris

6.72 Following the request from WG-FSA-17 (SC-CAMLR-XXXVI, Annex 7, paragraph 8.4), the Secretariat presented an analysis of gear loss by fishing vessels in the Convention Area as contribution to the marine debris monitoring program (WG-FSA-18/17). Gear loss was analysed using data on hooks lost as reported by fishing vessels in the haul-by-haul C2 data form. The Secretariat highlighted the differences in rates of reported gear loss and proportions of line lost between statistical areas and over time, noting that the results may reflect differences in the interpretation and implementation of gear loss reporting requirements. The Secretariat recommended a modification to the C1 form to include reporting of gear loss, and clarification of the definition of ‘hooks lost attached to sections’ and ‘other hooks lost’ in the C2 form to reduce reporting discrepancies.

6.73 The Working Group thanked the Secretariat for its work and recommended that the requirements for reporting gear loss be clarified, including the removal of ‘other hooks lost’ from the C2 form, and that the Scientific Committee consider modifying the C1 data form to incorporate reporting of gear loss by trawl vessels.

6.74 The Working Group recommended that future work on fishing gear loss consider the following:

- (i) the correlation between gear type and rates of gear loss
- (ii) consideration of the retrieval of lost gear in estimates of cumulative gear loss
- (iii) further analysis of the relationship between the numbers of hooks reported lost and the extrapolated length of line lost to investigate trends between variables
- (iv) the effect of the presence of sea-ice as a potential indicator of high risk gear loss areas.

6.75 The Secretariat presented an update on the CCAMLR marine debris monitoring program (WG-FSA-18/18), including a summary of data holdings. The Working Group acknowledged that this is one of the longest time series within the CCAMLR dataset and encouraged more Members to participate in monitoring and data collection.

6.76 The Working Group considered debris levels over time and noted the clear decline in observed marine debris since the implementation of the program in 1989, suggesting the efficacy of conservation measures in place.

6.77 The Working Group recommended that potential opportunities for engagement with other organisations, such as the Committee for Environmental Protection (CEP) or the Council of Managers of National Antarctic Programs (COMNAP), be further considered in order to increase the scope of the marine debris program in the Antarctic.

Future work

Organisation of intersessional activities

7.1 The Working Group recommended that an e-group focused on the collection, formatting and use of by-catch data be created during the intersessional period, and its activities reported to WG-FSA-19.

7.2 The Working Group recommended that an e-group focusing on CPUE standardisation methods be created during the intersessional period in order to summarise the different approaches used by the different Members and to produce a list of recommended approaches according to the characteristics of the available data, fishing gear and aim of the research, and its activities reported to WG-SAM-19 and WG-FSA-19.

7.3 The Working Group agreed that the proposed survey in the Ross Sea MPA SRZ (WG-FSA-18/33 Rev. 1) required additional consideration prior to implementation. It requested that the Scientific Committee consider mechanisms that would advance the development of a statistically robust sampling design that would address the objectives of the proposal within the SRZ.

7.4 The Working Group noted that PSATs can provide useful information (e.g. WG-FSA-18/22), but are expensive and still have a high failure rate. The Working Group recommended a focused workshop on PSAT specifications and best practices be held to improve their functionality, reliability of data and success rate.

Notifications of other scientific research

7.5 The Working Group noted the notification submitted by New Zealand (SC CIRC 18/01), indicating the intent to contribute research towards the Research and Monitoring Plan for the RSRMPA, including ecosystem and fish surveys (WG-EMM-18/02) as well as oceanic buoys deployed as part of international research collaborations.

7.6 The Working Group noted the notification submitted by Germany (SC CIRC 18/43), indicating the intent to deploy vertical longlines in Subareas 48.6 and/or 48.5 to sample *D. mawsoni* in order to test population hypotheses, better understand the species' ecological role in the Weddell Sea and to demonstrate the ability of scientific research vessels such as the RV *Polarstern* to conduct such sampling.

7.7 The Working Group noted the notification submitted by Australia (SC CIRC 18/58), indicating the intent to conduct research in Division 58.4.1 and Subarea 88.1 focusing on krill and its predators. Dr Ziegler also notified the Working Group that Australia plans to conduct its annual random stratified trawl survey in Division 58.5.2 in 2019.

7.8 The Working Group noted the notification submitted by the UK (SC CIRC 18/63), indicating the intent to conduct research on icefish (Subarea 48.3) and krill in the South Sandwich Islands, including the use of deep-water cameras for benthic work combined with genetic information to inform connectivity across these islands.

Other business

Weddell Sea MPA (WSMPA) Proposal

8.1 WG-FSA-18/08 Rev. 1 presented revisions made from the first submission of the Weddell Sea MPA (WSMPA) proposal to the Commission in 2016 (CCAMLR-XXXV/18). An additional area at the east coast of the Antarctic Peninsula had been included and the depth delineation of the adult *D. mawsoni* habitat had been revised to 550–2 100 m in the light of the habitat analyses and modelling presented at WG-SAM-17 (WG-SAM-17/30). Additionally, the harmonisation of the management plan and the research and monitoring plan with the RSRMPA (CM 91-05) had been carried out to the extent possible. Both the management plan and the research and monitoring plan for the proposed WSMPA also now reflect the outcomes from the WS-DmPH-18 (see WG-SAM-18/33 Rev. 1).

8.2 The Working Group noted that the work presented had addressed the advice from WG-SAM-18 (Annex 6, paragraphs 8.1 to 8.6) and WS-SM-18 (Annex 7, paragraphs 3.61 to 3.65), on the identification and establishment of potential unfished scientific reference areas (SRA) outside the existing fisheries research blocks in Subarea 48.6, particularly the suitability of each parameter in terms of high, medium and low for 5° longitude segments in Subarea 48.6.

8.3 The Working Group noted that the inclusion of SRA within the WSMPA proposal would be a valuable addition to enable research into whether longline fishing for *D. mawsoni* had wider ecosystem and trophic impacts. The Working Group further noted the two locations in the adult toothfish habitat of Subarea 48.6 suggested in WG-FSA-18/08 Rev. 1 had been identified as most suitable for establishment of SRA, inter alia based on their similarity to areas within the current fishery: one in the sector between 20°–15°W (i.e. between Subarea 48.5 and the fisheries research block 486_5) and a second one in the sector between 10°–15°E on Astrid Ridge, north of the fisheries research block 486_4.

8.4 The Working Group noted the offer from Germany for accommodating 20 scientists from CCAMLR Members on each of two research cruises to be undertaken in the first 10 years after the adoption of the WSMPA.

Catch and effort mapping

8.5 WG-FSA-18/43 presented a method to produce high-resolution maps of effort and catches in longline fisheries. The Working Group noted the method provided significant advances over methods that only used longline midpoints and recalled WG-FSA-12/55 and WG-FSA-14/P06 which also presented methods of spatially mapping catch and effort data. The Working Group thanked the authors for their offer to share the code with interested Members.

Weird leech

8.6 WG-FSA-18/P01 presented features on a new species of weird deep-sea leech found parasitising Whitson's grenadier (*Macrourus whitsoni*) in the Ross Sea. The paper described morphological features and phylogenetic relationships with similar taxa. The Working Group was thrilled with the new discovery and expressed its appreciation to the authors of the study.

Otolith library

8.7 Following the request from Members (SC-CAMLR-XXXVI, paragraph 4.98) the Secretariat demonstrated an online otolith library to the Working Group. The Working Group thanked the Secretariat for the development and noted the utility of the resource for training purposes.

8.8 The Working Group agreed that the otolith library should be a public access site and recommended the addition of the following features:

- (i) extra metadata fields to accommodate fish serial numbers and methods used to age otoliths
- (ii) standardised image resolutions and readability index criteria
- (iii) training and validation sets of images for instructing otolith readers.

8.9 The Working Group recommended that the Secretariat develop a database that contains ageing data, metadata, reference sets and readings thereof, to store data collected by multiple Members conducting age readings. The Working Group noted that a potential database structure was developed at the *Dissostichus* Ageing Workshop (SC-CAMLR-XXX, Annex 7, paragraphs 10.1 to 10.19 and in WG-FSA-12/43). The Working Group requested the Secretariat to correspond with those Members engaged in otolith ageing to determine how to integrate this data into the existing CCAMLR database.

Whale depredation research

8.10 The Working Group welcomed a presentation by Dr P. Tixier (Australia) on his current research on orca and sperm whale depredation across Patagonian toothfish fisheries in the CCAMLR Convention Area and adjacent waters. This research aims at assessing the implication of depredation on fish stock management and developing new mitigation measures. Dr Tixier invited other members to contribute to this project by sharing data (whale sightings, photos, etc.), and noted that he intends to present more research outcomes to future meetings of WG-FSA.

Advice to the Scientific Committee

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

- (i) IUU fishing activity –
 - (a) fishing prior to the start of the fishing season negatively impacting assessments (paragraph 2.3)
 - (b) estimation of IUU removals across the Convention Area (paragraph 4.96)
 - (c) data collection protocols to report effort, catch and biological data for recovered IUU fishing gear (paragraph 4.97).
- (ii) Catch and effort data collection –
 - (a) indications of intention to fish (paragraph 2.6)
 - (b) clarity required on how incomplete hauls at the end of a reporting period should be reported in catch and effort forms (paragraph 2.18).
- (iii) De-identification of vessels in VMS data –
 - (a) review the requirement of CM 10-04, Annex 10-04/B to allow testing of the approach for the early season closure mechanism (paragraph 2.23).
- (iv) Catch limit management –
 - (a) procedure for forecasting closure of exploratory fisheries, especially in Subareas 88.1 and 88.2 (paragraphs 2.21 and 2.26).
- (v) Assessments –
 - (a) catch limit for *C. gunnari* in Subarea 48.3 (paragraph 3.8)
 - (b) catch limit for *C. gunnari* in Division 58.5.2 (paragraph 3.15)
 - (c) catch limit for *D. eleginoides* in Subarea 48.3 (paragraph 3.22)
 - (d) catch limit for *D. mawsoni* in Subarea 48.4 (paragraph 3.27)
 - (e) catch limits for *D. mawsoni* in Subarea 88.1, including shelf survey (paragraphs 4.144, 4.145 and 4.150).
- (vi) Ross Sea region –
 - (a) winter survey proposal (paragraphs 4.143 and 4.144, Table 7)
 - (b) shelf survey continuation (paragraphs 4.147 to 4.151, Table 7)
 - (c) research in SRZ of the RSRMPA (paragraph 4.161 and Table 7).
- (vii) Subarea 88.2 –
 - (a) requirement for research plans in notifications for the exploratory fishery in Subarea 88.2 (paragraph 4.174)

- (b) catch limits for *D. mawsoni* in individual research blocks (paragraphs 4.176 and 4.178).
- (viii) Research fishing including data-poor fisheries for *Dissostichus* spp. –
 - (a) proposed catch limits for research blocks based the trend analysis using the last 5 years of data (paragraphs 4.5 and 4.8)
 - (b) review the requirement in CM 21-02 for a data collection plan and a fishery operation plan in notifications that require a research plan (paragraph 4.21)
 - (c) standardisation of notification of research timeframes (paragraph 4.23)
 - (d) review the objectives and provisions of CM 24-01 given differences in interpretation (paragraph 4.26)
 - (e) review the need to review research plans in both WG-SAM and WG-FSA (paragraph 4.25)
 - (f) review the objectives, priorities and definitions of data-poor exploratory fisheries (paragraph 4.19)
 - (g) research fishing in Subarea 48.1 (paragraphs 4.43 to 4.54, Table 5)
 - (h) research fishing in Subareas 48.2 and 48.4 (paragraphs 4.61 and 4.68)
 - (i) research fishing in Subarea 48.6 (paragraphs 4.5, 4.74, 4.85 and 4.92, Table 5)
 - (j) research fishing in Divisions 58.4.1 and 58.4.2 (paragraph 4.119, Table 6)
 - (k) research fishing in Division 58.4.3a (paragraphs 4.127 and 4.128, Table 6)
 - (l) research fishing in Division 58.4.4b (paragraphs 4.136 and 4.137, Table 6)
 - (m) research fishing in Subarea 88.3 (paragraphs 4.189 to 4.199, Table 7).
- (ix) Other fisheries research –
 - (a) consideration of crab research fishing in Subarea 88.2 (paragraphs 4.209 and 4.217)
 - (b) design of acoustic surveys to assess the distribution of fish (paragraph 4.221)
 - (c) krill larvae identified in zooplankton data collected during research fishing samples (paragraph 4.237).
- (x) Non-target catch and interactions in CCAMLR fisheries –
 - (a) by-catch reporting instructions (paragraph 6.4)

- (b) development of a by-catch work plan (paragraph 6.14)
- (c) mechanisms to improve data collection on sharks (paragraph 6.31)
- (d) proposed changes to CMs 41-01 and 41-09 (paragraph 6.36)
- (e) the inability to assess the impacts of the krill fishery on finfish populations (paragraph 6.46)
- (f) consideration of region-specific by-catch limits (paragraph 6.49)
- (g) allocating time to the further development of risk assessments for non-target species (paragraph 6.52)
- (h) review of VMEs and the implementation CMs 22-06 and 22-07 (paragraph 6.71)
- (i) modifications to C1 form to report gear loss (paragraph 6.73).

Close of the meeting

10.1 At the close of the meeting Dr Welsford thanked all participants for their patience and hard work that had allowed the Working Group to make significant progress in addressing the priorities of the Scientific Committee. He also thanked the rapporteurs and the Secretariat for their efficiency and support throughout the meeting.

10.2 On behalf of the Working Group, Mr Somhlaba thanked Dr Welsford for his even-handed guidance of the Working Group and his ability to keep the meeting focussed and to keep everyone entertained.

References

- Aronson, R.B., K.E. Smith, S.C. Vos, J.B. McClintock, M.O. Amsler, P.O. Moksnes, and J.C. Schiferl. 2015. No barrier to emergence of bathyal king crabs on the Antarctic shelf. *P. Natl. Acad. Sci. USA*, 112 (42): 12997–13002.
- Belchier, M., T. Peatman and J. Brown. 2012. The biology, ecology and development of fishery management advice for the anomuran crabs at South Georgia (CCAMLR Subarea 48.3). *CCAMLR Science*, 19: 1–15.
- Eleaume, M., C. Chazeau, A. Martin and J. Blettry. 2018. Preliminary report on invertebrate by-catch in research blocks 58.4.1, 58.4.2, 54.4.3a and 58.4.4b. Document *WG-FSA-18/51*. CCAMLR, Hobart, Australia: 11 pp.
- Gallagher, M. and C.P. Nolan. 1999. A novel method for the estimation of age and growth in rajids using caudal thorns. *Can. J. Fish. Aquat. Sci.*, 56 (9): 1590–1599.

- Griffiths H.J., R.J. Whittle, S.J. Roberts, M. Belchier and K. Linse. 2013. Antarctic Crabs: Invasion or Endurance? *PLoS ONE*, 8 (7): e66981.
- Kasatkina, S. 2016. Integrated analysis of the by-catch data in the Ross Sea toothfish fishery. Document *WG-FSA-16/13 Rev. 1*. CCAMLR, Hobart, Australia: 36 pp.
- Kasatkina, S. 2017. Analysis of the toothfish fishery indices in Subareas 88.1 and 88.2 when using different types of longline gears. Document *WG-SAM-17/23*. CCAMLR, Hobart, Australia: 24 pp.
- Smith, C.R., L.J. Grange, D.L. Honig, L. Naudts, B. Huber, L. Guidi and E. Domack. 2012. A large population of king crabs in Palmer Deep on the west Antarctic Peninsula shelf and potential invasive impacts. *Proc. Biol. Sci.*, 279 (1730): 1017–1026.
- Yates, P., P. Ziegler, P. Burch, D. Maschette, D. Welsford and S. Wotherspoon. 2017. Spatial variation in Antarctic toothfish (*Dissostichus mawsoni*) catch rate, mean weight, maturity stage and sex ratio across Divisions 58.4.1, 58.4.2 and 58.4.3b. Document *WG-FSA-17/16*. CCAMLR, Hobart, Australia: 30 pp.
- Zhou, S. and S.P Griffiths. 2008. Sustainability Assessment for Fishing Effects (SAFE): A new quantitative ecological risk assessment method and its application to elasmobranch by-catch in an Australian trawl fishery. *Fish. Res.*, 91: 56–68.

Table 1: WG-FSA priorities for consideration by the Data Management Group.

| Topic | Priority |
|---|--|
| Section A – Mandatory data collection under CCAMLR and CCAMLR conservation measures | |
| Data type examples: Catch and effort data (C1, C2, C5 etc.), in-season reporting (5-/10-day reporting, monthly reporting, daily reporting), Scheme of International Scientific Observation (SISO) observer data, activity notifications | |
| 1. Assuring the quality of the formally required data that is submitted by Members and vessels to the CCAMLR Data Centre (C1, C2, etc. and observer data forms) | |
| (i) Development and management of required data submission form versions | High – but need to link to timeframe (see 1iv) |
| (ii) Development of standard data instructions and manuals for data submission and collection, including version management of these instructions and manuals; development of standard metadata information | High |
| (iii) Development and documentation of data validation and data correction algorithms to be used to assure quality prior to data submission to the CCAMLR Data Centre | Medium |
| (iv) Development of timeline and priorities for incoming data workflow, integration into Data Warehouse timeframe and in discussion with Members | High |
| (v) Development of standard data APIs for data collection/submission that work alongside Excel spreadsheets to allow Members to generate data submissions directly from generalised or in-house software | Low |
| 2. Timelines for revisions of required data and data formats | |
| (i) Timelines for the review of data collected (including trade-offs with existing data collection, versioning, technology aides/automation, timing) by CCAMLR for all required data | Medium |
| (ii) Development of standard timelines for the post-submission revision and correction of errors of data submitted to the CCAMLR Data Centre; focus on development of default processes to streamline this point | Medium |
| Section B – Additional data not mandatory through conservation measures | |
| Data type examples: Research plan data, CEMP data, age-length data, otoliths, krill acoustic data | |
| 3. Assuring the availability and quality of data submitted by Members that are not required to be submitted to the Secretariat (e.g. age or otolith data, age-length data) | |
| (i) Development and management of non-required datasets held by the CCAMLR Data Centre (e.g. research plan additional data collection, age data, otoliths readings) | High |
| (ii) Description of data collection forms, instructions and manuals used to collect these data, including version management, of data held by the CCAMLR Data Centre; development of a single repository/website for data collection version control that allows to cross-reference to collected data retrospectively | Medium |
| Note – an example is the <i>Data Collection Manual</i> from 1999, now mostly translated into Column A of C1/C2 forms | |
| (iii) Development and documentation of data validation and data correction algorithms used by the CCAMLR Data Centre; primarily led/driven by Members for data not required through CCAMLR conservation measures | Low |

(continued)

Table 1 (continued)

| Topic | Priority |
|--|----------|
| Section C – Processes for all data types post submission | |
| 4. Post-submission data validation, algorithms and subsequent data correction | |
| (i) Documentation of data loading/verification rules and processes, including versioning of these data, used to assure quality by the CCAMLR Data Centre when loading submissions | Medium |
| (ii) Documentation and improvement of tag-matching methods and algorithms used by the CCAMLR Data Centre, including version control; task is critical to toothfish management | High |
| (iii) Post-submission error correction processes, including consideration of potential corrections by Members who analyse data held by the CCAMLR Data Centre | Low |
| 5. Data access and extracts | |
| (i) Standard database documentation, extract formats, tables included, secure access methods for required and non-required data that is released by the CCAMLR Data Centre | High |
| (ii) Development of timelines for improvement and revisions to data extract documentation and formats of data released by the CCAMLR Data Centre | High |
| (iii) Standard documentation of data requests to the Data Centre: | |
| (a) data requests in relation to the work of CCAMLR and its working groups, including information on use | Medium |
| (b) data requests to the Data Centre not in direct relation to the work of CCAMLR and its working groups, including information on use | |
| 6. Data visualisation | |
| (i) Development of tools to explore data, integration of online geographic information system (GIS), links to larger projects such as any marine protected area research and monitoring plans (MPA RMPs) for data and summaries of data held by the CCAMLR Data Centre | Low |
| 7. Data communication | |
| (i) Consistent development and documentation of standard and automated reporting for internal and external reporting of data held by the CCAMLR Data Centre: | |
| (a) internal reporting, e.g. repeated requests from the Working Groups to the Secretariat during meetings should be automated where sensible which is a priority for WG-FSA | Medium |
| (b) further development of external reporting (Fishery Reports) is not a high priority to WG-FSA. However, a priority is to ensure that Fishery Reports are self-contained. Data communication could be improved in the process of automating report output. | Medium |
| (c) reporting for the <i>Statistical Bulletin</i> is mostly automated already and thus a low priority, but development or improvement of documentation of the reporting is a priority. | Medium |

Table 2: Illustrative example of estimates of productivity parameters for time periods 2000–2018 in five-yearly blocks.

| Parameter | | 2000–2004 | 2005–2009 | 2010–2014 | 2014–2018 |
|-------------------------|--------------------------------|-----------|-----------|-----------|-----------|
| Mean size at age (cm) | Age = 5 | 75.0 | 76.0 | 73.2 | 77.1 |
| | Age = 6 | 80.1 | 80.2 | 79.7 | 81.3 |
| | Age = 7 | ... | ... | ... | ... |
| | Etc... | | | | |
| Mean weight at length | Length = 80 cm | | | | |
| | Length = 90 cm | | | | |
| | Length = 100 cm | | | | |
| | Length = 110 cm | | | | |
| | Etc... | | | | |
| Mean recruitment | Model estimated YCS | n/a | 0.99 | 0.95 | 1.05 |
| Recruitment variability | Model estimated (σ_R) | 0.64 | 0.65 | 0.55 | 0.62 |
| 50% maturity (age) | | 8.5 | 7.6 | 7.3 | 6.4 |
| 50% maturity (length) | | | | | |
| 90th percentile age | | 17.3 | 16.7 | 16.8 | 17.2 |
| Sex ratio | | 55:45 | | | |

Table 3: Recommendations from the Stock Assessment Review extracted verbatim from the report (Annex 5, where further description of these points can be found), and target group, priorities and timelines suggested by WG-FSA. RP – review panel, SC – Scientific Committee, SA – stock assessments, VB – von Bertalanffy.

| | Review panel comments | Target | Evaluation | Priority | Timeline |
|------------------|---|------------------------|----------------------------|---------------|----------|
| Documentation | | | | | |
| | 1. It is recommended that a standardised format be developed by CCAMLR for the presentation of details of assessments to facilitate understanding of the assumptions, data preparation and inputs, parameter estimation and results across the assessments performed by the CCAMLR, and that a public summary document with these details be developed and updated at a fixed period (e.g. five years). | WG-SAM WG-FSA | Summary | High | 2019/20 |
| Stock hypotheses | | | | | |
| | 2. A number of assessments described the proposed stock hypotheses and described ideas for future work. The RP suggests that appropriate experts be consulted, and a review be planned if these assessments or CCAMLR require evaluation of the hypotheses. | SC WG-SAM WG-FSA | Area dependent data review | High / Medium | Ongoing |
| Surveys | | | | | |
| | 3. Where possible, such surveys should be continued and optimised to ensure recruitment variability can be detected. | SC WG-FSA | Assessment | High | Ongoing |
| | 4. Subareas 88.1/88.2 – Consideration should be given to restricting the data from the survey to be more representative of recruitment. | WG-SAM WG-FSA | Sensitivity | High | 2019 |
| | 5. Subareas 88.1/88.2 – Consideration should be given to designing the survey to take this into consideration or increasing the catch limit, so that the unused catch limit can be released after the survey, or by releasing excess fish, etc.? | SC WG-FSA | Review | Medium | Ongoing |
| | 6. Division 58.5.2a more appropriate approach to fitting the survey might be to fit the index-at-age data using a multivariate likelihood function and the empirical variance-covariance matrix. | WG-SAM WG-FSA | Sensitivity | High | 2019 |
| Ageing | | | | | |
| | 7. In some cases just a single experienced reader has been used. The RP suggests that, where possible, increasing the number of readers to a minimum of two experienced readers, within laboratories, would be beneficial. | Members | Uncertainty | Medium | Ongoing |
| | 8. It would be interesting to investigate how smoothing the ALK matrix (by applying a kernel or use some sort of spline function) would affect the SA. | WG-SAM | Sensitivity | Medium | Ongoing |
| Growth | | | | | |
| | 9. The RP suggests that all SA's implement methods to account for these potential biases in fitting Von Bertalanffy growth curves. | WG-SAM | Sensitivity | Medium | Ongoing |
| | 10. Additionally, investigation of the impact of errors in ageing on the VB by the SA scientists have shown that the fit is robust to this error. The RP suggests that this be investigated occasionally to ensure that no biases occur. | WG-SAM WG-FSA | Sensitivity | Medium | Ongoing |

(continued)

Table 3 (continued)

| Review panel comments | Target | Evaluation | Priority | Timeline |
|--|------------------|--------------|----------|----------|
| 11. Because changing the VB can affect the calculated virgin biomass, and thus the depletion estimates, the RP suggests that the SA scientists explore whether the fitted VB in these cases is sufficiently precautionary. | WG-SAM WG-FSA | Sensitivity | Medium | 2019 |
| 12. The RP also suggests that the SA scientists investigate the use of other growth curves that may exhibit better properties in regard to the data. A more flexible curve might produce a more realistic fit. | WG-SAM WG-FSA | Sensitivity | Medium | 2019 |
| 13. The RP recommends that sensitivity analyses be used to assess the impact of the different choices of the growth model on stock assessment results and on biological reference points. | WG-SAM WG-FSA | Sensitivity | Medium | 2019 |
| 14. Potential changes in growth rates and fishery selectivity will influence tag-recapture rates, particularly due to the domed-shaped selectivity of these fisheries. The RP also recommends that more flexible growth curves be investigated. | WG-SAM WG-FSA | Sensitivity | Medium | 2019 |
| 15. The RP recommends that the use of age-length keys be investigated to estimate the age composition of tagged fish released as an input to the assessment models for all the toothfish stocks, instead of the current approach. | WG-SAM WG-FSA | Sensitivity | Medium | 2019/20 |
| Data weighting | | | | |
| 16. The RP recommends that data weighting methods for tagging data should be further investigated. For example, consideration should be given to using data weighting methods based on the average time at liberty. | WG-SAM WG-FSA | Sensitivity | Medium | Ongoing |
| Tag loss | | | | |
| 17. The RP suggests that it is timely to update this analysis for the Subarea 48.3+Subarea 48.4 and Subarea 88.1, SSRUs 882A and 882B stocks based on more recent information that may include fish with a longer time-at-liberty. Changes in tag loss rates should be investigated. Information on the uncertainty involved in the estimation should be provided. | WG-SAM WG-FSA | Sensitivity | High | 2019 |
| Initial tagging mortality | | | | |
| 18. The RP encourages future research on the estimation of initial tagging mortality rates, and factors that may cause this to vary. | WG-SAM WG-FSA | Experimental | Medium | Ongoing |
| Tag detection | | | | |
| 19. The review panel encourages future research on the estimation of tag detection rates, and factors that may cause this to vary. | WG-SAM WG-FSA | Sensitivity | Medium | Ongoing |
| 20. The RP recommends that implementation of good tagging protocols (release and recapture) be encouraged for all vessels involved in these fisheries. | WG-FSA | Review | High | Ongoing |
| Time at liberty truncation | | | | |
| 21. Tagging data was limited to recapture years-at-liberty less than 4 for Division 58.5.2 (although data exist for up to six years at liberty) and Subarea 48.3 and Subarea 48.4 assessments, but six years at liberty for Subarea 88.1, SSRU 882A and 882B assessments. The RP recommends further investigation of this issue. | WG-SAM WG-FSA | Sensitivity | Medium | Ongoing |

(continued)

Table 3 (continued)

| | Review panel comments | Target | Evaluation | Priority | Timeline |
|---|-----------------------|------------------------|------------|----------|----------|
| Selectivity | | | | | |
| 22. The spatial distribution of the fleets has changed over time, particularly in the early years of the fisheries and in Subarea 88.1, SSRU 882A and 882B and temporal changes in selectivity should be considered. | WG-FSA | Sensitivity | Medium | 2019/20 | |
| Natural mortality | | | | | |
| 23. The RP recommends that consideration should be given to estimating age-specific natural mortality rates using a functional form with few parameters and sex-specific natural mortality rates. Simulation analysis should be conducted to determine in what circumstances natural mortality rates can be reliably estimated. | WG-SAM | Research & sensitivity | Medium | 2019/20 | |
| Recruitment standard deviation | | | | | |
| 24. The RP recommends that consideration should be given to adjusting the penalty for years in which there is incomplete information about year class strength. | WG-SAM WG-FSA | Sensitivity | Medium | 2019 | |
| Sex structure | | | | | |
| 25. The RP suggests that a more thorough evaluation is needed on the necessity of sex. If it is concluded that a sex-structured model is appropriate, all the data collection programs need to be modified to collect the appropriate sex information. | WG-FSA | Sensitivity | Medium | Ongoing | |
| 26. A standard set of diagnostic plots across the assessments covering important and sensitive parameters is encouraged to be included in each stock assessment. | WG-FSA | Review | Medium | 2019 | |
| Ecosystem drivers in assessment models | | | | | |
| 27. This was beyond the scope of the Terms of Reference. However, CCAMLR may wish to consider an external review whose goal is to consider this question specifically. | WG-FSA | Review | Medium | This WG | |

Table 4: Research block biomass estimates and recommended catch limits for Subareas 48.6 and 58.4.

| Subarea/ division | Research block | Species | Trend decision | Adequate recaptures | B (tonnes) | Catch limit 2017/18 | 0.04*B | 0.8*CL | 1.2*CL | Recommended catch limit 2018/19 (tonnes) |
|----------------------|-------------------|-----------------------|-------------------|------------------------|---------------|------------------------|--------|--------|--------|--|
| 48.6 | 486_2 | <i>D. mawsoni</i> | I.S.U | Y | 4372 | 169 | 175 | 135 | 203 | 175 |
| 48.6 | 486_3 | <i>D. mawsoni</i> | D | Y | 2521 | 40 | 101 | 32 | 48 | 32 |
| 48.6 | 486_4 | <i>D. mawsoni</i> | I.S.U | Y | 8387 | 120 | 335 | 96 | 144 | 144 |
| 48.6 | 486_5 | <i>D. mawsoni</i> | I.S.U | N | 8569 | 228 | 343 | 182 | 274 | 274 |
| 58.4.1 | 5841_1 | <i>D. mawsoni</i> | I.S.U | N | 6520 | 96 | 261 | 77 | 115 | 115 |
| 58.4.1 | 5841_2 | <i>D. mawsoni</i> | I.S.U | N | 4497 | 97 | 180 | 78 | 116 | 116 |
| 58.4.1 | 5841_3 | <i>D. mawsoni</i> | I.S.U | N | 3683 | 186 | 147 | 149 | 223 | 149 |
| 58.4.1 | 5841_4 | <i>D. mawsoni</i> | I.S.U | N | 591 | 16 | 24 | 13 | 19 | 19 |
| 58.4.1 | 5841_5 | <i>D. mawsoni</i> | I.S.U | N | 4004 | 42 | 160 | 34 | 50 | 50 |
| 58.4.1 | 5841_6 | <i>D. mawsoni</i> | I.S.U | N | 4069 | 108 | 163 | 86 | 130 | 130 |
| 58.4.2 | 5842_1 | <i>D. mawsoni</i> | I.S.U | N | 4585 | 42 | 183 | 34 | 50 | 50 |
| 58.4.4b | 5844b_1 | <i>D. eleginoides</i> | I.S.U | N | 470 | 20 | 19 | 16 | 24 | 19 |
| 58.4.4b | 5844b_2 | <i>D. eleginoides</i> | D | N | 298 | 28 | 12 | 22 | 34 | 22 |
| 58.4.3a | 5843a_1 | <i>D. eleginoides</i> | D | N | 1263 | 38 | 51 | 30 | 46 | 30 |

Table 5: Summary of the assessment of the new and underway Area 48 research proposals against the criteria set out in SC-CAMLR-XXXVI, Annex 7, paragraph 4.7. Summary of the rationale behind the scores are in the notes below, and details in paragraphs 4.39 to 4.92. n/a indicates not applicable.

| Subarea: | 48.1 | 48.2 | 48.2 and 48.4 | 48.6 |
|--|------------------------------------|-----------------------------|------------------------|--|
| | WG-FSA- 18/20 Rev. 1 Ukraine | WG-FSA- 18/49 Ukraine | WG-FSA- 18/52 UK | WG-FSA-18/34 Japan, South Africa and Spain |
| Conservation measure under which proposal submitted | | | | |
| (i) (a) Is the proposed research likely to generate an index of local stock abundance? | 2 | Y | n/a | Y |
| (b) Is the proposed research likely to generate estimates of biological parameters relating to productivity? | Y | 3 | 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 | 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? | 4 | 5 | Y | Y |
| (iii) Are the likely impacts from the proposed research to dependent and related species consistent with Article II? | 1 | 6 | Y | 7 |
| (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 | 1 | Y | 1 |
| (v) Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs? | Y ⁸ | Y ⁸ | Y ⁸ | Y ⁸ |
| (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)? ¹⁰ | 2 | Y | Y | 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)? ¹⁰ | 9 | 9 | Y | 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? | n/a ¹² | 10 | Y | 11 |

(continued)

Table 5 (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 (Figure 5).
 3. Requires an increase in the number of otoliths collected and aged.
 4. Catch limit only applies to 1st year of proposal.
 5. CPUE in southern research area is declining.
 6. Requires increased sampling of by-catch species.
 7. Requires more data analysis.
 8. Based on vessel tagging detection and survival rates in WG-FSA-17/36.
 9. Priority should be given to the completion of research programs already in place over new research proposals (SC-CAMLR-XXXVI, paragraph 3.64).
 10. Based on milestones not being achieved on the assessment of biological parameters, analyses of by-catch species, seabirds and marine mammals.
 11. Based on milestones not being achieved on productivity parameters.
 12. Not applicable as this is a new proposal by this Member for this area.
-

Table 6: Summary of the assessment of the new and underway Area 58 research proposals against the criteria set out in SC-CAMLR-XXXVI, Annex 7, paragraph 4.7. Summary of the rationale behind the scores are in the notes below and details in paragraphs 4.107 to 4.138.

| Subarea: | 58.4.3a | 58.4.4b | 58.4.1 and 58.4.2 |
|--|----------------------------------|----------------------------------|--|
| | WG-FSA-18/61 France and Japan | WG-FSA-18/44 France and Japan | WG-FSA-18/59 Australia, France, Japan, Republic of Korea, Spain |
| Conservation measure under which proposal submitted | | | |
| (i) (a) Is the proposed research likely to generate an index of local stock abundance? | 2 | 2 | Y |
| (b) Is the proposed research likely to generate estimates of biological parameters relating to productivity? | Y | Y | Y |
| (c) Is the proposed research likely to test a hypothesis of relationship of fish in the research area to the overall stock? | 1 | 1 | 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? | Y | Y | Y |
| (iii) Are the likely impacts from the proposed research to dependent and related species consistent with Article II? | 6 | 5 | 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? | 1 | 1 | Y |
| (v) Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs? | 3 | 3 | 4 |
| (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)? ¹⁰ | 2 | 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)? ¹⁰ | 2 | 2 | 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? | 2 | 2 | Y |

(continued)

Table 6: (continued)

Notes:

1. There is not enough information in the proposal.
 2. There is a lack of data due to low research fishing effort in these area in recent seasons.
 3. The proposed vessels have multiple years of experience but have unknown calculated effective survival rates.
 4. 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.
 5. Spatio-temporal patterns of data were presented, however, further analysis of biological samples is pending.
 6. A large proportion of by-catch species are present in catch data.
-

Table 7: Summary of the assessment of the new and underway Area 88 research proposals against the criteria set out in SC-CAMLR-XXXVI, Annex 7, paragraph 4.7. Summary of the rationale behind the scores are in the notes below and details in paragraphs 4.141 to 4.199. n/a indicates not applicable.

| Subarea: | 88.1 | | 88.1 and 88.2 | | 88.2 | | 88.3 | |
|--|-------------------------------|-----------------------------|-----------------------------|-------------------------------|--------------------------------|--|------|--|
| | WG-FSA-18/33 Rev. 1 Russia | WG-FSA-18/41 New Zealand | WG-FSA-18/40 New Zealand | WG-FSA-32 Rev. 1 Russia | WG-FSA-18/16 Rev. 1 Ukraine | WG-FSA-18/42 Republic of Korea and New Zealand | | |
| Conservation measure under which proposal submitted | | | | | | | | |
| (i) (a) Is the proposed research likely to generate an index of local stock abundance? | Y | Y | n/a | 10 | Y | Y | | |
| (b) Is the proposed research likely to generate estimates of biological parameters relating to productivity? | Y | Y | Y | Y | Y | 4 | | |
| (c) Is the proposed research likely to test a hypothesis of relationship of fish in the research area to the overall stock? | Y | Y | Y | 11 | 5 | 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? | Y | Y | Y | 12 | 1 | Y | | |
| (iii) Are the likely impacts from the proposed research to dependent and related species consistent with Article II? | Y | Y | Y | 13 | 1 | 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? | 14 | Y | Y | 15 | 6 | 6 | | |
| (v) Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs? | 16 | Y ³ | Y ³ | 17 | Y ³ | 7 | | |
| (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 | 18 | Y | 8 | | |
| (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)? ¹⁰ | Y | Y | Y | Y | 2 | Y | | |

(continued)

Table 7 (continued)

| Subarea: | 88.1 | 88.1 and 88.2 | 88.2 | 88.3 | | |
|--|-------------------------------|-----------------------------|-----------------------------|----------------------------|--------------------------------|---|
| Proposal and country/criteria: | WG-FSA-18/33 Rev. 1 Russia | WG-FSA-18/41 New Zealand | WG-FSA-18/40 New Zealand | WG-FSA-32 Rev. 1 Russia | WG-FSA-18/16 Rev. 1 Ukraine | WG-FSA-18/42 Republic of Korea and New Zealand |
| (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? | 19 | Y | Y | n/a | n/a | 9 |
| Notes: | | | | | | |
| 1. There is not enough information in the proposal. | | | | | | |
| 2. Priority should be given to the completion of research programs already in place over new research proposals (SC-CAMLR-XXXVI, paragraph 3.64). | | | | | | |
| 3. Based on vessel tagging detection and survival rates in WG-FSA-17/36. | | | | | | |
| 4. Aging data still to be provided. | | | | | | |
| 5. No hypothesis presented to consider stock connectivity between Subareas 88.3 and 48.1. | | | | | | |
| 6. The Working Group requested more integration between Ukraine and the existing research in Subarea 88.3. | | | | | | |
| 7. Tagging statistics are not available for the vessel proposed by the Republic of Korea, but it is part of the experimental design. | | | | | | |
| 8. Catch distribution agreed between Members. | | | | | | |
| 9. Milestones have been delayed due to the New Zealand vessel not fishing in 2017/18 due to ice conditions. | | | | | | |
| 10. There is no information available on the distribution of the target species within CCAMLR data | | | | | | |
| 11. Alternative hypotheses exist for estimating crab populations in the Southern Ocean | | | | | | |
| 12. No information exists for this area, and survey is effort limited. | | | | | | |
| 13. By-catch estimation will be difficult if lice depredation occurs. | | | | | | |
| 14. The Working Group recommended a review after one year of the research program. | | | | | | |
| 15. Additional details for the proportion of the catch that are mature males is desirable. This information could be derived from first year of survey or other publications on related species. | | | | | | |
| 16. 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). | | | | | | |
| 17. Of the two vessels proposed for this research only one has calculated tag detection and survival statistics (WG-FSA-17/36). | | | | | | |
| 18. The research program is new therefore operational practices are unknown | | | | | | |
| 19. Analyses are pending for this region. | | | | | | |

Table 8: Catch Limits from the trend analysis for Subarea 88.2. * – individual 200 tonne limits with an overall limit of 400 tonnes in research blocks 882_1–882_4.

| Subarea/ division | Research block | Species | Trend decision | Adequate recaps | B (tonnes) | Catch limit 2017/18 | 0.04*B | 0.8*CL | 1.2*CL | Proposed catch limit 2018/19 (tonnes) |
|----------------------|-------------------|-------------------|-------------------|--------------------|---------------|------------------------|--------|--------|--------|---|
| 882 | SSRUH | <i>D. mawsoni</i> | ISU | Y(all) | 11759 | 200 | 470 | 160 | 240 | 240 |
| | | | ISU | Y(effective) | 4419 | 200 | 177 | 160 | 240 | 177 |
| 882 | 882_1 | <i>D. mawsoni</i> | ISU | N | 11288 | 200* | 451 | 160 | 240 | 240 |
| 882 | 882_2 | <i>D. mawsoni</i> | ISU | Y(all) | 15523 | 200* | 620 | 160 | 240 | 240 |
| | | | ISU | Y(effective) | 8370 | 200* | 330 | 160 | 240 | 240 |
| 882 | 882_3 | <i>D. mawsoni</i> | ISU | N | 3342 | 200* | 134 | 160 | 240 | 160 |
| 882 | 882_4 | <i>D. mawsoni</i> | D | N | 6666 | 200* | 266 | 160 | 240 | 160 |



Figure 1: Reported sightings of IUU or unidentified vessels within the Convention Area. The figure does not include reports of unidentified fishing gear sighted or retrieved in the Convention Area which may be indicative of IUU activity and is not corrected for changes in surveillance effort.

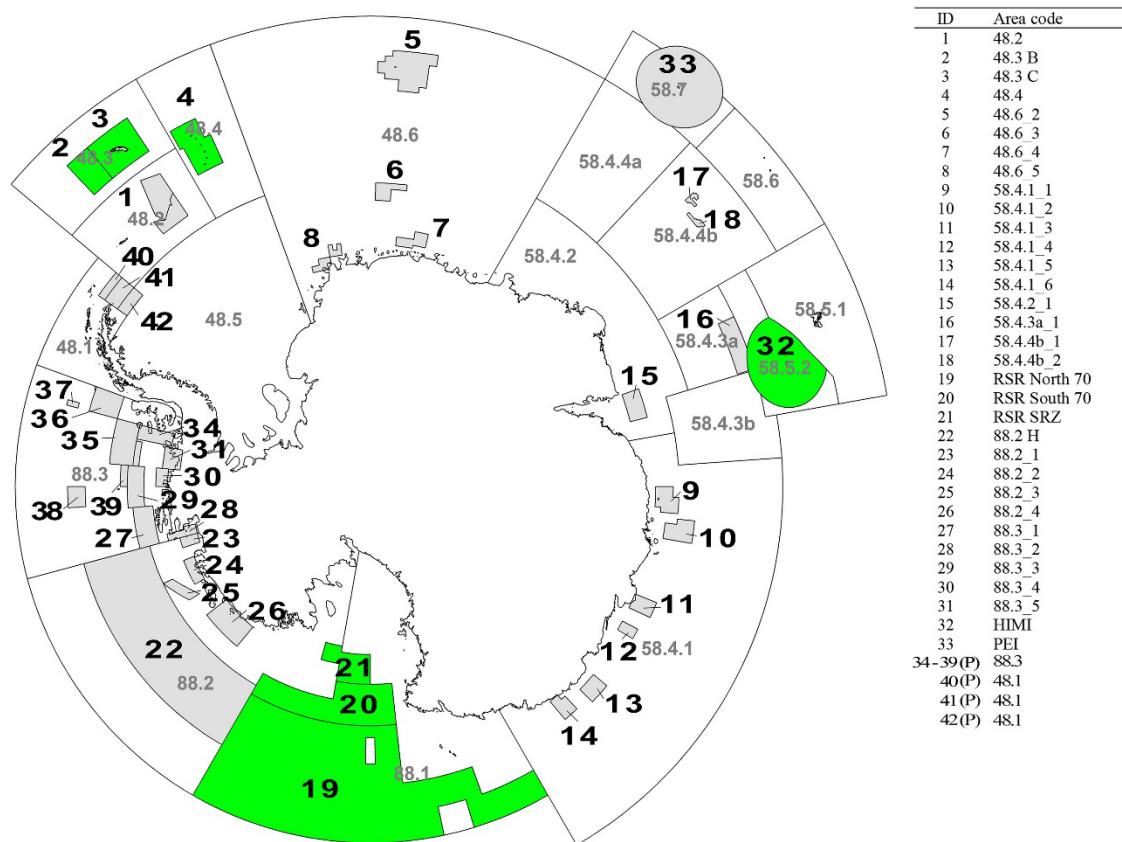


Figure 2: Map of the Convention Area showing areas with toothfish catch limits in place or areas with proposed research fishing. Areas shown in green have catch limits set using integrated assessments. Areas 34 to 42 are areas that have been proposed for the first time in 2018 for research fishing.

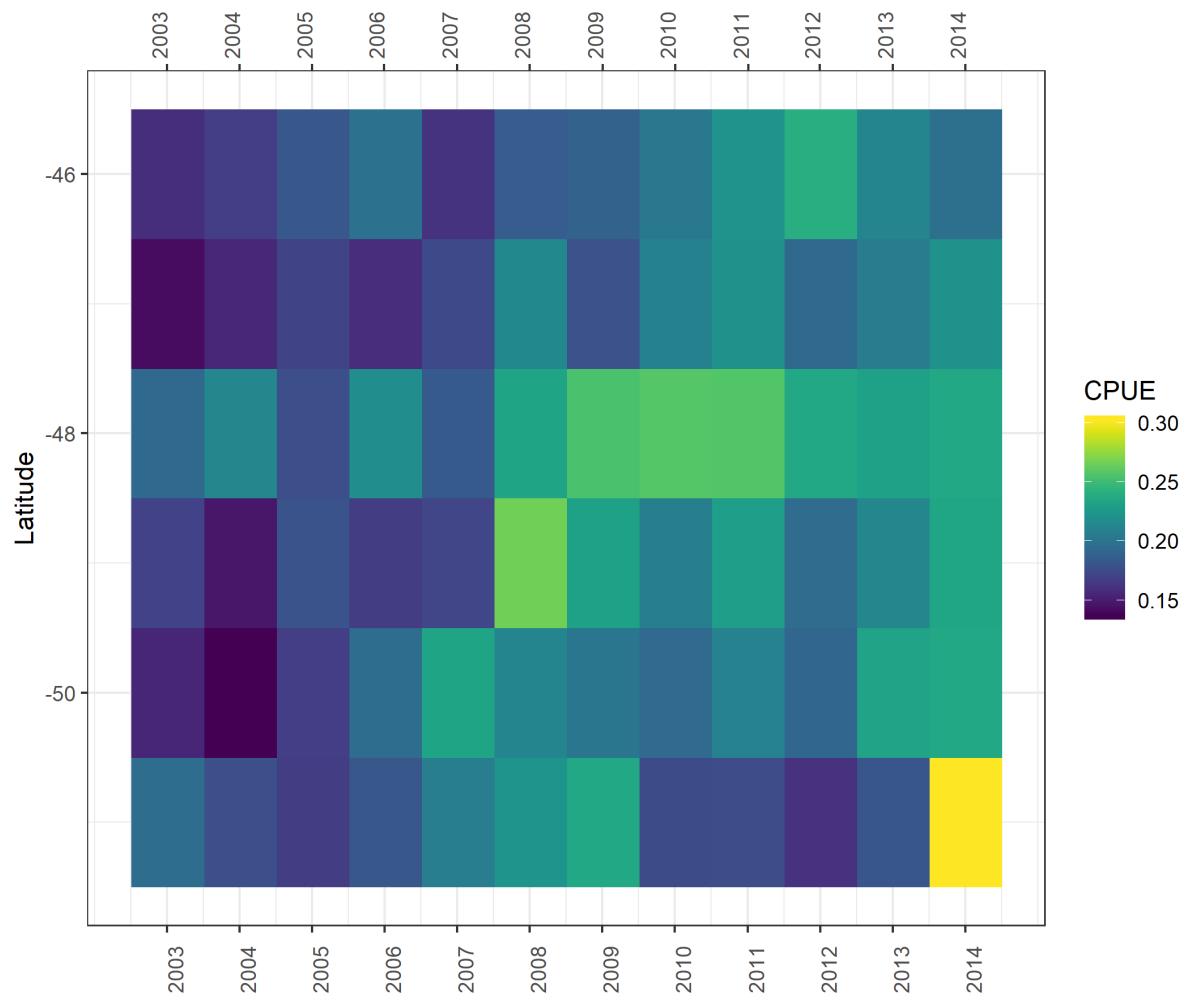


Figure 3: An example of mean CPUE by latitude over time for the years 2003–2015 for Division 58.5.1.

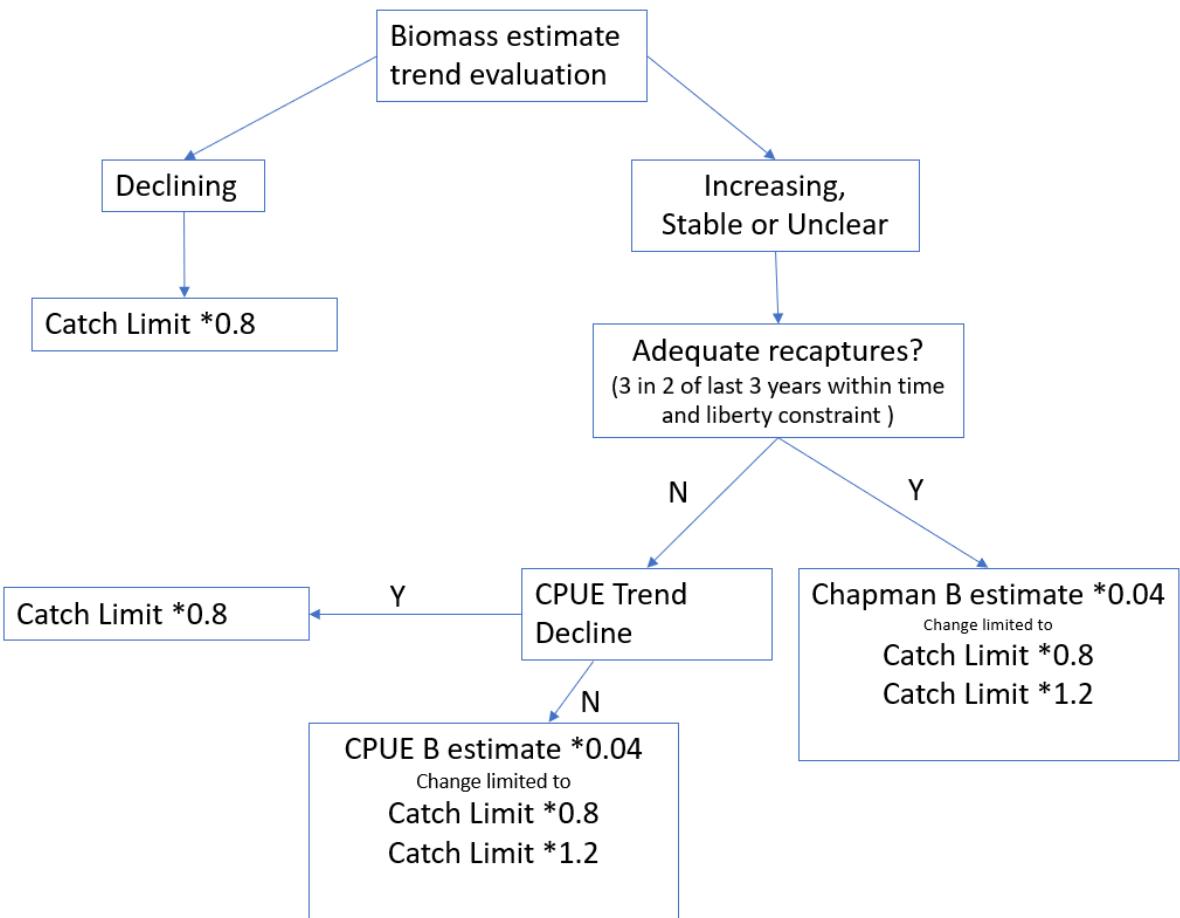


Figure 4: Linear trend analysis decision rules for determining catch limits for research blocks using biomass estimates from CPUE by seabed area and/or Chapman based estimates from tag release – recapture data. All changes to catch limits are bound by a maximum increase or decrease of 20% in relation to the previous decision (see SC-CAMLR-XXXVI, Annex 7, paragraph 4.33 for decision rules on linear trend analysis outcomes).

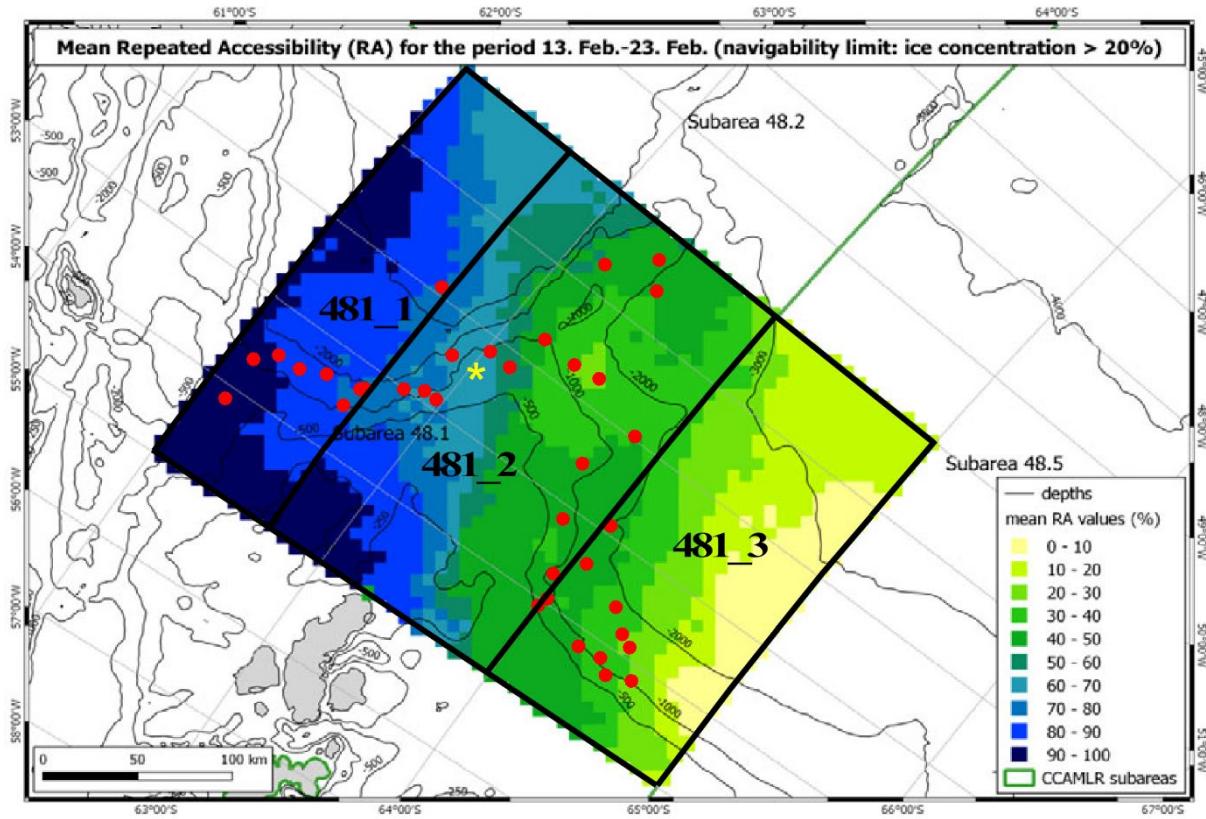
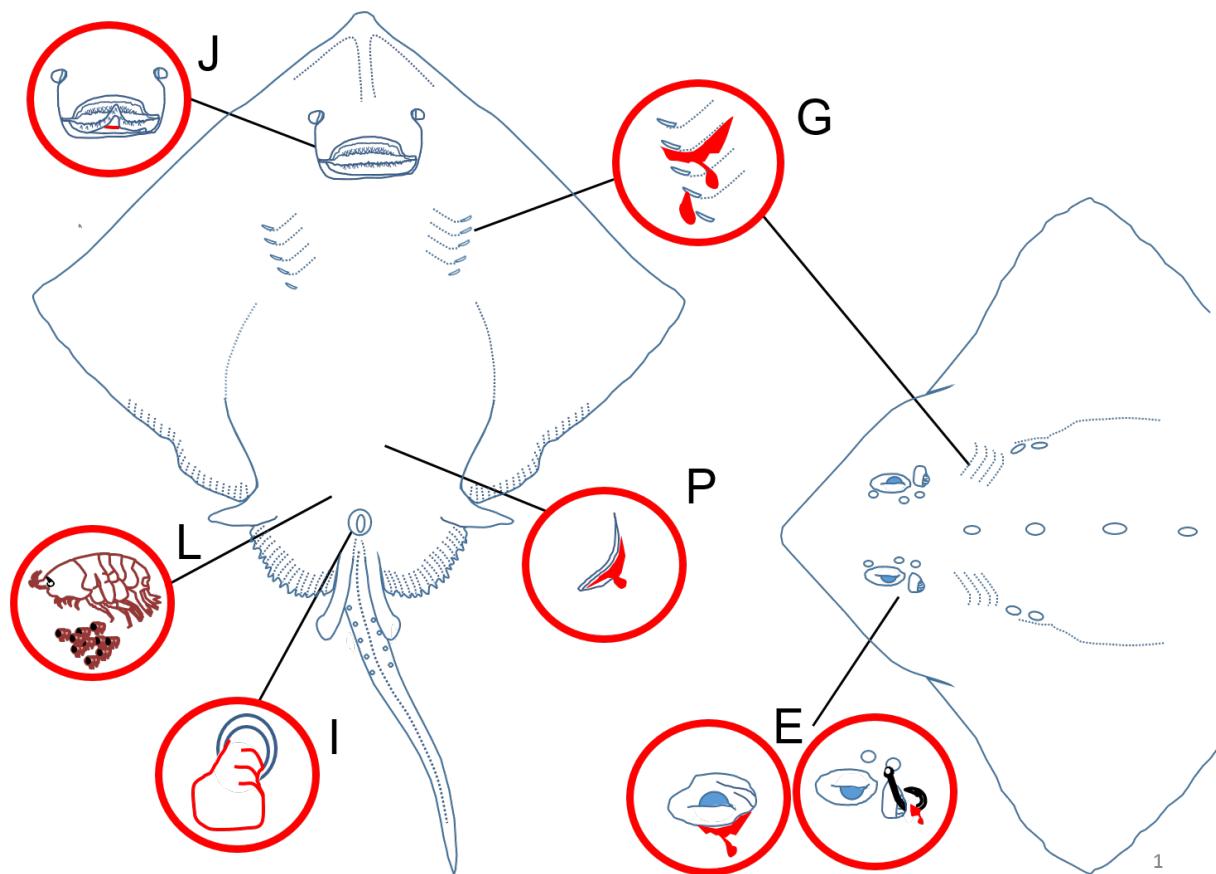


Figure 5: Map showing the mean repeated accessibility (RA) for the period 18–23 February for fishing vessels with a fishing limit of 20% sea-ice concentration (as estimated in WG-FSA-18/01) in the research blocks proposed by Ukraine for a new 3-year *Dissostichus* spp. research program. The locations of the proposed longline stations are shown as red points (based on Table 1 in WG-FSA-18/20 Rev. 1) and the registered VME is shown as a yellow star. Repeated accessibility was calculated as the probability that a particular area is fishable by fishing vessels at a given time and again at least once within the subsequent two years, i.e. that accessibility was given at least twice within the 3-year time span.



| Category | Description |
|----------|---|
| 0 | No visible injuries |
| J | Broken jaw or significant tearing of tissue around jaw. |
| G | Bleeding from the gills on either dorsal or ventral surface |
| L | Significant damage from sea lice around the peritoneal cavity |
| I | Intestinal prolapse exceeding 3 cm, including if bleeding |
| P | Injury penetrating the peritoneal cavity |
| E | Injury to the eye or spiracle |

Figure 6: Diagram showing categories of skate injuries to be recorded at tagging and release of skates and a description of each category. A skate with no injuries would receive a category of '0'. The alphabetical code(s) could be recorded in a 'Injury' field in the tagging sheet of the e-longline book.

Appendix A

List of Participants

Working Group on Fish Stock Assessment (Hobart, Australia, 8 to 19 October 2018)

| | |
|------------------------------------|--|
| Convener | Dr Dirk Welsford Australian Antarctic Division, Department of the Environment dirk.welsford@aad.gov.au |
| Australia | Mr Dale Maschette Australian Antarctic Division, Department of the Environment and Energy dale.maschette@aad.gov.au |
| | Ms Gabrielle Nowara Australian Antarctic Division, Department of the Environment gabrielle.nowara@aad.gov.au |
| | Dr Paul Tixier Deakin University p.tixier@deakin.edu.au |
| | Dr Philippe Ziegler Australian Antarctic Division, Department of the Environment and Energy philippe.ziegler@aad.gov.au |
| Chile | Professor Patricio M. Arana Pontificia Universidad Católica de Valparaíso patricio.arana@pucv.cl |
| | Mr Juan Carlos Quiroz Instituto de Fomento Pesquero juquiroz@udec.cl |
| China, People's Republic of | Ms Haiting Zhang Shanghai Ocean University zh_ting@163.com |
| | Dr Guoping Zhu Shanghai Ocean University gpzhu@shou.edu.cn |

European Union

Professor Philippe Koubbi
Sorbonne Université, BOREA Research Unit
philippe.koubbi@sorbonne-universite.fr

Dr Marta Söffker
Centre for Environment, Fisheries and Aquaculture
Science (Cefas)
marta.soffker@cefas.co.uk

France

Dr Marc Eléaume
Muséum national d'Histoire naturelle
marc.eleaume@mnhn.fr

Mr Nicolas Gasco
Muséum national d'Histoire naturelle
nicolas.gasco@mnhn.fr

Dr Clara Péron
Muséum national d'Histoire naturelle
clara.peron@mnhn.fr

Mr Benoit Tourtois
French Ministry for Food and Agriculture
benoit.tourtois@developpement-durable.gouv.fr

Germany

Dr Stefan Hain
Alfred Wegener Institute for Polar and Marine Research
stefan.hain@awi.de

Italy

Dr Davide Di Blasi
National Research Council, Institute of Marine Sciences
davide.diblasi@ge.ismar.cnr.it

Dr Marino Vacchi
Institute of Marine Sciences (ISMAR)
marino.vacchi@ge.ismar.cnr.it

Japan

Dr Taro Ichii
National Research Institute of Far Seas Fisheries
ichii@affrc.go.jp

Mr Naohisa Miyagawa
Taiyo A & F Co. Ltd.
n-miyagawa@maruha-nichiro.co.jp

Dr Takehiro Okuda
National Research Institute of Far Seas Fisheries
okudy@affrc.go.jp

Mr Takeshi Shibata
Taiyo A & F Co. Ltd.
t-shibata@maruha-nichiro.co.jp

Korea, Republic of

Professor Gun Wook Baeck
Gyeongsang National University
gwbbaeck@gnu.ac.kr

Dr Seok-Gwan Choi
National Institute of Fisheries Science (NIFS)
sgchoi@korea.kr

Mr Hyun Joong Choi
Sunwoo Corporation
hjchoi@swfishery.com

Dr Sangdeok Chung
National Institute of Fisheries Science
sdchung@korea.kr

Mr TaeBin Jung
Sunwoo Corporation
tbjung@swfishery.com

Dr Chang-Keun Kang
Gwangju Institute of Science and Technology
ckkang@gist.ac.kr

Professor Jae-Won Kim
Gangwon State University
kjw01@gw.ac.kr

Mr Hae Jun Lee
Hongjin Company
vitamin1223@naver.com

Mr Sang Gyu Shin
National Institute of Fisheries Science (NIFS)
gyuyades82@gmail.com

New Zealand

Mr Alistair Dunn
Ministry for Primary Industries
alistair.dunn@mpi.govt.nz

Mr Jack Fenaughty
Silvifish Resources Ltd
jack@silvifishresources.com

Dr Sophie Mormede
National Institute of Water and Atmospheric Research
(NIWA)
sophie.mormede@niwa.co.nz

Dr Steve Parker
National Institute of Water and Atmospheric Research
(NIWA)
steve.parker@niwa.co.nz

Russian Federation

Dr Svetlana Kasatkina
AtlantNIRO
ks@atlantniro.ru

South Africa

Mr Christopher Heinecken
Capricorn Fisheries Monitoring
chris@capfish.co.za

Mr Sobahle Somhlaba
Department of Agriculture, Forestry and Fisheries
ssomhlaba@gmail.com

Spain

Dr Takaya Namba
James Wallace
takayanamba@gmail.com

Mr Joost Pompert
Pesquerias Georgia, S.L
joostpompert@georgiaseafoods.com

Mr Roberto Sarralde Vizuete
Instituto Español de Oceanografía
roberto.sarralde@ieo.es

Ukraine

Dr Kostiantyn Demianenko
Institute of Fisheries and Marine Ecology (IFME) of the
State Agency of Fisheries of Ukraine
s_erinaco@ukr.net

Dr Leonid Pshenichnov
Institute of Fisheries and Marine Ecology (IFME) of the
State Agency of Fisheries of Ukraine
lkpbikentnet@gmail.com

Mr Illia Slypkov
Institute of Fisheries and Marine Ecology (IFME)
i.v.slypkov@ukr.net

United Kingdom

Dr Mark Belchier
British Antarctic Survey
markb@bas.ac.uk

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

Dr Phil Hollyman
British Antarctic Survey
phyman@bas.ac.uk

Ms Georgia Robson
Centre for Environment, Fisheries and Aquaculture
Science (Cefas)
georgia.robson@cefas.co.uk

United States of America

Dr Jefferson Hinke
National Marine Fisheries Service, Southwest Fisheries
Science Center
jefferson.hinke@noaa.gov

Dr Christopher Jones
National Oceanographic and Atmospheric Administration
(NOAA)
chris.d.jones@noaa.gov

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

Secretariat

| | |
|---|-------------------------|
| Executive Secretary | Dr David Agnew |
| Science | |
| Science Manager | Dr Keith Reid |
| Observer Scheme Program Coordinator | Isaac Forster |
| Science Support Officer | Emily Grilly |
| Fisheries and Ecosystems Analyst | Dr Stephane Thanassekos |
| SISO Support Officer | Michaela Doyle |
| Fishery Monitoring and Compliance | |
| Fishery Monitoring and Compliance Manager | Bonney Webb |
| Compliance Administration Officer | Ingrid Slicer |
| Trade Data Analyst | Eldene O'Shea |
| Data Assistant | Alison Potter |
| Finance and Administration | |
| Finance and Administration Manager | Deborah Jenner |
| Finance Assistant | Christina Macha |
| General Office Administrator | Maree Cowen |
| Communications | |
| Communications Manager | Doro Forck |
| Communications Officer (Web architecture and content) | Narelle Absolom |
| Publications Officer | Belinda Blackburn |
| French Translator/Team Coordinator | Gillian von Bertouch |
| French Translator | Floride Pavlovic |
| French Translator | Bénédicte Graham |
| Russian Translator/Team Coordinator | Ludmilla Thorne |
| Russian Translator | Blair Denholm |
| Russian Translator | Vasily Smirnov |
| Spanish Translator/Team Coordinator | Jesús Martínez |
| Spanish Translator | Margarita Fernández |
| Spanish Translator | Marcia Fernández |
| Print Production (temporary position) | David Abbott |
| Information Systems and Data Services | |
| Information Systems and Data Services Manager | Tim Jones |
| Systems Analyst | Ian Meredith |
| Data Steward | Dr Elanor Miller |

Agenda

Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2018)

1. Opening of the meeting
 - 1.1 Organisation of the meeting
 - 1.2 Subgroup organisation and coordination
2. Review of data available
 - 2.1 Data management
 - 2.2 Catch and effort data and biological observations from CCAMLR fisheries
 - 2.3 Fishery Report updates
3. Review of updated stock assessments and provision of management advice (all fisheries)
 - 3.1 *Champscephalus gunnari*
 - 3.1.1 *C. gunnari* Subarea 48.3
 - 3.1.2 *C. gunnari* Division 58.5.1
 - 3.1.3 *C. gunnari* Division 58.5.2
 - 3.2 *Dissostichus* spp.
 - 3.2.1 *Dissostichus* spp. in Subarea 48.4
4. Research to inform current or future assessments in ‘data-poor’ fisheries (e.g. new fisheries, activities in closed areas, areas with zero catch limits and in Subareas 48.6 and 58.4) notified under Conservation Measures 21-01, 21-02 and 24-01
 - 4.1 Generic issues
 - 4.1.1 Trend analysis and setting catch limits
 - 4.1.2 Tagging performance
 - 4.1.3 Transitioning from area biomass estimates to integrated stock assessments
 - 4.1.4 Process for reviewing research proposals
 - 4.2 Management area research reviews and management advice
 - 4.2.1 *Dissostichus* spp. Area 48
 - 4.2.2 *Dissostichus* spp. Area 58
 - 4.2.3 *D. mawsoni* Area 88
 - 4.2.4 Other fisheries research
5. Scheme of International Scientific Observation

6. Non-target catch and ecosystem impacts of fishing
 - 6.1 Fish by-catch
 - 6.1.1 Status and trends in finfish by-catch
 - 6.1.2 Risk assessment methods for finfish by-catch
 - 6.2 Incidental mortality of seabirds and marine mammals
 - 6.3 Invertebrate by-catch and vulnerable marine ecosystems (VMEs)
 - 6.4 Marine debris
7. Future work
 - 7.1 Organisation of intersessional activities
 - 7.2 Notifications of other scientific research
8. Other business
9. Advice to Scientific Committee
10. Adoption of the report and close of the meeting.

List of Documents

Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2018)

- WG-FSA-18/01 Analyses of ice conditions in the research area proposed by Ukraine for a multi-year *Dissostichus* research program in Statistical Subarea 48.1
H. Pehlke, S. Hain, K. Teschke and T. Brey
- WG-FSA-18/02 On multi-year variability of the Patagonian toothfish (*Dissostichus eleginoides*) size composition in longline catches in the South Georgia maritime zone
N.N. Kukharev and A.F. Petrov
- WG-FSA-18/03 Finding of a tag on toothfish from the stomach of *Dissostichus mawsoni*
L. Pshenichnov and P. Zabroda
- WG-FSA-18/04 Brief report on the results of oceanological work of Ukrainian vessels in the CCAMLR area in the season 2017/18
V. Paramonov and L. Pshenichnov
- WG-FSA-18/05 Hydroacoustic data obtained around Elephant Island and South Orkney Islands during austral summer 2018
N.A. Alegría and P.M. Arana
- WG-FSA-18/06 Preliminary insights of Antarctic toothfish sub-adults life-history traits from the southern Weddell Sea (Subarea 48.5)
M. La Mesa, F. Donato and E. Riginella
- WG-FSA-18/07 Managing the Ross Sea toothfish fisheries – A response to the consultation responses (COMM CIRC 18/39)
Secretariat
- WG-FSA-18/08 Rev. 1 Informing the Working Group on Fish Stock Assessment about the revisions of the WSMPA proposal about the revisions of the WSMPA proposal
S. Hain, K. Teschke, H. Pehlke and T. Brey on behalf of the German Weddell Sea MPA project team
- WG-FSA-18/09 Implementation of by-catch move-on rules in exploratory fisheries
Secretariat

| | |
|---------------------|---|
| WG-FSA-18/10 | Fish by-catch in the krill fishery: 2018 update Secretariat |
| WG-FSA-18/11 Rev. 1 | Implementation of the CCAMLR Scheme of International Scientific Observation during 2017/18 Secretariat |
| WG-FSA-18/12 | Estimates of local biomass with uncertainty for Antarctic (<i>Dissostichus mawsoni</i>) and Patagonian (<i>D. eleginoides</i>) toothfish in research blocks in Subareas 48.6 and 58.4 Secretariat |
| WG-FSA-18/13 Rev. 1 | Summary of incidental mortality associated with fishing activities collected in scientific observer and vessel data during the 2018 season Secretariat |
| WG-FSA-18/14 | Meta-analysis of catch reporting in CCAMLR exploratory fisheries Secretariat |
| WG-FSA-18/15 | Measurement of capacity in CCAMLR exploratory fisheries in Subareas 88.1 and 88.2: Secretariat update 2018 Secretariat |
| WG-FSA-18/16 Rev. 1 | Research proposal for <i>Dissostichus</i> spp. in Subarea 88.3 by Ukraine in 2019 Delegation of Ukraine |
| WG-FSA-18/17 | Analysis of gear loss by fishing vessels in the CCAMLR Convention Area as contribution to the marine debris program Secretariat |
| WG-FSA-18/18 | Report on the CCAMLR Marine Debris monitoring program: 2018 update Secretariat |
| WG-FSA-18/19 | Mesozooplankton distribution and community structure in the Pacific and Atlantic sectors of the Southern Ocean during austral summer 2017/18: a pilot study conducted from Ukrainian longliners E.A. Pakhomov, L.K. Pshenichnov, A. Krot, V. Paramonov, I. Slypko and P. Zabroda |
| WG-FSA-18/20 Rev. 1 | Research proposal for <i>Dissostichus</i> spp. in Subarea 48.1 by Ukraine in 2019 Delegation of Ukraine |

| | |
|--------------|---|
| WG-FSA-18/21 | Trophic niche of the Antarctic toothfish caught in SSRU 88.3 as inferred from fatty acids and stable isotopes C.-K. Kang, S.-G. Choi, H.Y. Kang, Y.-J. Lee, S. Chung and D.H. An |
| WG-FSA-18/22 | Depth and temperature preferences of Antarctica toothfish (<i>Dissostichus mawsoni</i>) from a pilot popup satellite archival tag study in the Mawson Sea C.H. Lam, S.-G. Choi, E. Kim, S. Chung, J. Lee and D.H. An |
| WG-FSA-18/23 | Report on recent French catches of sea pens (Pennatulacea) in Lena Bank (CCAMLR sector 58.4.4b) A. Martin, J. Blettery and M. Eléaume |
| WG-FSA-18/24 | Diet composition and feeding strategy of Antarctic toothfish, <i>Dissostichus mawsoni</i> in the research blocks 58 and 88 for the exploratory longline fishery in 2014–2018 of Korea G.W. Baeck, S.-G. Choi, S. Chung and D.H. An |
| WG-FSA-18/25 | Sharks by-catch observed on bottom longlines fishery off the Kerguelen Islands in 2006–2016, with a focus on <i>Etmopterus viator</i> C. Chazeau, S.P. Iglésias, N. Gasco, A. Martin and G. Duhamel |
| WG-FSA-18/26 | Preliminary tag-recapture based population assessment of Antarctic toothfish in Subarea 48.4 T. Earl and A. Riley |
| WG-FSA-18/27 | Stock status and population assessment of the Antarctic starry skate (<i>Amblyraja georgiana</i>) in Subarea 48.3 M. Söfftker, N.D. Walker, M. Belchier and J. Ellis |
| WG-FSA-18/28 | Report on fish by-catch on exploratory fishing in Divisions 58.4.1 and 58.4.2 C. Péron, P. Yates, D. Maschette, C. Chazeau, P. Ziegler, D. Welsford, N. Gasco and G. Duhamel |
| WG-FSA-18/29 | New C2 form project N. Gasco, C. Chazeau, A. Martin, P. Pruvost, C. Péron and G. Duhamel |
| WG-FSA-18/30 | Improving observer's identification skills for better data quality through a phone application N. Gasco, A. Martin, C. Chazeau, C. Péron, P. Pruvost and G. Duhamel |

| | |
|---------------------|---|
| WG-FSA-18/31 | Outline for year 3 of the 3-year longline survey to determine toothfish population connectivity between Subareas 48.2 and 48.4 G. Robson, P. Hollyman and C. Darby |
| WG-FSA-18/32 Rev. 1 | Research program on study of life cycle, species composition, biology and resource potential of craboids (Anomura, Decapoda) in the Pacific Ocean Antarctic Area in 2018–2021 by the Russian Federation Delegation of the Russian Federation |
| WG-FSA-18/33 Rev. 1 | Research program to examine the life cycle and resource potential of <i>Dissostichus</i> species in the Special Research Zone within the Ross Sea region marine protected area (RSRMPA) in 2018–2027 Delegation of the Russian Federation |
| WG-FSA-18/34 | Proposed continuation of a multi-Member longline survey on Antarctic toothfish (<i>Dissostichus mawsoni</i>) in Statistical Subarea 48.6 in 2018/19 by Japan, South Africa and Spain Delegations of Japan, South Africa and Spain |
| WG-FSA-18/35 | Preliminary results from the second year of a three-year survey into the connectivity of toothfish species in Subareas 48.2 and 48.4 – update to WG-SAM-18/30 G. Robson, M. Söffker, E. MacLeod and P. Hollyman |
| WG-FSA-18/36 | Summary of the toothfish fishery and tagging program in the Amundsen Sea region (SSRUs 882C–H) to 2017/18 S. Mormede and S. Parker |
| WG-FSA-18/37 | Progress towards an assessment of Antarctic toothfish (<i>Dissostichus mawsoni</i>) in Subarea 88.2 SSRUs 882C–H for the years 2002/03 to 2017/18 using a two-area model S. Mormede and S. Parker |
| WG-FSA-18/38 Rev. 1 | Proposal for a skate tagging program in the Ross Sea region to estimate the local biomass trend for starry skates (<i>Amblyraja georgiana</i>) S. Parker and M. Francis |
| WG-FSA-18/39 | Research results from the SPRFMO exploratory fishing program for Antarctic toothfish 2016 and 2017 J.M. Fenaughty, M. Cryer and A. Dunn |
| WG-FSA-18/40 | Proposal for a winter longline survey of Antarctic toothfish in the northern region of Subareas 88.1 and 88.2 Delegation of New Zealand |

- WG-FSA-18/41 Proposal to continue the time series of research surveys to monitor abundance of Antarctic toothfish in the southern Ross Sea, 2018–2022
S.M. Hanchet, K. Large, S.J. Parker, S. Mormede and A. Dunn
- WG-FSA-18/42 Revised joint research proposal for *Dissostichus* spp. in Subarea 88.3 by Korea and New Zealand
Delegations of the Republic of Korea and New Zealand
- WG-FSA-18/43 A new method to produce high resolution maps of effort and catches in longline fisheries
N. Gasco, C. Péron, C. Chazeau, A. Martin, P. Pruvost and G. Duhamel
- WG-FSA-18/44 Revised continuation proposal of a multi-Member longline survey on Patagonian toothfish (*Dissostichus eleginoides*) in Division 58.4.4b in 2018/19 by Japan and France
Delegations of Japan and France
- WG-FSA-18/45 Spatial distribution and population structure of juvenile Antarctic toothfish (*Dissostichus mawsoni*) in the South Shetland Islands (Subarea 48.1)
M. La Mesa, E. Riginella and C.D. Jones
- WG-FSA-18/46 Summary of the toothfish fishery and tagging program in the Ross Sea region (Subarea 88.1 and SSRUs 882A–B) through 2017/18
S. Mormede and S. Parker
- WG-FSA-18/47 A comparative morphometric analysis of sagittal otoliths of three icefishes (Channichthyidae) in Antarctic waters
G. Plaza, C. Rodríguez-Valentino and P.M. Arana
- WG-FSA-18/48 Rev. 1 Description of the tagging process and the development of a cradle for optimum landing and measuring of large fish followed by the Spanish F/V *Tronio*
R. Sarralde, C. Heinecken and P. Lafite
- WG-FSA-18/49 Rev. 1 Progress report on the research for *Dissostichus* spp. in Subarea 48.2 by the Ukraine in 2015–2018 and notification of research in 2019
Delegation of Ukraine
- WG-FSA-18/50 Annual report of research fishing operations at Division 58.4.3a in the 2017/18 fishing season
Delegations of France and Japan

| | |
|---------------------|---|
| WG-FSA-18/51 | Preliminary report on invertebrate by-catch in research blocks 58.4.1, 58.4.2, 54.4.3a and 58.4.4b M. Eléaume, C. Chazeau, A. Martin and J. Blettery |
| WG-FSA-18/52 | Subarea 48.2 research and research proposals for 2019 – overview G. Robson, L. Pshenichnov, D. Marichev and C. Darby |
| WG-FSA-18/53 Rev. 1 | Information about tagged Patagonian toothfish (<i>Dissostichus eleginoides</i>) tagged in the CCAMLR Convention Area and recovered in the SIOFA management area by two Spanish vessels in 2017/18 R. Sarralde and S. Barreiro |
| WG-FSA-18/54 Rev. 1 | Update of ongoing work on age and growth of Antarctic toothfish (<i>Dissostichus mawsoni</i>) from Division 58.4.1 by Australia and Spain L.J. López-Abellán, M.T.G. Santamaría, R. Sarralde, S. Barreiro, B. Farmer and T. Barnes |
| WG-FSA-18/55 | Estimates of abundance of <i>Dissostichus eleginoides</i> and <i>Champscephalus gunnari</i> from the random stratified trawl survey in the waters surrounding Heard Island in Division 58.5.2 for 2018 G. Nowara, T. Lamb and P. Ziegler |
| WG-FSA-18/56 | A preliminary assessment for mackerel icefish (<i>Champscephalus gunnari</i>) in Division 58.5.2, based on results from the 2018 random stratified trawl survey D. Maschette and D. Welsford |
| WG-FSA-18/57 | Report on fishing effort and seabird interactions during the season extension trials in the longline fishery for <i>Dissostichus eleginoides</i> in Statistical Division 58.5.2 T. Lamb |
| WG-FSA-18/58 Rev. 1 | Report on <i>Dissostichus mawsoni</i> exploratory fishery research in East Antarctica (Divisions 58.4.1 and 58.4.2) between the 2011/12 and 2017/18 fishing seasons P. Yates and P. Ziegler |
| WG-FSA-18/59 | Proposal for multi-Member research on the <i>Dissostichus mawsoni</i> exploratory fishery in East Antarctica (Divisions 58.4.1 and 58.4.2) from 2018/19 to 2021/22 Delegations of Australia, France, Japan, Republic of Korea and Spain |

| | |
|---------------------|--|
| WG-FSA-18/60 | Analyses of illegal, unreported and unregulated (IUU) fishing activities in Divisions 58.4.1 during the 2013/14 season and 58.4.3b during the 2014/15 season Delegation of Australia and CCAMLR Secretariat |
| WG-FSA-18/61 | Revised continuation proposal of multi-Member research on Patagonian toothfish (<i>Dissostichus eleginoides</i>) exploratory fishery in 2018/19 in Division 58.4.3a by France and Japan Delegations of France and Japan |
| WG-FSA-18/62 | Baited Remote Underwater Video (BRUV) system to monitor Antarctic toothfish distribution and abundance: pilot study results and future design D. Di Blasi, S. Canese, E. Carlig, L. Ghigliotti, S.J. Parker and M. Vacchi |
| WG-FSA-18/63 Rev. 1 | Indicative trends in by-catch of sharks in the CAMLR Convention Area C.D. Jones |
| WG-FSA-18/64 | Progress update on Antarctic toothfish inter-connectivity project D. Maschette, A. Polanowsk, B. Deagle, D.C. Welsford and P. Ziegler |
| WG-FSA-18/65 | Reproductive ecology of Antarctic toothfish, <i>Dissostichus mawsoni</i> (Norman, 1937) (Actinopterygii: Nototheniidae), in the Antarctic waters (SSRUs 58 and 88) J.-W. Kim, S.-G. Choi, S. Chung and D.H. An |
| WG-FSA-18/66 | Towards further development of stock assessment of stock abundance for Subarea 48.6 taking into account the developments since 2012 – a discussion paper Delegations of Japan and South Africa |
| WG-FSA-18/67 | Annual report of research fishing operations at Division 58.4.4b in the 2017/18 fishing season Delegations of Japan and France |
| WG-FSA-18/68 | Spatial pattern of major by-catch fishes at Division 58.4.4b during 2012/13–2016/17 Delegations of Japan and France |
| WG-FSA-18/69 | Spatial pattern of major by-catch fishes at Division 58.4.3a during 2012/13–2016/17 Delegations of Japan and France |

| | |
|--------------|--|
| WG-FSA-18/70 | Spatial pattern of major by-catch fishes at Subarea 48.6 during 2012/13–2016/17 Delegations of Japan and South Africa |
| WG-FSA-18/71 | Annual report of research fishing operations at Subarea 48.6 in the 2017/18 fishing season Delegations of Japan and South Africa |
| WG-FSA-18/72 | Preliminary results of stock estimation for <i>D. mawsoni</i> using CASAL in the research block 486_2 T. Okuda |
| WG-FSA-18/73 | Genetic analysis of skates (<i>Amblyraja</i> spp.) caught as by-catch around South Georgia and the South Sandwich Islands W.P. Goodall-Copestake, S. Perez-España, P. Hollyman and M. Belchier |
| WG-FSA-18/74 | Ageing two myctophid fishes using otolith from king and macaroni penguins in the Marion Island and its implication to feeding preference of penguins on those myctophids M. Duan, G.P. Zhu, A. Makhado and L. Wei |
| WG-FSA-18/75 | Otolith chemistry reveals local population structure of Antarctic toothfish (<i>Dissostichus mawsoni</i>) within the CCAMLR Subarea 48.6 L. Wei, G.P. Zhu, S. Somhlaba, X.Y. Yu and M. Duan |
| WG-FSA-18/76 | Fatty acids composition of spiny icefish <i>Chaenodraco wilsoni</i> in the Bransfield Strait and its implication to local food availability Q.Y. Yang, G.P. Zhu and K. Reid |

Other documents

| | |
|-------------------|--|
| WG-FSA-18/P01 | New Antarctic deep-sea weird leech (Hirudinida: Piscicolidae): morphological features and phylogenetic relationships A. Utevsky and S. Utevsky <i>Syst. Parasitol.</i> , (2018). Springer, Netherlands, doi: https://doi.org/10.1007/s11230-018-9816-y . This article was registered in the Official Register of Zoological Nomenclature (ZooBank) as 0FFF1867-BF3B-4D2B-83EFBE894F838912 |
| CCAMLR-XXXVII/12 | IUU fishing activity and trends in 2017/18 and IUU Vessel Lists Secretariat |
| SC-CAMLR-XXXVI/20 | The Ross Sea region Marine Protected Area Research and Monitoring Plan A. Dunn, M. Vacchi and G. Watters (Co-conveners) |

| | |
|------------------------------|--|
| SC-CAMLR-XXXVII/01 | Report of the Co-conveners of the CCAMLR Workshop for the Development of a <i>Dissostichus mawsoni</i> Population Hypothesis for Area 48 (19 to 21 February 2018, Berlin, Germany) Workshop Co-conveners (C. Darby (UK) and C. Jones (USA)) |
| SC-CAMLR-XXXVII/02 Rev. 1 | Summary Report of the CCAMLR Independent Stock Assessment Review for Toothfish (Norwich, United Kingdom, 18 to 22 June 2018) |
| SC-CAMLR-XXXVII/BG/01 Rev. 2 | Catches of target species in the Convention Area Secretariat |
| SC-CAMLR-XXXVII/BG/21 | Marine debris and entanglements at Bird Island and King Edward Point, South Georgia, Signy Island, South Orkneys and Goudier Island, Antarctic Peninsula 2017/18 C. Waluda |
| SC-CAMLR-XXXVII/BG/23 | Efficiency of the multi-year research programs for the <i>Dissostichus</i> species exploratory fishery: comments on the multi-Member research in the East Antarctic (Division 58.4.1) Delegation of the Russian Federation |
| WG-SAM-18/33 Rev. 1 | Annex to WS-DmPH-18 report: Towards the development of a stock hypothesis for Antarctic toothfish (<i>Dissostichus mawsoni</i>) in Area 48 M. Söflker, A. Riley, M. Belchier, K. Teschke, H. Pehlke, S. Somhlaba, J. Graham, T. Namba, C.D. van der Lingen, T. Okuda, C. Darby, O.T. Albert, O.A. Bergstad, P. Brtnik, J. Caccavo, A. Capurro, C. Dorey, L. Ghigliotti, S. Hain, C. Jones, S. Kasatkina, M. La Mesa, D. Marichev, E. Molloy, C. Papetti, L. Pshenichnov, K. Reid, M.M. Santos and D. Welsford |

Using catch data in fishery monitoring and closure forecasting in the Ross Sea toothfish fisheries

1. This procedure has been developed specifically for the Ross Sea, it would be equally applicable to any area for which the catch limit was small and the number of vessels notified to fish was large.

2. For the first three days of fishing operations in the Ross Sea region, which will open on 1 December, calculations will be made on historical catch data for the vessels that have notified their intent to fish. The historical catch rate (kg/day) for any vessel notified to fish in an area of Conservation Measure (CM) 41-09 (northern, southern) will be calculated as the sum of the catch taken in the relevant area over the last five years divided by the number of days fished, defined as a day on which hooks were set, in the relevant area over the last five years. The catch rate applicable to vessels which have not fished in the relevant area in any of the last five years will be the sum of the total catch by all vessels divided by the number of days fished by all vessels over the last five years.

3. The Secretariat will request that all vessels that are present send a message to the Secretariat by 0001 UTC on 30 November to indicate if they intend to fish in the area north of 70°S on 1–3 December; noting that a null response will be interpreted as intention to fish.

4. On 30 November the Secretariat will calculate a projected daily total catch for each vessel that is present in the relevant area and that has declared its intention to fish, using the historical daily catch calculation described in paragraph 2. Based on this projection, the Secretariat will apply the following procedure:

- (i) if an area in a fishery is projected to exceed its catch limit after only one day of setting hooks, the Secretariat will advise Members accordingly and that area of the fishery will not be opened; or
- (ii) if an area in a fishery is projected to exceed its catch limit after two days of setting hooks, a notification that that area of the fishery would close at 2359 on 2 December (i.e. with no gear set after 2359 on 1 December) will be made on 30 November; or
- (iii) if an area in a fishery is projected to exceed its catch limit after three days of setting hooks, the Secretariat will not indicate a closure for that area of the fishery until data from 1 December is available. The historical catch data for those vessels that are actively fishing will then be used in the projection
- (iv) a revised projection indicating that an area in the fishery will exceed its catch limit after five days of setting hooks would result in a notification of closure from 2359 on 4 December

- (v) if the revised projection indicates that an area in the fishery will not exceed its catch limit after five days of setting hooks, the Secretariat will, on day 4, transition to a projection based on catch and effort data from the current season.

5. The Secretariat will inform Members and vessels of the outcomes of this procedure on 30 November, and as required thereafter.

6. Because the catch in the northern area of the Ross Sea is relatively low, significant over- or under-runs of the limit may be expected. Both over- or under-runs can be accommodated within the overall catch limit with the following change to CM 41-09:

The total catch of *Dissostichus mawsoni* in the 2018/19 season in Statistical Subarea 88.1 and SSRUs 882A–B shall not exceed a precautionary catch limit of 3 157 tonnes applied as follows:

All areas outside the Ross Sea region marine protected area –

2 645 tonnes, of which no more than 591 tonnes be taken north of 70°S.

If, however, more than 591 tonnes have been taken north of 70°S by the time that the Secretariat has issued a closure notice for the fishery north of 70°S, then the amount that may be taken south of 70°S is reduced by the amount taken over 591 tonnes north of 70°S.

Special Research Zone of the Ross Sea region marine protected area –

467 tonnes.

Appendix E

Vessel tagging procedures survey

All vessels should follow the CCAMLR tagging protocol for tagging toothfish (www.ccamlr.org/node/85702).

This survey has been designed for an observer to be able to complete independently from the vessel, however, it may be useful to liaise with the fishing master for accuracy in some instances (e.g. the volume of the holding tank). You are requested to select the most appropriate fields for the questions listed or provide descriptive details where instructed. If possible, provide an example representative video or photos of the tagging process which includes fish landing, fish handling, tagging, data recording and fish release.

| Equipment and operation | |
|--|---|
| Tagging station location | On deck – Open air |
| | On deck – Under cover |
| | In factory |
| | Other – Please describe |
| | How frequently are tagging guns cleaned or maintained? Every haul, periodically, once per trip |
| | Vertical distance from water surface to hauling bay (m) |
| | Vertical distance from fish release position to water surface (m) |
| | Distance from tagging station to release location (m) |
| Holding tank | |
| Holding tank information (if used) | Y/N |
| | Volume (l) |
| | Shape (square, rectangle, circle etc.) |
| | Does the tank have flowing water (Y/N) |
| Landing and handling fish | |
| Large fish landing and lifting equipment | Net |
| | Stretcher or cradle |
| | Other – Please describe |
| | Approximate minimum length of fish when lifting gear is used (cm) |
| Transporting fish | When transporting the fish between the hauling bay and the tagging station, are any of the following obstacles present: |
| | <ul style="list-style-type: none"> Bulkheads Machinery Factory equipment (e.g. conveyor belts) Steps or multiple levels |
| | Any other obstruction? |
| Is lifting equipment used to carry fish between hauling bay and tagging station? (Y/N) | |
| How are tagging data recorded at the tagging station? | Direct to computer/Paper data sheet/waterproof board or notepad/Photograph/Other |
| Releasing fish | Describe any aids used for release of fish (e.g. cradle, slide) |

| Personnel and training | |
|--|--|
| Tagging responsibilities | Crew |
| | Observer(s) |
| | Combination |
| | Number of crew trained for tagging procedures |
| | If any tagging training occurs on the vessels is it practical, theoretical or a combination? |
| | Languages by crew trained for tagging |
| | Title of person responsible for overall tagging training (e.g. fishing master, bosun, factory manager, observer, company representative/other) |
| | When a tagged fish is landed and the observer is not present, how is the observer notified? |
| Assessment of fish suitability for tagging | CCAMLR tagging protocol and fish suitability assessment criteria available for viewing near tagging station: (Y/N) |