Annex 7

Report of the Working Group on Fish Stock Assessment
(Hobart, Australia, 2 to 13 October 2017)

Contents

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Opening of the meeting

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 2 to 13 October 2017. The Convener, Dr D. Welsford (Australia), opened the meeting and welcomed participants to Hobart (Appendix A). As in previous meetings, Dr Welsford encouraged all participants to engage in discussion and where differences of views existed that these be presented as different testable hypotheses rather than simply as statements of positions.

1.2 Mr A. Wright (Executive Secretary) extended the Secretariat's warm welcome to all participants and Mr T. Jones and Ms B. Blackburn (Secretariat) provided an overview of the meeting server and web-based support provided by the Secretariat.

Organisation of the meeting and adoption of the agenda

2.1 The work plan for WG-FSA at this meeting was focused on providing advice on:

(i) outcomes of assessments in CCAMLR fisheries
(ii) reviewing progress in research activities involving toothfish
(iii) review of outcomes of the Workshop on the Scheme of International Scientific Observation (WS-SISO) of relevance to WG-FSA.

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

2.3 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.

2.4 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).

2.5 The report was prepared by M. Belchier (UK), P. Burch (Australia), C. Darby and T. Earl (UK), J. Fenaughty (New Zealand), I. Forster and E. Grilly (Secretariat), C. Jones (USA), D. Maschette (Australia), S. Mormede and S. Parker (New Zealand), K. Reid (Secretariat), M. Söffker (UK), S. Somhlaba (South Africa), P. Yates and P. Ziegler (Australia).

Subgroup organisation and coordination

2.6 Dr Welsford reminded the Working Group that all substantive discussions, and particularly discussions leading to advice to the Scientific Committee, would be conducted in plenary. Where items require additional detailed discussion, some of the work of the meeting may be considered in subgroups and the outcomes of these subgroup discussions reported to the plenary.

Review of data available

Secretariat information and data systems

2.7 The Executive Secretary reported on a restructuring of Secretariat data services undertaken during 2017. He noted that the overarching goal was to strengthen the Secretariat's information and data services to Members. The restructure included the merging of the previous Data Services with Information and Communications Technology, the transfer of fishery monitoring responsibilities to Fishery Monitoring and Compliance, previously undertaken by Data Services, and securing appropriate information systems and data management expertise. He anticipated that the restructure would lead to improved efficiencies in relation to the use of available Secretariat resources, increased technical engagement with users, an unambiguous focus for information systems and data service responsibilities in the Secretariat and increased rigor around strategic planning to support information and data processes, including in relation to data quality, data products, web-based data services, data documentation and user requirements.

2.8 The Executive Secretary noted that the restructure had led to the departure of Dr David Ramm who had made a valuable contribution to CCAMLR over 21 years. This followed the departure of Lydia Millar in December 2016. Lydia had dedicated 19 years to CCAMLR. On behalf of all CCAMLR Members, the Executive Secretary expressed appreciation to Dr Ramm and Ms Millar for their respective contributions to the organisation.

2.9 The Working Group thanked the Secretariat for the very informative presentations and also thanked Dr Ramm and Ms Millar for their contributions to the Working Group over many years.

2.10 The Working Group noted the developments in Information Systems and Data Services during 2017, noting their relationship to the projects identified in SC-CAMLR-XXXV/BG/25. The Information Systems and Data Services Manager reported on the new automated data load and the resulting improvements in efficiencies and reliability of the data processing for catch and effort and observer data submissions and the proposed development for C1 and C2 data forms. It was also highlighted how the process of automating the data load also triggered developments in related projects, developing data rules and redeveloping a data registry. A new online GIS, currently in development by British Antarctic Survey (BAS), was presented to the Working Group, supported by a data portal that supports the provision of data and basic metadata.

2.11 The Working Group acknowledged the changes introduced by the Secretariat in the information and data systems management and recognised that this was a long-term project intended to yield efficiencies and improved data quality to the work of WG-FSA.

2.12 The Working Group noted that the e-group established to develop terms of reference for the data management group (DMG) had not been able to conclude its work intersessionally and provided feedback to the Secretariat in order to revise the terms of reference for presentation to the Scientific Committee. In particular, the Working Group noted the importance of providing an enhanced mechanism for communication between the Secretariat and data providers, as well as data users, in order to ensure that the workplan of the Secretariat and the expectations of Members with respect to information and data management services are met. The Working Group noted the terms of reference as documented in SC-CAMLR-XXXVI/BG/28 Rev. 1.

2.13 The Working Group agreed that through the period of change in the Secretariat's information and data management processes it was important to have documentation available in an accessible format in order to explain to data users what additional data quality measures are being implemented as part of the data loading process and the potential impacts of these as they are applied to historical data holdings.

Illegal, unreported and unregulated (IUU) fishing activities

2.14 The Secretariat presented CCAMLR-XXXVI/28 Rev. 2 that provided area-specific information on illegal, unreported and unregulated (IUU) fishing activity, including:

(i) in 2017, gillnets had been reported by Members during fishing operations in Subarea 48.6 and Divisions 58.4.1 and 58.5.2, but there were no reports of vessel sightings

(ii) various action taken by Contracting Parties, non-Contracting Parties and other organisations, including Interpol, in respect of CCAMLR IUU-listed vessels resulting in the investigation and prosecution of beneficial owners or the detainment or sinking of several IUU-listed vessels

(iii) catch data obtained by Spain from three IUU-listed vessels, the *Asian Warrior*, *Zemour 1* and *Zemour 2* operating in Division 58.4.1 in 2014. This data is likely to represent typical IUU fishing activity in Division 58.4.1 since 2004, when the vessels were first sighted, until 2015, when global action against these vessels was underway.

2.15 The Working Group welcomed the new information on IUU activity and, in particular, the catch data from the IUU-listed vessels using gillnets in areas in which research fishing is undertaken. The data emerging from ongoing investigations confirms that IUU fishing remains an important issue for CCAMLR and especially the potential impacts on research fishing in Division 58.4.1 (paragraph 4.136).

2.16 The Working Group noted the unprecedented availability of catch data from IUU vessels that included:

(i) reported removals
(ii) video footage
(iii) catch in gillnets recovered by an authorised vessel

and agreed that this data could allow a review of the relationship between reported IUU vessel sightings and levels of removals and requested further analysis of the data in order to evaluate:

(iv) any additional data that becomes available

(v) toothfish catch per unit effort (CPUE) (by weight and number) and spatial and temporal variations in catch rates

(vi) species and size compositions, including primary by-catch groups

(vii) size selectivity of gillnets

(viii) temporal variation in the spatial distribution of IUU activity (e.g. investigating the likelihood of a transition between exploratory and more targeted activity)

(ix) potential impacts of IUU removals on previous research conducted in the region (also with the aid of mapping the spatial and temporal overlap with CCAMLR research)

(x) the temporal and spatial distribution of authorised fishing vessels in relation to available IUU data.

2.17 The Working Group welcomed the offer from Dr Yates to work with the Secretariat to coordinate the analysis of IUU data from Division 58.4.1 and noted that if other data becomes available during the course of the intersessional period, then this should be included in the analysis.

2.18 The Working Group also noted that in 2014 the *Asian Warrior*, *Zemour 1* and *Zemour 2* appear to have concentrated fishing effort in areas coinciding with relatively high predicted mean weight and proportions of fish that were mature (WG-FSA-17/16). The Working Group noted that spatial predictions such as those in WG-FSA-17/16 may facilitate estimation of toothfish and by-catch catch compositions for these IUU vessels. Conversely, the data from IUU vessels may contribute to validating spatial predictions.

Long-distance movements of toothfish

2.19 The Secretariat presented WG-FSA-17/04 that provided an update of WG-FSA-16/04 on the long-distance movements of toothfish arising from the CCAMLR tagging program. The analysis indicated that while most toothfish are recaptured close to their tagging location, some fish undertake movements of thousands of kilometres between release and recapture. For both species, 80–90% of fish that undertook movements of >200 km (and moved between fisheries) moved in an anticlockwise direction, although the reason for this distinct pattern in directionality remains unclear.

2.20 The Working Group thanked the Secretariat for this useful paper and noted that while the pattern of movement is important in defining the biological population, this may have limited impacts on the definition of fishery stock units, but the potential for movements to introduce biases into assessments should be taken into consideration in stock assessments.

2.21 The Working Group also noted that investigating the length of fish that undertook long-distance movement, as well as potentially examining otolith microchemistry, could provide insights into the life-history characteristics of those fish that undertake long-distance movements (paragraphs 6.7 and 6.8).

Data from the current fishing season

2.22 The Working Group reviewed data submitted to the Secretariat from CCAMLR fisheries and fishery-based research in 2016/17 (SC-CAMLR-XXXVI/BG/01 Rev. 1) and noted the total

catches in fisheries for Antarctic (*Dissostichus mawsoni)* and Patagonian (*D. eleginoides)* toothfish, mackerel icefish (*Champsocephalus gunnari*) and Antarctic krill (*Euphausia superba*) in the Convention Area.

2.23 The Working Group noted that some fisheries for *D. mawsoni* were closed by the Secretariat in 2016/17 (SC-CAMLR-XXXVI/BG/01 Rev. 1). All but one of these closures were triggered by catches of *D. mawsoni* approaching the relevant catch limits, while the closure of research block 5841_6 was triggered when the by-catch limit for Macrourids was reached (paragraph 6.7).

2.24 The Working Group noted that there was a 56% overrun of the catch limit in Subarea 88.1 SSRUs B, C, G with a catch of 596 tonnes compared to a catch limit of 378 tonnes with a closure date of 4 December 2016, four days after the opening of the fishery. The Working Group also noted that the overall catch in Subarea 88.1 was 98% of the catch limit for the whole fishery.

2.25 The Working Group noted that other options may be available to avoid catch overruns, such as effort limitation or increased frequency of catch and effort reporting to the Secretariat as well as the potential to increase the reporting to the fishery on the cumulative catch (paragraphs 3.88 to 3.100). The Working Group encouraged further consideration of such options.

CASAL verifications

2.26 The Secretariat performed verifications of CASAL-based assessments for *D. eleginoides* in Subareas 48.3, 48.4 and 58.6 and in Divisions 58.5.1 and 58.5.2 as well as for *D. mawsoni* in Subarea 88.1 using the input parameter files, output files and initial assessment results (maximum of the posterior density (MPD) estimates) from the CASAL assessments submitted to WG-FSA in 2017. CASAL version v. 2.30-2012-03-21 rev. 4648 was used for the verification runs. There was no difference in any of the *D. eleginoides* assessments and less than 2% difference in the MPD estimate of unfished spawning biomass (B_0) in the *D. mawsoni* assessment.

2.27 The Working Group recalled that in 2014 WG-SAM (SC-CAMLR-XXXIII, Annex 5, paragraph 2.29; SC-CAMLR-XXXIII, paragraph 2.7) recommended that CASAL version 2.30-2012-03-21 rev. 4648 be considered the current approved CCAMLR version until a process is agreed for validating and approving updated software and the use of newer versions of CASAL would need to be reviewed by WG-SAM and would require documentation and sufficient justification.

2.28 The Working Group agreed that if Members are aware of benefits of using newer versions of CASAL that these versions be brought to WG-SAM for review in order to allow all Members developing assessments to benefit from those newer versions.

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

Champsocephalus gunnari

C. gunnari in Subarea 48.3

3.1 The fishery for *C. gunnari* in Subarea 48.3 operated in accordance with Conservation Measure (CM) 42-01 and associated measures. In 2016/17, the catch limit for *C. gunnari* was 2 074 tonnes. Fishing early in the season was conducted by one vessel using midwater trawls and the total reported catch was 66 tonnes as of 28 September 2017. Details of this fishery and the stock assessment of *C. gunnari* are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.2 The Working Group noted that in recent years low amounts of fishing effort were being deployed in Subarea 48.3 and that this has resulted in a very low uptake of the catch limit by the fishery. Only one vessel had fished up to the time of the 2017 WG-FSA meeting, trawling for 89 hours, which compared to a total average vessel trawling time of 1 500 hours per season during the early 2000s when the uptake of the catch limits was higher.

3.3 In January 2017, as part of its regular monitoring program (WG-FSA-17/44), the UK undertook a random stratified bottom trawl survey of the South Georgia and Shag Rocks shelves. A total catch of 17.4 tonnes of *C. gunnari* was reported from the research survey. Stomach content analysis showed a higher than expected proportion of *Themisto* sp., rather than the krill seen in other years.

3.4 WG-FSA-17/51 compared methods of aggregating the length distributions from multiple hauls using a mean of positive values (as previous assessments in this subarea), or a sum (equivalent to a mean of all values). The Working Group agreed that the assessment should change to using the sum, which reduces the likelihood of over-representing young fish in the population length distribution when small fish are clustered in particular survey strata.

3.5 WG-FSA-17/47 presented a preliminary assessment of *C. gunnari* in Subarea 48.3 based on the random stratified bottom trawl survey. A bootstrap procedure was applied to the survey data to estimate the demersal biomass of *C. gunnari* in this subarea. The bootstrap estimated the median demersal biomass at 91 531 tonnes, with a one-sided lower 95% confidence interval of 47 424 tonnes. A catch limit of 4 733 tonnes for 2017/18 and 3 269 tonnes for 2018/19 would ensure at least 75% biomass escapement after a two-year projection period.

Management advice

3.6 The Working Group recommended that the catch limit for *C. gunnari* in Subarea 48.3 should be set at 4 733 tonnes for 2017/18 and 3 269 tonnes for 2018/19.

C. gunnari at Kerguelen Islands (Division 58.5.1)

3.7 A short-term assessment of *C. gunnari* in Division 58.5.1 was conducted based on the northeast part of the 2017 POKER biomass survey (WG-FSA-17/63). A bootstrap procedure

was applied to the survey data to estimate the demersal biomass of *C. gunnari* in this stratum. The assessment was implemented using the generalised yield model (GYM). The bootstrap estimated the mean demersal biomass at 35 368 tonnes for the northeast shelf, with a one-sided lower 95% confidence interval of 19 399 tonnes. The catch was dominated by a single 2+ age class. The CCAMLR harvest control rule, which ensures 75% biomass escapement after a two-year projection period, yielded a catch limit of 3 081 tonnes for 2017/18 and 2 753 tonnes for 2018/19.

3.8 The Working Group recalled its advice regarding the design of strata used in the icefish assessment in Division 58.5.1 (SC-CAMLR-XXXV, Annex 7, paragraphs 3.9 to 3.13), and recommended that further stratification of the northeast region be considered in future surveys, taking account of factors such as depth and distribution observed in previous surveys. It also requested a report on the most recent POKER survey be tabled to WG-FSA.

C. gunnari at Heard Island (Division 58.5.2)

3.9 The fishery for *C. gunnari* in Division 58.5.2 operated in accordance with CM 42-02 and associated measures. In 2016/17, the catch limit for *C. gunnari* was 561 tonnes. Fishing was conducted by one vessel and the total reported catch up to 28 September 2017 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).

3.10 The results of a random stratified trawl survey in Division 58.5.2 undertaken in April 2017 were summarised in WG-FSA-17/14 Rev. 1. The Working Group noted that *C. gunnari* catch rates were substantially higher than the long-term average from 2006 to 2016. Based on data gathered during the survey, an assessment was presented in WG-FSA-17/22. The length–weight relationship and growth parameters were updated using the survey data. The best fit of CMIX to the survey length distribution was achieved when the population was estimated to consist of three year classes from 1+ to 3+, with the 3+ cohort containing the largest number of fish, and estimated to make up 97% of the biomass.

3.11 A short-term assessment was conducted in GYM, using the one-sided bootstrap lower 95% confidence bound of total biomass of 3 901 tonnes of age 1+ to 3+ fish from the 2017 survey and fixed model parameters. Estimates of yield indicate that 526 tonnes of icefish could be taken in 2017/18 and 395 tonnes in 2018/19.

Management advice

3.12 The Working Group recommended that the catch limit for *C. gunnari* in Division 58.5.2 should be set in 2017/18 at 526 tonnes and at 395 tonnes in 2018/19.

Issues common to *C. gunnari* assessments

3.13 The Working Group recommended that a standard set of diagnostic plots and information are included in each of the assessments of *C. gunnari*, relating to the survey and assessment:

(i) Survey information –

(a) haul data – location (map including bubble plots) and catch and CPUE (table) including strata

(b) haul-by-haul CPUE (kg/km^2) column chart including strata

(c) number of fish measured and weighed from the survey used in the assessment

(d) time series of length-frequency distribution.

(ii) Assessment –

(a) distribution plot of the bootstrap runs of survey biomass

(b) survey biomass time series plot (estimates of biomass with confidence intervals including lower one-sided 95th percentile)

(c) CMIX plots where applicable

(d) code used for conducting calculations and assessment

(e) table of parameters used and their source

(f) previous lower 95th percentile stock assessment projection versus survey estimated time series.

3.14 Examples of these diagnostics will be developed intersessionally between interested Members and presented to WG-SAM-18.

3.15 The Working Group noted that in previous assessments, hauls with exceptionally high CPUE had been excluded from the analysis in an ad hoc fashion. The Working Group recommended that where outliers existed, a sensitivity analysis of their influence on the assessment should be performed, and further consideration given as to whether the stratification remains appropriate.

3.16 Dr S. Kasatkina (Russia) noted that *C. gunnari* is a species with semi-pelagic distribution. Investigations provided in previous years showed that bottom trawl surveys significantly underestimate *C. gunnari* biomass (SC-CAMLR-XXII, Annex 5, paragraphs 5.153 to 5.173). Length-age composition of catches taken by bottom trawls will not reflect the population structure in terms of young and immature fish to a considerable degree. Assessment for *C. gunnari* requires estimating demersal and pelagic components of ice-fish population in the water column above the layer sampled by bottom trawl.

3.17 Dr Kasatkina noted that icefish assessment should be prepared by combining data from bottom trawl survey and acoustic survey respectively. In this case a more representative estimate of the fish biomass and population structure might be available for the projection and management advice (SC-CAMLR-XXII, Annex 5, paragraph 5.166; SC-CAMLR-XXVIII, Annex 6, paragraphs 3.23 and 3.24). Moreover, the realistic data on *C. gunnari* stock state and distribution patterns is very important for understanding the trophic chain and competitive relations considering the consumption of considerable amounts of young icefish by penguins and mammals.

3.18 The Working Group noted that the method of biomass estimation of *C. gunnari* based on bottom trawl surveys excludes an unknown and variable pelagic component of the stock. The Working Group noted that the integration of acoustic data collection with trawl survey data could potentially allow total stock biomass to be estimated and should be explored as future work.

3.19 The Working Group also recalled previous advice (SC-CAMLR-XXXII, Annex 4, paragraphs 4.31 to 4.33) based on analysis in WG-SAM-13/31 Rev. 1, which described a retrospective analysis and sensitivity evaluation of the performance of the CCAMLR harvest control rule (HCR) for *C. gunnari* in Subarea 48.3. The Working Group noted that the retrospective analysis showed biomass projections using the CCAMLR HCR algorithm for icefish in Subarea 48.3 (which does not include recruitment or the pelagic biomass component) fall below the subsequent year's survey estimates with a high probability, indicating that the projections upon which the catch advice is based are consistent with CCAMLR objectives.

Dissostichus spp.

Generic advice on assessments

3.20 The Working Group recommended that where some data series are incomplete at the time of assessment, the assessment presented to the Working Group should be based on data that have been through data quality assurance processing rather than placing an emphasis on including the most recent data. It further recommended that toothfish stock assessments should be carried out up to, and including, the current season and include the reported catch data where fishing has been completed, or the anticipated catch for the current season.

3.21 The Working Group recommended that fitting survey data as two separate datasets, a biomass index and proportions-at-age, is preferred over the numbers of fish at age to be able to distinguish between signals in biomass and year-class strength (YCS) in the survey data.

3.22 The Working Group recommended that in addition to information available in the Fishery Reports, WG-SAM consider the further development of basic indicators of fishery performance and stock status (e.g. SC-CAMLR-XXXIII, Annex 7, paragraph 2.5) that could be reported in years between stock assessments to identify any trends that may indicate an unexpected change in status or fishery performance.

D. eleginoides in Subarea 48.3

3.23 The fishery for *D. eleginoides* in Subarea 48.3 operated in accordance with CM 41-02 and associated measures. In 2016/17, the catch limit for *D. eleginoides* was 2 750 tonnes and the total reported removal was 2 192 tonnes. Fishing in the current season finished on 14 September 2017 (www.ccamlr.org/node/75667).

3.24 WG-FSA-17/53 presented an updated integrated assessment for *D. eleginoides* in Subarea 48.3. Compared to the last assessment in 2015, the model was updated with available data from 2015/16 and 2016/17, revised tagging data extracted from the CCAMLR database,

age–length keys (ALKs) were developed for the most recent two years, and depredation estimates were updated. Catch data for the 2016/17 season were complete and standardised CPUE was based on three of the six vessels (see paragraph 3.20). The CPUE and estimates of depredation were higher in 2017 than in previous assessments.

3.25 The assessment estimated B_0 at 83 200 tonnes (95% CIs: 79 000–88 100 tonnes), spawning stock biomass (SSB) of 42 200 tonnes (38 900–52 600 tonnes) and a stock status in 2017 of 0.51 (0.49–0.53). The long-term catch limit that satisfied the CCAMLR decision rules was 2 600 tonnes.

3.26 The Working Group noted that the likelihood profiles from the time series of cohorts of tagged fish showed a declining trend in the MPD values of SSB_0. The Working Group suggested that additional work to understand the pattern was a priority for future work on this assessment.

Management advice

3.27 The Working Group recommended that the catch limit for *D. eleginoides* in Subarea 48.3 be set at 2 600 tonnes for 2017/18 and 2018/19 based on the results of this assessment.

Dissostichus spp. in Subarea 48.4

D. eleginoides in the South Sandwich Islands (Subarea 48.4)

3.28 The fishery for *D. eleginoides* in Subarea 48.4 operated in accordance with CM 41-03 and associated measures. The catch limit for *D. eleginoides* in Subarea 48.4 in 2016/17 was 47 tonnes and 28 tonnes were taken (www.ccamlr.org/node/75667).

3.29 WG-FSA-17/52 presented the stock assessment which was updated with data from the 2015/16 and 2016/17 seasons of catches, length distributions, tag release and recapture data, and age data.

3.30 The Working Group recommended that future work include investigations of a potential temporal pattern in the fits to the tag data, where expected values were higher than observed up to 2007/08, and then lower than observed after 2007/08.

3.31 The Working Group noted that there is migration of *D. eleginoides* between Subareas 48.3 and 48.4, and that fish tend not to reproductively mature in Subarea 48.4, rather they likely move to Subarea 48.3 to spawn. The Working Group recommended further review of the stock hypothesis and future work to reflect links between populations in the assessments of *D. eleginoides* in Subareas 48.3 and 48.4.

Management advice

3.32 The Working Group recommended that the catch limit for *D. eleginoides* in Subarea 48.4 should be set at 26 tonnes for 2017/18 and 2018/19 based on the results of this assessment.

D. mawsoni in the South Sandwich Islands (Subarea 48.4)

3.33 The fishery for *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 2016/17 was 38 tonnes plus 18 tonnes for the research survey outlined in WG-FSA-16/40 Rev. 1, of which 19 tonnes were taken in the fishery and 17 tonnes in the research plan (www.ccamlr.org/node/75667).

3.34 WG-FSA-17/49 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 2017 was 970 tonnes (95% CI: 453–1 487 tonnes), just below the geometric mean of the series of Chapman estimates of 979 tonnes. A harvest rate of 0.038, applied to the geometric mean of the 2010–2017 series, resulted in a yield of 37 tonnes.

3.35 The Working Group noted that the confidence intervals were calculated analytically and that bootstrap or other methods to estimate uncertainty could be used to better describe the variability in the data, especially with low numbers of recaptures.

3.36 The Working Group noted that the decrease in tags recaptured from a tagged cohort with time was larger than expected and suggested further work to understand if the cause was emigration, the pattern in spatial overlap of fishing effort, and/or variability in recapture rate. This larger than expected decline in the number of tagged fish recaptured through time might impact on the estimate of local biomass, and sensitivities were suggested to understand the size of the effect. The Working Group further noted that the low numbers of tag recaptures, especially in the most recent years, can create variation in the estimation of biomass, especially when catch limits are low.

Management advice

3.37 The Working Group recommended that the catch limit for *D. mawsoni* in Subarea 48.4 be set at 37 tonnes for 2017/18 based on the results of the assessment.

D. eleginoides in Division 58.5.1

3.38 The fishery for *D. eleginoides* in Division 58.5.1 is conducted in the French exclusive economic zone (EEZ). Details of the fishery and the stock assessment are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.39 WG-FSA-17/60 presented an updated stock assessment of *D. eleginoides* at Kerguelen Islands (Division 58.5.1 inside the French EEZ) which included a revised tag-shedding parameter and a compensation for fish migration between Division 58.5.1 and Division 58.5.2 at an annual migration rate of 0.004 as developed at WG-SAM-17 (WG-SAM-17/11).

3.40 The Working Group noted the continued progress with the development of the model and encouraged the continued expansion in the range of years with aged data in the model. The Working Group noted that as the amount of age data in the model increases, there would be an increase in the robustness of the model fit. The Working Group requested more details on the

time series of catches used in the assessment (summarised in the Division 58.5.1 Fishery Report) and that for future assessments the full model diagnostic summary developed by WG-SAM is presented.

3.41 The updated assessment model estimated B_0 at 223 980 tonnes (95% CI: 205 030–245 900 tonnes), with the biomass in 2017 at 143 700 tonnes (123 060–167 030 tonnes). Estimated SSB status was 0.64 (0.60–0.68).

3.42 The Working Group agreed that the catch limit set by France of 5 050 tonnes in 2017/18, which allows for average depredation rates (313 tonnes, based on the average of the estimated depredation from the 2003/04 season to the 2015/16 season), is consistent with the CCAMLR decision rules for the model runs presented.

Management advice

3.43 No new information was available on the state of fish stocks in Division 58.5.1 outside areas of national jurisdiction. The Working Group, therefore, recommended that the prohibition of directed fishing for *D. eleginoides*, described in CM 32-02, remain in force in 2017/18.

D. eleginoides in Division 58.5.2

3.44 The fishery for *D. eleginoides* in Division 58.5.2 operated in accordance with CM 41-08 and associated measures. Details of the fishery and the stock assessment are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.45 A series of research papers presented new information for consideration by the Working Group in the development of the Division 58.5.2 stock assessment, centred around previous recommendations on the development of the assessment from WG-FSA and WG-SAM. These included updated growth parameters, inclusion of a migration component from Division 58.5.2 to Division 58.5.1 of 1.0% per annum (WG-SAM-17/11), revised tag-loss estimates (WG-FSA-17/21) and a revised maturity-at-age relationship (WG-FSA-17/P04).

3.46 WG-FSA-17/P04 presented a revised maturity key for *D. eleginoides* in Division 58.5.2 based on histological analyses and calibration of macroscopic staging criteria from 2004 to 2015. Age-at-maturity estimates, obtained based on the assumption that fish of macroscopic stages ≥ 2 were mature, decreased between the 2004–2009 and 2010–2015 periods for both sexes. However, the magnitude of this temporal variation in age at maturity varied between gear types and fishing depths, and variable sampling regimes likely influenced these variations.

3.47 In the stock assessment model a new maturity ogive was used resulting in a 5% increase in the estimate of B_0 but at the same relative status of current biomass.

3.48 The Working Group noted that the revised maturity-at age-function predicted that some young fish in the age range of 1–7 are mature. This appears to be inconsistent with the expectation of the life-history characteristics of a long-lived deep-water species. The Working Group also noted that there seemed to be evidence of skip spawning. The Working Group encouraged further research and comparison with other stocks to determine whether the

findings of the spawning characteristics of *D. eleginoides* in Division 58.5.2 were consistent with the information collected in other areas. The Working Group also noted that the revised maturity ogives in WG-FSA-17/P04 indicated differences in the age at maturity by sex, and that other evidence of different growth functions by sex suggest future work to consider the effect of developing a two-sex model.

3.49 WG-FSA-17/21 re-estimated tag-shedding rates in *D. eleginoides* fisheries in Division 58.5.2. Tag-loss rates were generally low, with longline-caught and recaptured fish losing their tags faster than trawl-caught and recaptured fish. Single tag-loss rates for longline varied strongly between time periods, with 0.7% for 2003–2006, 2.1% for 2007–2011 and 0.6% for 2012–2015. The longline parameter estimates for these time periods were used in the revised stock assessment for *D. eleginoides* in Division 58.5.2, resulting in a negligible change in the B_0 and stock status estimates.

3.50 Two additional changes to the assessment model structure and fit were also made in 2017, converting the survey data from numbers at age and length into a biomass index and proportions at age, and using the Francis method of data weighting similarly to the approach in other toothfish stock assessments. These changes resulted in increased estimates of B_0 and relative status of the current biomass and revised the time series of recruitment estimates.

3.51 The Working Group noted that the assessment model estimated selectivities in the fishery, which has low selection at the youngest ages and a dome-shaped selection at the oldest ages, indicating that that there was the potential for cryptic spawning biomass.

3.52 The Working Group requested that WG-SAM review the impact of the selectivity assumptions used in CASAL models on the proportion of cryptic biomass, including in relation to maturity proportions at age. The review should consider standardised approaches to estimation, diagnostics, their usage and interpretation, and the implications for management advice (SC-CAMLR-XXXII, Annex 6, paragraphs 4.104 and 4.105).

3.53 The updated assessment model leads to a smaller estimate of B_0 than that obtained in 2015, with a Markov Chain Monte Carlo (MCMC) estimate of 77 286 tonnes (95% CI: 71 492–84 210 tonnes). Estimated SSB status was 0.61 (0.58–0.64). Despite the smaller biomass, changes to the model compared to 2015, in particular its higher productivity, with the updated maturity parameters, meant that the catch limit that satisfies the CCAMLR decision rules has increased from 3 405 tonnes to 3 525 tonnes.

Management advice

3.54 The Working Group recommended that the catch limit for *D. eleginoides* in Division 58.5.2 be set at 3 525 tonnes for 2017/18 and 2018/19 based on the outcome of this assessment.

D. eleginoides in Subarea 58.6

3.55 The fishery for *D. eleginoides* at Crozet Islands is conducted within the French EEZ and includes parts of Subarea 58.6 and Area 51 outside the Convention Area. Details of this fishery and the stock assessment are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.56 WG-FSA-17/59 presented an updated stock assessment of *D. eleginoides* at Crozet Islands (Subarea 58.6 inside the French EEZ). Outputs from a series of model runs were considered which included updated depredation rates and tag-shedding estimates.

3.57 The Working Group requested more details on the time series of catches (summarised in the Subarea 58.6 Fishery Report) used in the assessment and that for future assessments the full model diagnostic summaries developed by WG-SAM-15 should be presented with an assessment.

3.58 The updated assessment model estimated B_0 at 56 810 tonnes (95% CI: 50 750–63 060 tonnes), with the biomass in 2017 at 37 900 tonnes (32 030–44 400 tonnes). Estimated SSB status was 0.67 (0.63–0.70).

3.59 The Working Group agreed that the catch limit set by France of 1 100 tonnes in 2017/18, which allows for average depredation rates (527 tonnes, based on the average of the last three years), is consistent with the CCAMLR decision rules for the model runs presented.

Management advice

3.60 No new information was available on the state of fish stocks in Subarea 58.6 outside areas of national jurisdiction. The Working Group, therefore, recommended that the prohibition of directed fishing for *D. eleginoides*, described in CM 32-02, remain in force in 2017/18.

D. mawsoni in Subarea 88.1

3.61 The exploratory fishery for *Dissostichus* spp. in Subarea 88.1 operated in accordance with CM 41-09 and associated measures. In 2016/17, the catch limit for *Dissostichus* spp. was 2 870 tonnes, including 40 tonnes set aside for the Ross Sea shelf survey. Fishing was conducted by 16 longline vessels and the total reported catch was 2 821 tonnes. Details of this fishery and the stock assessment are contained in the Fishery Report (www.ccamlr.org/node/75667).

3.62 WG-FSA-17/56 reported on an analysis of variability in catch rates of target and by-catch species of different longline gear types within selected small-scale research units (SSRUs) of Subareas 88.1 and 88.2. Catch rates (kg/1 000 hooks) were used to compare spatial and temporal variability in catch and by-catch rates by evaluating residual deviations from the long-term average and cluster analysis on spatial heterogeneity with the Coniss method. The analysis indicated spatio–temporal variability in catch rates by SSRU and season, as well as differences in toothfish length distributions. It also indicated the influence of gear type on by-catch rate data and length-species compositions of non-target fish species in the catches. The paper recommended that the gear type should be considered when planning research programs and analysing the fishery performance.

3.63 The Working Group recalled that this analysis had been presented to WG-SAM-17 (Annex 5, paragraphs 4.56 to 4.60) and noted the necessity to provide additional analyses on differences between catch rates and length- or species compositions of catch obtained from different gear types.

3.64 WG-SAM-17 had noted that there was a range of additional variables that were likely to influence catch rates of target and non-target species, such as depth and bait type. The Working Group noted that WG-SAM-16 and WG-FSA-16 (SC-CAMLR-XXXV, Annex 7, paragraph 3.57) and WG-SAM-17 had recommended the use of multivariate methods such as generalised linear mixed models (GLMMs) and generalised additive models (GAMs) for the analysis of catch data in order to address this issue and recommended exploration using these statistical methods. These methods have indicated that factors other than gear type were important in describing catch rates of *D. mawsoni* in Divisions 58.4.1 and 58.4.2 in WG-FSA-17/16.

3.65 The Working Group discussed difficulties in standardising CPUE on trotlines by using the number of hooks, making comparison with Spanish longline and autoline problematic. The Working Group also noted that considerable differences in the reporting rate of by-catch between vessels had been highlighted during the 2016 meeting of the Scientific Committee (WG-FSA-15/04 Rev. 1) and these reporting differences should be considered in future generalised linear model (GLM) and GLMM analyses.

3.66 The Working Group noted that spatial and temporal analyses and gear-specific differences in catch rates should be considered when calculating toothfish density used in the first stages of the development of research plans. However, it was also noted that differences in the gear type of vessels operating within fisheries as in Subarea 88.1 and Division 58.5.2 have not been a barrier to the development of integrated stock assessments for toothfish.

3.67 WG-FSA-17/07 provided an updated characterisation of the toothfish fishery in the Ross Sea region (Subarea 88.1 and SSRUs 882A–B), including recommendations for new catch limits for by-catch species in the areas open to fishing (paragraphs 6.21 to 6.23).

3.68 WG-FSA-17/36 described the tag-recapture data inputs to the 2017 Ross Sea region stock assessment, including estimates of effective tag detection and tagging survival rates. Vessel-specific effective tag survival and detection rates describe the relative likelihood of the survival of fish tagged by a vessel and the detection of tagged fish by a vessel.

3.69 The Working Group recalled that the method directly estimates vessel-specific tag detection and tagging survival rates by pairing each individual tag release or recapture event with all other fishing events that occurred within a specified distance and in the same fishing season and had shown that there were significant differences between vessels in the Ross Sea region (Mormede and Dunn, 2013). For the stock assessment, effective tag survival and detection rates for a vessel are calculated from a combination of the individual vessel tag survival and detection rates and the catch proportion of the vessel in the fishery.

3.70 The Working Group noted that although individual vessel effective tag survival and detection rates did not change in a consistent way towards better or worse performance over time (as indicated by analyses carried out during the meeting), the decreases in the overall effective tag survival and detection rates were caused by vessels with poor performance taking a higher percentage of the total catch in more recent years. The catch-weighted effective survival rates of tagged fish for the fishery have generally decreased since 2001 from 80% to about 65% and the effective tag detection rates from 100% to about 85% in the most recent years (WG-FSA-17/36, Table 7).

3.71 The Working Group noted that the effective tag detection rates were relatively similar across gear type and Member during the period from 2014 to 2017, whereas the effective tag

survival rate varied strongly by gear type and Member (Figures 1 and 2). The effective tag survival rate for trotline was nearly half that for autoline and Spanish longline, and substantially lower for Korean, Russian and Ukrainian vessels compared to other Members fishing in the Ross Sea region.

3.72 The Working Group noted that differences in training programs and tagging practices implemented by each Member may contribute to variation in effective tagging rates. The Working Group recalled a similar discussion on reported by-catch in the Ross Sea toothfish fishery in 2015 (SC-CAMLR-XXXIV, Annex 7, paragraphs 8.1 to 8.9) with similar groupings of Members. The by-catch differences had also been linked to operational practices.

3.73 The Working Group requested that all Members fishing in the Ross Sea region provide information about their tagging training processes and provide video footage of the tagging process on board each fishing vessel to WG-FSA-18 to enable an evaluation of tagging practices. The Working Group also noted that photos of large numbers of tagged fish would help with an evaluation of the variability in tagging practices on a vessel.

3.74 The Working Group requested that the Secretariat update the meta-analysis on by-catch in the Ross Sea toothfish fishery for WG-FSA-18 (WG-FSA-15/04 Rev. 1).

3.75 WG-FSA-17/37 Rev. 1 and 17/38 presented an updated assessment model for *D. mawsoni* in the Ross Sea region that used catch, catch-at-age and tag-recapture data from 1998 to 2017 and included the results from the Ross Sea shelf survey from 2012 to 2017. The MPD estimate of B_0 using CASAL rev. 4648 were within 2% of that from rev. 5470 used in WG-FSA-17/37 (see paragraph 2.26). The model estimates of unfished biomass of 72 620 tonnes (95% CI: 65 040−81 050 tonnes) and current status of 0.72 (0.69–0.75) were higher than those from the 2015 assessment. This difference was likely driven by the revised estimates of the effective tag survival and detection rates.

3.76 Model sensitivity runs indicated that the data from the Ross Sea shelf survey were required to reliably estimate relative YCS from 2003 to 2011. The Working Group noted that the information from the survey data on YCS contrasted strongly with that from the commercial catch-at-age data.

3.77 The Working Group noted a consistent bias in estimated versus observed median length of tag recaptures in the diagnostic plot and recommended future work to investigate this issue.

3.78 The yield that satisfied the CCAMLR decision rules was estimated using different scenarios for a catch split between the shelf, slope and north areas of the Ross Sea region consistent with previous fishing activities, or between the areas north and south of 70°S and the special research zone (SRZ) of Ross Sea region marine protected area (MPA) consistent with CM 91-05. The estimated yields ranged from 3 213 to 3 378 tonnes.

3.79 All yield estimates were higher than that pre-specified catch limit for 2018 in CM 91-05 which states that 'the total catch limit shall be fixed at a level within the range of 2 583 to 3 157 tonnes per fishing season, based on advice from the Scientific Committee in 2017, 2018 and 2019 (CM 91-05, paragraph 28i)'. The Working Group therefore agreed that the catch limit be set at 3 157 tonnes for the 2017/18 and 2018/19 fishing seasons as per CM 91-05.

Shelf survey

3.80 WG-FSA-17/57 presented a summary of longline surveys that have been conducted to monitor recruitment of *D. mawsoni* in the southern Ross Sea since 2012. Six annual surveys have been conducted at a similar time of the year using standardised gear.

3.81 The Working Group noted that the survey time series has successfully tracked strong year classes through time, providing the first estimates of YCS, recruitment variability and recruitment autocorrelation for the *D. mawsoni* stock in the Ross Sea.

3.82 The Working Group noted that it was important to identify the relationship between sub-adult *D. mawsoni* and fish length-frequency data collected subsequently from commercial catch. Such an analysis could also provide information on fish movement.

3.83 The Working Group considered the proposal by New Zealand in WG-SAM-17/39 to continue the Ross Sea shelf survey for a further five years from 2018 and recalled the advice from WG-SAM-17 (Annex 5, paragraphs 4.69 to 4.72). The Working Group noted that the core strata would be sampled every year with the McMurdo and Terra Nova strata sampled in alternate years. Although an effort-limited survey, the different maximum catch rates observed in these strata would give rise to a total catch limit of 45 tonnes in 2018, 2020, 2022 and 65 tonnes in 2019 and 2021.

3.84 The Working Group noted that, to date, the survey has taken place following the commercial fishing season in areas where commercial fishing occurs. Following the adoption of CM 91-05, from 2017/18 the surveys will take place within a region of the MPA where fishing activities will be otherwise prohibited. Changes to fish density in the region resulting from a reduction in fishing effort may result in higher survey catch rates in the future and the survey catch limit may need to be reviewed.

3.85 The Working Group noted that in 2017, operational and sea-ice constraints meant the survey commenced from Terra Nova Bay in the northwestern stratum of the survey area. High catch rates encountered in this region at the start of the survey in 2017 required a reduction in station numbers in the southern strata to avoid exceeding the catch limit. Sampling fewer stations in the core strata resulted in a higher variance of survey estimates.

Management advice

3.86 The Working Group recommended that the catch limit be set at 45 tonnes for the 2017/18 survey and 65 tonnes for the 2018/19 survey and that the catch limits are deducted from, and not additional to, the Ross Sea region catch limit.

3.87 The Working Group recommended that following the procedure outlined in CM 91-05, the catch limit for the Ross Sea region (Subarea 88.1 and SSRUs 882A–B) in the 2017/18 season be 3 157 tonnes, with 467 tonnes allocated to the SRZ, 591 tonnes north of 70°S, 2 054 tonnes south of 70°S, and 45 tonnes for the Ross Sea shelf survey.

Capacity

3.88 WG-FSA-17/05 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 similar pattern to previous updates and did not indicate an over-capacity in the fishery. In the 2016/17 season, catch rates in Subarea 88.1 were the highest on record and the fishery was closed on 31 December 2016.

3.89 Based on a measure of potential daily fishing capacity and the catch limit for an area, the Working Group noted that the notified fishing capacity in some management areas compromises the ability of the Secretariat to forecast and issue a timely closure notice using the current fishery forecasting procedure. Catch overruns are likely to occur in areas with small catch limits, high catch variability and where substantial numbers of vessels enter simultaneously.

3.90 In the 2016/17 season, the fishery in SSRUs 881B, C and G was closed on 4 December 2016 with an overrun of 58% (218 tonnes). The Working Group noted that this overrun was the result of the combination of a relatively small catch limit and high catch rates (up to 50 tonnes per line) of vessels on a fishing ground that had been inaccessible for many years due to sea-ice.

3.91 At the request of the Working Group, the Secretariat reviewed the data from the fishery in SSRUs 881B, C and G in December 2016 and provided an illustration of the predicted cumulative catch based on the sum of the previous individual daily catch rates of the vessels in the fishery (Figure 3), which showed that the predicted and actual catches were very similar as the catch limit was approached.

3.92 The Working Group agreed that, had a pre-emptive closure been issued such that vessels were required to set and haul all gear by 00:00h on 2 December 2016, then it is likely that the level of overrun would have been reduced.

3.93 The Working Group also noted that the number of hooks deployed is reported in the daily catch and effort reports, but is not currently used in the catch forecasting. The Working Group agreed that CPUE (catch per hook) and the hook count could be used to improve the forecasting process by including catch that might be taken after the closure date from gear set prior to the closure into the predicted closure date forecast.

3.94 The Working Group noted that other options may also be available to avoid catch overruns, for example effort limitation, increased frequency of catch and effort reporting, or increased reporting to the fishery by the Secretariat on the current cumulative catch. The Working Group requested the Scientific Committee to further consider such options.

3.95 Within the current closure forecasting approach, where the catch limit may be reached within seven days of the start of the fishery, it may not be possible to collect sufficient catch data to issue a closure notice in time to prevent an overrun. The Working Group asked the Scientific Committee to consider whether in these instances a pre-emptive closure notice should be issued using predicted catch rates from previous years, and that incremental extensions to the closure date could then be issued accordingly.

3.96 Where the catch limit may be reached within seven days it may not be possible to collect sufficient catch data and issue a closure notice to prevent an overrun utilising the existing closure forecasting approach.

3.97 The Working Group agreed that in situations where catch limits may be reached before the Secretariat is able to predict a closure time, a pre-emptive closure notice should be issued based on the predicted catch rates and that extensions for the closure could be issued should the rate of increase in the cumulative catch be less than predicted.

3.98 The Working Group noted that catch allocations to individual Members or vessels in a fishery, or an area with a small catch limit, could help to avoid catch overruns. In addition, any substantial catch overrun in an area in a fishing season could be compensated by the catch limit in the subsequent fishing season.

3.99 The Working Group noted that with the introduction of the Ross Sea region MPA in 2017/18, mechanisms to avoid catch overruns may need to be considered for the management of the Olympic fishery in the SRZ due to its relatively low catch limit.

3.100 Dr Kasatkina noted that WG-FSA-17/05 linked capacity in the fishery with the ability of the Secretariat to forecast and issue a timely closure notice. She was concerned that the current fishery forecasting system could lead to restrictions for notified vessels to enter simultaneously in some management areas. Dr Kasatkina noted that the Secretariat should be able to develop systems to forecast timely closure notices that would support all notified vessels that operate in accordance with CM 41-09 in the Ross Sea fishery.

Research proposals in the special research zone of the Ross Sea region marine protected area (MPA)

3.101 The Working Group considered two proposals by Members to conduct toothfish research in the newly created SRZ of the Ross Sea region MPA submitted by Russia (WG-FSA-17/26) and Ukraine (WG-FSA-17/35).

3.102 WG-FSA-17/26 presented a proposal for a 10-year research program under CM 24-01 in the SRZ with a focus on providing data on toothfish biomass, stock structure, movement and life history. The proposed research fishing follows a grid in a main research area as recommended by the Scientific Committee in 2013 (SC-CAMLR-XXXII, paragraphs 3.155 to 3.160) and an additional area following one of three options, with a tagging rate of 5 fish per tonne and a catch limit of 100 tonnes (60 tonnes in the main research area and 40 tonnes in the additional area). The proposal indicated that the research program provides opportunities for collaborative investigations in the SRZ by the Russian vessel in the main area and vessels from other CCAMLR Members in the additional area.

3.103 WG-FSA-17/35 presented a proposal by Ukraine for scientific research in the SRZ under CM 24-01. The proposed research includes tag deployments to examine the toothfish life cycle, abundance and movement, stratified surveys of slope habitats with contrasting local exploitation rates to monitor effects of fishing on toothfish and other demersal fishes, and biological sampling to investigate life-history hypotheses and biological parameters, including the stock structure, of toothfish. The proposal suggested a tagging rate of 3 fish per tonne for the first 30 tonnes of catch and 1 fish per tonne thereafter and included a program of plankton sampling and the collection of acoustic and temperature data.

3.104 Dr K. Demianenko (Ukraine) informed the Working Group that, if the proposal was approved, the Ukrainian vessel would concentrate its fishing activity on the proposed research, but if the proposal was not approved, it would still be able to conduct some of the proposed research as part of the Olympic fishery in the SRZ.

3.105 The Working Group recalled its advice from WG-SAM-17 (Annex 5, paragraphs 4.73 to 4.81) that the SRZ will be open to exploratory fishing from 2017/18 onwards with a catch limit of 15% of the overall catch limit for the Ross Sea region. It further noted that there is no requirement in CM 91-05 for Members to submit proposals for conducting research in the SRZ, and that under CM 91-05 a requirement to tag toothfish at a rate of 3 fish per tonne would not be introduced until the start of the 2020/21 season.

3.106 The Working Group noted that careful consideration should be given to the potential impact of research conducted within the SRZ upon the Ross Sea region stock assessment. As the SRZ is open to all vessels notified to fish in the Ross Sea region fishery, concern was raised that prior to the introduction of a 3 fish per tonne requirement in 2020/21, different tagging rates as indicated in the research proposals could introduce bias into the stock assessment.

3.107 The Working Group requested that the Scientific Committee consider how research proposals conducted in the SRZ link to the Ross Sea region MPA research and monitoring plan (RMP) and/or contribute to the management of *D. mawsoni* in the Ross Sea region.

3.108 The Working Group evaluated the two research plans against the priority elements for scientific research in support of the Ross Sea region MPA in the SRZ in CM 91-05, Annex 91-05/C, Table 2.

3.109 With respect to the Ukrainian proposal, the Working Group noted that, despite the recommendation from WG-SAM-17, the proposal still lacks specific objectives and details about the data collection program, data analyses and how these analyses contribute to the research objectives and priority elements. The Working Group also noted that standard protocols are yet to be developed for the collection and analysis of acoustic data from longline vessels before acoustic data can be used.

3.110 With respect to the Russian proposal, the Working Group noted that the systematic survey design was a suitable approach to develop time series of a range of data such as abundance indices and catch composition and biological characteristics in the SRZ. The Working Group also welcomed the links between outcomes of this research with the topics from the RMP (SC-CAMLR-XXXVI/20) presented during the meeting.

3.111 The Working Group noted that 60 hauls were proposed for the main area by the Russian autoline vessel *Palmer* and 40 hauls in an additional area by a vessel from another Member. The location of the additional area was dependent on sea-ice conditions, but the Working Group noted that the strategy where fishing would take place with variable sea-ice conditions was unclear (SC-CAMLR-XXXIV/BG/31).

3.112 The Working Group noted that catch rates from previous research in the same area (autoline from 2002 to 2006 and trotline from 2010 to 2012) should be used to estimate a catch limit for this effort-limited survey.

3.113 The Working Group recommended that proponents of research within the SRZ should consider the impact of exploratory fishing in the SRZ on their ability to conduct specific research plans. Coordination of research activities with other Members may reduce these impacts.

3.114 The Working Group noted that CM 91-05 does not prescribe how catch limits for research within the SRZ are to be allocated. The Working Group recommended that this issue should be considered by the Scientific Committee. It recommended that research catches in the SRZ should be allocated from the SRZ catch limit to ensure that the objective of limiting the exploitation rate in the SRZ is preserved.

D. mawsoni in Subarea 88.2

3.115 WG-FSA-17/39 presented a summary of the toothfish fishery and tagging program in the Amundsen Sea region (SSRUs 882C–H) and assessed whether the current research plan in this area is thus far achieving its goals and if the current fishing levels are precautionary.

3.116 The Working Group noted that catch rates, length-frequency data, access to research blocks and Chapman biomass estimates for the north and south areas all indicate that the current catch limits in the Amundsen Sea region are precautionary.

3.117 The Working Group recommended that the research plan should continue as recommended by the Scientific Committee in 2016 (SC-CAMLR-XXXV, paragraph 3.215).

3.118 The Working Group noted that the rate of development of scientific information needed for the development of an assessment may be improved by a coordinated approach to the collection and analyses of data from SSRUs 882C–H. In particular, while the research blocks developed by the Scientific Committee in 2014 (SC-CAMLR-XXXIII, paragraphs 3.173 and 3.174) had successfully focused effort into areas of tag release, there was still a lack of spatial overlap of effort between years. In addition, in recent years, a number of new vessels had entered the fishery that had unknown metrics of tagged fish survivability or rates of detection of tagged fish and inter-vessel calibration of these had not been undertaken.

3.119 The Working Group recommended that vessels intending to participate in research fishing in SSRUs 882C–H in 2017/18 coordinate their research fishing for the coming seasons by targeting those seamounts in SSRU 882H and in the research blocks in SSRUs 882C–G that had been fished in recent years to maximise the likelihood of recapturing tagged fish.

3.120 Further, the Working Group encouraged Members to coordinate their research fishing to allow for vessel calibration analyses to be undertaken (i.e. fishing within 20 km of locations fished by other vessels in the same season).

3.121 The Working Group requested that the Scientific Committee consider approaches by which research by Members who intend to carry out research in SSRUs 882C–H can be coordinated to develop the progress towards achieving a robust assessment for the region.

3.122 The Working Group also noted that there were a number of years and research blocks in SSRUs 882C–H for which no ageing data was available. The Working Group recalled previous advice (SC-CAMLR-XXXV, paragraph 3.213) requesting that Members provide validated age data for the area.

3.123 The Working Group requested that Members age otoliths as per the priorities given in Table 1 to develop annual ALKs.

3.124 The Working Group recommended that each Member when ageing otoliths should:

(i) use a standard reading protocol for *D. mawsoni* as documented in SC-CAMLR-XXXI, Annex 7, paragraphs 10.1 to 10.19, WG-FSA-12/43 and Australian (WG-FSA-14/45) or Russian (WG-FSA-12/18) manuals

(ii) cross-validate their readings both using multiple readings of the same otolith by the same laboratory and between different Member laboratories, and by readings of standard reference otolith sets, and report these to WG-SAM. This can be done with both physical otolith preparations and high-resolution photographs of prepared otoliths (SC-CAMLR-XXXI, Annex 7, paragraphs 10.9 to 10.17)

(iii) seek coordination among Members to conduct cross-validation tests that could be organised and conducted through the use of an e-group, and a repository of photographic reference sets that could be made available on the CCAMLR website. Discussions within the e-group could include developing a standardised format for photographic reference sets.

3.125 In selecting otoliths for ageing from the otolith collection, the Working Group recommended that otoliths selected for ageing should be taken as a random sample from the available otoliths, with a minimum of five otoliths from fish in each 10 cm length bin for each sex (or if five are not available, then the maximum number available) for each Member in each year.

3.126 The Working Group noted that these age data, including readings of the reference set, should be provided to the Secretariat, and reported, along with sampling methods, ageing methodology and progress on cross-validation, to WG-SAM-18 for evaluation and hence potential inclusion in analyses for WG-FSA-18 for SSRUs 882C–H.

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

Generic issues and advice from WG-SAM-17

4.1 The WG-SAM Convener summarised advice from the 2017 meeting of the Working Group, including recommendations related to procedures for proposals and reporting on research plans in data-poor fisheries. The Working Group recalled that the primary goal of research plans conducted in data-poor fisheries should be to develop a robust estimate of stock status and enable the estimation of precautionary catch limits consistent with CCAMLR decision rules (SC-CAMLR-XXX, Annex 5, paragraph 2.25), and that research objectives should be to develop: (i) an index of stock abundance, (ii) a hypothesis of relationship of fish in the research area to the overall stock, and (iii) estimates of biological parameters relating to productivity (i.e. maturity, growth and recruitment) (SC-CAMLR-XXX, Annex 5, paragraph 2.27).

4.2 The Working Group recognised that not all research programs proposed in accordance with CM 24-01 are aimed at developing a stock assessment, and that specific objectives for these research proposals must be clearly described, as they may be exempt from a number of conservation measures.

4.3 WG-FSA-17/13 proposed procedures for proposals and reporting on research plans in data-poor fisheries. The Working Group reviewed these criteria and their potential application to proposals for research in data-poor fisheries. The Working Group agreed that it is important to have clearly identified standardised requirements for proposal reviews, and that these requirements provide structure and clarity for those Members developing research proposals. It will also provide clarity for the Working Groups when evaluating these proposals.

4.4 The Working Group noted that specific milestones, as demonstrated in several proposals, should be developed in all research plans for data-poor fisheries. This can include information from previous papers, etc. to demonstrate that this work has been done successfully. The Working Group developed a number of specific milestones that may be applicable to research plans in data-poor areas as suggestions for milestones to be incorporated into proposals submitted next year as appropriate (Table 2).

4.5 The Working Group drew on elements of WG-FSA-17/13, along with discussions during the course of the meeting to develop research criteria for evaluating research proposals submitted for data-poor fisheries.

4.6 The Working Group recalled that CM 24-01, Annex 24-01/A, format 2 provides the template for research proponents to provide information on planned research and research capability. The Working Group used the categories in CM 24-01/A, format 2 and advice from the Scientific Committee to evaluate research proposals and progress reports in data-poor fisheries (i.e. research plans submitted under CMs 21-02 and 24-01 in areas where no stock assessment is in place) (SC-CAMLR-XXIX, paragraph 3.126; SC-CAMLR-XXIX, Annex 6, paragraph 5.1) to evaluate if research plans would be likely to meet their objectives.

4.7 The Working Group therefore recommended evaluating research proposals against the following criteria:

(i) Is the proposed research likely to:

  (a) generate an index of localised stock abundance
  (b) estimate biological parameters relating to productivity
  (c) test a hypothesis of relationship of fish in the research area to the overall stock (SC-CAMLR-XXX, paragraph 2.4; SC-CAMLR-XXX, Annex 5, paragraph 2.27)?

(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 (CM 24-01, Annex 24-01/A, format 2, category 4b)?

(iii) Are the likely impacts from the proposed research on dependent and related species consistent with Article II (CM 24-01/A, format 2, category 4c)?

(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 (CM 24-01/A, format 2, category 3)? Appropriate milestones are set out in Table 2.

(v) Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs (CM 24-01/A, format 2, category 5)?

For example:

(a) vessels with no or little experience in toothfish tagging programs may organise extra training, crew exchange, or scientific collaboration to demonstrate capability

(b) new vessels could gain experience outside data-poor fisheries, using experienced vessels for participation in research plans.

(vi) Has the collective research team demonstrated a thorough understanding of environmental conditions and associated logistics and capacity to carrying out the proposed research plan on the water (CM 24-01/A, format 2, category 5)?

(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 analysis (CM 24-01/A, format 2, category 5)?

For example:

(a) the research team may bring in experience from other CCAMLR Members with the needed experience, including non-fishing Members

(b) the research team may identify specific tasks to be completed by contractors by identifying the contractors and detailing the arrangement.

4.8 The Working Group recommended that other considerations beyond target catch and finfish by-catch should be included in research proposals in data-poor areas and reported to the Working Groups. This should include data collection protocols and characterisation of vulnerable marine ecosystem (VME) taxa, seabirds and marine mammals (such as described in WG-FSA-17/45 and 17/46). Further consideration could include information on other components of the ecosystem within the proposed research area, such as physical oceanographic properties or habitat characteristics, which could be collected by the vessel or characterised though other research initiatives. The latter could elucidate other potential ecosystem interactions with the proposed research, or allow for more robust evaluation and optimisation of methodologies and/or sampling designs to address stated objectives and hypotheses.

4.9 The Working Group recommended to the Scientific Committee that a new or modified proposal tabled in future years should directly address the evaluation criteria by cross-referencing paragraphs in the proposal to these criteria, or cross-referencing to previous report text.

4.10 The Working Group considered the issue of proposals that had been revised during the meeting and new elements, ad hoc modifications, or revisions in sampling designs of research proposals that were beyond that originally tabled and formally discussed at WG-FSA. It agreed that the role of WG-FSA was to evaluate and provide comment on proposals submitted by the deadline to WG-FSA. Additional comments from WG-FSA on the proposals, as well as potential revisions to proposals by the proponents should be forwarded to the Scientific Committee for consideration.

4.11 The Working Group noted the difficulty of evaluating the capability of proponents to implement: (i) at-sea activities if a new research platform is proposed, and given there is currently no mechanism to evaluate the importance of different kinds of at-sea experience (e.g. experience of scientific observers, crew, and officers), (ii) proposed data and sample analyses where no such analyses have been presented to working groups in the past.

4.12 The Working Group reviewed an updated map of regions contained in all proposals (Figure 4) and requested that all proponents provide the geographic data required (Annex 5, paragraph 4.16) in order that the Secretariat can provide this to working groups routinely in the future.

4.13 The Working Group noted that the different geographic projections used in the display of maps in the different proposals made the review of those proposals very difficult. It recommended that all plots use the projection provided by CCAMLR in its GIS and R packages (Thanassekos and Robinson, 2017) or state the projection used on the map.

4.14 The Working Group noted that the large and scattered number of research blocks for these proposals would benefit from a more integrated, holistic strategy, which was also a recommendation set out in the Second CCAMLR Performance Review (CCAMLR-XXXVI/01) and requested guidance from the Scientific Committee on how to develop such a strategy.

4.15 The Working Group noted that Ukraine has proposed to conduct research in Subareas 48.1 (WG-FSA-17/32), 48.2 (17/27), 88.1 (17/35), 88.3 (17/34) and Division 58.4.2 (17/33). The Working Group noted the large amount of data and sample analysis activity that would be required to achieve the research objectives, including ageing the required number of otoliths across multiple subareas/divisions. 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.

4.16 The Working Group requested that the Scientific Committee give consideration to the feasibility of proposals where individual Members have notified to undertake research in multiple division/subareas, since they may not have the capacity to complete milestones of the research when commitments are spread across multiple research programs.

4.17 The Working Group discussed the issue that in several of the data-poor research plans, research that was agreed was not completed due to a variety of reasons. In particular, the Working Group noted that considerable time was dedicated to discussing and improving research proposals both at WG-SAM and WG-FSA, but noted research is often not completed as priority is given to other fisheries (e.g. Olympic fisheries, or other research proposals) rather than the completion of the research plan. The Working Group noted that the data collection phase can cease while the data analysis phase continues and is not considered as failing to meet all the objectives.

4.18 The Working Group requested the Scientific Committee to develop mechanisms to ensure that completion of existing research is given priority.

Gear selectivity and standardisation of effort

4.19 The Working Group noted the ongoing discussions about gear selectivity and standardisation of effort between trotlines and Spanish/autolines (Annex 5, paragraphs 4.22, 4.39 and 4.41). The Working Group recalled that the effect of gear type will depend on the research question asked (SC-CAMLR-XXXV, Annex 7, paragraphs 4.55 to 4.61), for example questions regarding stock hypotheses such as life stages in areas, biological parameters or spatial distributions may not be affected, whereas catch rate analyses or tag release performance may be (paragraph 3.71 and Figure 1). However, at present gear type and Member State are often still conflated variables that would need to be disentangled (WG-FSA-15/04 Rev. 1 and 17/16).

4.20 The difference between model-based and design-based effects on analysis is an area of active discussion in statistics, and the Working Group noted that particularly regarding the characteristics of different gears, a focus topic at WG-SAM would be useful to address the following issues:

(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 CPUE evaluations

(iv) characterisations of gear types, such as bait types or hook types and line length and number of hooks.

Estimates of local biomass and catch limit for data-poor fisheries

4.21 WG-FSA-17/42 provided estimates of local biomass of toothfish with bootstrapped confidence intervals, for *D. mawsoni* and *D. eleginoides* in research blocks in Subareas 48.2, 48.6, 58.4 and 88.3. The default CPUE by seabed area and Chapman mark-recapture methods agreed at WG-SAM-16 (SC-CAMLR-XXXV, Annex 5, paragraph 2.28) were applied with revised parameter values agreed at WG-SAM-17 (Annex 5, paragraph 3.10).

4.22 Estimates of local biomass presented in WG-FSA-17/42 were updated over the course of the meeting to include:

(i) vulnerable biomass estimates from the 2017 assessments in the Subarea 88.1 and Division 58.5.2 reference areas

(ii) a median CPUE in the last three complete seasons in which fishing occurred, applied to calculate the reference areas' CPUE

(iii) the agreed natural mortality value of 0.13, applied in the calculation of the number of tagged *D. mawsoni* available for recapture

(iv) fixing of some small data-processing issues to ensure all catch and tagged fish recaptures were being included in estimates

(v) one year of tags at liberty, used in Chapman estimates in research blocks 486_2 and 486_3 (paragraph 4.80).

4.23 Changes made throughout the course of the meeting to the R Markdown used to generate the local biomass were documented in a GitHub repository that was shared with Working Group members for review and comment.

4.24 The Working Group noted that the Ross Sea region vulnerable biomass estimated in the 2017 assessment increased by about 10% relative to the 2015 assessment whilst the Heard Island and McDonald Islands (HIMI) vulnerable biomass decreased by about 25%. These changes were reflected in changes in the CPUE by seabed area estimates of biomass for the research blocks.

4.25 The Working Group noted that *D. mawsoni* biomass estimates from the CPUE by seabed area method in WG-FSA-17/42 have increased relative to the estimates that were presented at WG-FSA-16, and that these changes were due to reference area biomass and the reference seabed area in the Ross Sea region. These estimates also demonstrated greater overlap in confidence intervals with the Chapman estimates in some *D. mawsoni* research blocks. It was further noted that there was less change in biomass estimates for *D. eleginoides* compared to WG-FSA-16 estimates relative to *D. mawsoni*, as there was only a change in the reference area biomass parameter value and no change to the seabed area parameter value for the HIMI reference area.

4.26 The Working Group recalled past advice to use the lowest of the two values, as well as the desire to move to tag-based estimates where suitable. It further recalled that the CPUE by seabed area method is only intended as a first indication where no other information is available. Development of an integrated method using both values and their uncertainty was presented at WG-SAM-17 (WG-SAM-17/37) and further development was encouraged. The Working Group noted that the trends in the tag-based estimates of biomass could provide further information on the suitability of such estimates to provide advice.

4.27 The Working Group noted that in some cases there were still differences in estimates between methods, and that these may be due to a systematic bias in both methods, which could be related to tag survival, migrations and other factors. Specific reasons for these differences require further exploration in the future.

Development of trend analysis rules for methodology and calculation of catch limits in data-poor toothfish fisheries

4.28 The Working Group considered whether there was the potential to use the available time series of biomass estimates in existing research blocks to indicate how the local stock might be responding to the catches within the research blocks. It considered methods for determining catch limits for research blocks to interpret this information, including using a rule based on a qualitative interpretation of trend to recommend catch limits.

4.29 The time series of biomass indices for each research block (Figure 5 for *D. mawsoni* and Figure 6 for *D. eleginoides*) were qualitatively evaluated by the Working Group to determine if the trend in the indices was increasing, stable, decreasing, or was not able to be determined.

4.30 Where the trend was stable or increasing, the Working Group considered rules that would allow the catch limit to increase, but not be subject to high levels of interannual variability. Similarly, where the trend showed a decrease, the Working Group considered that reductions in catch limits would be appropriate, and these should be robust to high interannual fluctuations as well.

4.31 The Working Group noted that the International Council for the Exploration of the Sea (ICES) had adopted a procedure that used recent trends in abundance indices to update the catch limit, while restricting interannual fluctuations to a maximum of 20% per year (ICES, 2012).

4.32 The Working Group then developed a set of trend analysis rules based on the qualitative evaluation of trend, and used the biomass estimates from the Chapman method if reliable, and the CPUE method otherwise, to determine a proposed catch limit for each of the research blocks. These estimates were then constrained so that they did not change by more than 20% per annum.

4.33 The trend analysis rules developed by the Working Group for choosing a methodology for estimation and calculation of catch were:

> Apply a 4% exploitation rate to the Chapman and/or CPUE by seabed area biomass estimates, including up to the most recent season in which sampling has been completed for each research block (B4%):
>
> - IF the trend was stable –
>
> - if adequate recaptures, use the B4% from the most recent Chapman estimate
> - otherwise use the B4% from the most recent CPUE by seabed area estimate.
>
> - IF the trend was declining –
>
> - use the current catch limit × 0.8 (regardless of adequate recaptures or not).
>
> - IF the trend was increasing –
>
> - if adequate recaptures, use the B4% from the most recent Chapman estimate
> - otherwise use the B4% from the most recent CPUE by seabed area estimate.
>
> - IF the trend was too short, too variable, or trends between abundance indices are in conflict –
>
> - if adequate recaptures, use the B4% from the most recent Chapman estimate
> - otherwise use the B4% from the most recent CPUE by seabed area estimate.
>
> - AND constraining any changes in the proposed catch limit to be not more than a 20% increase or decrease from the current catch limit.

4.34 Trends were qualitatively evaluated over recent years, and adequate recaptures are defined as at least three recaptures per year in at least two of the last three years.

4.35 The results of the applied trend analysis rules to estimate catches for data-poor fisheries in 2017/18 are set out in Table 3. The Working Group recommended that these catches be used for management advice of these fisheries in the 2017/18 season.

4.36 The Working Group noted that similar rules applied by ICES for low-information stocks had been evaluated using management strategy evaluation (MSE) (ICES, 2012). Whilst the Working Group agreed that the trend analysis rules developed here to calculate catches could be used for management advice for the 2017/18 season, it acknowledged that it lacked a formal evaluation of how the different methods may perform for the management of data-poor stocks in CCAMLR.

4.37 The Working Group recommended the Scientific Committee consider the following as priority work for WG-SAM and WG-FSA:

(i) MSEs underlying the establishment of these trend analysis rules for providing advice on catch limits be a priority topic for WG-SAM-18, particularly if they are to be applied in future years

(ii) the method for qualitative evaluation of trends be better formalised

(iii) how Members who fish in research blocks develop methods to understand the relationship of local biomass estimates to the rest of the stock, and describe these methods to WG-SAM-18

(iv) how Members who fish in research blocks investigate the patterns in Chapman biomass estimation using both one and three years of tagged fish at liberty, and recommend only tagged fish recaptured after one year at liberty be used if evidence of immigration was found

(v) that additional work should be conducted to examine the applicability of these trend analysis rules when survey designs change (e.g. changes in fixed effort surveys, or changes in participating vessels).

4.38 It was recognised that fishing within research blocks as a strategy for obtaining information necessary to provide management advice is an interim step in the much broader goal of understanding the dynamics and productivity of overall toothfish stocks in the CAMLR Convention Area. As such, the Working Group acknowledged that new methods and strategies will be required to incorporate consideration of future proposals that endeavour to undertake research fishing outside of existing research blocks.

Management area research reviews

Dissostichus spp. in Area 48

4.39 WG-FSA-17/54 noted that although there are many research proposals tabled for Area 48, there is currently no coordinated research strategy for the area. It recommended the

development of regional stock hypotheses which would allow Members to focus on specific aspects of required research, the results of which would in turn assist in developing additional testable hypotheses.

4.40 The Working Group considered that the requirement of the development of stock hypotheses is a priority for data-poor fisheries research, including the identification of critical areas to test hypotheses for all regions beyond local area research proposals that sample only a limited portion of the stock (paragraphs 4.131 to 4.133). It noted that such effort was already underway in Area 58 and followed the research plan established in the Ross Sea region. Potential processes to develop such overarching structures were discussed, including setting up multi-Member workshops such as that proposed by Germany in February 2018 (paragraph 8.22), or bringing stock hypothesis papers to the CCAMLR working groups. The Working Group noted that in areas where information was missing to develop stock hypotheses, such as hydrological models, then collating that information and developing hypotheses should be a first priority and the resulting stock hypotheses should be used to direct research activity.

Review of available information and data quality

Subarea 48.2

4.41 WG-FSA-17/30 presented the results from an elemental microchemistry study of *Dissostichus* spp. in Subarea 48.2 by Chile. Results indicated differences in nursery areas and adults between *D. mawsoni* and *D. eleginoides*, consistent with *D. mawsoni* inhabiting colder areas, which might be latitude and/or depth related. Results also showed significant differences within species consistent with an ontogenetic habitat shift in both species. Future work will include further otolith sampling and ageing of the fish analysed, as well as an increase in water chemistry sampling to help elucidate the patterns seen.

4.42 The Working Group thanked Chile for bringing such an advanced analysis so soon after the survey was completed. It noted that the expected distributions and movement of toothfish based on otolith microchemistry were consistent with that based on other information such as length frequencies in different areas. It further noted that previous work (e.g. Darnaude et al., 2014; Sturrock et al., 2015) showed the influence of physiological processes on the deposition of metals in otoliths and that the environmental signal could be confounded with the physiological signal. The Working Group suggested that using such a method on recaptured tagged fish after a long-distance migration might help to identify signals in microchemistry data. The Working Group agreed that incorporating the age of the fish into the analysis would be useful and suggested that a workshop on otolith ageing and otolith microchemistry might be helpful to foster collaborations and progress in this field.

4.43 WG-FSA-17/43 reported the results of the survey by Ukraine in Subarea 48.2. The results included catch, length–weight and age data for both species of toothfish.

4.44 The Working Group thanked Ukraine for ageing toothfish in this area. It recommended that the ages be validated using a CCAMLR otolith reference set, that between-reader calibrations be conducted and results of those be presented as a separate paper to WG-SAM along with a description of the method used.

4.45 The Secretariat encouraged Members who have collected otoliths and aged them to contribute to the Secretariat reference set, as only one is available at the moment, although a digital reference set is also available. Australia noted that it is currently in the process of developing another otolith reference set based on a different preparation methodology as detailed in WG-FSA-17/15. Further diagnostic plots such as age frequency were also requested.

4.46 The Working Group further recommended that detailed mark-recapture data be presented by year of release and of recapture by species, and that a description of the gear be provided to the Secretariat for addition to the gear library.

4.47 The Working Group noted that the sample size for biological analyses seemed very low based on the number of fish caught. It requested that a protocol specifying the sampling targets for biological data be provided. It also noted that these data should be statistically analysed, and that equations and fits should be provided for the biological relationships such as the growth curve.

4.48 The Working Group recalled that the local area sampled in a research plan does not comprise a stock, and that local area Chapman biomass estimates do not constitute a stock assessment and, therefore, the abundance estimation, while essential for the determination of precautionary catch limits for the survey, was only representative of local abundance. Furthermore, some Members recalled that the *Simeiz* presented a low effective tagging survival rate and tag-detection rate in the Ross Sea region (WG-FSA-17/36, Table 6), and that this should be taken into consideration when calculating local biomass based on mark-recapture data from this vessel. The Working Group suggested that biomass estimates from the Secretariat could be used to set catch limits.

4.49 The Working Group noted a five-fold increase in Macrourid by-catch in the 2016/17 season and recalled the advice from WG-SAM-16 (SC-CAMLR-XXXV, Annex 5, paragraph 4.114) to provide spatial and depth plots of these catches as well as corresponding numbers of toothfish caught. The Working Group suggested that a separate paper on by-catch in the area should be presented to WG-FSA. It further noted there might be a need to implement move-on rules within this research proposal.

Subareas 48.2 and 48.4

4.50 WG-FSA-17/46 reported an update on the results of the first year of a survey by the UK to investigate the connectivity between Subareas 48.2 and 48.4. The survey is located in an area where both species are expected to be found.

4.51 WG-FSA-17/48 presented the proposed location of research stations for all the Subarea 48.2 proposals in the 2018 fishery. The Working Group thanked the authors for collating all the information in one document (paragraph 4.73).

Review of progress towards a stock assessment and research proposals

4.52 The research proposals in the format submitted to WG-FSA were assessed following the criteria set out in paragraph 4.7 and summarised in Table 5. The Working Group agreed that

the review criteria were aimed at evaluating new proposals and not progress made on existing proposals. The Working Group noted that it provided advice generic to all proposals and the discussion below is specific to where the proposal did not clearly meet a criterion.

Subarea 48.1

4.53 WG-FSA-17/32 presented the proposal by Ukraine to conduct research in Subarea 48.1. This proposal assumes that Subarea 48.1 comprises an entire stock unit delimited by contours and currents.

4.54 The Working Group noted that the research proposal is likely to generate a local abundance index but is geographically constrained with no plan to widen the research into a broader stock hypothesis. It reiterated the need to develop stock hypotheses in this area. The Working Group recalled that a number of demersal fish surveys have been carried out over the years, mostly in the shelf zone in the Subarea 48.1, notably by the USA and Germany. These surveys had caught small toothfish, and incorporating that information would help inform the development of a stock hypothesis.

4.55 The Working Group recalled the advice by WG-SAM-17 (Annex 5, paragraph 4.103) to present to WG-FSA information that was missing in the proposal submitted to WG-SAM. It noted that although some recommendations were implemented, biological sampling and statistical analyses proposed were still missing. The Working Group recalled that there are many proposals by Ukraine to carry out research and that the capacity of this Member to carry out all the proposed data and sample analysis is uncertain.

4.56 The Working Group noted that a new vessel is proposed for the work in Subarea 48.1 which has no demonstrated experience and performance in toothfish tagging programs. The Working Group welcomed the information offered by Dr Demianenko that the research proposed will include a video program documenting every tagging event, which will help document the suitability of fish that were tagged.

4.57 The Working Group noted that the sea-ice analyses were inconsistent with the experience of scientists in the same area at the time sea-ice conditions were summarised, and that the extent of sea-ice might be underestimated in the proposal, with many areas potentially inaccessible at the time of the survey.

4.58 The Working Group noted that not enough information was available to assess if the proposed catch limit of 40 tonnes was consistent with Article II, or if the survey was to be catch or effort limited. It noted that a local biomass estimate based on 2011 data suggested 68 tonnes, and that previous effort in the region could have been used to estimate local area biomass based on CPUE by seabed area (Arana and Vega, 1999).

4.59 Dr Demianenko stressed that research on toothfish in Subarea 48.1 will take into account the data-poor status of this marine area, in particular concerning toothfish. He also mentioned that Ukraine is ready to involve other vessels in this research program, including those with multiannual experience in the Antarctic fishery, including research activities.

Subarea 48.2

4.60 WG-FSA-17/27 presented the proposal by Chile to continue research in Subarea 48.2, including a change of vessel to the FV *Puerto Toro*, which uses trotlines. The design was the same as that presented at WG-SAM-17, with additional oceanographic transects to help inform biogeographic models where both species of toothfish occur. As tagging is very important, the proponents noted their intention to use baskets to haul fish and thoroughly assess the suitability of fish for tagging. This proposal was coordinated with Ukraine, and operational agreements were reached for this season. Chile noted that it is willing to continue collaboration with other countries in the future.

4.61 The Working Group noted that the research proposal from Chile is likely to generate local abundance indices but is geographically constrained with no plan to widen the research into a broader stock hypothesis. It further noted that although the proposal has a data collection plan for by-catch, it is not currently looking at the impacts of the research on by-catch species.

4.62 The Working Group noted that a new vessel is proposed by Chile which has no demonstrated experience and performance in toothfish tagging programs. It acknowledged that the observer has extensive experience in the Chilean national tagging program.

4.63 The Working Group noted that, consistent with the principles for research plans described in WG-FSA-17/13, the prospecting phase in any one area should be limited to one year, and that estimations of local biomass using CPUE by seabed area or Chapman estimates should be developed thereafter.

4.64 WG-FSA-17/31 presented the proposal by Ukraine to continue research in Subarea 48.2. This revised proposal included the recommendations from WG-SAM-17 and the intent to conduct plankton, acoustics and conductivity temperature depth probe (CTD) sampling.

4.65 The Working Group noted that the research proposal is likely to generate local abundance indices but is geographically constrained with no plan to widen the research into a broader stock hypothesis. Recalling previous discussions, the Working Group noted the need for a stock structure hypothesis in this area.

4.66 The Working Group welcomed the collection of information on the wider ecosystem and was interested in how the information collected using the plankton net would be used. It noted that although the proposal has a data collection plan for by-catch, it is not currently looking at the impacts of the research on by-catch species. The Working Group further recalled that there are many proposals by Ukraine to carry out research and that the capacity of this Member to carry out all the proposed data and sample analysis is uncertain.

4.67 The Working Group noted that the proposed vessel has multiple years of experience in the fishery but that its effective tagging performance is quite low (WG-FSA-17/36, Table 6). The Working Group noted that this information is not currently included in the assessments of proposals and requested advice from the Scientific Committee on ways to include this information more formally.

Management advice

4.68 The Working Group recommended that the existing 75 tonne catch limit be applied as the precautionary catch limit for the research proposed by Chile and Ukraine.

4.69 The Working Group noted the proposal that half the catch limit be allocated to each of the two vessels, and that the catch of the Chilean vessel be reallocated to the Ukrainian vessel fishing in March should the Chilean vessel not be able to fish in February due to, for example, unfavourable sea-ice conditions, as it was reflected in SC-CAMLR-XXXIV, paragraph 3.262.

Subareas 48.2 and 48.4

4.70 WG-FSA-17/45 presented the proposal by the UK to continue research investigating the connectivity between Subareas 48.2 and 48.4. The proposal includes a further two years of on-board activity and a subsequent two years of desk-based analyses of the data. The Working Group thanked the UK for including all the recommendations made at WG-SAM-17 and noted that the sampling regime in the updated proposal was in addition to the routine sampling proposed in the initial proposal. The Working Group noted that this proposal satisfied all the criteria set out in paragraph 4.7.

4.71 The Working Group noted that the proposal is effort-limited with 20 stations planned in the coming year and a precautionary catch limit for toothfish was proposed at 18 tonnes in Subarea 48.4 and 23 tonnes in 48.2 based on average catch rates for *D. mawsoni* in Subarea 48.4 under CM 41-03. The Working Group noted that in the previously agreed UK effort-limited proposal, the addition of an extra two stations, from 18 to 20 stations, had been planned and therefore there was a consequent need to increase the catch limit accordingly, particularly as the 2016/17 catches in Subarea 48.4 had nearly reached the catch limit. Calculation of the required increase in the catch limit was not discussed during the meeting of the Working Group.

Management advice

4.72 The Working Group requested that the Scientific Committee consider a catch limit taking into account its previous advice as well as the proposed modifications to this survey.

4.73 The Working Group noted that all of the proponents of research in Subarea 48.2 were present at the WG-FSA meeting, allowing collaboration to be developed further. The proponents submitted WG-FSA-17/48 Rev. 1, further clarifying the coordination of the research and analysis within each proposal as already previously outlined in WG-FSA-17/48.

Subarea 48.5

4.74 WG-FSA-17/25 presented an updated proposal for the third stage of the Russian research program in the Weddell Sea. A five-year longline survey program was proposed in the eastern region of the Weddell Sea, with the objectives to estimate fish distribution and abundance and assess biological parameters related to productivity of toothfish and by-catch species in Subarea 48.5, and to collect data for biological analysis of toothfish, including gonad histology, genetic analysis and parasitological analysis.

4.75 The Working Group recalled that the history of the reviews of this proposal was described in Annex 5, paragraphs 4.90 to 4.94. It noted that the Scientific Committee had requested an update on the analyses of catch rates in Subarea 48.5 (SC-CAMLR-XXXIII, paragraph 3.230; SC-CAMLR-XXXIV, paragraphs 3.271 to 3.275 and Annex 5, paragraph 4.94), and that such an update had not been provided to WG-SAM-16 (SC-CAMLR-XXXV, Annex 5, paragraph 4.71). It noted that WG-SAM-17 was not able to evaluate the proposal and that WG-FSA could not review the proposal either.

4.76 Dr Kasatkina noted that the background paper on previous Russian survey activities undertaken in Subarea 48.5 was submitted to the Commission in 2016 (CCAMLR-XXXV/BG/29 Rev. 1). She also noted that one or two vessels of the CCAMLR Member countries operating an autoline system are invited to take part in the Russian research program in the Weddell Sea. International scientific observation is invited on board the Russian vessel. She also noted that implementation of the research program will provide data on toothfish resource potential that is needed for planning the MPA in the Weddell Sea.

Subarea 48.6

4.77 WG-FSA-17/10 presented an update on the proposal by Japan and South Africa to continue their research plan in Subarea 48.6. Although the proposal was similar to that presented at WG-SAM-17, the proposal to extend research block 486_2 was withdrawn.

4.78 Analysis of mark-recapture data showed that including more than one year at liberty for tags increased the biomass estimate in research blocks 486_2 and 486_3, and that larger fish were present in those areas, consistent with a migration hypothesis, as seen in SSRU 882H. The proponents further proposed that research block 486_2 not be split into two blocks for the coming season due to a lack of clear scientific evidence at this stage.

4.79 The Working Group thanked the proponents for presenting their stock hypothesis for this region, and suggested it be brought to the workshop next year (paragraph 8.22). It also noted that the biomass estimates based on mark-recapture data were consistent over time, which provided additional confidence in these results.

4.80 The Working Group agreed that tags recaptured after one year at liberty only (rather than up to three) be used for research block 486_2 and 486_3 and that all research proposals investigate the effects of this option in the future. It further agreed that research block 486_2 not be split in the forthcoming year, but that data analyses consider the difference between the two parts of the research block.

4.81 The Working Group noted that the proposed vessels have multiple years of experience in the fishery but that their effective tagging performance metrics are currently unknown.

4.82 The Working Group noted that there have been ongoing issues implementing the research plan due to either accessibility of the fishing grounds or fishing capacity, including vessel commitments or preferences to fish elsewhere. It further noted that the aim of the research in the different research blocks varies and that annual access to all the grounds was not necessary for the success of some objectives of the research. Fishing capacity was still highlighted as a potential issue which might be mitigated by the inclusion of the Norwegian proposal in a single plan in the future.

4.83 WG-FSA-17/61 presented the proposal by Norway to start a survey in Subarea 48.6. The proposed research aims to investigate the east–west stock connectivity in the region, noting that the proposal in WG-FSA-17/10 investigates the north–south connectivity in the region, including the use of acoustics, of pop-up satellite archival tags (PSATs), and of environmental data collection. The authors noted that based on PSAT results from the Ross Sea, the detailed behaviour of toothfish is similar to that of cod, and using acoustic data might help describe vertical movement patterns of toothfish, as well as movements to areas not fished (such as deeper waters). They also noted that the gear type is different from other surveys and will allow comparison with other vessels.

4.84 The Working Group sought clarification of the areas Norway proposed to fish, and noted that the Norwegian proposal was in a prospecting phase whilst the joint Japanese/South African proposal (WG-FSA-17/10) was already in a catch-limited phase. The proponents confirmed that in the first year the research would be carried out in the research blocks and would develop the stock hypothesis to direct the location of research in the following years.

4.85 The Working Group noted that the proposal did not provide sufficient 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. The Working Group further discussed the plans to estimate toothfish density using acoustics, and how to compare it with other methods. It welcomed the proposed research and noted previous efforts to separate toothfish from macrourid acoustics signatures which might be of help.

4.86 The proponents began collaboration with Japan and South Africa (WG-FSA-17/10) and submitted a revision of WG-FSA-17/61 highlighting this collaboration and the revision from a prospecting phase design to a catch-limited survey design to match the existing research plan. The Working Group acknowledged the collaboration achieved during the meeting, however, it could not comment on the revised proposal and assessed the original proposal as submitted.

Management advice

4.87 The Working Group noted that catch limits were calculated for this region using the trend analysis rules (paragraph 4.33) and recommended they be applied as shown in Table 3.

Dissostichus spp. in Subarea 58.4

4.88 WG-FSA-17/09 presented results on sex ratios, gonadal development and validation of macro- versus micro-staging of maturity in *D. mawsoni* from Subarea 88.2 and Division 58.4.1 from samples collected in February and March 2013. Sex ratios were, on average, 0.5 and skewing towards females with larger sizes. The paper stated that the ovarian development was consistent with group-synchronous spawning, and that at the time of data collection, 45% of females were at a mature stage. At a total length of 100 cm, 80% of females were mature, while 100% of males larger than 150 cm total length were mature.

4.89 The Working Group noted these results in relation to discussions around WG-FSA-17/16. The Working Group suggested further work to progress towards maturity ogives on age and length at smaller spatial scales, evaluate spatial patterns in gonadosomatic indices and sex ratios, and explore gonadosomatic indices for a selected size mode throughout the regions.

4.90 The Working Group considered WG-FSA-17/12, presenting results of fatty acid and stable isotope signature analyses to examine the feeding ecology of *D. mawsoni*. The paper found spatial variation in resource utilisation between the Ross Sea shelf and western Indian Ocean sector of the Southern Ocean and the slope towards the Pacific Ocean sector, indicating a depth-dependent dietary difference between these regions, apparently closely related to an ontogenetic shift during migration. Bayesian models highlighted the nutritional importance of Notothenid fish to the diet of *D. mawsoni* and estimated a dietary shift during ontogeny and associated migration to deeper water.

4.91 The Working Group noted the distinct distribution of the posteriors showing that the Ross Sea ecosystem diet composition stood out as different from the Indian and Pacific Ocean sectors, indicating that the foodweb may have a different structure between areas. However, the Working Group also recalled that the Ross Sea samples came primarily from the Ross Sea shelf survey, sampling typically fish of <100 cm. The observed difference could, therefore, be a sign of an ontogenetic shift where size drives some of the prey choice, and the posterior distribution of the results on diet composition mirrored the size distribution obtained during the Ross Sea shelf survey.

4.92 The Working Group suggested as future work to link the dietary work presented in this paper to the wider stock hypotheses for the studied regions, and to test whether the observed differences in the diet composition of smaller fish was indeed evidence of an ontogenetic shift.

4.93 WG-FSA-17/P03 presented results of next-generation sequencing of stomach contents collected from *D. mawsoni* in Subareas 58.4 and 88.3. A total of 19 species were identified from the stomach of *D. mawsoni* in this study, which included 14 fish species and five molluscs. Two fish species, Whitson's grenadier (*Macrourus whitsoni*) and *Chionobathyscus dewitti*, were the most important prey items. These results suggested that using next-generation sequencing for diet studies is, within limitations, possible.

4.94 The Working Group noted that genetic sequences of Antarctic metazoans were not always readily available on GenBank. The Working Group noted that a list of species or species groups that are encountered during research fishing in the CCAMLR area could specifically contribute to addressing these gaps. Prof H. Kim (Republic of Korea) noted that his research group had no such list but would generally welcome Members providing more samples of metazoans from the Convention Area which they offered to sequence and upload to GenBank.

4.95 The Working Group considered WG-FSA-17/P02, which described levels of mercury concentration in different organs of *D. mawsoni* collected in Subarea 88.3 and Division 58.4.1. While 40% of the total mercury concentration was found in the muscle, both muscle and liver showed signs of bioaccumulation. Mercury concentrations were correlated with fish weight and length. The levels found in *D. mawsoni* were below the tolerable weekly intake for total mercury recommended by the Joint FAO/WHO Expert Committee on Food Additives and the tolerable weekly intake for methylmercury proposed by the European Food Safety Authority, suggesting that consumption of *D. mawsoni* presents no health risk to humans. The Working Group noted that the normal pattern of biomagnification in the Antarctic food chain as proposed

by Gionfriddo et al., 2016 was not observed for *D. mawsoni* as top predator, and speculated whether the longevity or other physiological attributes of *D. mawsoni* may play a role in this. The Working Group suggested to look at methylmercury concentrations in different age groups of toothfish to see whether there was evidence of age-related susceptibility to methylmercury accumulation.

4.96 WG-FSA-17/15 presented an update on the ageing of *D. mawsoni* from Subarea 88.2 and Division 58.4.1 undertaken by Australia. Using a subset of otoliths from the New Zealand reference collection, all pairwise comparisons between Australian readers and against the reference ages showed a high level of precision. The level of age-estimation overlap between the 'bake and embed' and 'thin section' methods for each reader was high, indicating that either method can be used to provide reliable age estimates for *D. mawsoni*.

4.97 The Working Group noted that Australia and New Zealand are developing digital collections of aged *D. mawsoni* otolith images prepared from thin sections. Acknowledging the potential for digital reference collections to support inter-laboratory calibration in multi-Member ageing programs, the Working Group encouraged the development of digital reference sets by all Members undertaking *D. mawsoni* ageing.

4.98 The Working Group recommended that Members provide the appropriate material in order that the Secretariat can create a digital repository on the CCAMLR website containing otolith ageing and calibration instruction manuals (including WG-FSA-17/15), digital reference collections and a record of the locations of physical reference material. Growth bands in some digital images could also be annotated for training purposes. The Working Group further noted that a centralised database of ages would facilitate the increasing number or multi-Member ageing programs, and recalled that this was discussed at SC-CAMLR-XXXI, Annex 7, paragraphs 10.18 and 10.19.

4.99 WG-FSA-17/66 presented preliminary results for age and growth of *D. mawsoni* in Division 58.4.1. Estimated growth curves differed from estimates in previous years and comparisons were made between growth curves from all seasons in this division and those used in the Ross Sea integrated assessment.

4.100 The Working Group welcomed the progress made and presented in this paper. The Working Group noted the low variance of readings at older ages, suggesting cross-validation between readers to minimise reading errors at the more difficult reading ages, and to explore whether regional differences could contribute to the observed difference in growth curves.

4.101 The Working Group noted the shift of the growth curve over time, suggesting that *D. mawsoni* in this region are growing larger at older ages than in previous years, suggesting a change over time which could be indicative of changes in the environment, such as climate change (paragraphs 8.6 to 8.10), or result from interannual differences in sampling rates of older fish. The Working Group recommended that plots of age–length curves should be routinely provided for assessments, and for datasets of more than one year of readings should contain:

(i) panels with and without the estimated growth curves
(ii) data points distinguished by sex and/or year

to facilitate the observation and understanding of temporal or biological trends in ageing data.

4.102 The Working Group also encouraged the exploration of alternative growth models and parameterisation, which could also help understand and detect changes and patterns such as associated with environmental change and/or regional differences in growth.

4.103 The Working Group considered WG-FSA-17/16 which reported on the development of generalised additive mixed models (GAMMs) to characterise relationships between the relative density, weight, maturity and sex ratio of *D. mawsoni* with environmental variables, to progress the development of a stock hypothesis for Subarea 58.4. Spatial heterogeneity in catch composition indicated that *D. mawsoni* were not randomly distributed across the area. Models were used to generate predictions of *D. mawsoni* density and composition across a broad spatial scale and revise hypotheses relating to the structure and functioning of the stock.

4.104 The Working Group noted that fishing depths reported by vessels were used for the estimation, and GEBCO depths for the predictions, and recommended to use the same depth dataset for the estimation and prediction. The Working Group recommended to cross-validate the model estimation by leaving out components of latitude and longitude data and then back-estimating into that space, to check the performance of the model. The Working Group also noted that some thought would need to be given on how environmental data, collected at fine-scale level, would be used to generate predictions across the scale of divisions.

4.105 The Working Group noted that the model had standardised catch data to number of hooks, and included gear as a fixed effect in the initial model, as well as including vessel as a random effect. The Working Group noted that the presented paper provided both the initial model and the final model, and recommended that all papers including statistical modelling processes should: (i) include the initial as well as the final model (i.e. the preferred model based on model selection), and (ii) describe the model optimisation and selection process from the initial to the final model.

4.106 The paper identified BANZARE Bank as a region of spawning activity for toothfish, and the Working Group discussed the role of BANZARE Bank as a source of toothfish larvae in this region. Following the work of Hanchet et al., 2008 and WG-FSA-12/48 on passive circumpolar dispersion of *D. mawsoni* larvae, the current hypothesis is that potential spawning around BANZARE may be retained along the continent and provide juveniles for the entire region. Spawning activity has been observed on BANZARE during a survey in 2008 (WG-FSA-08/57), an area where only large fish without any recruits or juveniles were observed. The Working Group noted that BANZARE Bank could be a region where large *D. mawsoni* migrate to spawn, in line with the predictions generated in the paper.

4.107 The Working Group discussed the potential of the work presented in this paper to inform the research design and questions in this region, noting that the results provide sufficient information to refine existing stock hypotheses, which could be further evaluated by appropriate research questions and use of research blocks or modifications to research locations. The Working Group noted the analogous situation to the development of the fishery in the Ross Sea, where the stock hypothesis informed the research designed in the area, and recommended the development of specific research questions around the stock hypothesis that could be addressed in research proposals in the future.

4.108 Mr Maschette informed the Working Group that in addition to progressing the stock hypothesis through modelling, genetic investigations are planned to inform delineation of *D. mawsoni* stocks in the subarea as well as throughout the CCAMLR region and adjacent

management regions. Mr Maschette thanked scientists from New Zealand, South Africa and the UK for providing samples to progress this work and invited all Members fishing to collaborate through tissue sample contributions.

D. mawsoni in Divisions 58.4.1 and 58.4.2

4.109 A report of progress on exploratory fishing activity undertaken by Australia, France, Japan, Republic of Korea and Spain between the 2011/12 and 2016/17 fishing seasons in Divisions 58.4.1 and 58.4.2 was presented in WG-FSA-17/17 Rev. 1. The report included the quantity of data and samples collected and an overview of progress toward research milestones. The associated research plan and reports relating to specific research milestones were submitted as companion papers.

4.110 The Working Group discussed the different reasons as to why research could not be completed in the research blocks. The research proponents noted that this was due to mechanical problems (Australia), macrourid by-catch limits (Australia), sea-ice limiting access (Korea), and insufficient fuel on board to complete research in Division 58.4.1 after the fishing season in Area 88 (Spain). The Working Group noted that there is an allocation system in place to distribute initial catch shares between the research proponents in this area. This system guarantees an agreed catch proportion in a research block, but can lead to the catch limit not being taken in a research block. The Working Group noted that the date for redistribution of catch allocations was brought forward to 1 February for the next season in order to provide a longer time window for the vessels to carry out research.

4.111 The research proposals in the format submitted to WG-FSA were assessed following the criteria set out in paragraph 4.7, summarised in Table 5. The Working Group acknowledged that this process is aimed at new proposals and not existing proposals, and the intent of the criteria was assessed. The Working Group noted that it provided advice generic to all proposals (paragraphs 4.52 to 4.87). Advice provided below is by exception, whereby only questions for further clarification, or criteria not fully satisfied, are discussed in this section. All research proposals under this agenda item were proposed under CM 21-02.

4.112 The Working Group considered WG-FSA-17/18 Rev. 1, a proposal for the continuation of the research plan on *D. mawsoni* by Australia, France, Japan, Republic of Korea and Spain as set out in WG-FSA-16/29. The proposal contained changes relating to the agreement among proponents relating to the deadline for redistribution of initial catch allocations between proponents, and to by-catch sampling.

4.113 The Working Group noted that 2018 will be the final year of the research plan, with a comprehensive re-evaluation scheduled in 2018, which will include questions such as catch limits not being reached.

4.114 Dr Kasatkina noted that implementation of the research programs in Subarea 58.4 is based on data collection by several vessels in each research block. These vessels operate using different gear types, which also have significant differences in line length and number of hooks and this may influence data used in estimates of biomass, stock structure and productivity parameters. Gear effect might be a critical factor for efficiency and reliability of multiple years'

programs in Subarea 58.4. She recommended providing inter-calibration between fishing systems in frame of each research block and including this activity into research programs.

4.115 The Working Group noted that this research proposal satisfied all criteria set out in paragraph 4.7 (Table 5).

Management advice

4.116 The Working Group noted that the catch limits were calculated using the trend analysis rules (paragraph 4.33) and recommended they be applied as shown in Table 3.

D. mawsoni in Division 58.4.2

4.117 The Working Group considered WG-FSA-17/33, a proposal for research fishing by Ukraine on *D. mawsoni* in three research blocks in SSRUs A and B of Division 58.4.2 during the 2017/18 season, and recalled the recommendations made by WG-SAM-17 on this proposal (Annex 5, paragraphs 4.34 to 4.37).

4.118 The Working Group was not able to evaluate this proposal in regard to the likelihood of generating a local biomass index and whether the proposed research was likely to test a hypothesis of relationship of fish in the research area to the overall stock. The Working Group considered that the proposal did not contain the details needed for WG-SAM, WG-FSA and the Scientific Committee to evaluate the likelihood of success.

4.119 The Working Group noted that the research plan proposed a catch limit as well as an effort limit, but the impact on the dependent and related species and the target species stock was not clear from the information presented in the proposal.

4.120 While the proposed research platforms have demonstrated experience in toothfish tagging programs, the Working Group noted that the notified vessel had low calculated effective survival rates (WG-FSA-17/36, Table 6).

4.121 The Working Group noted concerns about the accessibility of the proposed research region during the proposed survey times due to sea-ice, and further noted that the same vessel was notified as research platform in Subareas 88.1 and 88.2, raising concerns as to whether the vessel would be able to commit to all proposed research.

4.122 The Working Group noted that the historical research already conducted in this region was not taken into account in the proposed research in WG-FSA-17/33, with questions also raised as to how the resulting data would be incorporated into the existing results. The Working Group recalled discussions on this subject elsewhere (paragraphs 4.16, 4.17 and 4.20).

D. eleginoides in Division 58.4.3a

4.123 WG-FSA-17/55 outlined the research plan in Division 58.4.3a by France and Japan as a continuation of the plan set out in WG-FSA-16/55, including recommendations made by the Scientific Committee in 2016 (SC-CAMLR-XXXV, paragraph 3.250).

4.124 The Working Group noted that the proposal is likely to generate local abundance indices, but is geographically constrained, and that there is no description of a plan to widen the research into a broader stock hypothesis.

4.125 The Working Group noted that the proposed vessels have multiple years of experience but have unknown calculated effective survival rates. The *Mascareignes III* has participated in the *D. eleginoides* fishery in Subarea 58.6 and Division 58.5.1 for 16 years and been a participant in tagging operations that have released 59 038 tagged *D. eleginoides* between 2006 and 2017 of which 6 386 have subsequently been recaptured (WG-FSA-17/59, 17/60). The *Mascareignes III* has tagged 8 140 and recaptured 895 *D. eleginoides*. Thus, more than 800 tagged *D. eleginoides* by the *Mascareignes III* were recaptured by the vessels operating in Subarea 58.6 and Division 58.5.1. Therefore, sufficient tagging data exists for the proponents to evaluate effective tagging survival and tag detection rates for the *Mascareignes III* in the intersessional period using the methods developed by Mormede and Dunn (2013). No comparative information was available for the *Shinsei Maru No. 3*.

4.126 The Working Group recalled discussions at WG-SAM-17 regarding why the catch limit has not been taken since 2013/14 and further recommendations made by WG-SAM-17 (Annex 5, paragraphs 4.43 and 4.44), and noted that these recommendations have been addressed in WG-FSA-17/55. The Working Group noted that research was still being conducted at the time of the WG-FSA meeting.

Management advice

4.127 The Working Group noted that catch limits were calculated for this region using the trend analysis rules (paragraph 4.33) and recommended they be applied as shown in Table 3.

D. eleginoides in Division 58.4.4

4.128 WG-FSA-17/11 outlined the revised research plan by France and Japan for research blocks 5844b_1 and 5844b_2 in the 2017/18 season and included advice from WG-SAM-17. The research plan proposed to continue the current research operation for the next fishing season with the same survey design as before.

4.129 The Working Group noted that the proposed vessels have multiple years of experience but have unknown effective tagging survival rates. For both French vessels that proposed to carry out the research, the *Saint-André* and *Ile Bourbon*, sufficient tagging data exists from activity in other CCAMLR subareas for the proponents to evaluate effective tagging survival and tag detection rates for these vessels in the intersessional period using the methods developed by Mormede and Dunn (2013).

Management advice

4.130 The Working Group noted that catch limits were calculated for this region using the trend analysis rules (paragraph 4.33) and recommended they be applied as shown in Table 3.

General discussion on Subarea 58

4.131 The Working Group noted that an important purpose of the designation of research blocks is to concentrate research effort to maximise the likelihood of recaptures in areas where tagged fish had been released.

4.132 The Working Group noted that research on the density and length distribution of fish, spatial patterns in their biology, movement of fish and linkages to areas outside of research blocks, such as provided in WG-FSA-17/16, would be helpful to design such research.

4.133 The Working Group considered that, based on the available information for Subarea 58.4 presented in WG-FSA-17/16, the population hypothesis could now be reviewed for the region. This would allow future research with the objective of developing a spatial management advice and to guide future research efforts, for example, to gain a better understanding of the location of areas critical to the life history of toothfish, such as spawning regions, juvenile areas or feeding grounds. Oceanographical research and activities conducted on non-fishing vessels could also contribute to the further development of the stock hypotheses.

4.134 The Working Group also recalled Figure 1 in WG-FSA-17/13, noting that the central part of the diagram outlined the process for progressing from a research-block focus to developing a regional stock assessment. It was considered that the research in this region was now close to this stage. Consequently, the review of the research, scheduled by the proponents for 2018, should consider moving to the next stage in the process.

4.135 The Working Group recalled that a focus topic on the stock hypothesis of *D. mawsoni* in Divisions 58.4.1 and 58.4.2 was planned for WG-SAM-18 as part of the strategic work plan of the Scientific Committee. The Working Group encouraged close intersessional collaboration of research proponents in Divisions 58.4.1 and 58.4.2 in preparation for this focus topic.

4.136 The Working Group recalled that the data emerging from ongoing investigations confirms that IUU fishing remains an important issue for CCAMLR and especially in the potential impacts on research fishing in Division 58.4.1 (paragraphs 2.14 to 2.18) and that impacts of IUU fishing could be a significant impact on research conducted in the region.

4.137 The Chair of the Scientific Committee recalled that within the strategic planning for the Scientific Committee, a focus topic on Area 58 was planned for WG-SAM-18.

D. mawsoni in Subarea 88.3

Review of available information and data quality

Review of progress towards a stock assessment and research proposals

4.138 The Working Group considered a revised proposal from Ukraine (WG-FSA-17/34) and a new joint proposal from the Republic of Korea and New Zealand (WG-FSA-17/40) to conduct research in Subarea 88.3. The Working Group recalled that WG-SAM-17 recommended that the proponents collaborate to produce a single multi-Member coordinated research proposal for

presentation at WG-FSA-17 (Annex 5, paragraph 4.89). The Working Group further noted that such a collaboration would require development of a detailed plan:

(i) to coordinate the spatial distribution of effort among proponents and between seasons

(ii) for the allocation of total catch and distribution of responsibility for milestone achievements among proponents.

4.139 WG-FSA-17/34 and 17/40 were assessed following the criteria summarised in Table 6.

4.140 The Working Group noted that the Ukrainian proposal in WG-FSA-17/34 had not fully addressed feedback from WG-SAM-17. In particular, the proposal stated the intention to acquire toothfish age data and develop an assessment model, however, there remained insufficient specification of how and when this would be achieved (e.g. a research timeline and detailed milestones that could be used to evaluate research progress).

4.141 The Working Group noted a lack of detail in WG-FSA-17/34 on a stock hypothesis, including ambiguity about which of the *Dissostichus* species were being investigated (Table 6(i)c).

4.142 The Working Group noted that the joint proposal from the Republic of Korea and New Zealand was designed to build on previous research by continuing to focus on those research blocks where tagged fish have previously been released on the slope, whilst also prospecting two of the northern seamount complexes and two areas on the southern shelf where no fishing has occurred. The main objective of the proposal is to determine the abundance of *D. mawsoni* in Subarea 88.3. Secondary objectives are to improve understanding of stock structure of toothfish in this area, to carry out calibration trials between the two vessels, investigate the spatial and depth distributions of by-catch species and to trial electronic monitoring systems. The Working Group noted that surveys will be effort limited in the 2017/18 season and catch limited in the 2018/19 and 2019/20 seasons.

4.143 The Working Group agreed that, rather than standardising fishing operations between the *Greenstar* and *Janas* during vessel calibration trials (including soak time and length of line), the *Greenstar* should retain its normal gear configurations to facilitate comparison of data collected by the Republic of Korea among areas.

4.144 The Working Group noted interannual variation in toothfish length compositions in some locations within Subarea 88.3, including research blocks 883_3 and 883_4 and on the seamounts, and that these variations complicate the development of a stock hypothesis. It was further noted that the plan for more controlled depth stratification, as outlined in WG-FSA-17/40, can be used to investigate whether these variations are likely to be influenced by fishing depth.

4.145 The Working Group recalled previous recommendations for the prioritisation of research blocks in Subarea 88.3 which were based on increasing the likelihood of recapturing tagged fish (SC-CAMLR-XXXIV, paragraph 3.290; SC-CAMLR-XXXV, paragraph 3.257). However, given recent releases of tagged fish across all research blocks (WG-FSA-17/40, Table 2), the Working Group agreed that research block prioritisation could be based on sea-ice conditions and vessel safety, with the exception of research block 883_3, which should be a high priority for completion of the calibration trial and recapturing of tagged fish.

4.146 The Working Group noted the proposed number of sets and anticipated catch by research block or prospecting area for the *Greenstar* and *Janas* (WG-FSA-17/40, Table 7) and agreed that these are appropriate for achieving the research objectives.

Management advice

4.147 The Working Group recommended that the catch limits be applied as shown in Table 7.

Other fisheries research

4.148 The Working Group reviewed WG-FSA-17/28, which presented a revised research plan from Chile proposing a bottom trawl research survey of the distribution, abundance and biological characteristics of Antarctic demersal fish communities in the 2017/18 season on the shelf areas of Subarea 48.1 (Elephant Island) and Subarea 48.2 (South Orkney Islands).

4.149 The proposed survey will be conducted in four depth strata between 100 and 500 m using two bottom trawl nets, with stations in the same approximate geographic coordinates as those used by RV *Polarstern* (led by Germany) around Elephant Island in 2012, and by the RV *Yuzhmorgeologiya* (led by the USA) around the South Orkney Islands in 2009. The proposed catch limits for this research are 50 tonnes in Subarea 48.1 and 50 tonnes in Subarea 48.2. The survey will be using two nets: the 'Hardbottom Snapper Trawl' and the 'Casanova 55.80-71.00' bottom trawl nets.

4.150 The Working Group recommended that the Hardbottom Snapper Trawl, which is the bottom trawl that was used by the USA in the previous survey in 2009, be prioritised during the survey and Casanova 55.80-71.00 be used in the inter-calibration between the two nets to allow the standardisation and ultimately the comparability between catches made using the two nets. The Working Group agreed that the proposed catch limits of 50 tonnes in Subarea 48.1 and 50 tonnes in Subarea 48.2 were appropriate for the survey. Station location and trawl duration should replicate previous trawl survey research undertaken by the USA and Germany in the region.

4.151 Prof. P. Arana (Chile) confirmed that, as chief scientist of the research proposal, he will be on board the fishing vessel to ensure that the survey will be conducted as planned. He noted that the US trawl would be used for the survey as a priority and further noted that, in the face of potential operational difficulties during fishing sampling hauls, the US sampling gear will be replaced by the Casanova gear.

4.152 The Working Group was informed of additional research initiatives beyond the primary demersal biomass survey objectives set out in WG-FSA-17/28. These include collecting finfish specimens to investigate the origin and maintenance of Antarctic fish biodiversity, as well as specimen, genetic, haematological and life-history data to investigate the subtle changes in diversity patterns across the spatial distribution of notothenioid fish species.

4.153 WG-FSA-17/P01 provided results of a time series of trammel net catches in Potter Cove (King George Islands). The Working Group welcomed the results in the paper and it noted that

the discussions of these analyses were sufficiently dealt with in WG-FSA-16 and the conclusion of the Working Group is essentially similar to those given in SC-CAMLR-XXXV, Annex 7, paragraph 6.6. The Working Group further noted that the trends of these results, which are consistent with sporadic surveys that have been conducted in the offshore areas of this region and offshore survey by Chile, using the same gear type as previous surveys in the region, will provide further information on the status of these resources.

Scheme of International Scientific Observation (SISO)

5.1 Data collected by observers on all fishing vessels operating in the Convention Area during 2016/17, based on data received by the Secretariat up until 15 September 2017, were presented by the Secretariat (WG-FSA-17/58 Rev. 2).

5.2 The Working Group noted that in previous years this paper only contained data from longline and finfish trawl vessels, however, this year the Secretariat has included incidental mortality associated with fishing (IMAF) and sampling information from krill trawl vessels to provide a more complete summary of SISO information for the season. Extrapolated seabird mortalities in the longline fishery were the second lowest on record, although the Secretariat noted that there were still observer datasets outstanding which were likely to contain mortalities that had been reported in vessel catch and effort data. The Working Group supported the updated content and design of the paper and agreed that the summary table of mortalities from all CCAMLR fisheries presented be included in the WG-FSA report for consideration.

5.3 The Working Group thanked all SISO observers for their contribution to scientific data collection this season. Collectively, the observers in the Convention Area have collected over 500 000 biometric measurements in 2016/17.

5.4 WG-FSA-17/41 presented New Zealand's submission to the CCAMLR Observer Training Program Accreditation Scheme (COTPAS). An initial review of the submission had been completed by the Secretariat and Members were invited to participate in a peer review of the submission through a closed e-group, as per the process outlined in SC-CAMLR-XXXIII/10.

5.5 The Working Group welcomed New Zealand's submission, noting the value of understanding individual Members' observer training standards. The Working Group noted that Australia undertook the peer review process in 2014 and reiterated the opportunity it provides for Members to review and improve their national observer program. Invitations for Members to participate in the peer review of the New Zealand submission will be provided in an SC circular.

5.6 WG-FSA-17/03 presented the redesigned observer logbooks for longline and trawl finfish fisheries. The Working Group endorsed the design and content of the new logbooks, noting the recommendations developed from the WG-FSA considerations outlined in the WS-SISO Convener's report (SC-CAMLR-XXXVI/08). The Working Group recommended that the Scientific Committee endorse the new logbooks, noting that they will be applied for the 2018/19 season, although they are available for Members to use voluntarily for the 2017/18 season as detailed in SC-CAMLR-XXXVI/BG/38.

Workshop on SISO report and recommendations

5.7 The WS-SISO Convener's report (SC-CAMLR-XXXVI/08) presented the results from the Workshop held in Buenos Aires, Argentina, from 3 to 7 July 2017. The Working Group noted the importance of the first dedicated SISO Workshop and its success in the development of new observer data collection protocols and forms.

5.8 The Working Group welcomed and endorsed the Convener's report and provided recommendations on the following issues that were addressed to WG-FSA:

(i) Observers should continue with the current practice of using basket, trot or magazine numbers as an indicator of the section of line and observer samples for by-catch, rather than using the VME line segment number, as in many cases they are analogous, and not all fisheries are required to collect VME data. The Working Group also recommended that observers should be able to use a range for these numbers as it is often difficult to tell exactly in which basket, trot or magazine the by-catch was sampled. The Working Group encouraged Members to ensure that the crew on vessels work closely with observers to assist the observer in identifying the correct section of the line.

(ii) Fields in the observer logbooks that were introduced to collect data for the Year-of-the-Skate should be removed, as the relevant information is captured in the remaining forms.

(iii) The requirement for skates to be hauled to the roller, rather than cut off at the surface, should be retained, as this approach allows for accurate assessment of skate condition as skates in poor health are required to be landed under CM 33-03. Additionally, the Working Group recalled WG-FSA-08/30 which detailed the physical difficulty of releasing skates at the surface, the potential for injury to the animal during the procedure and significant safety risks for the crew undertaking the procedure. The Working Group further noted that while WG-FSA-08/30 detailed skate handling procedures for autoline vessels, a similar understanding of procedures on Spanish and trotline gear types was desirable, and encouraged Members to submit materials describing skate handing methodology, including, if possible, videos of skates being hauled from the water to the roller and released.

(iv) Due to the difficulty in quantifying and determining the number and cause of mortalities, collection of data on seabird collisions with fishing vessels was not considered to be a priority for SISO. Further discussion on this matter is found in paragraphs 6.26 to 6.28.

Non-target catch and interactions in CCAMLR fisheries

Fish and invertebrate by-catch

6.1 The Secretariat presented WG-FSA-17/04 providing an update on fish by-catch in the krill fishery. Commercial catch data and CCAMLR SISO data up to 1 September 2017 were used to examine the frequency of occurrence, length-frequency distribution and geographic provenance of the key fish taxa reported. There is continued evidence of an increase in the data

quality from the observer scheme, as well as an increase in the reporting of fish by-catch in the commercial krill fishery catch data. The paper noted a high degree of overlap in the most frequently reported taxa between the C1 data and SISO data. Species distributions for main species were plotted, with painted rockcod (*Lepidonotothen larseni*) the most frequently reported species in both datasets. The characteristics (species and size frequency) of fish taken as by-catch in the krill fishery are consistent with those reported in the diet of krill-dependent predators from the region in which the krill fishery operates.

6.2 The Working Group noted that there may be sufficient data on fish by-catch in the krill fishery to examine the factors influencing vessel-specific differences in the frequency of fish by-catch and encouraged such analyses to be conducted. The Working Group recalled the work carried out in the Ross Sea using a pairwise comparison to assess the fish tagging performance of vessels and suggested that a comparative method (e.g. Mormede and Dunn, 2013) be investigated to evaluate by-catch data from krill fisheries. The Working Group also noted that issues remain with the ability to scale estimates of fish by-catch to total catch with the data reported from vessels using a continuous fishing system.

6.3 The Working Group recalled the advice from WG-FSA-16 (SC-CAMLR-XXXV, Annex 7, paragraphs 5.11 to 5.13) encouraging national coordinators to task SISO observers to collect quality close-up photographs of each species identified in a trip and subsequently submitting verified photos to the CCAMLR Secretariat in order that these can be made available in by-catch guides for observers. The Working Group reiterated the need for correct species identifications and noted the importance of expert comparison and confirmation of observer identifications to maintain and improve data quality.

6.4 The Working Group noted that although by-catch data is presented in individual fishery reports, currently there are no similar summaries of by-catch from the toothfish or icefish fisheries and requested the Secretariat to present this information at future meetings.

6.5 WG-FSA-17/64 presented length–weight relationships for six fish species commonly associated with the *E. superba* fishery. The samples were collected during krill fishing operations in the Atlantic sector of the Southern Ocean from January to August 2016. Additional information detailing the relationships between standard length and total length of the species studied was also presented.

6.6 The Working Group noted that information on fish species derived from the *E. superba* fishery will be very helpful in understanding the interaction between the krill fishery and fish communities associated with krill swarms and acknowledged that krill fishing vessels can provide a useful scientific platform to produce relevant biological information for fish species associated with krill populations.

6.7 WG-FSA-17/65 described the use of otolith elemental signatures to understand the habitat shifts of *Electrona carlsbergi*. This is one of the most important pelagic myctophids in the Convention Area, having a circumpolar distribution between the subtropical confluence zone and the Southern Ocean. This study provides a stock structure hypothesis building on biological studies carried out during the 1990s and providing useful information to study the habitat shift of this species using otolith elemental signature analysis.

6.8 The Working Group noted that this form of analysis could be used to test habitat shift and life-history processes of fish species in the Southern Ocean and to couple elemental

signature analysis with water chemistry providing a good pathway for understanding energy transfer in Southern Ocean ecosystems. The Working Group welcomed a plan for future work which may incorporate other trace elements, linking with published biological data to look at migration routes and other fish species. The Working Group suggested that additional studies might consider incorporating ageing information and differentiation by sex. The Working Group suggested that this technique might be evaluated for testing hypotheses of toothfish movement in data-poor areas, as has been done for Subareas 88.1 and 88.2 (WG-SAM-14/33).

6.9 In 2016/17, research undertaken by Australia and Spain in research block 5841_6 was not completed due to exceeding the 16% by-catch limit for *Macrourus* spp. WG-FSA-17/23 presented an analysis which concluded that concentrating fishing for *D. mawsoni* in the depth range of 1 100–1 600 m would reduce by-catch of *Macrourus* spp. The authors highlighted that the current research grid in research block 5841_6 inhibits the ability of vessels to avoid *Macrourus* spp. by-catch. They proposed to either modify the research grid to avoid the depth range of high by-catch, or remove it completely, consistent with research in the majority of research blocks in Divisions 58.4.1 and 58.4.2.

6.10 The Working Group recalled the three principles of CCAMLR's strategy for managing by-catch in the Convention Area (SC-CAMLR-XXII, Annex 5, paragraph 5.230), which are:

(i) avoidance
(ii) mitigation, and lastly
(iii) the assessment of yield for finfish if mortality is not preventable.

6.11 These are applied in order to ensure that research and fisheries are consistent with CCAMLR's objectives to limit the catch of non-target species. The Working Group further agreed that by-catch limits should consider impacts on by-catch species and the ecosystem, as well as avoiding excessive removals of biomass that are not utilised.

6.12 The Working Group noted that while undertaking research in research block 5841_6 in 2016/17, the *Antarctic Discovery* triggered two move-on rules. The *Antarctic Discovery* caught ≥ 1 tonne of *Macrourus* spp. in one haul triggering CM 33-03, paragraph 5, and also exceeded 16% of the vessel catch of *Dissostichus* spp. in a 10-day period in research block 5841_6, triggering CM 33-03, paragraph 6.

6.13 The Working Group requested that the Scientific Committee consider whether the existing move-on rule should be reviewed to potentially explore whether modifications in the move-on rule may help avoiding or mitigating *Macrourus* by-catch whilst still allowing vessels to continue undertaking research in this research block in the future. The Working Group noted that consideration should be extended to other areas where a similar issue might occur.

6.14 The Working Group recalled that the original purpose of the research grid in research block 5841_6 was to maximise the likelihood of tag recaptures from the Spanish depletion experiment (SC-CAMLR-XXXI, paragraphs 3.141 to 3.143).

6.15 To allow the avoidance and mitigation of *Macrourus* by-catch, the Working Group recommended to remove the research grid in research block 5841_6 and to structure research fishing similarly as in other research blocks within Division 58.4.1 that do not have research grids, i.e. distribute fishing effort across a range of depth strata (<1 000, 1 001–1 500, 1 501−2 000 m) with at least five longlines in each depth strata per fishing Member deployed in accordance with the minimum separation distances in CM 41-01, Annex 41-01/B.

6.16 WG-FSA-17/23 also provided estimates of biomass and sustainable catch limits for the *M. whitsoni*/*caml* species morph in all research blocks of Divisions 58.4.1 and 58.4.2 by applying the CPUE by seabed area method following the recommendation from WG-FSA-16 (SC-CAMLR-XXXV, Annex 7, paragraph 6.17). The analysis used biomass estimates of *M. whitsoni* from the 2008 Ross Sea assessment as the reference biomass (SC-CAMLR-XXVII, Annex 5, paragraphs 6.18 and 6.19). *Macrourus* spp. biomass was estimated separately by longline gear type in each research block due to differences in reported catch rates. The authors considered that the biomass and sustainable catch estimates from this study be considered as the basis for management advice in setting sustainable catch limits for *Macrourus* spp. within these divisions.

6.17 The Working Group noted the differences in *Macrourus* catch rates for the three longline gear types that were presented for the Ross Sea and how the catch rates had changed over time. These differences included the decline in the catch rates of autoline and the concurrent increase in Spanish longline and trotline catch rates in 2016 and 2017.

6.18 The Working Group recalled the analysis of by-catch in the Ross Sea undertaken by the Secretariat in 2015 (WG-FSA-15/04 Rev. 1) and that the apparent by-catch rates may also be associated with whether it is the crew or the observer that is tasked with collection of the data used for by-catch reporting by the vessel. The Working Group requested the Secretariat to reissue the survey reported in WG-FSA-15/04 Rev. 1 in order to evaluate whether recent changes in by-catch reporting rates were as a result of changes in how by-catch reporting is implemented on vessels. In addition, the Working Group requested the Secretariat to evaluate possible correlations with tag survivability and detection as discussed in paragraphs 3.71, 3.72 and 3.74.

6.19 The Working Group noted that the catches of *Macrourus* spp. in research block 5841_6 in 2016/17 were well below the removals that would be considered sustainable if part of a targeted fishery based on the estimates provided by WG-FSA-17/23.

6.20 The Working Group recommended that the by-catch limits for *Macrourus* spp. in Divisions 58.4.1 and 58.4.2 be retained at 16% of the *D. mawsoni* catch limit for 2017/18 and that multi-Member research proposals should be reviewed in 2018 to account for areas of high by-catch and incorporate the habitat model and stock hypothesis developed by WG-FSA-17/16.

6.21 WG-FSA-17/07 provided an updated characterisation of the toothfish fishery in the Ross Sea region (Subarea 88.1 and SSRUs 882A–B), including recommendations for new catch limits among areas for by-catch species to accompany the introduction of the Ross Sea region MPA. By-catch limits in the open areas south of 70°S, north of 70°S and in the SRZ were either fixed based on a local area biomass estimate if available or otherwise set as a percentage of the toothfish catch limit for the area.

6.22 The Working Group recommended updated catch limits by area for Macrourids, skates and other species in the Ross Sea region, consistent with the implementation of the Ross Sea region MPA (CM 91-05). The by-catch limits using the recommended toothfish catch limit for the Ross Sea region of 3 157 tonnes are shown in Table 8.

6.23 The Working Group requested that the Scientific Committee note CM 91-05 (2016), and review related conservation measures, including CM 33-03 governing the limitation of by-catch in new and exploratory fisheries and CM 41-09 setting limits on the exploratory fishery for *D. mawsoni* in Subarea 88.1 prior to the season start on 1 December 2017.

Marine mammal and seabird by-catch

6.24 The Secretariat presented WG-FSA-17/58 Rev. 2 providing a summary of the scientific observer data collected in CCAMLR fisheries in the Convention Area during 2016/17. This paper summarised the data collected by scientific observers operating in the Convention Area on board fishing vessels during the 2016/17 season from data received by the Secretariat up to 15 September 2017. Information on observer deployments, incidental mortality and fish sampling was presented.

6.25 The Working Group thanked the Secretariat for presenting this information and noted that the extrapolated incidental mortality of 116 seabirds in all CCAMLR longline fisheries in 2017 (Table 9) was the second-lowest on record.

6.26 The Working Group also noted that the number of seabird interactions in longline fishing activities in the CAMLR Convention Area was very low compared to other longline fisheries globally. There has been a steady and significant decrease of seabird mortalities due to fishing gear interactions in the CCAMLR area following the development of mitigation measures by the Working Group on Incidental Mortality Associated with Fishing (WG-IMAF) and the Agreement on the Conservation of Albatrosses and Petrels (ACAP), which are now providing a template for other regional management organisations.

6.27 The Working Group noted that there are likely to be a number of other seabird mortalities within the Convention Area that are not directly reported by the observer as captured on the fishing gear during their tally period. These additional mortalities can arise when seabirds hit the superstructure of vessels, including fishing vessels, tourist vessels and other vessels operating in the Convention Area.

6.28 The Working Group recommended that the Scientific Committee consider whether the matter of seabird mortalities not associated with fishing gear be included as a potential topic of mutual interest with the Committee for Environmental Protection (CEP). This would allow a broader range of information from other sources of mortality to be available for monitoring status and trends of seabird mortality in the Convention Area, as well as potential options for mitigation.

6.29 WG-FSA-17/20 presented an update on the fishing effort and seabird interactions in the longline fishery in Division 58.5.2 for the season extension trials in the periods 1–14 November 2016, 15–30 November 2016, 1–14 April 2017 and 15–30 April 2017. During the two November 2016 extension trials, four white chinned petrels (*Procellaria aequinoctialis*) and a macaroni penguin (*Eudyptes chrysolophus*) were caught. In the April 2017 season extension trials, one grey petrel (*P. cinerea*) and one *P. aequinoctialis* were caught.

6.30 The Working Group noted that it was important to analyse seabird interactions with respect to the level of fishing effort deployed during the season, considering the increase in effort in the latter part of the season in recent years in Division 58.5.2.

6.31 WG-FSA-17/24 proposed to amend CM 25-02 such that the instruction to longline fishing vessels to deploy streamer lines while setting is removed for vessels that use longline weighting according to CM 24-02. The proponents highlighted the effectiveness of longline weighting (CM 24-02) in reducing seabird mortalities and suggested that this instruction in CM 25-02 was obsolete and the conservation measure should be updated.

6.32 The Working Group recalled that in the past when proposals for modification of conservation measures were presented, they were accompanied by an analysis of a scientific trial of the effects of the proposed change. The Working Group recalled WG-FSA-16/38, 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). It also recommended that such a scientific trial of the need for streamer lines should be presented to ACAP.

6.33 The Working Group noted that current best practice for the mitigation of seabird interactions during setting of longline fishing gear from ACAP was to use both streamer lines and longline weighting and recommended that CM 25-02 should remain in place.

6.34 WG-FSA-17/50 highlighted problems in the sampling and extrapolation of seabird mortalities using observer-reported seabird interactions outside the standard observation period. The authors noted that the inclusion of non-random observations such as interactions provided to the observer by the crew and interaction observations recorded from video footage taken outside the standard observation period, if not reported correctly, may result in bias in the raised seabird mortality estimates.

6.35 The Working Group discussed whether the method used to extrapolate seabird mortalities was appropriate when observations were non-random or in areas with seasonal variability in seabird mortality. The Working Group noted that observation periods may not be random when observers are notified by crew of a mortality event occurring outside the observation period, and the observer consequently starting their observation period to coincide with the mortality event to accurately record seabird mortalities.

6.36 The Working Group recalled the work of WG-IMAF on developing the extrapolation method and suggested that alternative methods for extrapolating seabird mortalities, such as raising numbers per haul per vessel rather than per season per area, could be considered by WG-SAM.

6.37 The Working Group noted that it was essential for observers to be issued with clear instructions how to report seabird mortalities both during and outside the observation period, and recommended Members work with their scientific observer coordinators to ensure appropriate guidance was provided on this issue. The Working Group also recommended that such instructions be included in the forthcoming CCAMLR SISO manual.

Future work

Five-year strategic plan for the CCAMLR Scientific Committee

7.1 The Working Group considered the proposed five-year work plan for the Scientific Committee presented by the Chair of the Scientific Committee (WG-EMM-17/02). The paper provides an expansion of the recommendations of the Scientific Committee (SC-CAMLR-XXXV, Table 1) which were discussed and put forward by the Scientific Committee Symposium in October 2016. The paper outlined the work plan across themes and indicated a timeline by which each topic should be addressed. The Working Group noted that WG-SAM and WG-EMM had provided feedback and suggestions relating to the document.

7.2 The Chair of Scientific Committee noted that the document will be updated to include the recommendations for future work arising from the WG-FSA meeting and submitted as a revision to the Scientific Committee for further consideration. This would include reference to the proposed workshop on the development of a stock hypothesis for toothfish in the Weddell Sea region (paragraph 8.22) proposed by Germany for February 2018 and the proposed independent review of CCAMLR's CASAL integrated toothfish stock assessments, proposed for Norwich, UK, in the week prior to the 2018 WG-SAM meeting (paragraphs 7.11 to 7.14).

Pop-up satellite archival tags (PSATs) workshop

7.3 The Working Group recalled discussion at WG-SAM-17 (Annex 5, paragraph 4.65) relating to a proposal for a two-day workshop to consider the use of PSATs in CCAMLR toothfish research (WG-SAM-17/33). The Working Group discussed the paper's recommendation that a two-day workshop involving scientists with an interest in archival tagging and PSAT manufacturers would be a useful way of advancing the use of PSATs for toothfish studies.

7.4 The Working Group noted that the arrangements suggested by Germany for a CCAMLR technical expert workshop to develop an interim toothfish population hypothesis for Area 48 and a regional toothfish research strategy for Subarea 48.6 to be convened in February 2018 in Berlin (Germany) would allow for a separate two-day PSAT workshop to be convened back-to-back. It also noted that there may be interest from the Coalition of Legal Toothfish Operators (COLTO) in attending and contributing to this workshop.

7.5 The Working Group agreed that, given the increasing use of PSATs in CCAMLR fisheries research, developing a mechanism for scientists to engage in detailed discussion on their use would be beneficial. Issues such as tag design and data storage and management, battery life, geolocation capability, deployment, attachment and data analysis methods were topics of interest to the Working Group. The Working Group also noted that trials on the suitability of different tags for use in Southern Ocean deployments, as presented in WG-SAM-17/33, were a useful method for assessing tag performance.

7.6 The Working Group noted that it could be beneficial for WG-FSA to develop a strategy for the use of PSATs in CCAMLR fisheries research in advance of a workshop involving manufacturers and fishing industry. This would enable consideration of the specific requirements and specifications for PSATs used in toothfish research in the Southern Ocean that could then be communicated to tag manufacturers. As tags with different sensors and capabilities will require new designs, these tags would need to be tested in Antarctic environments. The work program associated with the development and implementation of PSAT tagging programs for CCAMLR could be considered during WG-FSA-18. The Working Group encouraged the submission of information to the Working Group on other fisheries research programs in which PSATs are deployed and noted that PSAT deployment could provide information on long-term survivorship of rajids returned to the sea following capture in toothfish fisheries.

7.7 The Working Group noted that Korean scientists will be carrying out a program of research using PSATs in the southwest Atlantic Ocean sector (FAO Area 41) with the results expected in 2019 and Japan and Norway planned to deploy PSATs in Subarea 48.6 in 2018.

Fish in the Antarctic ecosystem

7.8 The Working Group noted that fisheries research programs carried out by CCAMLR Members provided extensive information on the ecology and biology of non-target fish species within CCAMLR. However, it was unclear whether such information was more appropriately considered by WG-FSA or WG-EMM and often ended up not being considered in detail by either working group.

7.9 The Working Group noted that there were opportunities to work with external bodies such as the Scientific Committee on Antarctic Research (SCAR) to bring greater visibility to such research. It was noted that a joint CCAMLR/SCAR themed symposium on 'the role of fish in Antarctic ecosystems', run in conjunction with a future SCAR biology meeting, could provide a mechanism to showcase research on non-target fish species. The Chair of the Scientific Committee undertook to develop this further during the intersessional period and noted that the next SCAR biology symposium would be in 2020.

Environmental data

7.10 The Working Group considered the collection of environmental data from fishing vessels operating within CCAMLR and how these data may be brought into the working groups. The Working Group noted that there are a number of initiatives currently underway by CCAMLR Members, both within and outside the CCAMLR region, where fishing vessels are used to collect environmental data. Such programs using fishing vessels as 'vessels of opportunity' could provide information to other Members on how the collection of such data can be coordinated. However, it was noted that these data are often of variable quality and issues of instrument calibration and data resolution could prevent their use. The Working Group also noted that, where possible, environmental data streams should be integrated with existing initiatives such as the Southern Ocean Observing System (SOOS) to avoid the possible duplication of data standards and management.

Independent review of integrated stock assessment methods

7.11 The Working Group considered a proposal to establish an independent review process of CCAMLR's integrated stock assessments (WG-FSA-17/62). The Working Group recalled that in 2013, the Commission endorsed the Scientific Committee's recommendation to develop a process to facilitate independent reviews of CCAMLR stock assessments (CCAMLR-XXXII, paragraph 5.14) and noted a request from the Scientific Committee that the group comprising the Scientific Committee Chair and Vice-Chairs and the working group conveners provide further advice on the process in 2017 (SC-CAMLR-XXXV, paragraph 13.24).

7.12 The terms of reference for the review process (Appendix D) were considered by the Working Group, noting that the primary objective for the expert panel is 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. CCAMLR's assessments would be compared relative to international best practices, and improvements to the assessment methods suggested where appropriate. The current toothfish stock assessments to be reviewed at a single meeting are the Ross Sea region (Subarea 88.1), HIMI (Division 58.5.2) and South Georgia (Subarea 48.3).

7.13 The Working Group considered the selection of external reviewers and recommended that they should be as independent from the CCAMLR stock assessment process as practicably possible. It was agreed that three reviewers were likely to be the optimum number and that they should have extensive fish stock assessment experience with extensive experience of Bayesian methods. Suggestions for reviewers would be sought from Members and agreed by the Chair of the Scientific Committee and the conveners of WG-SAM and WG-FSA and this process could be facilitated by the Secretariat.

7.14 The Working Group recommended that the Scientific Committee consider the choice of convener for the meeting and also clarify the process for report development and submission. It was noted that the report could be provided to WG-SAM immediately after the independent review panel meeting and its findings be considered by the Working Group.

7.15 The Working Group noted that the request for funds for the reviewers, estimated to be approximately US$53 400 (Appendix D), would need to be further considered by the Standing Committee on Administration and Finance (SCAF). The Working Group noted that the meeting would be open to all Members but that those attending should be experienced in the use of Bayesian integrated stock assessment methods.

Other business

Sea-ice analysis

8.1 The Working Group noted that the sea-ice analysis presented in WG-FSA-17/08 linked sea-surface temperature in the Pacific Ocean associated with El Niño/La Nina conditions, the extent of sea-ice in the Weddell Sea and the Ross Sea and the potential that such large-scale teleconnections can be used to predict future access to research blocks.

8.2 The Working Group noted that sea-ice distribution in the Southern Ocean reflected a complex interaction of physical processes, including the Southern Annular Mode, the Amundsen Sea Low and the ozone hole, and that existing global climate models were unable to resolve spatial differences in sea-ice around the Antarctic and have limited potential use in operational decisions. The Working Group suggested that the time series presented in WG-FSA-17/08 could be compared with when fishing activity took place in research blocks to better evaluate the potential predictive capacity of such approaches for research fishing.

Marine debris

8.3 The Secretariat presented an update on the CCAMLR marine debris monitoring program (WG-FSA-17/02) and included a review of the occurrence of plastic debris on beaches and in seabird colonies in the entanglement of marine mammals. Overall, the frequency of occurrence of man-made debris on beach surveys and in seabird colonies is lower than historical levels but remains an issue in the CAMLR Convention Area. The Secretariat thanked those Members that had submitted data to the marine debris program and encouraged all Members that conduct fieldwork in the CCAMLR region to submit similar data.

8.4 The Working Group thanked the Secretariat for the update and noted that this CCAMLR program was established to monitor the potential impacts of fishing on the marine environment and requested that lost gear reported from vessels, from both observer and commercial data, be included in future annual updates on marine debris from the Secretariat.

8.5 The Working Group noted that marine debris data was submitted by three Members and encouraged the Scientific Committee to consider ways to encourage more Members to participate in marine debris monitoring, including potential links with the CEP and Council of Managers of National Antarctic Programs (COMNAP) in expanding engagement across more sites and national programs (see SC-CAMLR-XXXV, Annex 7, paragraph 8.38).

Climate change response work program

8.6 WG-FSA-17/01 presented a draft climate change response work program addressing the remaining terms of reference of the climate change intersessional correspondence group (ICG) to develop approaches for integrating considerations of the impacts of climate change into the work of CCAMLR. The ICG sought feedback from WG-FSA on the draft work program, specifically advice on issues, information gaps identified, proposed actions and relevant activities already underway, as well as advice on appropriate timeframes for responding to research activities.

8.7 The Working Group thanked Australia and Norway for preparing WG-FSA-17/01 and noted that it is important for WG-FSA to consider issues related to climate change. It also noted that the workplan set out in the paper would need to be considered in the context of the other priorities identified by the Scientific Committee. The Working Group recognised that a number of the activities identified in the plan were already part of the five-year plan for the Scientific Committee and that it would be important for WG-FSA and the Scientific Committee to have a strategy to ensure that it was able to deliver advice that was robust to the potential effects of climate change.

8.8 The Working Group noted that despite being the focus of a great deal of work in WG-FSA, there was no specific mention of toothfish in the work program despite there being climate change impacts on the benthic habitats in the Antarctic (Griffith et al., 2017). The Working Group recommended that an appropriate mechanism be developed to bring climate change science and the potential impacts on finfish in the Southern Ocean into the work of WG-FSA and noted that this could include the routine analyses of time series of data from fisheries and associated research data to detect potential climate-related changes.

8.9 The Working Group noted that the proposed Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED) workshop to be held in Hobart in April 2018 directly addressed questions provided by WG-EMM and had a spatial focus on Area 48 and encouraged Members to engage with this work (SC-CAMLR-XXXV, Annex 6, paragraphs 6.18 and 6.19).

8.10 The Working Group also noted that there were considerable opportunities for fishing vessels to participate in the collection of oceanographic data, including through CTDs attached to gear, that could be coordinated in a way that enhanced their contribution to climate-related science.

Global Environment Facility proposal

8.11 CCAMLR-XXXVI/02 provided an update on the development of the proposal for funding support from the Global Environment Facility (GEF) to build capacity among GEF-eligible CCAMLR Member countries to strengthen their participation in CCAMLR. The project was approved by the GEF Council at its meeting in May 2017 and work is currently underway to develop the full project document.

8.12 The Working Group welcomed the report and agreed that, if successful, it would contribute significantly to building capacity within CCAMLR among GEF-eligible Members. It encouraged all Members to consider whether opportunities existed within their research programs to create opportunities to raise capacity in CCAMLR that could contribute to the success of the project.

8.13 The Working Group noted that the operational details and mechanisms for supporting the proposal, including implications for Secretariat support, were a matter for the Commission.

Ross Sea region MPA Research and Monitoring Plan

8.14 SC-CAMLR-XXXVI/20 presented a proposed RMP for the Ross Sea region MPA and the Working Group noted that the Co-conveners of the Ross Sea region MPA Research and Monitoring Plan Workshop (WS-RMP-17) had undertaken to seek recommendations from all of the working groups in order to provide a revised RMP to the Scientific Committee for consideration.

8.15 The Working Group noted that the draft RMP contained a description of the research requirements associated with the SRZ, but that some clarity of the requirements in the short and long term would be desirable.

8.16 The Working Group noted that the RMP did not seek to prioritise the areas of research that had been identified but that it is advantageous to allow national Antarctic programs to select the work that they would undertake rather than for CCAMLR to seek to agree on a priority for the list of important research areas.

8.17 The Working Group noted that the first five-year review would reveal gaps in the delivery of the RMP and that this would likely require an update of the RMP and a prioritisation to address identified gaps.

8.18 The Working Group noted that coordination of research between different Members is important and that there was a need for a mechanism to achieve coordination. To help with the evaluation of a research plan, the Working Group requested the Scientific Committee develop a research plan pro forma, similar to the one for data-poor fisheries. Information from the RMP should also be used, including the list of topics (SC-CAMLR-XXXVI/20, Table 1), how the list related to geographic locations (SC-CAMLR-XXXVI/20, Table 2) and project details as listed in SC-CAMLR-XXXVI/20, paragraph 10.

Weddell Sea MPA

8.19 The Working Group considered the scientific background document in support of the Weddell Sea MPA proposal (WG-FSA-17/29). The document informed on the work carried out intersessionally to develop analyses of relevant data layers, including an updated *D. mawsoni* habitat model and associated cost layers.

8.20 The Working Group recalled the discussion from WG-SAM-17 (Annex 5, paragraph 6.8) and clarified that the 60% protection targets for adult *D. mawsoni* reflected the spatial distribution of protection, including areas under ice, and was not analogous to a target level of a spawning stock biomass in the CCAMLR decision rules. The Working Group also noted that, where protection was provided as a result of areas currently being inaccessible due to ice cover, the MPA review process would provide a mechanism to ensure that the protection targets are maintained in the event of large-scale environmental change.

8.21 The Working Group noted that the current Marxan analysis was restricted to adult toothfish and that data on other life-history stages of toothfish, such as the distribution of juveniles for surveys in Subarea 48.1 (see Kock et al., 2000), including from adjacent regions, could be used to better reflect the distribution of *D. mawsoni* in the Weddell Sea.

8.22 The Working Group welcomed the proposal from Germany to host a workshop in 2018 to further examine toothfish dynamics and movement in the region to inform a working stock structure hypothesis (SC CIRC 17/58) and noted that the development of this hypothesis would contribute to the management of *D. mawsoni* in Area 48 and to the definition of the fishery research zones in the Weddell Sea MPA proposal.

8.23 Dr Kasatkina noted that there are populations of dominant fish species in the Weddell Sea that are of commercial importance, or potential commercial importance, including *D. mawsoni*; spiny icefish (*Chaenodraco wilsoni*); *P. antarctica* and Antarctic rockcod (*Trematomus eulepidotus*). She noted that Russia had repeatedly indicated that information on the commercial potential of these fish species and krill for future rational use should be included in the MPA proposal (SC-CAMLR-XXXIV, paragraphs 3.19 and 3.20; SC-CAMLR-XXXVI, Annex 3, paragraph 5.4) and requested clarification on planned activities in relation to these issues.

Collaboration on code used for analysis

8.24 The Working Group noted the increasing use of GitHub by Members as the preferred environment for collaborating code development during this Working Group. It was agreed that there were many benefits arising from sharing code in a version-controlled transparent environment such as GitHub.

8.25 The Working Group was informed by the Secretariat that a GitHub organisation and corporate account had been created by the Secretariat (www.github.com/ccamlr) to allow centralised administration of code.

8.26 It was noted that participation in code repositories that are private can be facilitated by the Secretariat using the CCAMLR corporate account, but this would require an annual fee (currently A$21 per person, per month) and would have to be considered by SCAF.

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) the unprecedented availability of catch data from IUU vessels (paragraph 2.16).

(ii) Assessments –

(a) catch limit for *C. gunnari* in Subarea 48.3 (paragraph 3.6)

(b) catch limit for *C. gunnari* in Division 58.5.2 (paragraph 3.12)

(c) catch limit for *D. eleginoides* in Subarea 48.3 (paragraph 3.27)

(d) catch limits for *D. eleginoides* and *D. mawsoni* in Subarea 48.4 (paragraphs 3.32 and 3.37 respectively)

(e) prohibition of directed fishing for *D. eleginoides* in Division 58.5.1 outside areas of national jurisdiction (paragraph 3.43)

(f) catch limit for *D. eleginoides* in Division 58.5.2 (paragraph 3.54)

(g) prohibition of directed fishing for *D. eleginoides* in Subarea 58.6 outside areas of national jurisdiction (paragraph 3.60)

(h) catch limits for *D. mawsoni* in Subarea 88.1 including shelf survey (paragraphs 3.86 and 3.87).

(iii) Ross Sea region –

(a) monitoring fishing capacity and potential improvements to fishery closure forecasting (paragraphs 3.94 to 3.97)

(b) tagging details using video (paragraph 3.73)

(c) research in SRZ of the Ross Sea region MPA (paragraphs 3.107 and 3.114).

(iv) Subarea 88.2 –

(a) continuation of research plan with coordination between Members intending to carry out research (paragraphs 3.117, 3.119 and 3.121).

(v) Research fishing in data-poor fisheries for *Dissostichus* spp. –

(a) cross-referencing evaluation criteria in new or modified proposals (paragraph 4.9)

(b) revision process and review of research proposals (paragraph 4.10)

(c) integrated strategy for research proposal (paragraph 4.14)

(d) capacity to complete planned research and evaluation of vessel performance in research (paragraphs 4.16, 4.18 and 4.67)

(e) priority work for WG-SAM and WG-FSA (paragraph 4.37)

(f) research fishing in Subareas 48.2 and 48.4 (paragraphs 4.68 and 4.72)

(g) research fishing in Subarea 48.6 (paragraph 4.87)

(h) research fishing in Divisions 58.4.1 and 58.4.2 (paragraph 4.116)

(i) research fishing in Division 58.4.3a (paragraph 4.127)

(j) research fishing in Division 58.4.4b (paragraph 4.130)

(k) research fishing in Subarea 88.3 (paragraph 4.147).

(vi) Scheme of International Scientific Observation (SISO) –

(a) redesigned observer logbooks (paragraph 5.6).

(vii) Non-target catch and interactions in CCAMLR fisheries –

(a) mechanisms to avoid *Macrourus* by-catch in Division 58.4.1, including move-on rules and catch limits (paragraphs 6.13, 6.15 and 6.20)

(b) mechanisms to avoid *Macrourus* by-catch in Subarea 88.1 associated with the Ross Sea region MPA (paragraphs 6.22 and 6.23)

(c) incidental mortality of seabirds in CCAMLR fisheries (paragraphs 6.25 and 6.28).

(viii) Future work –

(a) independent review process of CCAMLR's integrated stock assessments (paragraphs 7.14 and 7.15).

(ix) Other business –

(a) Marine debris monitoring (paragraph 8.5)

(b) Ross Sea region MPA RMP (paragraph 8.18).

Close of meeting

10.1 In closing the meeting, Dr Welsford thanked all participants for their patience and hard work in accomplishing the long list of tasks presented to the Working Group, including the provision of advice on catch limits in assessed fisheries and the development of review criteria and advice on research proposals for research on toothfish. He also thanked the rapporteurs and the Secretariat for their support to the work of WG-FSA-17.

10.2 On behalf of the Working Group, Dr Belchier thanked Dr Welsford for his strong leadership combined with a good sense of humour that had enabled the Working Group to deliver such a large amount of clear advice to the Scientific Committee.

10.3 The Working Group noted that the former Convener, Dr Stuart Hanchet, would be retiring next year and therefore would not be returning the Working Group. Mr Dunn was asked to convey the Working Group's thanks and best wishes to Dr Hanchet for his sustained positive contribution to the work of WG-FSA and CCAMLR.

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Table 1: Number of *D. mawsoni* otoliths collected on Member vessels and ages available by year for small-scale research units (SSRUs) 882H and 882C–G. The priorities for the ageing of otoliths are indicated as high, medium or lower priority collections for ageing by green, orange and blue respectively. Existing collections from which some otoliths have been aged are shown in yellow. ARG – Argentina; AUS – Australia; ESP – Spain; GBR – United Kingdom; KOR – Republic of Korea; NOR – Norway; NZL – New Zealand; RUS – Russian Federation; UKR – Ukraine; URY – Uruguay; ZAF – South Africa.

Year	Number aged	Member										
		Number of otoliths collected										
		ARG	AUS	ESP	GBR	KOR	NOR	NZL	RUS	UKR	URY	ZAF
882North (882H)												
2003	184	0	0	0	0	0	0	563	0	0	0	0
2004	235	0	0	0	0	0	0	596	0	0	0	0
2005	234	0	0	0	0	0	55	332	0	0	0	0
2006	173	0	0	0	170	0	750	245	0	0	0	0
2007	0	136	0	0	67	0	475	0	117	0	0	0
2008	289	0	0	0	46	0	0	862	113	0	3	0
2009	13	0	0	16	715	47	0	22	0	0	0	701
2010	0	48	0	9	386	9	0	0	0	0	0	0
2011	251	0	0	0	233	36	0	817	553	0	0	0
2012	244	0	0	0	264	49	0	907	140	0	0	0
2013	388	0	0	0	22	24	40	775	235	32	0	0
2014	169	0	0	0	68	111	0	249	26	48	0	0
2015	335	0	339	0	0	0	76	0	0	32	0	0
2016	0	0	0	0	395	0	0	0	122	0	0	0
2017	0	0	342	0	0	0	0	0	0	0	107	0
882South (882C–G)												
2006	23	0	0	0	71	0	0	131	6	0	0	0
2007	0	-	-	-	-	-	-	-	-	-	-	-
2008	0	-	-	-	-	-	-	-	-	-	-	-
2009	341	0	0	0	120	0	0	405	0	0	0	0
2010	0	0	0	30	0	0	0	0	0	0	0	0
2011	121	0	0	0	45	10	0	286	511	0	0	0
2012	0	0	0	0	0	0	0	0	70	0	0	0
2013	383	0	0	0	0	0	0	505	0	0	0	0
2014	29	0	0	0	186	42	220	33	301	40	0	0
2015	166	0	307	0	0	308	610	0	50	96	0	0
2016	180	0	0	492	661	138	0	275	799	192	0	0
2017	0	0	177	0	0	345	0	1	490	943	123	0

Table 2: Prospective milestones for reporting information to WG-SAM and WG-FSA from research plans in data-poor fisheries as defined in SC-CAMLR-XXIX, Annex 6, paragraph 5.1. The items listed below are a guide for creating a tailored set of milestones according to the individual objectives of each research plan in data-poor fisheries against which WG-FSA can assess progress of each research plan, as appropriate. Due dates for milestones should be specified in each individual research plan. Actual milestones to be agreed by the Scientific Committee for each research plan.

	Milestones
Fishing operations	1. Fishing operational data specified in the research plan (e.g. standardisation of gear or procedures or data to be collected) 2. Sampling requirements as specified in the research plan (e.g. fish length, weight, otoliths, by-catch species composition, tags deployed, vulnerable marine ecosystem sampling)
Biological sampling and analysis	3. Tissue samples collected as specified: otolith sampling, gonad sampling, other
Sample processing as agreed	4. Otoliths to be aged, validation procedures completed and adequate for use 5. Maturity analysis as specified (methods, sample sizes, by sex)
Biological parameter estimation	6. Length–weight relationships 7. Maturity ogive parameter values 8. Age–length keys, growth model parameters
Tagging data	9. Tagging rate achieved, tag releases by season in each research block, overlap statistic achieved 10. Vessel calibration studies conducted
By-catch data	11. Data and samples collected as specified in the research plan 12. Analyses conducted as specified in the research plan (e.g. satellite tagging, oceanography, diet)
Data analysis, as specified in the research plan	13. Hypothesis testing of stock structure 14. Vessel calibration studies as specified: catch rate and size selectivity, tagged fish survival and tag detection analysis 15. Illegal, unreported and unregulated fishing estimation (current and historical) 16. Expected tagging program performance 17. Preliminary stock status, and biomass estimates, and harvest rate incorporating data collected to date (e.g. selectivity, size, biological parameters) 18. Analysis of biological data for target and non-target species 19. Analysis of potential effects of fishing on the ecosystem

Table 3: Toothfish catch limits for the 2016/17 season, decision rules used for choice of methodology and calculation of catch, and proposed catch limits for the 2017/18 fishing season for data-poor fisheries, by research block for data-poor toothfish fisheries.

Research block	2016/17 catch limit	Qualitative rule	Adequate tag recaptures	Agreed method	Chapman method estimate	CPUE method estimate	Catch limit without 20% max. change	Catch limit proposed for 2017/18 with 20% max. change
486_2	170	Stable	Y	Chapman	169	121	169	169
486_3	50	Declining	Y	Catch limit × 0.8	82	18	40	40
486_4	100	Stable	Y	Chapman	230	142	230	120
486_5	190	n/a	-	CPUE	-	334	334	228
5841_1	80	n/a	-	CPUE	480	142	142	96
5841_2	81	Stable	N	CPUE	-	170	170	97
5841_3	233	Stable	N	CPUE	532	145	145	186
5841_4	13	n/a	-	CPUE	-	24	24	16
5841_5	35	Not certain	N	CPUE	172	213	213	42
5841_6	90	Increasing	N	CPUE	243	165	165	108
5842_1	35	n/a	-	CPUE	-	129	129	42
5843a_1*	32	Not certain	N	CPUE	73	64	64	38
5844b_1*	25	Stable	N	CPUE	104	18	18	20
5844b_2*	35	Declining	N	Catch limit × 0.8	45	18	28	28

* Catch for the current season is incomplete.

Table 4: Summary of the assessment of the Area 48 research proposals against the criteria set out in paragraph 4.7. It is acknowledged that this process is aimed at new proposals and not existing proposals and the intent of the criteria were assessed. Summary of the rationale behind the scores are in the notes below, and details in paragraphs 4.52 to 4.87. n/e indicates not evaluated.

Subarea:	48.1	48.2		48.2 and 48.4	48.5	48.6	
Proposal and country/criteria:	WG-FSA-17/32 Ukraine	WG-FSA-17/27 Chile	WG-FSA-17/31 Ukraine	WG-FSA-17/45 UK	WG-FSA-17/25 Russia	WG-FSA-17/10 Japan and South Africa	WG-FSA-17/61 Rev. 1 Norway
Conservation measure under which proposal submitted	24-01	24-01	24-01	24-01	n/e	21-02	21-02
(i) (a) Is the proposed research likely to generate an index of local stock abundance?	Y	Y	Y	Y	n/e	Y	Y
(b) Is the proposed research likely to generate estimates of biological parameters relating to productivity?	Y	Y	Y	Y	n/e	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	1	Y	n/e	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?	5	Y	Y	Y	n/e	Y	Y
(iii) Are the likely impacts from the proposed research to dependent and related species consistent with Article II?	Y	2	2	Y	n/e	Y	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?	4	Y	Y	Y	n/e	Y	5
(v) Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs?	6	7	8	Y	n/e	9	Y
(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]	Y[11]	Y	Y	Y	n/e	12	Y

(continued)

Table 4 (continued)

Subarea:	48.1	48.2		48.2 and 48.4	48.5	48.6	
Proposal and country/criteria:	WG-FSA-17/32 Ukraine	WG-FSA-17/27 Chile	WG-FSA-17/31 Ukraine	WG-FSA-17/45 UK	WG-FSA-17/25 Russia	WG-FSA-17/10 Japan and South Africa	WG-FSA-17/61 Rev. 1 Norway
(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[10]	Y	Y[10]	Y	n/e	Y	Y

Notes (notes in grey apply to other research proposals; a single list of notes is used throughout the data-poor research proposal review tables):

1. Proposals will generate local abundance indices but are very geographically constrained and there is no plan to widen the research into a broader stock hypothesis.
2. Proposals have data collection plan but are not currently looking at the impacts of the research on by-catch species.
3. Not applicable as the criterion was not available before the research proposal was written.
4. Refer to Annex 5, paragraph 4.103 and WG-FSA-17.
5. There is not enough information in the proposal.
6. A new vessel is in the proposal, but it could be replaced by the *Simeiz* or *Koreiz* who have a track record.
7. A new vessel is in the proposal, but observer has experience in the national tagging program.
8. The proposed vessel has multiple years of experience but low calculated effective survival rates (WG-FSA-17/36, Table 6).
9. The proposed vessels have multiple years of experience but have unknown calculated effective survival rates.
10. These criteria need to include capacity over multiple proposals for the Member concerned.
11. There are concerns about the reliability of the ice analysis and accessibility of the fishing grounds.
12. There have been ongoing issues to get to the research blocks due to either accessibility of the fishing grounds or fishing capacity, including commitments elsewhere. The inclusion of the Norwegian proposal in a single plan for this area might address the capacity issue in the future.
13. The research plan proposed an effort-limited survey but the impact on the environment and/or target stock is unclear.
14. The proposed research is located within existing research blocks, however, details relating to accessibility of these areas during times when the proposed research will be conducted are missing from the research plan.

Table 5: Summary of the assessment of the Area 58 research proposals against the criteria set out in paragraph 4.7. It is acknowledged that this process is aimed at new proposals and not existing proposals and the intent of the criteria were assessed. Summary of the rationale behind the scores are in the notes below, and details in paragraphs 4.88 to 4.129.

Subarea:	58.4.3a	58.4.4b	58.4.1 and 58.4.2	58.4.2
Proposal and country/criteria:	WG-FSA-17/55 Japan and France	WG-FSA-17/11 Japan and France	WG-FSA-17/18 Rev. 1 Australia, France, Japan, Republic of Korea and Spain	WG-FSA-17/33 Ukraine
Conservation measure under which proposal submitted	CM 21-02	CM 24-01	CM 21-02	CM 21-02
(i) (a) Is the proposed research likely to generate an index of local stock abundance?	Y	Y	Y	5
(b) Is the proposed research likely to generate estimates of biological parameters relating to productivity?	Y	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	Y	Y	5
(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	13
(iii) Are the likely impacts from the proposed research to dependent and related species consistent with Article II?	Y	Y	Y	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?	Y	Y	Y	5
(v) Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs?	Y[9]	Y[9]	**Y**	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]	Y[10]	Y[10]	Y	Y[11]
(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[10]

(continued)

Table 5 (continued)

Notes (notes in grey apply to other research proposals; a single list of notes is used throughout the data-poor research proposal review tables):

1. Proposals will generate local abundance indices but are very geographically constrained and there is no plan to widen the research into a broader stock hypothesis.
2. Proposals have data collection plan but are not currently looking at the impacts of the research on by-catch species.
3. Not applicable as the criterion was not available before the research proposal was written.
4. Refer to Annex 5, paragraph 4.103 and WG-FSA-17.
5. There is not enough information in the proposal.
6. A new vessel is in the proposal, but it could be replaced by the *Simeiz* or *Koreiz* who have a track record.
7. A new vessel is in the proposal, but observer has experience in the national tagging program.
8. The proposed vessel has multiple years of experience but low calculated effective survival rates (WG-FSA-17/36, Table 6).
9. The proposed vessels have multiple years of experience but have unknown calculated effective survival rates.
10. These criteria need to include capacity over multiple proposals for the Member concerned.
11. There are concerns about the reliability of the ice analysis and accessibility of the fishing grounds.
12. There have been ongoing issues to get to the research blocks due to either accessibility of the fishing grounds or fishing capacity, including commitments elsewhere. The inclusion of the Norwegian proposal in a single plan for this area might address the capacity issue in the future.
13. The research plan proposed an effort-limited survey but the impact on the environment and/or target stock is unclear.
14. The proposed research is located within existing research blocks, however, details relating to accessibility of these areas during times when the proposed research will be conducted are missing from the research plan.

Table 6: Summary of the assessment of the Subarea 88.3 research proposals against the criteria set out in paragraph 4.7. It is acknowledged that this process is aimed at new proposals and not existing proposals and the intent of the criteria were assessed. Summary of the rationale behind the numbers are in the notes below, and additional details in paragraphs 4.138 to 4.146.

Subarea:		88.3	
Proposal and country/criteria:		WG-FSA-17/34 Ukraine	WG-FSA-17/40 Republic of Korea and New Zealand
Conservation measure under which proposal submitted		24-01	24-01
(i)	(a) Is the proposed research likely to generate an index of local stock abundance?	Y	Y
	(b) Is the proposed research likely to generate estimates of biological parameters relating to productivity?	Y	Y
	(c) Is the proposed research likely to test a hypothesis of relationship of fish in the research area to the overall stock?	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?	5	Y
(iii)	Are the likely impacts from the proposed research to dependent and related species consistent with Article II?	2	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?	5	Y
(v)	Do the proposed research platforms intended for this work have demonstrated experience and performance in toothfish tagging programs?	6	Y
(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]	14	Y

(continued)

Table 6 (continued)

Subarea:	88.3	
Proposal and country/criteria:	WG-FSA-17/34 Ukraine	WG-FSA-17/40 Republic of Korea and New Zealand
(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]	10	Y

Notes (notes in grey apply to other research proposals; a single list of notes is used throughout the data-poor research proposal review tables):

1. Proposals will generate local abundance indices but are very geographically constrained and there is no plan to widen the research into a broader stock hypothesis.
2. Proposals have data collection plan but are not currently looking at the impacts of the research on by-catch species.
3. Not applicable as the criterion was not available before the research proposal was written.
4. Refer to Annex 5, paragraph 4.103 and WG-FSA-17.
5. There is not enough information in the proposal.
6. A new vessel is in the proposal, but it could be replaced by the *Simeiz* or *Koreiz* who have a track record.
7. A new vessel is in the proposal, but observer has experience in the national tagging program.
8. The proposed vessel has multiple years of experience but low calculated effective survival rates (WG-FSA-17/36, Table 6).
9. The proposed vessels have multiple years of experience but have unknown calculated effective survival rates.
10. These criteria need to include capacity over multiple proposals for the Member concerned.
11. There are concerns about the reliability of the ice analysis and accessibility of the fishing grounds.
12. There have been ongoing issues to get to the research blocks due to either accessibility of the fishing grounds or fishing capacity, including commitments elsewhere. The inclusion of the Norwegian proposal in a single plan for this area might address the capacity issue in the future.
13. The research plan proposed an effort-limited survey but the impact on the environment and/or target stock is unclear.
14. The proposed research is located within existing research blocks, however, details relating to accessibility of these areas during times when the proposed research will be conducted are missing from the research plan.

Table 7: Number of sets and catch limits by small-scale research units (SSRU) and research block or prospecting area for New Zealand and the Republic of Korea research in Subarea 88.3 as described in WG-FSA-17/40, Table 3.

SSRU	Research block/ prospecting area	Region	*Greenstar*		*Janas*		Total	
			Sets	Catch	Sets	Catch	Sets	Catch
883A	883_1	slope	18	20	-	-	18	20
	883_2	shelf	14	25	-	-	14	25
883B	883_3	slope	15	25	15	25	30	50
	P_6	shelf	-	-	15	30	15	30
	P_8	north	-	-	10	10	10	10
883C	883_4	slope	50	50	-	-	50	50
	P_7	shelf	-	-	15	30	15	30
	P_9	north	-	-	10	10	10	10
883D	883_5	slope	18	10	-	-	18	10
	P_10	north	-	-	10	10	10	10
Totals			115	130	75	115	190	245

Table 8: Proposed catch limits for by-catch species in the Ross Sea region following the implementation of the Ross Sea region marine protected area (MPA). Each value is either fixed based on a local area biomass estimate or set as a percentage of the toothfish catch limit. The catch limits in brackets are based on the toothfish catch limit recommended of 3 157 tonnes.

	Macrourid		Skates		Other	
Special research zone	Fixed	(72 tonnes)	5%	(23 tonnes)	5%	(23 tonnes)
All areas outside the MPA and south of 70°S	Fixed	(317 tonnes)	5%	(104 tonnes)	5%	(104 tonnes)
All areas outside the MPA and north of 70°S	16%	(96 tonnes)	5%	(30 tonnes)	5%	(30 tonnes)

Table 9: Numbers of incidental mortalities of seabirds and marine mammals (IMAF) in 2016/17 received through vessel and observer data. Data source 'Obs. tally period' is the haul observation period conducted by observers, and the mortalities recorded during this period are used to calculate the extrapolated total (scaled by the percentage of hooks observed) for seabird mortalities. 'Obs. total' is the total number of mortalities reported by observers (includes incidental mortalities reported from outside the haul observation/tally period). Catch and effort are summary catch and effort data reported at 1-, 5- or 10-day intervals depending on the fishery. C1 and C2 data are haul-by-haul vessel data reported to the Secretariat at monthly intervals. Subareas and divisions[1] that are marked with an asterisk have incomplete datasets and fields marked with a dash have no fishing activity present, or data is not submitted to the Secretariat.

	Data source	Subarea					Division		Total
		48.1*	48.2*	48.3*	48.4	58.6 (French EEZ)	58.5.1 (French EEZ)	58.5.2*	
Longline									
Seabirds	Obs. tally period	-	0	12	1	4	14	2	33
	Obs. total	-	0	21	1	-	-	2	24
	Extrapolated total	-	0	37	3	16	56	4	116
	Catch and effort	-	0	24	1	-	-	2	27
	C2	-	0	20	1	-	-	2	23
Marine mammals	Vessel	-	0	0	0	-	-	6	6
	Observer	-	0	0	0	0	0	3	3
Finfish trawl									
Seabirds	Observer	-	-	3	-	-	-	0	3
	Catch and effort	-	-	3	-	-	-	0	3
	C1	-	-	3	-	-	-	0	3
Marine mammals	Vessel	-	-	0	-	-	-	0	0
	Observer	-	-	1	-	-	-	0	1
Krill trawl									
Seabirds	Observer	0	0	0	-	-	-	-	0
	Catch and effort	1	1	0	-	-	-	-	2
	C1	1	1	0	-	-	-	-	2
Marine mammals	Vessel	0	0	0	-	-	-	-	0
	Observer	0	0	0	-	-	-	-	0

[1] Subareas and divisions not listed in this table had no reported mortalities during 2016/17 or no fishing activities were undertaken.

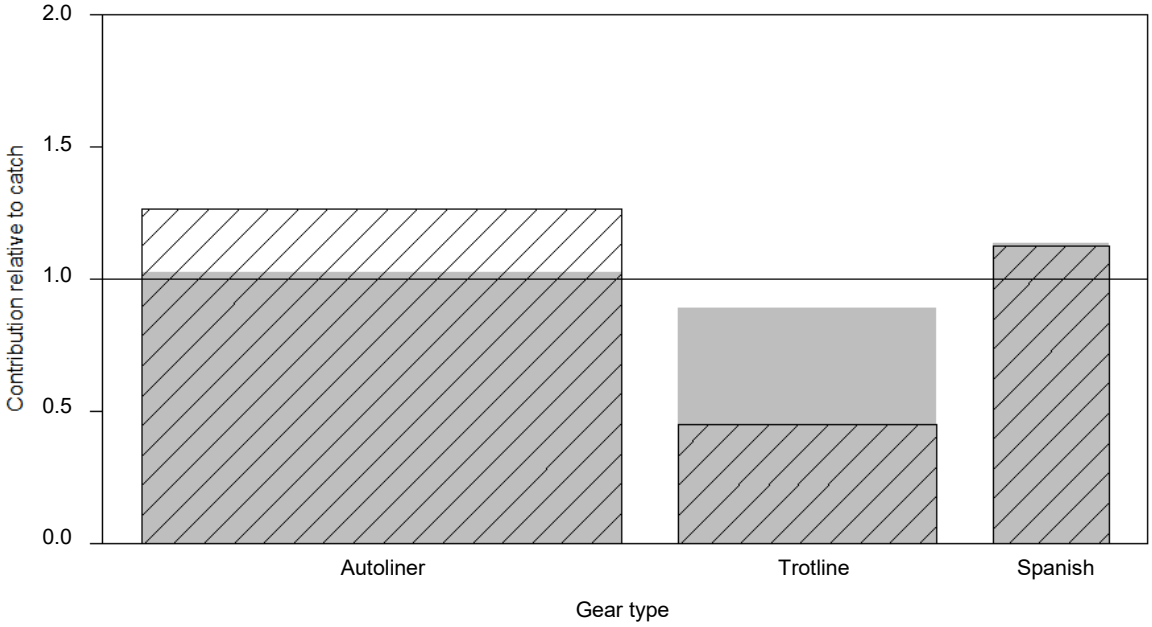

Figure 1: Relative contribution of information from tag release and recapture effort after taking into account vessel-specific effective release survival and detection rates of tagged fish, by gear type, over the period 2014–2017 in the Ross Sea region. Tag detection (grey bars) is the relative detection rate of tags estimated for each gear type and used within the Ross Sea region assessment model. Release survival (hashed bars) is the relative number of tagged fish released estimated for each gear type and used within the Ross Sea region assessment model. Gear types are listed in order of total catch, the proportion of catch is represented by the bar widths. The method whereby these statistics were calculated is provided in WG-FSA-17/36.

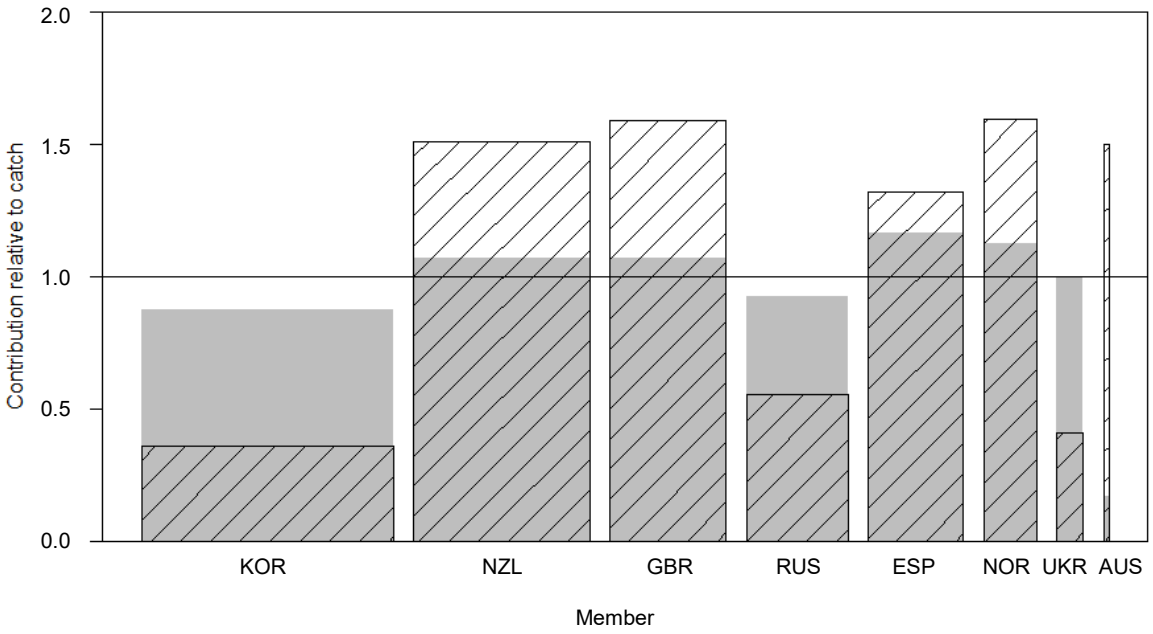

Figure 2: Relative contribution of information from tag release and recapture effort after taking into account vessel-specific effective release survival and detection rates of tagged fish, by Member, over the period 2014–2017 in the Ross Sea region. Tag detection (grey bars) is the relative detection rate of tags estimated for each Member and used within the Ross Sea region assessment model. Release survival (hashed bars) is the relative number of tagged fish released estimated for each Member and used within the Ross Sea region assessment model. Members are listed in order of total catch, the proportion of catch is represented by the bar widths. The method whereby these statistics were calculated is provided in WG-FSA-17/36. KOR – Republic of Korea; NZL – New Zealand; GBR – United Kingdom; RUS – Russia; ESP – Spain; NOR – Norway; UKR – Ukraine; AUS – Australia.

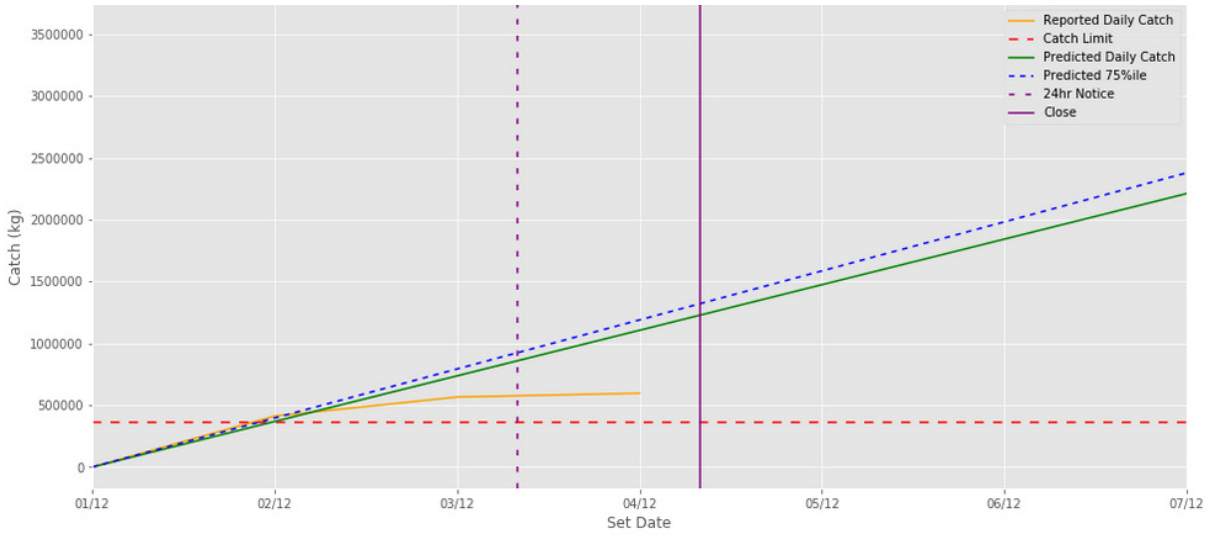

Figure 3: Predicted and reported cumulative daily catch, catch limit, closure notice and fishery closure for December 2016 in Subarea 88.1 SSRUs B, C and G. The daily cumulative catches are shown for the date on which gear was set rather than the date on which the catch was landed to simulate the use of potential catch (based on the number of hooks deployed).

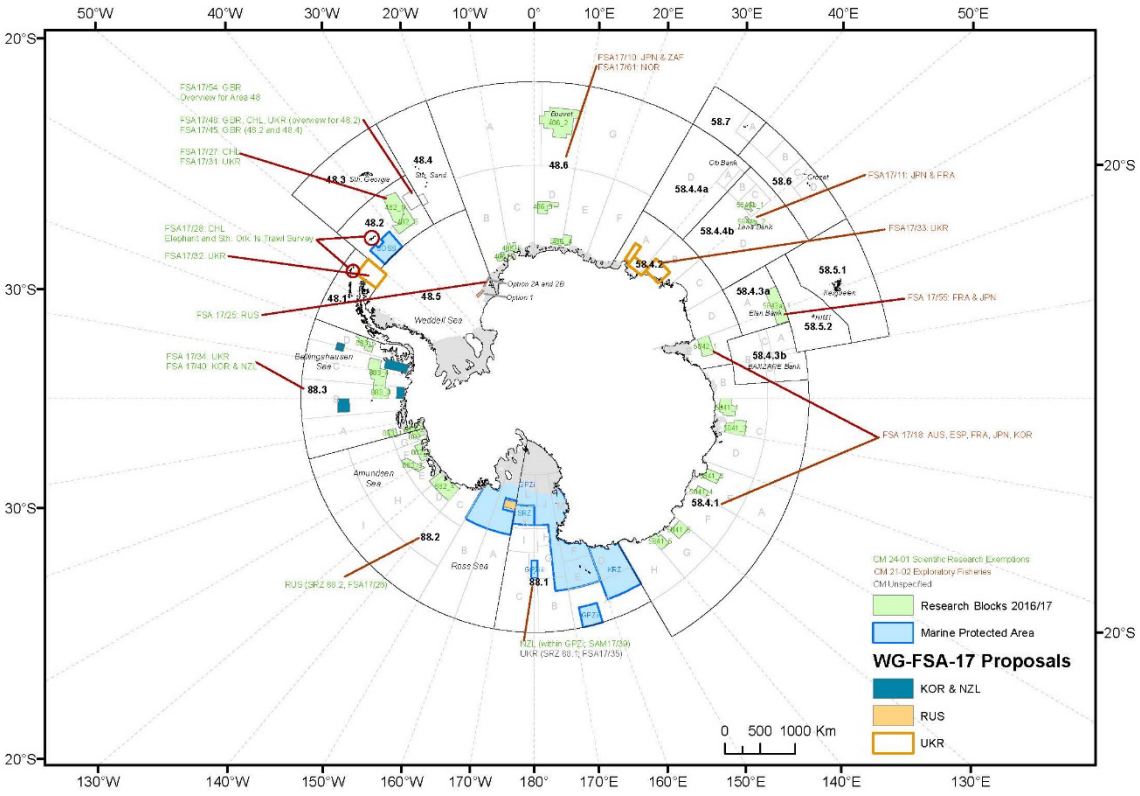

Figure 4: Map of existing and proposed research activities involving toothfish considered at WG-FSA-17. AUS – Australia; CHL – Chile; ESP – Spain; FRA – France; GBR – United Kingdom; JPN – Japan; KOR – Republic of Korea; NZL – New Zealand; NOR – Norway; RUS – Russia; UKR – Ukraine; ZAF – South Africa. RB – research block; GPZ – general protection zone; SRZ – special research zone.

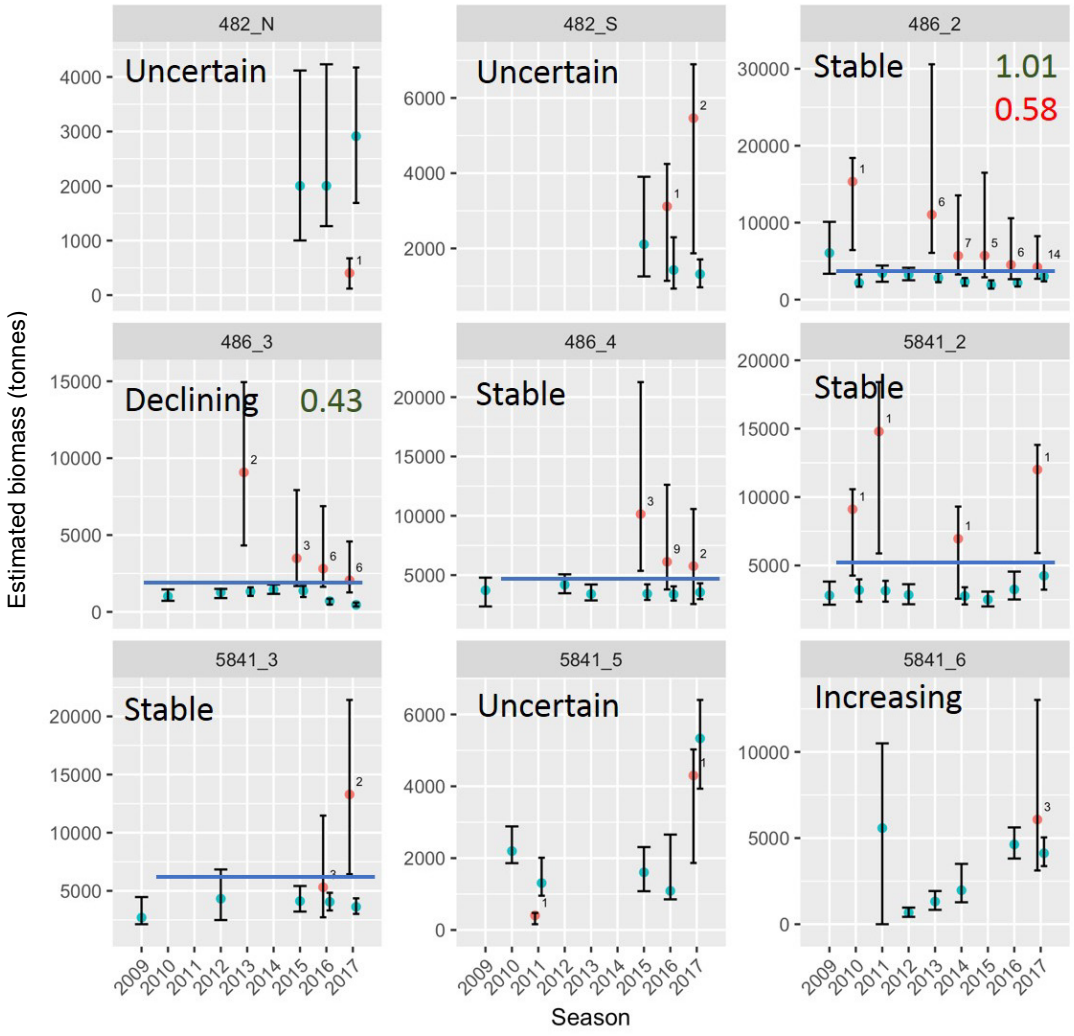

Figure 5: Estimated biomass of Antarctic toothfish (*Dissostichus mawsoni*) from 2009 to 2017 from nine research blocks within Subareas 48.2 and 48.6 and Division 58.4.1. Blue points represent CPUE estimates, and red points represent Chapman estimates. Numbers adjacent to symbols show the number of tags used in Chapman estimates.

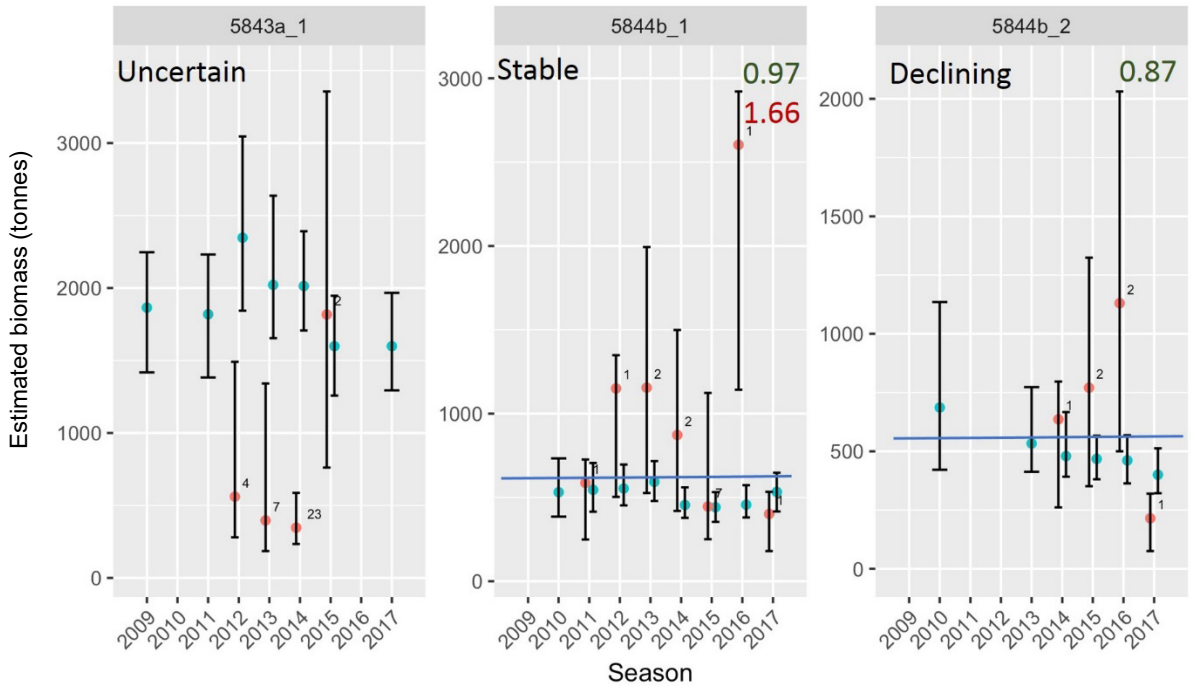

Figure 6: Estimated biomass of Patagonian toothfish (*Dissostichus eleginoides*) from 2009 to 2017 from three research blocks within Divisions 58.4.3a and 58.4.4b. Blue points represent CPUE estimates, and red points represent Chapman estimates. Numbers adjacent to symbols show the number of tags used in Chapman estimates.

Appendix A

List of Participants

Working Group on Fish Stock Assessment
(Hobart, Australia, 2 to 13 October 2017)

Convener	Dr Dirk Welsford Australian Antarctic Division, Department of the Environment dirk.welsford@aad.gov.au
Australia	Dr Paul Burch Australian Antarctic Division, Department of the Environment paul.burch@aad.gov.au
	Mr Dale Maschette Australian Antarctic Division, Department of the Environment dale.maschette@aad.gov.au
	Dr Peter Yates Australian Antarctic Division, Department of the Environment peter.yates2@aad.gov.au
	Dr Philippe Ziegler Australian Antarctic Division, Department of the Environment philippe.ziegler@aad.gov.au
Chile	Professor Patricio M. Arana Pontificia Universidad Catolica de Valparaíso patricio.arana@pucv.cl
	Mr Juan Carlos Quiroz Instituto de Fomento Pesquero juquiroz@udec.cl
	Mrs Patricia Ruiz Centro de Estudios Pesqueros pruiz@cepes.cl
	Mr Alejandro Zuleta CEPES azuleta@cepes.cl

China, People's Republic of	Dr Guoping Zhu Shanghai Ocean University gpzhu@shou.edu.cn
France	Dr Marc Eléaume Muséum national d'Histoire naturelle marc.eleaume@mnhn.fr
	Mr Arthur Rigaud Oceanic Developpement a.rigaud@oceanic-dev.com
	Mr Romain Sinegre Muséum national d'Histoire naturelle romain.sinegre@mnhn.fr
	Mr Benoit Tourtois French Ministry for Food and Agriculture bBenoit.tourtois@developpement-durable.gouv.fr
Germany	Dr Stefan Hain Alfred Wegener Institute for Polar and Marine Research stefan.hain@awi.de
	Mr Alexander Liebschner German Federal Agency for Nature Conservation alexander.liebschner@bfn-vilm.de
Japan	Mr Naohiko Akimoto Japanese Overseas Fishing Association nittoro@jdsta.or.jp
	Dr Taro Ichii National Research Institute of Far Seas Fisheries, Japan Fisheries Research and Education Agency ichii@affrc.go.jp
	Dr Takaya Namba Taiyo A & F Co. Ltd. takayanamba@gmail.com
	Dr Takehiro Okuda National Research Institute of Far Seas Fisheries, Japan Fisheries Research and Education Agency okudy@affrc.go.jp

	Mr Takeshi Shibata Taiyo A & F Co. Ltd. t-shibata@maruha-nichiro.co.jp
Korea, Republic of	Mr Seung Lyong Kim Ministry of Oceans and Fisheries kpoksl5686@korea.kr
	Ms Jihyun Zee Kim Ministry of Oceans and Fisheries zeekim@korea.kr
	Mr Gap-Joo Bae Hong Jin Corporation gjbae1966@hotmail.com
	Dr Seok-Gwan Choi National Institute of Fisheries Science (NIFS) sgchoi@korea.kr
	Mr Hyun Joong Choi Sunwoo Corporation hjchoi@swfishery.com
	Mr TaeBin Jung Sunwoo Corporation tbjung@swfishery.com
	Dr Chang-Keun Kang Gwangju Institute of Science and Technology ckkang@gist.ac.kr
	Professor Hyun-Woo Kim Pukyoung National University kimhw@pknu.ac.kr
	Dr Jaebong Lee National Institute of Fisheries Science (NIFS) leejb@korea.kr
	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
Norway	Dr Olav Rune Godø Institute of Marine Research olavrune@imr.no
Russian Federation	Dr Svetlana Kasatkina AtlantNIRO ks@atlantniro.ru
South Africa	Mr Sobahle Somhlaba Department of Agriculture, Forestry and Fisheries ssomhlaba@gmail.com
Spain	Mr Roberto Sarralde Vizuete Instituto Español de Oceanografía roberto.sarralde@ca.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
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 Timothy Earl
Centre for Environment, Fisheries and Aquaculture Science (Cefas)
timothy.earl@cefas.co.uk

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

United States of America

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	Andrew Wright
Science	
Science Manager	Dr Keith Reid
Observer Scheme Program Coordinator	Isaac Forster
Science Support Officer	Emily Grilly
Fisheries and Ecosystems Analyst	Dr Lucy Robinson
Fishery Monitoring and Compliance	
Fishery Monitoring and Compliance Manager	Sarah Lenel
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 Content Coordinator)	Warrick Glynn
Publications Officer	Belinda Blackburn
French Translator/Team Coordinator	Gillian von Bertouch
French Translator	Bénédicte Graham
French Translator	Floride Pavlovic
Russian Translator/Team Coordinator	Ludmilla Thornett
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
Business Systems and Data Analyst	Dr Sascha Frydman

Appendix B

Agenda

Working Group on Fish Stock Assessment
(Hobart, Australia, 2 to 13 October 2017)

1. Opening of the meeting

2. Organisation of the meeting and adoption of the agenda

    2.1 Organisation of the meeting
    2.2 Subgroup organisation and coordination
    2.3 Review of data available

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

    3.1 *Champsocephalus gunnari*
        3.1.1 *Champsocephalus gunnari* in Subarea 48.3
        3.1.2 *Champsocephalus gunnari* in Division 58.5.1
        3.1.3 *Champsocephalus gunnari* in Division 58.5.2

    3.2 *Dissostichus* spp.
        3.2.1 *D. eleginoides* in Subarea 48.3
        3.2.2 *Dissostichus* spp. in Subarea 48.4
        3.2.3 *D. eleginoides* in Division 58.5.1
        3.2.4 *D. eleginoides* in Division 58.5.2
        3.2.5 *D. eleginoides* in Subarea 58.6
        3.2.6 *D. mawsoni* in Subarea 88.1
        3.2.7 *D. mawsoni* in Subarea 88.2

    3.3 Fishery Report updates

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

    4.1 Generic issues and advice from WG-SAM-17

    4.2 Management area research reviews

        4.2.1 *Dissostichus* spp. in Area 48
            4.2.1.1 Review of available information and data quality
            4.2.1.2 Review of progress towards a stock assessment and research proposals
            4.2.1.3 Management advice and revision of Fishery Reports

4.2.2 *Dissostichus* spp. in Area 58
4.2.2.1 Review of available information and data quality
4.2.2.2 Review of progress towards a stock assessment and research proposals
4.2.2.3 Management advice and revisions to Fishery Reports

4.2.3 *Dissostichus mawsoni* in Area 88
4.2.3.1 Review of available information and data quality
4.2.3.2 Review of progress towards a stock assessment and research proposals
4.2.3.3 Management advice and revisions to Fishery Reports

4.2.4 Other fisheries research

5. Scheme of International Scientific Observation

5.1 Recommendations from WS-SISO-17

6. Non-target catch and interactions in CCAMLR fisheries

6.1 Fish and invertebrate by-catch
6.2 Marine mammal and seabird by-catch
6.3 Bottom fishing activities and vulnerable marine ecosystems (VMEs)

7. Future work

7.1 SC-CAMLR five-year strategic plan
7.2 Organisation of intersessional activities
7.3 Notifications of other scientific research

8. Other business

8.1 Reconciling krill catch and effort on continuous fishing system vessels
8.2 Other priority business not addressed elsewhere

9. Advice to the Scientific Committee

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

Appendix C

List of Documents

Working Group on Fish Stock Assessment
(Hobart, Australia, 2 to 13 October 2017)

WG-FSA-17/01	Proposal for a Climate Change Response Work Program for CCAMLR Delegations of Australia and Norway on behalf the Climate Change Intersessional Correspondence Group
WG-FSA-17/02	Report on the CCAMLR marine debris monitoring program Secretariat
WG-FSA-17/03	Proposed observer logbooks for the 2019 longline and finfish trawl fisheries Secretariat
WG-FSA-17/04	Fish by-catch in the krill fishery: 2017 update Secretariat
WG-FSA-17/05	Measurement of capacity in CCAMLR exploratory fisheries in Subareas 88.1 and 88.2: Secretariat update 2017 Secretariat
WG-FSA-17/06	Long-distance movements of Patagonian (*Dissostichus eleginoides*) and Antarctic toothfish (*D. mawsoni*) from fishery-based mark-recapture data Secretariat
WG-FSA-17/07	A characterisation of the toothfish fishery in the Ross Sea region (Subarea 88.1 and SSRUs 88.2A–B) to 2016–17 S. Parker and S. Mormede
WG-FSA-17/08	Correlation of sea-surface temperature in Ross Sea, Weddell Sea and the sea off Peru for the ice analysis T. Namba, T. Ichii and T. Okuda
WG-FSA-17/09	Gonad analysis of Antarctic toothfish in Subareas 58.4 and 88.3 J. Kim, S.-G. Choi, J. Lee, J. Lee and D. An
WG-FSA-17/10	Revised research plan for the 2017/18 exploratory longline fishery of *D. mawsoni* in Subarea 48.6 by South Africa and Japan Delegations of Japan and South Africa

WG-FSA-17/11	Revised research plan for the 2017/18 toothfish fishery in Division 58.4.4b by Japan and France Delegations of Japan and France
WG-FSA-17/12	Diets of Antarctic toothfish estimated from fatty acids and stable isotopes C.-K. Kang, S.-G. Choi, J. Lee, J. Lee and D. An
WG-FSA-17/13	Procedures for proposals and reporting on research plans in data-poor fisheries S.J. Parker and D.C. Welsford
WG-FSA-17/14 Rev. 1	The random stratified trawl survey to estimate the abundance of *Dissostichus eleginoides* and *Champsocephalus gunnari* in the waters surrounding Heard Island (Division 58.5.2) for 2017 G.B. Nowara, T. D. Lamb and P. Ziegler
WG-FSA-17/15	An update on the ageing of Antarctic toothfish, *Dissostichus mawsoni*, from East Antarctica and the Amundsen Sea G. Nowara, B. Farmer, T. Barnes, P. Ziegler and D. Welsford
WG-FSA-17/16	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 P. Yates, P. Ziegler, P. Burch, D. Maschette, D. Welsford and S. Wotherspoon
WG-FSA-17/17 Rev. 1	Joint report on exploratory fishing in Divisions 58.4.1 and 58.4.2 between the 2011/12 and 2016/17 fishing seasons Delegations of Australia, France, Japan, Republic of Korea and Spain
WG-FSA-17/18 Rev. 1	Continuation of multi-Member research on the *Dissostichus mawsoni* exploratory fishery in East Antarctica (Divisions 58.4.1 and 58.4.2) by Australia, France, Japan, Republic of Korea and Spain Delegations of Australia, France, Japan, Republic of Korea and Spain
WG-FSA-17/19	An integrated stock assessment for the Heard Island and McDonald Islands Patagonian toothfish (*Dissostichus eleginoides*) fishery in Division 58.5.2 P. Ziegler
WG-FSA-17/20	Report on fishing effort and seabird interactions during the season extension trials in the longline fishery for *Dissostichus eleginoides* in Statistical Division 58.5.2 T. Lamb

WG-FSA-17/21	Estimation of tag-loss rates for tagged fish in the Patagonian toothfish (*Dissostichus eleginoides*) fisheries at Heard Island and McDonald Islands in Division 58.5.2 P. Ziegler
WG-FSA-17/22	A preliminary assessment and revised growth model of mackerel icefish (*Champsocephalus gunnari*) in Division 58.5.2, based on results from the 2017 random stratified trawl survey D. Maschette, P. Burch, P. Yates and D. Welsford
WG-FSA-17/23	Mitigation of *Macrourus* by-catch in research block 58.4.1_6 and estimation of *Macrourus* biomass and sustainable catch in Divisions 58.4.1 and 58.4.2 D. Maschette, P. Burch, P. Yates and P. Ziegler
WG-FSA-17/24	Proposal to modify Conservation Measure 24-02 regarding the use of a streamer line Y. Korzun and S. Kasatkina
WG-FSA-17/25	Plan of the research program of Russian Federation in Subarea 48.5 (Weddell Sea) in season 2017/18 Delegation of the Russian Federation
WG-FSA-17/26	Research program to examine the life-cycle and resource potential of *Dissostichus* species in the Special Research Zone within the Ross Sea region Marine Protected Area (RSRMPA) in 2017–2027 Delegation of the Russian Federation
WG-FSA-17/27	Revised research longline fishing proposal for *Dissostichus* spp. in Subarea 48.2, second season Delegation of Chile
WG-FSA-17/28	Demersal finfish distribution, abundance and their biological characteristics in Statistical Subareas 48.1 (northern part) and 48.2 (2018–2020) Delegation of Chile
WG-FSA-17/29	Scientific background document in support of the development of a CCAMLR MPA in the Weddell Sea (Antarctica) – Version 2017 – Reflection of the recommendations by WG-EMM-16 and SC-CAMLR-XXXV K. Teschke, H. Pehlke and T. Brey
WG-FSA-17/30	Preliminary results of otolith elemental composition analysis of *Dissostichus* spp. in Subarea 48.2 Delegation of Chile

WG-FSA-17/31	Proposal for continuation of the Ukrainian research survey in Subarea 48.2 in 2017/18 and 2018/19 seasons Delegation of Ukraine
WG-FSA-17/32	Revised research program of Ukraine in Subarea 48.1 in 2018 Delegation of Ukraine
WG-FSA-17/33	Revised research plan for the 2017/18 exploratory longline fishery of *Dissostichus* spp. in Division 58.4.2 Delegation of Ukraine
WG-FSA-17/34	Revised research program of Ukraine in Subarea 88.3 Delegation of Ukraine
WG-FSA-17/35	Ukrainian research proposal for the 2017/18 season in Subarea 88.1 Delegation of Ukraine
WG-FSA-17/36	Mark-recapture inputs to the 2017 Ross Sea region stock assessment (Subarea 88.1 and SSRUs 88.2A–B) S. Parker and S. Mormede
WG-FSA-17/37 Rev. 1	Assessment models for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region to 2016/17 S. Mormede
WG-FSA-17/38	Diagnostic plots of stock assessment models for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region to 2016/17 S. Mormede
WG-FSA-17/39	The toothfish fishery and tagging program in the Amundsen Sea region (SSRUs 882C–H) to 2016/17 S. Parker and S. Mormede
WG-FSA-17/40	Joint research proposal for *Dissostichus* spp. in Subarea 88.3 by the Republic of Korea and New Zealand Delegations of the Republic of Korea and New Zealand
WG-FSA-17/41	New Zealand submission for the trial of the CCAMLR observer training program accreditation scheme A. Dunn, D. Kerrigan and A. McNabb
WG-FSA-17/42	Estimates of local biomass, including estimates of uncertainty, for Antarctic (*Dissostichus mawsoni*) and Patagonian (*Dissostichus eleginoides*) toothfish in research blocks in Subareas 48.2, 48.6, 58.4 and 88.3 CCAMLR Secretariat

WG-FSA-17/43	Report on the survey in Subarea 48.2 in 2015–2017 Delegation of Ukraine
WG-FSA-17/44	Report of the UK groundfish survey at South Georgia (CCAMLR Subarea 48.3) in January 2017 M. Belchier, V. Foster, S. Gregory, S. Hill, V. Laptikhovsky, P. Lafite and L. Featherstone
WG-FSA-17/45	Outline for year 2 of the 3-year longline survey to determine toothfish population connectivity between Subareas 48.2 and 48.4 M. Söffker and M. Belchier
WG-FSA-17/46	Preliminary results from the first year of a three-year survey into the connectivity of toothfish species in Subareas 48.2 and 48.4 K. Olsson, M. Belchier and M. Söffker
WG-FSA-17/47	Preliminary assessment of mackerel icefish *Champsocephalus gunnari* in Subarea 48.3 based on the 2017 groundfish survey T. Earl
WG-FSA-17/48 Rev. 1	Subarea 48.2 research and research proposals for 2018 – overview M. Söffker, M. Belchier, A. Zuleta, S. Hopf, P. Ruiz, J.C. Quiroz, L. Pshenichnov, D. Marichev and C. Darby
WG-FSA-17/49	Preliminary tag-recapture based population assessment of Antarctic toothfish in Subarea 48.4 N.D. Walker and T. Earl
WG-FSA-17/50	Estimating seabird by-catch in CCAMLR longline fisheries C. Darby and K. Olsson
WG-FSA-17/51	Estimates of length-frequency in the assessment of mackerel icefish *Champsocephalus gunnari* in Subarea 48.3 T. Earl
WG-FSA-17/52	Assessment of Patagonian toothfish (*D. eleginoides*) in Subarea 48.4 T. Earl
WG-FSA-17/53	Assessment of Patagonian toothfish (*D. eleginoides*) in Subarea 48.3 T. Earl and S. Fischer

WG-FSA-17/54	Developing a strategy for coordinated research leading to achievement of the CCAMLR objectives for Antarctic toothfish (*D. mawsoni*) in Area 48 C. Darby and M. Söffker
WG-FSA-17/55	Continuation of multi-Member research on the *Dissostichus eleginoides* exploratory fishery in 2017/18 in Division 58.4.3a by France and Japan Delegations of France and Japan
WG-FSA-17/56	Analysis of the toothfish fishery indices in Subareas 88.1 and 88.2 when using different types of longline gears S. Kasatkina
WG-FSA-17/57	Monitoring Antarctic toothfish (*D. mawsoni*) recruitment in the southern Ross Sea S.M. Hanchet, S. Mormede, S. Parker, K. Large, A. Dunn and B. Sharp
WG-FSA-17/58 Rev. 2	Summary of scientific observer data collected in CCAMLR fisheries in the Convention Area during 2017 CCAMLR Secretariat
WG-FSA-17/59	Updated assessment of Patagonian toothfish (*Dissostichus eleginoides*) in the vicinity of Crozet Islands (Subarea 58.6) R. Sinegre, G. Duhamel and J.B. Lecomte
WG-FSA-17/60	Updated stock assessment of Patagonian toothfish (*Dissostichus eleginoides*) in the vicinity of Kerguelen Islands (Division 58.5.1) R. Sinegre, G. Duhamel and J.B. Lecomte
WG-FSA-17/61 Rev. 1	Proposal for a longline survey on toothfish in Statistical Subarea 48.6 in 2017/18 Delegation of Norway
WG-FSA-17/62	Proposed process for independent review of CCAMLR toothfish stock assessments Scientific Committee Chair and Vice-Chairs and the working group conveners
WG-FSA-17/63	Stock assessment of mackerel icefish (*Champsocephalus gunnari*) in the vicinity of Kerguelen Islands (Division 58.5.1) after the 2017 Poker Biomass survey R. Sinegre and G. Duhamel

WG-FSA-17/64	Length-weight relationships of six fish species associated with krill fishery in the Atlantic sector of the Southern Ocean L. Wei, G.P. Zhu and Q.Y. Yang
WG-FSA-17/65	Otolith elemental signatures reveal habitat shift of *Electrona carlsbergi* L. Wei and G.P. Zhu
WG-FSA-17/66	Update of ongoing work on age and growth of Antarctic toothfish (*Dissostichus mawsoni*) from Division 58.4.1 by Spain L.J. López-Abellán, M.T.G. Santamaría, R. Sarralde and S. Barreiro

Other documents

WG-FSA-17/P01	Changing status of three notothenioid fish at the South Shetland Islands (1983–2016) after impacts of the 1970–80s commercial fishery E. Barrera-Oro, E. Marschoff and D. Ainley *Polar Biol*., 201 (2017): 1–8 http://dx.doi.org/10.1007/s00300-017-2125-0
WG-FSA-17/P02	Total mercury and methylmercury concentrations in Antarctic toothfish (*Dissostichus mawsoni*): Health risk assessment M. Yoon, M.-R. Jo, K.-T. Son, W.-S. Choi, S.I. Kang, S.-G. Choi, J.H. Lee and T.S. Lee *Arch. Environ. Con. Tox.* (in press)
WG-FSA-17/P03	Metabarcoding analysis of the stomach contents of the Antarctic toothfish (*Dissostichus mawsoni*) collected in the Antarctic Ocean T.-H. Yoon, H.-E. Kang, S.R. Lee, J.-B. Lee, G.W. Baeck, H. Park and H.-W. Kim *PeerJ* 5:e3977 https://doi.org/10.7717/peerj.3977
WG-FSA-17/P04	Spatio–temporal dynamics in maturation and spawning of Patagonian toothfish *Dissostichus eleginoides* on the subantarctic Kerguelen Plateau P. Yates, P. Ziegler, D. Welsford, J. McIvor, B. Farmer and E. Woodcock *J. Fish Biol.* (accepted), doi: 10.1111/jfb.13479
WG-EMM-17/02	Development of a five-year work plan for the CCAMLR Scientific Committee M. Belchier (Chair of SC-CAMLR)

WG-SAM-17/39	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-EMM-17/02	Development of a five-year work plan for the CCAMLR Scientific Committee M. Belchier (Chair of SC-CAMLR)
CCAMLR-XXXVI/02	Proposal for GEF (Global Environment Facility) funding to support capacity building in the GEF-eligible CCAMLR Members Delegations of Chile, India, Namibia, South Africa, Ukraine and the CCAMLR Secretariat
CCAMLR-XXXVI/28 Rev. 2	IUU fishing activity and trends in 2016/17 and IUU Vessel Lists Secretariat
SC-CAMLR-XXXVI/08	Convener's Report of the Workshop on the CCAMLR Scheme of International Scientific Observation (WS-SISO) (Buenos Aires, Argentina, 3 to 7 July 2017) WS-SISO Convener (J. Moir Clark (EU))
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-XXXVI/BG/01 Rev. 1	Catches of target species in the Convention Area Secretariat
SC-CAMLR-XXXVI/BG/38 Rev. 1	CCAMLR information and data systems update Secretariat

Appendix D

Terms of reference, outline funding requirements and timeline for the proposed independent CCAMLR stock assessment review

Terms of reference

1. The primary objective for the expert panel is 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. Specifically:

    (i) Inputs: Review the extent to which the data, modelling assumptions, model structure, priors and penalties are appropriate (including assessment of both biological and fishery components). This includes the choice of observations (survey, catch per unit effort (CPUE), tag, age, length), treatment and processing of observations, and biological parameters (values and derivation).

    (ii) Implementation: Review whether the statistical modelling and the resulting inferences on stock status and dynamics have been implemented using best-practice methods, including how these are implemented using CASAL. This includes modelling methods (i.e. best practices), estimation and data weighting, Markov Chain Monte Carlo (MCMCs) and diagnostics used.

    (iii) Improvements to modelling: Comment on any improvements that could or should be made to the methods to increase the reliability of the results for future management decision-making – including the potential use of alternative models or model structures.

    (iv) Improvements to data and research: Comment on other key areas of research or data collection that could decrease uncertainty or increase the utility of the modelling for future management decision-making.

2. Evaluate the utility of alternative models and structures that could be explored for the assessment of CCAMLR stocks and provide input to the evaluation process.

Funding required

- Hosting Member: meeting venue and meeting operations
- Assessing Members: develop presentations, documents, review time and travel to participate
- CCAMLR: expert reviewers' time and travel expenses to prepare, review and report outcomes.

Time:	Five days for preparation (background reading and assessment papers), five days for the review of the three assessments, five days for travel to and from the meeting, and report preparation for three reviewers at US$ 1 000/day =	US$45 000
Expenses:	Hotel and meals for six days × three reviewers × US$300/day =	US$5 400
Airfare:	US$1 000 (on average) × three reviewers =	US$3 000
Total estimated cost:		US$53 400

Timeline

Task	Timing
Scientific Committee endorses review, terms of reference and budget	October 2017
Reviewers identified and coordinated by the Chair of the Scientific Committee and the conveners of WG-SAM and WG-FSA and communicated via SC circular for comment	January 2018
Documents distributed	April 2018
Review occurs, including external experts	1 week prior to WG-SAM (2018)
CCAMLR report and external expert report presented to WG-SAM	June 2018
CCAMLR report and external expert report presented to WG-FSA	October 2018
Scientific Committee recommends actions based on review report and working group comments	October 2018
Update assessments and analyses as required for WG-SAM and WG-FSA	June to September 2019
Stock assessments and analyses presented based on the review recommendations	June to September 2019