Annex 7

Report of the Working Group
on Fish Stock Assessment
(Hobart, Australia, 5 to 16 October 2015)

Contents

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Opening of the meeting

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 5 to 16 October 2015. The Convener, Dr M. Belchier (UK), opened the meeting and welcomed participants (Appendix A). Mr A. Wright (Executive Secretary) extended the Secretariat's warm welcome to all participants.

1.2 The Working Group was saddened by the passing of Dr Konstantin Shust (Russia) in August 2015. Dr Shust had a long and productive association with CCAMLR, starting with his participation in the 1988 meeting of WG-FSA where two papers he co-authored were discussed. He went on to author a total of 34 meeting papers and participated in WG-FSA until 2010. The Working Group expressed its condolences to Dr Shust's family and colleagues.

Organisation of the meeting and adoption of the agenda

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

- updated stock assessment advice for all established fisheries for mackerel icefish (*Champsocephalus gunnari*) and Patagonian (*Dissostichus eleginoides*) and Antarctic toothfish (*D. mawsoni*) in the Convention Area

- robust scientific advice relating to exploratory fisheries for *Dissostichus* spp. notified under Conservation Measure (CM) 21-02, including data-poor fisheries, and scientific research fishing notified under CM 24-01 for 2015/16 and taking account of the advice provided by WG-SAM-15 (Annex 5).

2.2 The Working Group also reviewed and developed advice on bottom fishing activities and vulnerable marine ecosystems (VMEs), CCAMLR's Scheme of International Scientific Observation (SISO), incidental mortality and catches of non-target species in CCAMLR fisheries, including marine mammals and seabirds, depredation and biology and ecology of target and by-catch fish species.

2.3 The Working Group reviewed and adopted the agenda without change (Appendix B).

2.4 Components of WG-FSA's work were developed during the meeting by two subgroups:

- Subgroup on Assessments (coordinator: Dr C. Darby, UK)
- Subgroup on Research Plans for Data-poor Fisheries and Areas (coordinator: Dr C. Jones, USA).

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

2.6 In this report, paragraphs dealing with advice to the Scientific Committee and other working groups have been highlighted. These paragraphs are listed under Item 12. 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).

2.7 The report was prepared by A. Constable (Australia), R. Currey (New Zealand), C. Darby and T. Earl (UK), I. Forster (Secretariat), N. Gasco (France), E. Grilly (Secretariat), C. Jones and D. Kinzey (USA), K.-H. Kock (Germany), K. Large, S. Mormede and S. Parker (New Zealand), D. Ramm, K. Reid and L. Robinson (Secretariat), R. Sinegre (France), M. Söffker (UK), D. Welsford and P. Ziegler (Australia).

Review of available information

Data from the current fishing season

3.1 The Working Group reviewed data submitted to the Secretariat from CCAMLR fisheries and fishery-based research in 2014/15, including information relevant to stock assessments. These data were used in the assessments described in Items 4 and 5 and other work conducted during the meeting.

3.2 The Working Group noted the total catches in fisheries for *Dissostichus* spp., *D. eleginoides*, *D. mawsoni*, *C. gunnari* and Antarctic krill (*Euphausia superba*) in the Convention Area in 2014/15 (Table 1) and of *D. eleginoides* captured outside the Convention Area (Table 2).

3.3 The Working Group noted that approximately 12 tonnes of *C. gunnari* and 1 tonne of *Dissostichus* spp. were reported as by-catch in the krill fisheries in Subareas 48.1–48.3 (SC-CAMLR-XXXIV/BG/01). This relatively small catch by weight may nonetheless represent a substantial number of fish due to the small size of individuals generally taken as by-catch in krill fisheries.

3.4 The Working Group recognised that observer data on the by-catch from the krill fisheries potentially contain valuable information on the biology and distribution of juvenile *C. gunnari* and *Dissostichus* spp. The Working Group agreed that greater interactions and coordination was required with WG-EMM in order to make progress on matters related to by-catch in krill fisheries and other issues of relevance, including by-catch mitigation measures such as move-on rules which may need to be applied in krill fisheries, to both working groups. WG-FSA noted that the Scientific Committee will give these matters further consideration at SC-CAMLR-XXXIV.

3.5 The Working Group noted that management areas in five fisheries for *Dissostichus* spp. were closed by the Secretariat in 2014/15 (CCAMLR-XXXIV/BG/02). These closures were triggered by catches of *Dissostichus* spp. approaching the relevant catch limits. With the exception of the fishery in Subarea 88.2, the closures resulted in catches reaching 97–99% of

their respective catch limits. However, in Subarea 88.2, the catch limits for SSRU 882H and the whole fishery were exceeded by 8 and 5 tonnes respectively. The total catch in SSRU 882H reached 208 tonnes (104% of the catch limit).

3.6 The Secretariat advised that two vessels had fished in SSRU 882H in 2014/15 and their fishing operations appeared to have been constrained by patchy sea-ice in that region. A closure notice for SSRU 882H had been issued two days prior to the closure date and at the time of issue the catch was 89% of the catch limit; however, high catches in the final two days resulted in an 8 tonne overrun of the catch limit.

3.7 The Working Group discussed the significance of the 8-tonne overrun, and agreed that such an overrun was unlikely to impact the long-term status of the stock in Subarea 88.2. However, the Working Group agreed that overruns of catch limits should not be ignored and further consideration needs to be given to operational approaches which reduce the likelihood of overruns. The Secretariat noted that the management of catch limits means minor overruns and underruns are likely to happen and are part of normal process (see also CCAMLR-XXXI, paragraph 7.21).

3.8 The Working Group noted that an overrun in the fishery for *Dissostichus* spp. in Subarea 48.4 in 2014/15 had been avoided following the release of a large number of tagged fish by the only vessel fishing immediately prior to the closure. The Working Group discussed the application of this option in the exploratory fisheries, and recalled its advice that tagging rates in areas where tagging data are used in assessments should generally be maintained at a constant rate to avoid introducing bias in the stock assessment and its related advice (e.g. SC-CAMLR-XXXI, Annex 7, paragraph 5.47). The Working Group also noted that the release of tagged fish above the recommended tagging rate during the final stage of fishing may impact a vessel's tag-overlap statistic and increase the risk of tagging fish which may be less likely to survive.

3.9 The Working Group noted that other options may be available to avoid catch overruns, such as effort limitation or real-time reporting. The Working Group encouraged the Scientific Committee to further consider such options.

3.10 The Working Group also noted that in Subarea 88.1, a total of nine vessels fished in small-scale research units (SSRUs) B, C and G and those SSRUs were closed by the Secretariat on 7 December 2014. That closure was implemented seven days after the start of fishing and may indicate a situation where the catch limit could potentially be taken before sufficient data are available with which to forecast a closure (paragraphs 4.58 to 4.60).

3.11 The Working Group noted that 13 VME-indicator notifications were submitted in 2014/15 in accordance with CM 22-07 (CCAMLR-XXXIV/BG/02): 1 notification in SSRU 5841C (the first notification made in that division) and 12 notifications in SSRU 881H. These notifications ranged from 5 to 47 VME-indicator units and resulted in the declaration of one VME risk area in Division 58.4.1 and 10 new VME risk areas in Subarea 88.1.

3.12 Since 2008, the Secretariat has received a total of 169 VME-indicator notifications from exploratory bottom fisheries: 1 notification in Subarea 48.2, 2 in Subarea 48.6, 1 in Division 58.4.1, 116 in Subarea 88.1 and 49 in Subarea 88.2. No notification has been received from exploratory fisheries in Divisions 58.4.2, 58.4.3a and 58.4.3b. These VME-indicator notifications led to the declaration of 75 VME risk areas: 1 risk area in

Division 58.4.1, 58 risk areas in Subarea 88.1 and 16 risk areas in Subarea 88.2. In addition, nine VME fine-scale rectangles have been identified: seven VME fine-scale rectangles in Subarea 88.1 and two in Subarea 88.2 (www.ccamlr.org/node/85695).

Quarantined data

3.13 The Working Group noted that the Secretariat had implemented the Scientific Committee's advice from 2013 and 2014 that the fishery and observer data from certain vessels were unsuitable for analysis and should be quarantined (SC-CAMLR-XXXII, paragraph 3.228 and SC-CAMLR-XXXIII, paragraph 3.232). These data included the data from the *Yantar 35* in the Weddell Sea (Subarea 48.5 in 2013 and 2014); other data from that vessel had not been quarantined.

3.14 The Working Group noted that the Commission had endorsed the recommendation that all the data collected by the *Yantar 35* be quarantined until the Scientific Committee can make clear conclusions and provide advice (CCAMLR-XXXIII, paragraph 5.66). The Working Group noted that there had been differences in the interpretation of this advice from the Commission in respect of the years and management areas to which data from this vessel were to be applied and referred this matter to the Scientific Committee for further consideration.

3.15 The Working Group noted that the quality of the data which is used in stock assessments is critical for management advice, as applicable to the Ross Sea toothfish stock assessment (paragraph 4.77) in this instance. It recommended that data from the *Yantar 35* in areas outside Subarea 48.5 be investigated in this light in order to provide further advice to the Scientific Committee.

Exploratory fishery notifications in 2015/16

3.16 The Working Group noted Members' notifications to fish in exploratory fisheries for *Dissostichus* spp. in 2015/16 (Table 3, details of vessels, including withdrawn notifications, can be viewed at www.ccamlr.org/en/fishery-notifications/notified). These notifications followed a pattern similar to recent seasons. Notifications were received from nine Members for a total of 20 vessels in Subarea 88.1, eight Members and 19 vessels in Subarea 88.2, two Members and two vessels in Division 58.4.3a, three Members and three vessels in Subarea 48.6, five Members and five vessels in Division 58.4.1 and five Members and five vessels in Division 58.4.2. There were no notifications submitted for the exploratory fishery in Division 58.4.3b or for new fisheries.

3.17 The Working Group noted that the research plans for notified data-poor fisheries in Subareas 48.6 and 58.4 were submitted to WG-SAM-15 for review. In addition, the Secretariat had uploaded the shape files for the research blocks proposed in papers submitted to WG-FSA-15 (Annex 5, paragraph 6.6). These files were available from the CCAMLR GIS (gis.ccamlr.org) under 'Community data' for registered users only and the Working Group thanked the Secretariat for providing this facility and encouraged its continued use.

Research fishing in closed areas in 2015/16

3.18 The Working Group considered various proposals for research fishing in closed areas in 2015/16 (Table 4). These proposals had been submitted to WG-SAM-15 for review and were further discussed at WG-FSA-15 in paragraphs 5.34 to 5.43 (Subarea 48.2), paragraphs 5.44 to 5.54 (Subarea 48.5), paragraphs 5.84 to 5.87 (Division 58.4.4.b) and paragraphs 5.88 to 5.91 (Subarea 88.3).

Redevelopment of the CCAMLR database

3.19 The Secretariat presented an update on the redevelopment of the CCAMLR database (WG-FSA-15/03). This is a major multiyear project to update CCAMLR data holdings and associated IT and data infrastructure. This work began in 2013 and involves the implementation of an Enterprise Data Model, a new data warehouse and a process to extract, transform and load (ETL) data, as well as improvements in the data workflow and quality assurance. The user community can expect to notice significant improvements in data quality, database documentation and ease of use as the new system begins a process of acceptance testing from late 2015. Consequential changes will be required in requested data extracts to reflect the new data model and nomenclature.

3.20 Following acceptance testing (see also Annex 5, paragraph 2.51 and Annex 6, paragraph 2.12), the Working Group noted that the Secretariat will stage the rollout of the new data warehouse, and each stage will be accompanied by supporting documentation. The Working Group requested the Secretariat to develop user training materials and conduct workshops to facilitate the rollout of the new structure, including details on how the data fields from the old database would map to the new database, as well as training for those responsible for data inputs to allow standardisation.

3.21 The Working Group thanked the Secretariat for the updates on data management processes and noted that some aspects of this work had already provided improvements in quality assurance and feedback to data providers.

Marine debris

3.22 WG-FSA-15/15 presented a summary of the data on marine debris, including from beach surveys, debris associated with seabird colonies and entanglement of marine mammals, from Subareas 48.1, 48.2 and 48.3 (with additional data from Subarea 58.7) submitted to the Secretariat. Overall, there was no evidence of trends in the occurrence of marine debris but the data highlighted the continued presence of man-made marine debris in the Convention Area.

3.23 The Working Group noted that the issue of plastics in the marine environment is being increasingly highlighted in the media and scientific literature. The Working Group requested that the Secretariat contact other organisations (e.g. SCAR, CEP, IMO and the IWC) to investigate potential collaboration on data collection and analysis of marine debris data.

3.24 The issue of debris being transported into the Convention Area by ocean currents and long-ranging marine predators such as albatrosses means that there are difficulties in attributing the source of the debris. The Working Group recommended that the Scientific Committee consider the issue of marking hooks with vessel-specific identification marks so that the hooks found in seabird colonies could be traced back to the source.

Toothfish released untagged

3.25 In response to discussions originating in WG-FSA-14 (SC-CAMLR-XXXIII, Annex 7, paragraph 5.42) and a subsequent request for further consideration of the issue from the Commission (CCAMLR-XXXIII, paragraph 7.22), the Secretariat presented a summary of the frequency and location of the releases of live untagged *Dissostichus* spp. in exploratory fisheries (CCAMLR-XXXIV/07).

3.26 The Working Group acknowledged that, while there was no length data available for the toothfish that had been released untagged, it was likely that these were small fish (approx. 50 cm length). The Working Group agreed that all fish, regardless of size, should be treated in the same way (i.e. there should be no release of live untagged fish), including in respect of collection of biological and tagging data.

Offal discharge

3.27 In response to a request from New Zealand (COMM CIRC 15/15), the Secretariat assembled data from CCAMLR observer reports, vessel monitoring system (VMS) records and other information the Secretariat has available, related to reported incidences of offal discharge in the Ross Sea (CCAMLR-XXXIV/BG/10). VMS data was examined to identify all vessels that had been recorded within 10 km of the reported location from which offal was reported during the five days preceding the date of the report.

3.28 The Working Group thanked the Secretariat and expressed its concern that offal appeared to be discharged in an area where such a discharge was prohibited, noting especially that hooks in the offal presented a particular risk for seabirds and that discharge of offal may also have implications for the likelihood of depredation. Experts in the Working Group noted that the photograph of a fish head recovered in the offal (CCAMLR-XXXIV/BG/10, Figure 2) was in fact of a ling (*Genypterus blacodes*) and that this must have been transported in from outside the Convention Area as bait or food.

3.29 Noting that some of the offal reported still had hooks attached, the Working Group noted that this was another case for introducing vessel-specific marking of hooks (paragraph 3.24).

VMS data quality assurance

3.30 The Secretariat presented SC-CAMLR-XXXIV/BG/19 on the potential use of CCAMLR VMS data for compliance and data quality assurance by the Secretariat. In

particular, the paper presented an algorithm to determine an appropriate spatial and temporal overlap where a VMS location would be expected within a radius of 20 n miles and within four hours of the reported time of the fishing event.

3.31 The Working Group noted that the minimum frequency that the VMS position data is required to be provided is every four hours and that there was currently a proposal to change the reporting frequency to every one hour and that such a change would reduce the radius of the overlap range to 5 n miles. The Secretariat assured the Working Group that it could accommodate VMS data for all vessels at a higher frequency than currently required and noted that the generally recognised best practice of recording VMS data was at a frequency of every 15 minutes.

3.32 The Working Group agreed that it was vital that the locations of the catch data that were used in stock assessments were accurate and agreed that using the VMS data at appropriate resolution (at 15-minute intervals) was the best method for the data quality assurance processes. The Working Group also noted that this use of VMS data, and the required data quality assurance processes for the VMS data itself, would improve the utility of the VMS data for the Commission. The Working Group encouraged the Secretariat to implement the data quality assurance processes and recommended this issue be brought to the attention of the Standing Committee on Implementation and Compliance (SCIC).

Conversion factors

3.33 In response to the request from WG-FSA in 2014 (SC-CAMLR-XXXIII, Annex 7, paragraph 7.7v), the Secretariat presented a review of the product to green weight conversion factors used in the toothfish fishery (WG-FSA-15/02). The review was based on 46 638 records in C2 data that contained a conversion factor and product code as well as 69 974 fish measured by observers before and after processing to measure conversion factors.

3.34 The most frequently used processing code was ‘head, gutted and tailed’ (HGT), however, even within this one processing code there was considerable inter-vessel variability in the conversion factors used.

3.35 The Working Group noted that even within single processing methods such as HGT there were many factors that could influence the actual conversion factor, including the type (location) of cut used and how this changes over time depending on market forces and the equipment available on board to weigh pre-processed fish.

3.36 The Working Group agreed that it was important to highlight how variability in conversion factors could affect the green weight estimation and the consequences of this for the stock assessment and reconciliation of C2 and CDS data and recommended that additional information on the specific details of how the fish are actually processed is required.

3.37 The Working Group agreed that, in addition to the reporting of the product code, observers be tasked with providing a detailed description of the shape and distance from the front of the head of the cut used to remove the head of toothfish. The Working Group welcomed the offer from Mr C. Heinecken (South Africa) for South African observers to implement a trial collection of this additional conversion factor data in 2016 and to provide feedback in order for the required changes to be made to the observer logbooks and cruise

reports for implementation in 2017. The Secretariat undertook to circulate the revised version of the observer logbook, cruise report and instructions to technical coordinators in June 2016 in order that the new requirements could be included in the training of observers prior to deployment for the 2017 season.

3.38 Conversion factors used for the fisheries for *D. eleginoides* in Division 58.5.1 and Subarea 58.6 were presented in WG-FSA-15/77. A number of variables were found to significantly influence the conversion factor. The paper emphasised the need to calculate conversion factors with a sub-sample of the catch that is representative of the total catch on board a vessel, taking account of the size of the fish, location of fishing and time of year. The variability in processing between different vessels should also be considered.

3.39 The application of cumulative conversion factors was presented. The Working Group noted that individual conversion factors calculated during a trip did not necessarily relate to each other. However, if the conversion factor was applied in a cumulative series during the progression of the trip, it provided a far more robust conversion factor to calculate green weight.

IUU fishing

3.40 The Working Group noted that the summary of reports of illegal, unreported and unregulated (IUU) fishing submitted to the Secretariat, presented in CCAMLR-XXXIV/37, indicated that IUU activity (either vessels and/or gear) had been detected in 2014/15 in similar areas to those where it had been reported in previous years (Division 58.4.1 (SSRU E and H) and Subarea 48.6).

3.41 The Working Group also considered CCAMLR-XXXIV/BG/18 that provided detailed information on the gear used, the amount of catch taken and the depth distribution that the catch was taken from the logbooks of the IUU vessel *Kunlun*. It was noted that there was sufficient information in this paper to estimate the quantity of catch, selectivity and hauling speed of IUU fishing as well as information on the size of the fish, but unfortunately no by-catch data were recorded.

3.42 The Working Group also considered the information on efforts to combat IUU fishing presented in CCAMLR-XXXIV/32 and noted that there was additional information available that could allow the size and weight of catch to be estimated from surveillance videos.

3.43 The Working Group noted that most of the IUU catch appeared to be large fish and this may be due to the depth of the gillnet sets, or the mesh size which was likely to be 18−22 cm. The Working Group expressed great concern regarding the use of gillnet gear and especially on the ongoing impact that ‘ghost fishing’ of this gear has in the marine environment.

3.44 The Chair of the Scientific Committee drew the attention of the Working Group to SC-CAMLR-XXXIV/BG/12 that used expert industry analyses of the available information on IUU vessel sightings and landings to produce an estimate of IUU catch in 2015 of between 1 264 and 1 500 tonnes. The Working Group noted that this was the only paper submitted to CCAMLR this year that had attempted to provide an estimate of the total IUU catch in the Convention Area in 2015. Although the estimates are preliminary at this stage, it was agreed

that they are likely to be an underestimate of total removals by IUU fishing, as the analyses are confined to the catch of those three vessels that were actually detected and they do not include mortality associated with lost IUU gillnets.

3.45 The Working Group discussed the range of data available on IUU activity, including information collected by the Sea Shepherd organisation during 2014/15, which includes data on IUU gear used, toothfish length and weights and by-catch details, suggesting that other data previously collected during at-sea and port inspections could be used in order to assess product types and length–weight measurements to better understand the removals by IUU vessels. The Working Group also noted that counting the number of dead toothfish in recovered gillnets, either recovered by other vessels or recorded in the video footage such as that from the New Zealand Navy patrol vessel, could provide estimates of gear selectivity and the removals arising from IUU fishing.

3.46 The Working Group noted the increased attention given to the issue of IUU fishing in 2015 and drew the attention of the Scientific Committee and SCIC to its consideration of this issue.

3.47 The Working Group recommended that the Secretariat develop a form to provide organisations combatting IUU fishing with information on what data should be gathered that would be useful to CCAMLR in estimating IUU fish removals (e.g. specifications of gear recovered, specific biological information of fish recovered, etc.).

Stock assessments for fisheries for *Dissostichus eleginoides* in Subareas 48.3 and 48.4 and Division 58.5.2, for *D. mawsoni* in Subarea 48.4, for *Dissostichus* spp. in Subareas 88.1 and 88.2 and for *Champsocephalus gunnari* in Subarea 48.3 and Division 58.5.2

Assessment by management area

Champsocephalus gunnari Subarea 48.3

4.1 The fishery for *C. gunnari* in Subarea 48.3 operated in accordance with CM 42-01 and associated measures. In 2014/15, the catch limit for *C. gunnari* was 2 695 tonnes. Fishing early in the season was conducted by two vessels using midwater trawls and the total reported catch was 277 tonnes as of 16 September 2015. Details of this fishery and the stock assessment of *C. gunnari* are contained in the Fishery Report (www.ccamlr.org/node/75667).

4.2 The Working Group noted that the fishing effort deployed in Subarea 48.3 has been low in recent years and that this has resulted in the low uptake of quota by the fishery. High variability in the availability of icefish in the water column to the pelagic fishery was also noted.

4.3 WG-FSA-15/25 presented a preliminary assessment of *C. gunnari* in Subarea 48.3. The assessment was based on a random stratified bottom trawl survey of the South Georgia and Shag Rocks shelves that the UK undertook in January 2015 as part of its regular monitoring program (WG-FSA-15/30). A total catch of 7.2 tonnes was reported from the research survey.

4.4 The Working Group agreed that the length-based assessment for icefish should be used in Subarea 48.3, following the methodology presented in WG-FSA-15/25.

4.5 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 59 081 tonnes, with a one-sided lower 95% confidence interval of 36 530 tonnes. The harvest control rule, which ensures 75% biomass escapement after a two-year projection period, yielded a catch limit of 3 461 tonnes for 2015/16 and 2 074 tonnes for 2016/17.

Management advice

4.6 The Working Group recommended that the catch limit for *C. gunnari* should be set at 3 461 tonnes for 2015/16 and 2 074 tonnes for 2016/17 based on the outcome of the short-term assessment and forecast.

C. gunnari Heard Island (Division 58.5.2)

Research surveys

4.7 The Working Group noted that Australia had undertaken a random stratified trawl survey in Division 58.5.2 during May 2015 (WG-FSA-15/11). It noted that catches per haul of most finfish species were within 1 standard deviation of the mean of the estimates from the equivalent surveys undertaken between 2006 and 2014, with the exception of toothfish, unicorn icefish (*Channichthys rhinoceratus*) and macrourid species which were all more abundant than the long-term mean. These data were included in the preliminary assessments for *C. gunnari* (WG-FSA-15/12 Rev. 1), *C. rhinoceratus* (WG-FSA-15/50), *Macrourus caml* (WG-FSA-15/63) and *D. eleginoides* (WG-FSA-15/52) in Division 58.5.2 (paragraphs 8.10 to 8.28).

4.8 The fishery for *C. gunnari* in Division 58.5.2 operated in accordance with CM 42-02 and associated measures. In 2014/15, the catch limit for *C. gunnari* was 309 tonnes. Fishing was conducted by two vessels and the total reported catch up to 20 September 2015 was 4 tonnes. Details of this fishery and the stock assessment of *C. gunnari* are contained in the Fishery Report.

4.9 The results of the bottom trawl survey undertaken in May 2015 were summarised in WG-FSA-15/11. The Working Group noted that *C. gunnari* catch rates were close to the long-term average from 2006 to 2014. The length–weight relationship was updated using the survey data; other biological parameters were unchanged from previous assessments. The best fit of CMIX to the survey length distribution was achieved when the population was estimated to consist of four year classes from 1+ to 4+, with the 2+ cohort containing the largest number of fish, and estimated to make up 69% of the biomass.

4.10 A short-term assessment was conducted in the generalised yield model (GYM), using the one-sided bootstrap lower 95% confidence bound of total biomass of 3 048 tonnes of age 1+ to 3+ fish from the 2015 survey and fixed model parameters.

4.11 Estimates of yield indicate that 482 tonnes of icefish could be taken in 2015/16 and 357 tonnes in 2016/17 allowing 75% escapement of biomass after two years.

Management advice

4.12 The Working Group recommended that the Scientific Committee consider a catch limit for *C. gunnari* in 2015/16 of 482 tonnes and of 357 tonnes in 2016/17.

Dissostichus eleginoides Subarea 48.4

4.13 The catch limit for *D. eleginoides* in 2014/15 for Subarea 48.4 was 42 tonnes. The total reported catch was 42 tonnes.

4.14 WG-FSA-15/28 presented an updated integrated stock assessment for *D. eleginoides* in Subarea 48.4. Compared to the last assessment in 2014 this model was updated with observations for the 2014/15 season, revised tagging and recapture data for the full time series, a maturity ogive from Subarea 48.3 since insufficient data on maturity from Subarea 48.4 was available and changes to the assumed tag growth retardation period from 0.5 years to 0.75 years (WG-SAM-14/35; WG-FSA-14/49 and 14/50).

4.15 The Working Group noted the model estimated year-class strength (YCS) after 2007 although these year classes were not observed in the catch-at-age data. In addition, all years of tag recaptures were included for each tag-release year. During the meeting, the model was rerun with fixed YCS from 2008 to 2015.

4.16 This model estimated the unfished spawning stock B_0 at 1 476 tonnes (95% CI 1 241–1 781 tonnes) and spawning stock status in 2015 at 83% (95% CI 78–89%). The long-term catch limit that satisfied the CCAMLR decision rules was 47 tonnes. Model results and figures are provided in the Fishery Report.

4.17 The Working Group recalled the discussions on stock structure and potential links between the *D. eleginoides* stocks of Subareas 48.3 and 48.4 at WG-SAM-15 (Annex 5, paragraphs 2.46 and 2.47). Different growth rates and maturity suggested that there is no regular exchange between the two areas, but tag-recapture data show a small number of toothfish moving from Subarea 48.4 to Subarea 48.3 and genetic analysis indicated that both stocks belong mostly to the same genetic population. The Working Group recommended that the two areas are assessed separately until further information is available, as this is the most precautionary approach given the limited knowledge.

4.18 The assessment model estimated that the time series of YCS indicated two strong peaks in 1994 and 1997, followed by a period of lower recruitment. Considering that recruitment in Subarea 48.4 seems to be dominated by sporadic strong recruitment pulses, the Working Group discussed the applied approach of using lognormal recruitment variability with a CV = 1.0 for the projections and recommended that alternative approaches be explored such as resampling from the historical time series and including autocorrelation in the projected recruitment.

4.19 In addition, the Working Group recommended further work on only including data from fish recaptured within four years of release (WG-FSA-11/33 Rev. 1).

Management advice

4.20 The Working Group agreed that the stock assessment in Subarea 48.4 meets the criteria described in SC-CAMLR-XXVI (paragraph 2.11) and, therefore, the assessments could be performed on a biennial cycle without incurring significant additional risk.

4.21 The Working Group recommended that the catch limit for *D. eleginoides* in Subarea 48.4 should be set at 47 tonnes for 2015/16 and 2016/17 based on the results of this assessment.

D. mawsoni South Sandwich Islands (Subarea 48.4)

4.22 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 2014/15 was 28 tonnes. The total reported catch by two vessels was 28 tonnes. Details of this fishery and the stock assessment of *D. mawsoni* are contained in the Fishery Report.

4.23 WG-FSA-15/31 reported on a tag-recapture-based population assessment for *D. mawsoni* in Subarea 48.4 using the method agreed at WG-FSA-14, while WG-FSA-15/44 provided a general review of the Chapman tag-based stock estimation method. The review identified two main issues, namely the appropriate catch–weight correction application of the Chapman estimation method when applied to estimate low tag-recapture rate population abundance and the misidentification of species at release in Subarea 48.4.

4.24 The Working Group agreed that the proposed correction for the average weight of an individual fish should be applied as has been used in other tag-based assessments in the CCAMLR area and that the corrections applied for toothfish identified to species at recapture was appropriate.

4.25 The Working Group discussed the problems associated with zero values in low tag-recapture fisheries in which low levels of catches are taken as presented in WG-FSA-15/44. The high proportion of zero values to which 1 is added within the Chapman correction can increase abundance estimates in years for which no data is available. Some zeros are due to the low probability of expected recaptures, while others are due to violation of assumptions from the tagging program, such as high tag-release mortality, migration out of the area of the fishery, lack of mixing or a lack of overlap in the spatial distribution of tagged fish and fishing effort. The Working Group requested that this subject be reviewed and discussed at WG-SAM.

4.26 The Working Group reviewed tag-based stock estimation methods used in CCAMLR fisheries, particularly the number of tags available within research areas (paragraph 5.64) and concluded that the Chapman estimation method that uses an assumption of a single population of tags in each year of recapture should be applied, and which therefore reduces the influence of zeros in the assessment process.

4.27 The Subarea 48.4 assessment assumed a natural mortality rate of M = 0.13, a tag-loss rate of 0.0064 and an initial release tagging mortality rate of 0.1. Due to high variability in the estimated population estimates across years, a geometric mean of the relatively short time series was used as the basis for the final stock abundance of 1 014 tonnes. At a harvest rate of $\gamma = 0.038$, this would indicate a 2015/16 yield of 39 tonnes for *D. mawsoni* in Subarea 48.4.

Management advice

4.28 The Working Group recommended that the catch limit for *D. mawsoni* in Subarea 48.4 should be set at 39 tonnes for 2015/16 based on the results of this analysis.

Dissostichus eleginoides Subarea 48.3

4.29 The fishery for *D. eleginoides* in Subarea 48.3 operated in accordance with CM 41-02 and associated measures. In 2014/15, the catch limit for *D. eleginoides* was 2 400 tonnes. Fishing was conducted by six vessels using longlines and the total reported catch was 2 194 tonnes.

4.30 WG-FSA-15/59 presented an updated integrated assessment for *D. eleginoides* in Subarea 48.3. Compared to the last assessment in 2013, this model was updated with available data from 2013/14 and 2014/15 and revised tagging data received from the CCAMLR database from earlier fishing seasons.

4.31 The assessment estimated unfished spawning biomass at 85 900 tonnes (95% CIs: 81 600–91 300 tonnes) and spawning stock biomass (SSB) status in 2015 at 0.52 (95% CIs: 0.50–0.54). The long-term catch limit that satisfied the CCAMLR decision rules was 2 750 tonnes.

4.32 The Working Group noted that, while the median SSB was estimated to have fallen below the target level of 50% of the pre-exploitation median SSB from 2009 to 2012 (Figure 1), it was above the target level in 2015 and did not fall below the target for the remainder of the projection period under the recommended yield (paragraph 4.37). This was the first time that an assessment had shown that the stock may have fallen below the target level in the historical time period.

4.33 The Working Group noted that this was due to changes in the estimation of the virgin biomass B_0 and not changes in the abundance of the recent biomass estimates which were relatively consistent between assessments.

4.34 The Working Group noted that the model fitted the observed tag-recapture data very well. However, there were trends in lack of model fits to the commercial age composition data and the survey biomass index, with the model generally underestimating observations up to 2006 and overestimating observations after 2006. In addition, the observed age composition contracted after 2006.

4.35 The Working Group recommended further work exploring the underlying causes for this lack of model fits, including the effects of increased data weighting of the survey. The Working Group also noted that the planned ageing of the survey samples and future use of survey age proportions may improve the estimation of YCS.

4.36 In addition, the Working Group recommended a consistent application of the dispersion parameter for tagging data and an evaluation of alternative approaches to data weightings of all observations.

Management advice

4.37 The Working Group recommended that the catch limit for *D. eleginoides* in Subarea 48.3 should be set at 2 750 tonnes for 2015/16 and 2016/17 based on the results of this assessment.

D. eleginoides Kerguelen Island (Division 58.5.1)

4.38 The fishery for *D. eleginoides* in Division 58.5.1 is conducted in the French EEZ. In 2014/15, the catch limit for *D. eleginoides* was 5 100 tonnes. Fishing was conducted by seven vessels using longlines and the total reported catch up to 31 July 2015 was 2 884 tonnes.

4.39 WG-FSA-15/68 presented an updated stock assessment of *D. eleginoides* at Kerguelen Island (Division 58.5.1 inside the French EEZ), which included recommendations from WG-FSA-14 and the first ageing data and growth curve from the area. Preliminary results of a sex-based model were also presented at the meeting, showing less females than males were caught in the deep longline fishery. This result was in line with habitat modelling of the plateau (WG-FSA-14/42).

4.40 The Working Group noted that the fish growth parameters estimated for this division suggest that fish grow faster and to larger sizes than in the adjacent Division 58.5.2, and that the overall growth model is biased towards female growth. The Working Group recommended inter-laboratory comparisons of fish age estimates from otoliths and further work on growth estimation.

4.41 The Working Group also recommended further work on:

(i) update estimations of whale depredation (WG-FSA-06/63) using methods like the comparative catch-per-unit-effort (CPUE) analysis from WG-FSA-14/10 and include these estimates in the stock assessment

(ii) investigate the use of a uniform-log prior for B_0, a lognormal prior for YCS, double-normal plateau selectivities and application of YCS variability in stock projections when it has not been estimated in the model

(iii) further explore the sex-based model.

Management advice

4.42 The Working Group agreed that model R1 with fixed YCS, as described in WG-FSA-15/68, could be used to provide management advice for 2015/16. Although the long-term precautionary yield was not calculated, the catch limit set for 2015/16 by France of 5 300 tonnes satisfied the CCAMLR decision rules.

4.43 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 2015/16.

D. eleginoides Crozet Islands (Subarea 58.6)

4.44 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. In 2014/15 the catch limit for *D. eleginoides* was 850 tonnes. Fishing was conducted by seven vessels using longlines and the total reported catch up to 31 July 2015 was 433 tonnes.

4.45 WG-FSA-15/69 presented an updated stock assessment of *D. eleginoides* at Crozet Islands (Subarea 58.6 inside the French EEZ). The model included estimated levels of depredation by killer whales from generalised additive model (GAM) analyses of the fishery data and 10% of total catch depredation by killer whales in the predictions.

4.46 The Working Group noted that the recommendations it made for the Kerguelen stock assessment (paragraph 4.41) also applied to the Crozet stock assessment. It further recommended that the annual depredation calculations be presented in future stock assessments papers.

Management advice

4.47 The Working Group agreed that model R1 with fixed YCS, as described in WG-FSA-15/69, could be used to provide management advice for 2015/16. The Working Group noted that a catch limit of 1 780 tonnes would satisfy the CCAMLR decision rules. It noted that France had set a catch limit of 1 000 tonnes for 2015/16.

4.48 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 2015/16.

D. eleginoides Heard Island (Division 58.5.2)

4.49 The fishery for *D. eleginoides* in Division 58.5.2 operated in accordance with CM 41-08 and associated measures. In 2014/15, the catch limit for *D. eleginoides* was 4 410 tonnes. Fishing was conducted by six vessels using bottom trawls and longlines, and the

total reported catch up to 20 September 2015 was 2 675 tonnes. Details of this fishery and the stock assessment of *D. eleginoides* are contained in the Fishery Report.

4.50 WG-FSA-15/55 provided an update of the tagging and ageing program for *D. eleginoides* in Division 58.5.2. Tagging rates have been increased from 2 tags per 3 tonnes in previous fishing seasons to 2 tags per tonne in the current season, and since 2010 the tag-overlap statistic for the longline fishery increased from around 60% to over 90%. The Working Group recalled that there is a need to evaluate the bias introduced into stock assessment when fishing effort, tag distribution and underlying stock distribution is spatially heterogeneous, and recalled that Australia is currently undertaking a project to address these issues for toothfish stocks on the Kerguelen Plateau (WG-SAM-15/37). The Working Group recommended that sensitivities be run to investigate the impact, if any, of the change in tagging rate on the stock assessment and its advice.

4.51 Since WG-FSA-14, an additional 2 559 fish have been aged for fish captured during the 2014 and 2015 random stratified trawl survey, commercial fishing in 2013/14 and archived otoliths from tagged and recaptured fish from the 2009/10 to 2013/14 seasons, including a substantial number of fish over 30 years. Estimates of the age–length relationship derived from these samples are used in the assessment presented in WG-FSA-15/52.

4.52 WG-FSA-15/52 presented an updated assessment for *D. eleginoides* in Division 58.5.2 with data until the end of July 2015 and tag data from 2012 to 2015. Compared to the last assessment in 2014, the assessment also updated fish growth parameters, changed the priors on survey catchability q (as recommended by WG-SAM-15), B_0 and YCS, and split the trawl fishery into two periods of 1997–2004 and 2005–2015.

4.53 The estimated B_0 was strongly influenced by including recaptures in 2014 and partial recaptures in 2015, while updating the growth model and changing model priors for survey catchability q, B_0 and YCS, and splitting the trawl fishery into two periods had relatively little effect on the estimated B_0.

4.54 The updated assessment model leads to a smaller estimate of the virgin spawning stock biomass B_0 than that obtained in 2014, with a Markov chain Monte Carlo (MCMC) estimate of 87 077 tonnes (95% CI: 78 500–97 547 tonnes). Estimated SSB status in 2015 was 0.64 (95% CI: 0.59–0.69). The long-term catch limit that satisfied the CCAMLR decision rules was 3 405 tonnes.

4.55 The Working Group welcomed the progress made on the stock assessment. It noted the difference made by the update in the growth function, the difference in *D. eleginoides* growth functions between areas and recommended calculation of growth parameters is a focus topic for WG-SAM. The Working Group further recommended that sensitivities be run including the tag data from 2010 to 2012, with an investigation of the diagnostics. The Working Group noted that depredation was currently minimal (WG-FSA-15/53) and recommended that monitoring continues and depredation be included in the model should depredation increase.

Management advice

4.56 The Working Group noted that, although estimates of unexploited biomass have been variable over the last few years, estimates of stock status had been very consistent at about 0.65, and the biomass was above target, and that the assessment could be performed on a biennial cycle without incurring significant adverse risk (SC-CAMLR-XXVI, paragraphs 2.11 and 14.6).

4.57 The Working Group recommended that the catch limit for *D. eleginoides* in Division 58.5.2 should be set at 3 405 tonnes for 2015/16 and 2016/17 based on the outcome of this assessment.

Dissostichus spp. Subarea 88.1

Capacity

4.58 WG-FSA-15/09 presented an update of the metrics of capacity and capacity utilisation as described in WG-SAM-14/19 which have subsequently been used for annual monitoring of trends in capacity in exploratory toothfish fisheries in Subareas 88.1 and 88.2. The metrics showed the same pattern as when collated up to 2013 and do not indicate an excess capacity in the fishery.

4.59 A measure of potential daily fishing capacity as a function of the catch limit for an area indicates that for some management areas with low catch limits in Subareas 88.1 and 88.2 the notified fishing capacity is in excess of the level that would allow the Secretariat to forecast a closure date and issue a closure notice using the currently accepted approach.

4.60 The Working Group agreed that, while it was evident that an excess capacity of notified vessels could impact the management of the fishery, this situation had not yet actually occurred. Nevertheless, the Working Group noted that it was important to highlight potential situations where an excess of fishing capacity might make closure forecasting difficult in order that potential solutions can be prospectively evaluated, rather than introduced in response to a problem.

Dissostichus spp. Subarea 88.1

4.61 The exploratory fishery for *Dissostichus* spp. in Subarea 88.1 operated in accordance with CM 41-09 and associated measures. In 2014/15, the catch limit for *Dissostichus* spp. was 3 044 tonnes, including 68 tonnes set aside within the SSRUs 881J and L catch limit for the sub-adult survey and 200 tonnes set aside for the survey of the northern parts of SSRUs 882A–B.

4.62 WG-FSA-15/35 provided a 2015 update of the analysis summarising the impacts of sea-ice on demersal longlining in Subarea 88.1. It highlighted that 2014/15 was the third-worst ice year since the fishery began.

4.63 The Working Group noted the analysis was informative and agreed that ice analysis summaries could be included in the Fishery Reports. The Working Group highlighted the potential for collaboration with the work of the Council of Managers of National Antarctic Programs (COMNAP). It noted the constraining effect of sea-ice on the operations of the fishery and the risk that such conditions may worsen with the effects of El Niño and climate change. The Working Group highlighted the value of spatial models as tools to assess the effects of ice on assessments.

4.64 WG-FSA-15/36 presented an updated characterisation of the toothfish fishery in Subareas 88.1 and 88.2 from 1997/98 to 2014/15, summarising timing, depth and location of fishing effort together with biological characteristics of the catch of *D. mawsoni* up to, and including, the 2015 season.

4.65 The Working Group noted that SSRUs 881I and K in the Ross Sea slope were significantly constrained by sea-ice and this was reflected in the uneven distribution of catch across the three slope SSRUs. There had been a marked increase in the proportion of males in the Ross Sea north fishery throughout the series, but little change in other areas. Median length is still decreasing in slope and north Ross Sea areas (driven by the change in sex ratio) and the highly variable length frequency in SSRUs 882C–G may be due to spatial variation in fishing effort.

4.66 WG-FSA-15/37 presented a descriptive analysis of the toothfish tagging program in Subareas 88.1 and 88.2 from 2000/01 to 2014/15. Over 40 000 tagged fish have been released in the Ross Sea with over 2 500 recaptures. The two-year research plan in SSRUs 882C–G has resulted in 1 128 tagged fish released with 24 recaptures. These data, and data from the 2016 fishery, would be incorporated into developing a two-area model for SSRUs 882C–H.

4.67 The Working Group discussed the spatial pattern of tag availability relative to the distribution of fishing effort and recalled the need for a spatial overlap metric to index the bias on the assessment.

4.68 The Working Group noted that quarantined tagging data can result in a number of analytical effects and referred the question of the use of quarantined data in stock assessments to the Scientific Committee.

4.69 WG-FSA-15/40 presented a proposal to update the data collection plan for the Ross Sea fishery. As in the previous data collection plan discussed in 2010 (SC-CAMLR-XXIX, Annex 8, paragraph 6.31), it focused on ongoing yearly requirements for toothfish as well as intermittent targeted sampling for the key by-catch species, including skates, macrourids and other species (icefish, eel cods, deep-sea cod, etc.).

4.70 The Working Group welcomed the review of the data collection plan for the Ross Sea and its consideration of how to manage the many pressures on the workload of observers. The Working Group agreed that the quality and quantity of observer data was critical to the work of the Commission and that a priority needed to be placed on developing identification guides, instructions and sampling protocols to collect the information requested. It noted the discussions of by-catch data reporting (paragraphs 8.1 to 8.8) and referred further discussion to the Scientific Committee.

4.71 The Working Group noted the desire of many Members not listed in WG-FSA-15/40 to undertake fisheries research in the Ross Sea and that mechanisms need to be provided for their participation in the data collection plan and for refining the plan. It also noted the implementation of such plans will require time to ensure uptake and effective data collection by all Members.

4.72 WG-FSA-15/38 provided an update of the Bayesian sex- and age-structured population stock assessment for *D. mawsoni* in the Ross Sea region (Subarea 88.1 and SSRUs 882A–B). The diagnostic plots for the model fits were presented in WG-FSA-15/39, including the input data, maximum of the posterior density (MPD) and MCMC outputs. The assessment was updated to include catch, catch-at-age and tag-recapture data from 1997/98 to 2014/15 and the results from the Ross Sea shelf survey (WG-FSA-15/34). The assessment model estimates of stock dynamics were consistent with the 2013 assessment. Tag residuals showed year effects that appear to result from the concentration of effort in the year of recapture. This could be the result of ice coverage in those years and an analysis to quantify overlap between fishing and tagged fish release locations is being undertaken. Sensitivity analysis also revealed that the data from the Ross Sea shelf survey were essential to estimate relative YCS. YCS were estimated from 2003 to 2009 and showed one strong year class and two weak year classes. Exclusion of the quarantined age and tag data from the *Insung No. 7* in 2011 and the *Yantar 35* in 2013, 2014 and 2015 (total catches were retained), resulted in negligible changes to the assessment fit and forecast catch as no tagged fish reported by these vessels as released had been recaptured in the fishery. When included as a sensitivity, quarantined data resulted in down-weighting of the data. Despite this minor difference to the estimated stock and fishery trends, the Working Group requested the Scientific Committee to provide guidance on the inclusion or exclusion of the quarantined data for the *Yantar 35* (paragraphs 3.13 to 3.15).

4.73 The Working Group noted that the model diagnostics showed that the model was expecting longer mean length for tagged fish recoveries than observed in all years. This raised questions in respect to the value used for growth retardation from tagging, inaccuracy in estimating *k* in the von Bertalanffy growth model, or higher tag-related mortality in larger toothfish. The Working Group noted that this was a useful diagnostic and reasons for this lack of fit should be further investigated in future studies.

4.74 The yield, using the CCAMLR decision rules and current relative catch distribution between the shelf, slope and north areas of the Ross Sea region, was either 2 855 tonnes or 2 870 tonnes from the two reference case model runs R1 (including quarantined data) and R2 (excluded).

4.75 The Working Group investigated the current allocation of catches by SSRU using mean CPUE and fishable area (SC-CAMLR-XXVII, Table 4), which had 13% from the shelf SSRUs, 74% from the slope SSRUs and 13% from the northern SSRUs and determined that as the CPUE showed no trend (WG-FSA-15/36), the proportional allocation by SSRU should remain as applied in the current conservation measure.

4.76 WG-SAM-15 requested an investigation of the effect of differing catch allocations from the Ross Sea shelf, slope and northern offshore areas (Annex 5, paragraph 4.26). This analysis showed that reallocating the total catch into one of these three locations resulted in a difference to the long-term yield of less than 10%. The Working Group agreed that the spatial population model (SPM), while still being developed as results from the research projects in

Subareas 88.1 and 88.2 become available, may be able to provide advice to the Scientific Committee and the Commission. It noted, however, that methods for presenting diagnostics of such results remain to be determined and will need to be developed to accompany advice that may arise. The Working Group agreed that exploring allocation factors other than seabed area and CPUE, such as other ecosystem features, predator–prey overlap, ice dynamics, etc. would be valuable toward potential future refinement of the subdivision of the catch limit into SSRUs in the Ross Sea.

Management advice

4.77 The Working Group recommended that the catch limit for *D. mawsoni* in Subarea 88.1 should be set at either 2 855 tonnes (with quarantined data) or 2 870 tonnes (without quarantined data) for 2015/16 and 2016/17, depending on the outcomes of a decision on whether quarantined data should be used in assessments. It further recommended that the proportional allocation by SSRU should remain as applied in the current conservation measures, whilst taking into account the research survey proposals below.

Data collection proposals

4.78 Data collection proposals to collect information consistent with the medium-term research plan objectives (CCAMLR-XXXIII, paragraph 5.52) were as follows: (i) a winter survey proposal in the north of Subarea 88.1 (WG-SAM-15/47); (ii) a research proposal in the north of SSRUs 882A–B (WG-FSA-15/32; paragraphs 4.97 to 4.107); and (iii) a research proposal for the south of SSRUs 882A–B (WG-FSA-15/27; paragraphs 4.108 to 4.114).

4.79 WG-FSA-15/47 had been reviewed at WG-SAM-15 with no specific requests to modify the proposal brought forward to WG-FSA. Annex 5, paragraphs 4.27 to 4.29, described the survey design, and paragraph 4.29 requested the Commission to consider how the catch limit should be allocated.

4.80 The New Zealand proposal for the winter survey in SSRUs 881B–C was outlined for June 2016 and future years, with the potential for other Members to provide vessels for future years having suitable safety qualifications. For a catch limit, 100 tonnes (~3 100 fish) was requested – sufficient for 60 sets over 2–3 strata with at least 10 sets per strata. A catch limit would be set by stratum to ensure multiple strata sampled. This catch limit was required to obtain adequate samples while maintaining an incentive for a suitable vessel to participate.

4.81 The Working Group considered that the first year was a proof of concept as a foundation for future work, which would provide important insights into the toothfish biology within the northern area in winter. It endorsed the advice from WG-SAM-15 that the survey would address CCAMLR-agreed priorities and the request for the Commission to consider how the catch limit should be allocated from the Ross Sea catch limit.

4.82 WG-FSA-15/34 presented a research proposal to continue the southern Ross Sea shelf survey (formerly known as the sub-adult survey) for the next two years, 2016 and 2017. The survey is intended to focus primarily on estimating the relative abundance of sub-adult (<110 cm TL) toothfish in the core strata (A, B, C) in SSRUs 881J and L so as to provide a

time series of recruitment of toothfish. The survey is a continuation of the time series of CCAMLR-sponsored research surveys of these strata carried out from 2012 to 2015, which is fitted within the Ross Sea assessment model (WG-FSA-15/09) and enables the model to estimate recent recruitment abundance. A nominal catch limit of 40 tonnes was requested for each survey year. Following the recommendations of WG-SAM-15 and WG-EMM-15, an additional secondary survey objective was added to monitor larger (sub-adult and adult) toothfish in McMurdo Sound and Terra Nova Bay, where toothfish are believed to form an important part of the diet of Type C killer whales and Weddell seals. The Working Group noted that these strata had relatively high standard errors, so that they would be only able to detect relatively large changes in relative toothfish abundance in these areas.

4.83 The Working Group noted that the McMurdo Sound and Terra Nova strata are also areas with relatively high predator concentrations, and that WG-EMM-15 (Annex 6, paragraph 2.86) had noted the importance of conducting monitoring in this area to monitor abundance, spatial distributions and interactions. The Working Group noted that the timing of the surveys had been aligned with the ice-based ecosystem monitoring work undertaken on these three species by Italian, New Zealand and US scientists in these two areas (WG-FSA-15/33). It is proposed to conduct a vessel-based survey in McMurdo Sound in 2016 and Terra Nova Bay in 2017 to match the timing and location of the sea-ice based work. The results of the 2016 survey, and trends in the time series, will be presented to WG-FSA for review in 2016 and that a full review be completed and presented to WG-EMM, WG-SAM and WG-FSA in 2017.

4.84 The Working Group recommended that the Ross Sea shelf survey go ahead with a catch limit of 40 tonnes for each of 2015/16 and 2016/17 and that, as in previous years, the catch be taken from the catch limit on the shelf.

4.85 WG-FSA-15/P01 and 15/33 presented the background context and a proposal for a standardised ice-based survey for *D. mawsoni* in McMurdo Sound.

4.86 Results from a new monitoring program for *D. mawsoni* and other top predators carried out in McMurdo Sound in 2014 have shown toothfish catch rate, fish size and fish age similar to those observed prior to 2002. The results suggest that either large old fish have returned to McMurdo Sound following a temporary environmentally driven absence or that they remained locally present but were not detected in the areas sampled. These studies highlighted the importance of continued standardised monitoring for detecting the potential effects of fishing on the Ross Sea ecosystem, a proposal for which was outlined in WG-FSA-15/33. The proposal indicated that a maximum of 75 fish would be sampled biologically each year (12 fish were sampled in the 2014 research) with others tagged with conventional and electronic tags and released.

4.87 The Working Group noted that monitoring McMurdo Sound for the effects of fishing requires information on the abundance, distribution and interactions of toothfish, their predators and their prey, and that collecting this information was the first step in monitoring for the effects of fishing on these ecosystem components.

4.88 The Working Group noted that large fish appear to be prevalent in McMurdo Sound and in other areas such as SSRU 882G, which is unusual because in other shelf areas toothfish are generally much smaller and younger. The Working Group noted that the information

gathered by this sampling program could be used to further inform SPMs and to monitor for the effects of fishing on top predators through the collaborative work on toothfish predators and prey.

4.89 The Working Group agreed that in the long term it would be useful to determine what role these areas play in toothfish dynamics, how much movement of toothfish into these areas is needed to sustain the predators, and how these interactions may affect how we model natural mortality rates in the assessment models. While these questions are of interest in defining the ecological role of toothfish in the ecosystem and would lead to better spatial management advice, the Working Group noted that the research was unlikely to directly impact the assessment of the status and dynamics of the overall Ross Sea stock, which was driven by the fishery removals, tag-recapture data and larger-scale population processes.

4.90 WG-FSA-15/42 presented a spatially explicit population model of *D. mawsoni* in the Ross Sea region to investigate the effects of a proposed marine protected area (MPA) on the status of the toothfish population using several metrics. The study indicated that the MPA design proposed in 2013 is likely to result in a small increase in the catch limit under existing management rules, as well as a large increase in the proportion of the Ross Sea area with low levels of local depletion of the population and no increase in the area with higher levels of depletion.

4.91 The Working Group noted that it would be useful to update the SPM with recent data to determine its sensitivity to additional data. The Working Group agreed that the influence of sea-ice on the distribution of fishing effort was unlikely to influence the size structure of toothfish in the area, but that sea-ice would influence the distribution of fishing effort under various MPA scenarios.

4.92 The Working Group agreed that the approach used in WG-FSA-15/42 for evaluating the likely effects of alternative MPA scenarios, and the consequent redistribution of fishing effort on the toothfish population, may also be useful for the development of management strategy evaluations in the region. The Working Group requested that the Scientific Committee consider priority issues and scenarios that may utilise this approach.

4.93 WG-FSA-15/08 discussed a proposal to release 10 archival tags during the 2016 shelf survey being conducted by New Zealand. Tags have been obtained from two different companies that provide data on depth, temperature and light level or magnetic field to potentially characterise geolocation. The initial one-year pilot study will be used to evaluate which tags provide the most useful data. Later studies will be planned in context of the US and New Zealand MPA proposal with 50 archival tags released within the proposed general protection zone and special research zone. It is hoped that this will allow data to be collected and reported within two years of release. Fish will be double-tagged in addition to the archival tag which will be marked with contact details.

4.94 The Working Group noted that in previous tagging studies information on the archival tags had not been circulated sufficiently to the industry and one had been recaptured and remained on a vessel without being reported. It also noted that the proponent will endeavour to contact the 20 vessels notified to fish in the area prior to the fishing season and will contact Members and technical coordinators.

Dissostichus spp. Subarea 88.2

4.95 In 2014, the Scientific Committee and the Commission agreed to a two-year research plan in Subarea 88.2 in which the catch limit for SSRU 882H was 200 tonnes, and fishing in SSRUs 882C–G was restricted to the four research blocks with a combined catch limit for SSRUs 882C–G in 2015 of 419 tonnes, with no more than 200 tonnes to be taken from any one of the research blocks. In addition, a multi-Member research survey was agreed by the Scientific Committee and the Commission for SSRUs 882A–B for 2014/15 and 2015/16. The Commission agreed a catch limit of 50 tonnes per vessel and four vessels participated in 2014/15.

4.96 In 2015, the total reported catch of *Dissostichus* spp. in Subarea 88.2 (SSRUs 882C–H) was 624 tonnes. This was divided between research blocks 882_2 (188 tonnes), 882_3 (146 tonnes), 882_4 (82 tonnes) and SSRU H (208 tonnes). In addition, 109 tonnes were taken from the two research blocks in SSRUs 882A (82 tonnes) and 882B (27 tonnes) (Table 1). For 2016, eight Members with a total of 19 vessels have notified their intention to participate in the exploratory fishery for *Dissostichus* spp. in Subarea 88.2.

SSRUs 882A–B north

4.97 WG-FSA-15/32 provided the results of the first year of the two-year multi-Member longline survey for toothfish in the northern Ross Sea region (SSRUs 882A–B) as well as the proposed operations for the second year, combining and updating the separate Member-specific papers submitted to WG-SAM-15 (WG-SAM-15/17, 15/31, 15/32, 15/41, 15/42 and 15/46). The survey had variable but generally high catch rates, almost exclusively of *D. mawsoni*, with low levels of by-catch. Most fish were mature, with an age structure in each research block comparable to cell-specific estimates from the Ross Sea region SPM (Mormede et al., 2014). The survey proponents recommended minor modifications for the second year of operations to aid in the achievement of the objectives, including specification of data collection requirements, bathymetric survey requirements, research block-specific catch limits (25 tonnes per research block) to ensure a greater spread of effort, and a higher level of scientific oversight of survey operations to ensure optimal scientific design and data collection.

4.98 The Working Group recalled the discussion of the survey at WG-SAM-15 (Annex 5, paragraphs 4.30 to 4.36). It noted the value of updating the SPM with the biological and bathymetric data collected during the survey, given the potential influence of bathymetry on the expected distribution and age structure within the research blocks.

4.99 The Working Group recommended that vessels return to the same four blocks sampled in 2015 to enable the recapture of tagged fish and improve estimates of age composition, following this, any remaining effort could be used to sample new research blocks to improve the characterisation of the area.

4.100 Dr S. Kasatkina (Russia) noted that WG-FSA-15/32 provided the CPUE data as kg toothfish per km line set (WG-FSA-15/32, Table 2). However, data from the SSRUs 882A–B north survey revealed variability in the number of hooks per km line set (from 1 521 to 1 042 hooks per 1 km line set) between vessels participating in the survey and from trip set to trip set.

4.101 The Working Group agreed that CPUE data normalised to 1 000 hooks would be more suitable for the SSRUs 882A–B north survey in 2015. It further agreed that the variability of hooks per km line set requires attention to ensure standardised gear is used during the SSRUs 882A–B north survey.

4.102 Dr Kasatkina noted that results of the longline surveys for toothfish in the northern Ross Sea region (SSRU 882A–B) in 2015 revealed high values of CPUE which amounted to 3 500 kg per 1 km line set or to 5 000 kg per thousand hooks and with considerable variation in catches.

4.103 The Working Group agreed it was important to investigate the source of the high CPUE as CPUE is valuable data for understanding fish distribution patterns and for inclusion in the SPM.

4.104 Dr Kasatkina proposed to undertake further analysis for consideration by WG-SAM of the data collected from the SSRUs 882A–B north survey in 2015, with a particular focus on:

(i) reconciling the VMS data with reported haul locations
(ii) the relationship between hauling speed and number of fish caught per unit effort
(iii) the relationship between hauling time and catches.

4.105 The Working Group requested that the survey proponents provide support for this process by conducting an analysis of CPUE variability, haul duration and haul speed for WG-SAM-16 and include a comparison with all exploratory fisheries and closed areas.

4.106 The Working Group noted that a Norwegian vessel would not be able to participate in the survey this year (Table 1). It recalled the recommendation of WG-SAM-15 (Annex 5, paragraph 4.36) and requested that the Scientific Committee consider contingency plans for research survey proposals this year to enable alternative vessels with appropriate gear configurations to be substituted to ensure necessary data collection and continuity of the research survey. It noted that another similar allocation mechanism was proposed for Divisions 58.4.1 and 58.4.2 (WG-FSA-15/54).

4.107 The Working Group recommended the second year of the survey proceed applying the agreed design with a maximum of 6 900 hooks per set and 17 250 hooks per cluster, a minimum cluster separation of 10 n miles and a total effort limit of 244 950 hooks set per vessel and a tagging rate of 3 fish per tonne of catch. The Working Group agreed that a catch limit of 50 tonnes per vessel, and no more than 25 tonnes per research block, deducted from the catch limit from the Ross Sea region, was appropriate. It recommended that all survey participants complete the data collection requirements and bathymetric survey requirements and provide daily data summaries, as described in WG-FSA-15/32.

SSRU 882A south

4.108 WG-FSA-15/27 described the Russian research program on resource potential and life cycle of *Dissostichus* species from SSRU 882A from 2015 to 2018 and presented an updated version of the survey proposal from 2014 to incorporate recommendations from the Scientific Committee (SC-CAMLR-XXXIII, paragraph 3.226) and WG-SAM (Annex 5, paragraphs 4.41 and 4.42).

4.109 Dr Kasatkina recalled the discussion of the survey proposal at WG-SAM-15 (Annex 5, paragraphs 4.37 to 4.42). She noted that the recommendations of both SC-CAMLR-XXXIII and WG-SAM-15 have been addressed in the updated version of the Russian research program (WG-FSA-15/17):

(i) the catch limit for this research fishing should be subtracted from the Ross Sea catch limit (SC-CAMLR-XXXIII, paragraph 3.226)

(ii) an alternative vessel with appropriate gear configuration has been notified to participate in the research fishing. The longline vessel *Palmer*, which deploys the autoline system, will carry out the Russian research program in the southern region of SSRU 882A. Moreover, there is opportunity to invite scientists from other Member countries to take part in the Russian survey: a Ukrainian researcher is planned to be on board in 2015/16.

4.110 Dr Kasatkina noted that the proposed survey by Russia in the southern region of SSRU 882A includes sampling requirements that exceed the observer sampling requirements specified in CM 41-01, Annex 41-01/A. Moreover, the Russian program sampling is consistent with the Ross Sea region fisheries data collection plan proposed by WG-FSA-15/40. She noted that the Russian program requirements include tagging (5 toothfish per tonne of catch), toothfish biological sampling (length, weight, sex, stomach weight and stomach contents, gonad state and gonad weight, muscle tissue and otoliths), as well as sampling for more detailed analysis (gonad histology, muscle tissue for stable isotope analysis, genetic analysis and parasitological analysis). She noted that the majority of these sampling requirements would also be undertaken for by-catch species.

4.111 The Working Group noted that the design of a multiyear survey by Russia (surveying period, fishing gear) provides the possibility for combining data in the southern region of SSRU 882A with the SSRUs 882A–B north survey, consistent with the advice of SC-CAMLR-XXXIII (Annex 5, paragraph 4.20).

4.112 The Working Group noted the potential of the Russian research program to provide data to be used by the SPM of the Ross Sea region and to better understand toothfish movement and distribution relative to the remainder of the Ross Sea stock, as well as to support the fishery-dependent data collection plan for the Ross Sea region.

4.113 The Working Group noted that the research proposal had common objectives with the work in SSRUs 882A–B north and recalled its longstanding recommendation for collaborative research proposals. It noted that the proposed research survey addresses research priorities consistent with those identified for the proposed Special Research Zone in the revised Ross Sea region MPA proposal (CCAMLR-XXXIV/29; SC-CAMLR-XXXIV/BG/31).

4.114 The Working Group recommended that the proposal proceed and be undertaken with a catch limit of 100 tonnes taken from the Ross Sea region catch limit. It agreed that the proposed research catch limit should be subdivided, with a catch limit of 60 tonnes inside the main box and a catch limit of 40 tonnes taken from one of the three optional boxes (see WG-FSA-15/27; SC-CAMLR-XXXIII, paragraph 3.226).

General advice on stock assessment

4.115 The Working Group considered that when the SSB status is close to the target level, it is to be expected that SSB status will fluctuate around the target level over time as a result of: (i) variability in YCS, (ii) more information on the stock that may change model estimates such as those for B_0, current stock status and YCS, and (iii) as a function of adjustments using the CCAMLR decision rule.

4.116 The Working Group requested that the Scientific Committee include in its considerations for the priorities for WG-SAM the need to evaluate the expected behaviour of the stock status for all stocks when they are near the target level, with particular focus on what time period SSB status would typically be below the target level and by how much it would fluctuate around the target level given variability in, for example, YCS.

4.117 The Working Group recognised a number of issues discussed across stock assessments, and requested that the Scientific Committee consider the following as potential focus topics for WG-SAM:

(i) methods to estimate fish growth functions and simulations of the impact of sampling procedures on the growth curve estimates

(ii) the effect of applying single-sex versus sex-based assessment models and the impact on management advice

(iii) alternative data weighting approaches within a stock assessment model

(iv) methods to quantify the level of spatial overlap between tagged fish and subsequent fishing effort, and evaluation of the potential bias introduced into stock assessments and tag-based biomass estimates when the distributions of tagged fish, fishing effort and the underlying stock distribution are spatially heterogeneous

(v) the expected behaviour of the stock status for stocks which are near the target level, with particular focus on the uncertainty in B_0 estimation, the time period SSB status might be below the target level and by how much it would fluctuate around the target level given variability in, for example, YCS

(vi) evaluation of decision rules for stocks with an uncertain catch history, e.g. for stocks that had experienced IUU catches prior to the time when the assessment time series starts and thus the B_0 estimated by an assessment may not represent an unfished B_0

(vii) decision rules for the application of tag-based estimates of stock size without a corresponding estimate of B_0 (i.e. Chapman estimates).

Model diagnostics

4.118 WG-FSA-15/60 presented the model diagnostics and results from an integrated stock assessment model for *E. superba* in Subarea 48.1. In addition to the 'base-case' configuration of the krill model from WG-EMM-15/51 Rev. 1, seven alternative configurations based on different data weightings evaluated the influence of different data sources on the model estimates.

4.119 The Working Group noted that it was appropriate to discuss this paper in WG-FSA, given the expertise in stock assessment models present at the Working Group, but recommended that further developments of this assessment model be presented to both WG-SAM for review of the model structure and diagnostics, and to WG-EMM for management implications.

4.120 The Working Group considered that the model diagnostics were helpful to understand model fits to the data and the ability of the model to estimate all model parameters, including unfished recruitment R_0, the steepness of the stock–recruitment relationship and natural mortality. The likelihood profiles for unfished recruitment and recruitment steepness indicated that there was conflicting information in the data to estimate some of the correlated parameters concurrently with great confidence.

4.121 Dr Kasatkina indicated that some uncertainty in the presented model diagnostics for the *E. superba* assessment in WG-FSA-15/60 was associated with input data that were derived from acoustic and trawl samples. Dr Kasatkina noted that during the study period catch samples were obtained using different gear constructions. The latter should lead to high variability in gear characteristics (catchability, selectivity and swept volume) between research and commercial trawls and, as a result, should impact on krill length compositions and biomass density, or CPUE induces removed from catch samples. Moreover, estimates of krill biomass densities removed from acoustic and trawl samples are not comparable. Dr Kasatkina noted that there is no clear understanding of how the abovementioned uncertainty in data could impact on the real uncertainty associated with estimating krill population parameters in Subarea 48.1 from the proposed model. She expressed concerns regarding the risk to underestimate the real uncertainty provided by the proposed model diagnostics.

4.122 The Working Group recommended the following work to refine the assessment:

(i) evaluate models where some of the correlated parameters are fixed at different starting values while estimating only the remaining ones to determine boundary values and general model trends that could be important for management advice

(ii) present further model diagnostics on the prior and posterior distributions of model estimates, including boundary values

(iii) clarify how the median and variability of the pre-exploitation spawning biomass is estimated, noting that the biomass at the beginning of the estimated time series is not the same as the pre-exploitation median spawning biomass

(iv) account for, and evaluate, model uncertainty derived from the variability in length-frequency distributions and biomass density estimates of krill due to

different gear selectivities and trawl types. Different gear constructions can lead to high variability in catchability, selectivity and swept volume of used gears especially between researches trawl (IKMT, RMT8) and commercial trawls, as well as between commercial trawls. In addition, estimates of krill biomass densities removed from acoustic and trawl samples may not be directly comparable.

Generic issues

Fishery nomenclature and the CCAMLR regulatory framework

5.1 The Working Group discussed the regulatory framework as it related to the development of assessments in areas with different fishery status (e.g. exploratory or closed), as described in CCAMLR-XXXIV/17 Rev. 1. The Working Group agreed that, while the regulatory framework was mainly a Commission issue, the confusion caused by the implementation of research plans using commercial fishing vessels as research platforms in areas designated as closed or with a prohibition against fishing, made the administration of research plans in these areas confusing.

5.2 In particular, the Working Group noted that several research plans implemented in 'closed' areas under CM 24-01, are identical in design and purpose to those implemented in data-poor fisheries under CM 21-02.

5.3 The Working Group recommended that nomenclature could be adapted to align with the status of either being an exploratory fishery with an assessment, or an exploratory fishery with a research plan progressing towards an assessment. Closed fisheries would then become those that had a catch limit set to zero.

5.4 The Working Group recalled that some management areas have a prohibition on directed fishing under CM 32-02 and that these prohibitions may reflect the result of depleted fish stocks, toothfish overfishing due to IUU activity, or an absence of catch limits in other conservation measures. In addition, the Working Group recalled that there were also management areas (SSRUs and divisions) where there was not a prohibition in CM 32-02 but a catch limit of 0 tonnes was applied to exploratory fisheries for toothfish. The Working Group noted that understanding the reason why such prohibitions and zero-tonne catch limits arose had important implications for providing future management advice for those fisheries.

5.5 Dr Kasatkina expressed concern that the recommendations set out in CCAMLR-XXXIV/17 Rev. 1 have the potential to have significant impacts on CCAMLR fisheries. She noted that proposed recommendations for streamlining fishery status requires special considerations with a particular focus on: (i) how the status of some fisheries should be changed and which of new/revised conservation measure(s) would be required; (ii) which of ensuing consequences for CCAMLR fisheries would be provided by streamlining fishery status. Dr Kasatkina proposed to discuss CCAMLR-XXXIV/17 Rev. 1 in the intersessional period and conduct a workshop. The results of the workshop will be presented to WG-EMM and WG-FSA.

Research plans

5.6 The review of research plans by WG-SAM-15 was summarised in a self-assessment table and presented in WG-FSA-15/14, along with recommendations to help streamline the review process and improve the likelihood that research plans will reach their objectives.

5.7 The Working Group agreed that it would be more efficient to only review ongoing research plans by exception and to have standardised reporting on an annual basis to WG-FSA instead.

5.8 The Working Group noted the value of summaries of the status of fisheries, the need for overarching data collection plans specific to management areas (area, subarea or division specific) and the need for summaries of individual research proposals.

5.9 The Working Group agreed that an effective way to collate the required summaries was for the Secretariat to augment the existing Fishery Reports to ensure that a Fishery Report is available for each management area where toothfish are taken (either in research or commercial fishing). The Working Group recommended that the Fishery Reports include the following (in addition to the information currently contained in the existing fishery reports): an assessment annex (where there is an assessment) and a data collection plan, which will summarise research for the area. The data collection plan would then have appended summaries of the individual research proposals (along the lines of the research summary in CM 41-10, Annex 41-10/B), which would include hyperlinks to the original research proposals (and any revisions) as well as details of any amendments to that version of the proposal that were introduced in the most recent version of the plan prior to agreement by the Commission.

5.10 The Working Group recalled that for some exploratory fisheries, data collection plans had been developed and agreed by the Scientific Committee and the Commission (SC-CAMLR-XXXIII, paragraph 3.209; CCAMLR-XXXIII, paragraph 5.52). It agreed that, where such plans exist, they could be readily appended to the Fishery Report.

5.11 The Working Group recommended that as research plans are developed and reviewed, milestones related to providing estimates of local abundance, stock structure, natural mortality, age–length keys (growth), maturity ogive, selectivity and impacts on dependent and related species, should be agreed and used to evaluate the progress of research plans.

5.12 The Working Group further noted that the milestones specified would best be divided into at-sea and shore-based components in order to emphasise the need to develop analyses and stock assessments in addition to collecting catch, tagging and biological data as part of the steps required to develop a stock assessment to meet the objectives of the Convention (Table 5).

5.13 The Working Group noted that multi-Member research plans should be encouraged and that submission of a single research plan for multiple Members could be efficiently organised. The Working Group further noted that the analytical support necessary to develop a robust stock assessment is significant and that the workflow necessary to develop and maintain a robust stock assessment, as described in Table 5, is required to ensure the objectives of Article II are met.

5.14 The Working Group discussed whether the previous performance of survey proponents should be considered in evaluating the likelihood that survey proposals would be able to provide useful scientific information and achieve the survey objectives. The Working Group recommended that the Scientific Committee consider how previous performance of nominated proponents could be assessed and considered when evaluating future survey proposals.

Mark-recapture data analysis

5.15 The Working Group welcomed the development of R code to estimate the uncertainty of Chapman biomass estimates using a bootstrap method described in WG-FSA-15/49. The Working Group noted that in the current configuration, the Chapman biomass estimate is not made if no recaptures of tagged fish were found in the bootstrap calculations (paragraph 4.26) and requested additional analysis to determine the best analytical approach to address seasons where no recaptures were reported.

5.16 The Working Group discussed the analysis of tagging data within the research plans and suggested that the process of calculating biomass estimates could be reviewed by WG-SAM-16 with the aim of developing a 'best practices' document that Members could refer to when developing these types of analyses. The topics could include the recommended methods for treating seasons with no recaptures, methods to pool estimates among years, methods to estimate uncertainty, methods to determine the number of tagged fish at liberty, gear-specific effects on tag detection (e.g. to account for loss of tags if cachaloteras were used) and methods to determine the number of recaptured fish for biomass estimation.

5.17 The Working Group recommend that the Secretariat provide an updated revision of the summary table of local biomass estimation methods and recommended research catch limits in research blocks, catch reported in 2015, number of tagged fish available and the expected and observed recaptures (see SC-CAMLR-XXXIII, Annex 7, Table 5), with details of the methods used to calculate all values presented in the table provided in a document to WG-SAM-16.

5.18 As an initial component of the 'best practices for toothfish mark-recapture analysis' document, the Working Group discussed the method to determine the number of tagged fish at liberty and developed a process that could be used to calculate local estimates of indicative biomass. The process includes a mechanism to discount the number of tagged fish released by tagging mortality, natural mortality and tag shedding, and the criteria used to identify tagged fish available for recapture to include in Chapman biomass estimation or in the estimation of expected recaptures (such as treatment of tagged fish release data from quarantined trips, or the use of tagged fish released from trips with poor tag-overlap statistics).

5.19 The Working Group noted that natural mortality and tag-loss rate can be applied to the number of tagged fish available in any time-step. Although some fisheries show a highly seasonal pattern in recapture effort, resulting in an annual application of natural mortality and tag-loss rates, in some fisheries effort is distributed throughout the year. The Working Group noted that appropriate time-steps over which to apply mortality and tag-loss rate, as well as assumptions of mixing and equal probability of recapture associated with mark-recapture approaches, should be considered if using time-steps of less than a year.

5.20 After considering the additional analyses presented by the Secretariat that showed the frequency distribution of the time at liberty of tagged fish, the Working Group agreed that, while some fish had been recaptured after seven years, most tagged fish were recaptured within the first three years after release. Additionally, the Working Group noted that the retention of tagged individuals appeared to vary among areas, with research block 486_2 displaying a similar pattern to Subarea 88.2, where the current hypothesis included the reduction of the tag-recapture rate due to immigration of untagged fish in the area.

5.21 The Working Group had previously recommended that only tagged fish releases from vessels that have had a tagged fish recaptured should be used in mark-recapture analysis as a data quality assurance measure (SC-CAMLR-XXXII, Annex 6, paragraph 6.13). The Working Group reviewed tagged fish release and recapture data and noted that since 2009 all vessels have had at least one tagged fish recaptured (with the exception of 48 tagged fish released in the Ross Sea by the *Argenova XXI*).

5.22 The Working Group agreed that all tagged fish released in years, beginning in 2009, should be considered suitable for inclusion for the purposes of estimating biomass and expected recaptures in Subareas 48.6 and 58.4, unless there are specific reasons for their exclusion. The Working Group further agreed that all tags available for recapture be included in both biomass estimation analyses and in calculations of the number of recaptures expected in the coming season.

5.23 The Working Group considered factors, other than immigration, that were not currently accounted for that could potentially explain the apparently lower than expected rates of recaptures of tagged fish. These included the factors that influence the spatial pattern of fishing relative to the availability of tagged fish (paragraph 4.25), the effort that had been deployed to recapture tagged fish and the potential for gear and/or vessel-specific differences in tag-detection rates (paragraph 5.16).

5.24 The Working Group discussed the operational issues that might be preventing the data collection elements of research plans from being completed, as indicated by the research catch not being fully utilised for catch-limited research in some areas. The Working Group requested that the Scientific Committee consider that a possible solution to this may be, in the first instance, to give priority to research fishing in a particular block or area for a three-year time period to ensure that data that was necessary to perform an integrated stock assessment would be collected. The Working Group agreed that Subarea 48.6 would be a good candidate area if this approach of focusing research effort is implemented.

Provision of management advice in data-poor fisheries affected by IUU fishing

5.25 The Working Group recalled that there had been substantial IUU fishing for *D. eleginoides* in many of the divisions and subareas of the Convention Area during the 1990s, which had led to varying levels of depletion of these stocks and in some cases had led the Commission to close fisheries (e.g. Division 58.4.4). The Working Group further noted that IUU fishing for *D. eleginoides* had continued more recently in some of these stocks and that there had been a displacement of IUU fishing to *D. mawsoni* over the past decade. Recent sighting data suggest that this is a particular issue in the data-poor fisheries in Subareas 48.6 and 58.4 (paragraphs 3.40 to 3.47). Estimates of IUU catches were made for these fisheries up

until 2011 based on vessel sightings, but with the recent move to gillnets and the uncertainties associated with making estimates of IUU catches, the catches of *Dissostichus* spp. have not been estimated over the past five years.

5.26 The use of the current CCAMLR decision rules for providing management advice requires knowledge of the stock status at the beginning of the assessment period and knowledge of subsequent removals from the fishery. If IUU fishing had already reduced the stock size before the regulated fishery took place, then the estimate of unexploited SSB from the stock assessment would be underestimated. Consequently, exploiting a stock to 50% of an initial biomass estimate that had previously been over-exploited would not be consistent with CCAMLR Article II.

5.27 The Working Group agreed that, where estimates of IUU catches are available, they should be used in the assessment and that sensitivity analyses could be carried out to detect the effect of varying levels of these IUU catches on the results. However, where IUU fishing is known to have occurred, or still be occurring, and estimates of catches are unavailable, alternative methods for providing management advice need to be developed.

5.28 The Working Group recalled that an alternative way of providing management advice for these fisheries is to multiply an estimate of current vulnerable biomass by a precautionary exploitation rate where the exploitation rate would have high confidence in not reducing the stock further.

5.29 The Working Group recalled previous simulation work carried out to examine the effect of research catches on the recovery of depleted stocks by Welsford (2011). This analysis showed that even small research catches could delay the recovery of stocks which had been severely depleted. It also recalled previous discussions on this topic based on WG-SAM-13/37 at the 2013 WG-SAM meeting (SC-CAMLR-XXXII, Annex 4, paragraph 2.7viii) stating 'Combined catch limits for all research blocks in a stock or SSRU should be evaluated to ensure that the combined catch is lower than a precautionary exploitation rate. The Working Group recognised that exploitation rates of 3–4% of $B_{current}$ (at the scale of the stock or SSRU) are appropriate for stocks with current status ranging from 20% to 100% B_0, consistent with previously utilised methods (SC-CAMLR-XXX, Annex 7, paragraphs 5.22 and 5.34) to ensure that research catches do not delay recovery for depleted stocks (Welsford, 2011).' However, it was also noted that this advice was based on research fishing only being for five years with no fishing thereafter.

5.30 The Working Group agreed that further simulations would be useful to evaluate appropriate exploitation rates which include parameters specific to particular fisheries and stock–recruit relationships at various levels of stock status.

Circumpolar *D. mawsoni* habitat model

5.31 The Working Group considered WG-FSA-15/64, presented by the Secretariat, detailing work on modelling the circumpolar habitat suitability of *D. mawsoni* using the Maxent method. The paper presented two methods of selecting background data that included a random selection within the Convention Area and targeted selection of background that was restricted to where toothfish fishing had occurred. The results showed that model

parameterisation and predictions were highly sensitive to the background selection method used, but that model predictions from the target group background approach that was primarily driven by temperature, performed well in the regions where data had been collected. A post-processing method was applied to the target group model to constrain the predictions to regions that had suitable bathymetry that presented the most realistic predictions.

5.32 The Working Group welcomed this analysis and agreed that it provided a useful approach to understanding spatial differences in the habitat suitability of *D. mawsoni* and had also developed a useful approach to utilising fisheries data in a circumpolar scale model. The Working Group suggested that the model could be used to make inferences about the relative species composition of IUU catches associated with sightings data, such as those presented in CCAMLR-XXXIV/BG/12.

5.33 The Working Group encouraged further development of the spatial habitat modelling, including the consideration of other methods including presence–absence and abundance methods, testing the model predictions with independently derived data in time and or space, including testing predictions using the data that would be collected in the proposed research block 486_4 in areas of marginal habitat such as on Macquarie Ridge.

Management area research reviews

Subarea 48.2

5.34 WG-FSA-15/43 Rev. 1 provided a summary on the longline survey results in Subarea 48.2 undertaken by Ukraine in 2014/15. This survey was the first year of a three-year investigation aimed at estimating the status of *Dissostichus* spp. in this subarea. The Working Group noted that information collected included the ratio of the species *D. mawsoni* and *D. eleginoides* in the studied area and that both *D. mawsoni* and *D. eleginoides* are encountered in the northern regions, whilst only *D. mawsoni* were found in southern regions.

5.35 WG-FSA-15/43 Rev. 1 presented a plan by Ukraine to continue longline survey research activities in Subarea 48.2 for 2015/16. The Working Group noted that there were no changes to the research plan from that set out in WG-SAM-15/40. The Working Group noted the proposal to stratify the survey by area by dividing the survey region into the northern bank and the southern seamount area. The Working Group also noted that a reduction of the tagging rate to 3 fish per tonne was proposed in the southern seamount stratum as a result of the density of longline sets in this area being higher than in the northern banks region.

5.36 WG-FSA-15/10 presented a proposal by Chile to undertake a three-year program of toothfish research fishing in Subarea 48.2, which was an update of WG-SAM-15/53. The Working Group noted the similarity in the survey design, station locations and area presented in the proposal with that proposed by Ukraine.

5.37 The Working Group noted that neither of the proposals included a timeline to develop assessments, either by mark-recaptures or other preliminary stock assessment methods. The Working Group agreed that this should be developed and presented for review.

5.38 The Working Group noted the scientific benefits of having more than one vessel participating in the research, although there is the potential for interference between the plans

set out in WG-FSA-15/43 Rev. 1 and 15/10. The Working Group recommended that Ukraine and Chile coordinate on the research, including deliverables and milestones with respect to sampling efforts at sea, laboratory work and analytical work in view of the common aim of an integrated stock assessment for the area.

5.39 Drs K. Demianenko and L. Pshenichnov (Ukraine) recalled that the three-year research plan submitted by Ukraine had been considered by WG-FSA-14 and approved by the Scientific Committee and the Commission. The next season (2015/16) will be the second year of the three-year research plan and Ukraine indicated that it has all preconditions for completing the research plan.

5.40 In light of the new research plan by Chile, Drs Demianenko and Prof. P. Arana (Chile) requested that the Scientific Committee consider an appropriate catch limit for each research vessel ensuring that there is adequate spatial coverage in accordance with each research survey plan.

5.41 Consistent with other data-poor regions in the Convention Area, the Working Group agreed that the current catch levels should not increase with the increase in the number of participants undertaking the research, but that it would be desirable to coordinate spatial and temporal sampling of the area. This coordination should be undertaken by the two proponents. It was noted that the plans as set out with respect to laboratory and analytical intentions are very ambitious and undertaking work toward these objectives will require substantial determination by the proponents.

5.42 The Working Group noted that there are differences between tagging rates in the southern region of the research area (3 fish per tonne vs 5 fish per tonne). It was agreed that tagging at the higher rate of 5 fish per tonne would be more desirable as long as the condition of the fish allowed tagging at this higher rate.

5.43 The Working Group agreed that, as this is a closed area with very little historical longline fishing for *D. mawsoni*, it was important to collect as much information as possible on target, by-catch and other components of the ecosystem. The Working Group noted that there are genetic studies underway to determine potential linkages between the southern Subarea 48.4 and Subarea 48.2 stocks of *D. mawsoni*.

Dissostichus spp. Subarea 48.5

5.44 WG-FSA-15/29 described the revised Russian research plan to undertake research for *Dissostichus* spp. in Subarea 48.5 (Weddell Sea) from 2015/16 to 2019/20.

5.45 The Working Group noted both the review of research activities undertaken in 2012/13 (WG-SAM-15/22) and an earlier version of the proposal set out in WG-SAM-15/18 (Annex 5, paragraphs 4.8 to 4.16). The Working Group noted that the primary difference in the revised proposal was that the number of vessels notified to undertake the research was reduced to one.

5.46 The Working Group further requested a rationale for why a five-year, rather than a three-year, time frame for this research is specified in the revised proposal.

5.47 Dr Kasatkina recalled the Scientific Committee recommendation that a future Russian research program in the Weddell Sea would need to be consistent with the original research objectives approved in 2012 (SC-CAMLR-XXXIII, paragraph 3.233) and that WG-FSA-15/29 presented the original research program in the Weddell Sea adopted by the Scientific Committee in 2012 (WG-FSA-12/12; SC-CAMLR-XXXI, paragraph 9.16) with some revisions to incorporate the comments of WG-SAM-15 (Annex 5, paragraph 4.13).

5.48 Dr Kasatkina noted that WG-SAM-15 raised no objections, other than the number of vessels (two vessels) that participated in research fishing and concern about vessel safety in the Weddell Sea, given potentially heavy ice conditions. She also noted that one vessel was notified for research fishing. Moreover, there is the opportunity to invite scientists from other Member countries to provide full transparency of the research fishing. A Ukrainian researcher will be on board in 2015/16. She noted that analysis of ice conditions in the Weddell Sea from 2003 to 2015 provided evidence that three different spatial options could be undertaken depending on where ice conditions would be favourable.

5.49 The Working Group recalled the advice from WG-SAM in relation to the survey in this area (Annex 5, paragraphs 4.8 to 4.16). It recalled that during 2012/13 Russia fished in the area and reported that the catch limit was reached after the deployment of eight lines.

5.50 The Working Group agreed that once the analysis of the quarantined 2012/13 and 2013/14 data was complete, the strategy recommended to achieve the research objectives may change and, therefore, the Working Group cannot evaluate if the proposed design is appropriate at this time to reach the original objectives agreed by the Scientific Committee (SC-CAMLR-XXXIII, paragraphs 3.232 and 3.233).

5.51 Dr Kasatkina also noted that the proposal fully meets the requirements of CMs 21-01, 21-02 and 41-01 and that the catch limit was adopted by the Commission in 2012 (CCAMLR-XXX, paragraph 5.42). Dr Kasatkina emphasised that the Convention and conservation measures raise no objections against providing research investigations in the Weddell Sea and the quarantined data analysis requested by the Scientific Committee in parallel is an unrelated processes.

5.52 The Working Group agreed that it was unable to provide any further advice to that provided by the Scientific Committee in 2014 (SC-CAMLR-XXXIII, paragraphs 3.230 and 3.231).

5.53 The Working Group requested an update on the progress of the analysis of the data collected in 2012/13 and 2013/14 on the *Yantar 35* that both the Scientific Committee and WG-SAM had requested from Russia.

5.54 The Working Group noted that WG-SAM had agreed that the report from Russia (WG-SAM-15/22), describing the Russian analysis of the 2012/13 Subarea 48.5 fishing survey, be brought to the attention of SCIC. Some Members consequently requested that the Secretariat undertake an analysis of the quarantined data from research activities in Subarea 48.5 and provide a report to the working groups for further consideration in 2016. The Working Group agreed that the results of this and previous Secretariat analyses should be available to WG-SAM and WG-FSA in 2016 before it is able to make recommendations in respect of the research proposal going forward.

Research plans for data-poor exploratory fisheries in Subarea 48.6

5.55 The current limits on the exploratory fishery for *Dissostichus* spp. in Subarea 48.6 are described in CM 41-04. In 2014/15 the catch limit was revised to 538 tonnes and applied to the suite of research blocks shown in Figure 1 (see Fishery Report).

5.56 For 2016 a total of three vessels, one each from Chile, Japan and South Africa, had notified their intention to participate in the exploratory fishery for *Dissostichus* spp. in Subarea 48.6.

5.57 The Working Group noted that WG-SAM had reviewed research proposals by Japan (WG-SAM-15/06) and South Africa (WG-SAM-15/39) to continue research to develop stock assessments for toothfish in Subarea 48.6. It also noted the advice on developing an assessment in research block 486_2 and developing new research blocks in this subarea (Annex 5, paragraphs 3.2 to 3.5).

5.58 The Working Group noted that no fishing had occurred since WG-SAM and, therefore, there was no data available to update estimates of biomass from those presented at WG-SAM-15. Hence, South Africa's research plan was unchanged from that presented in WG-SAM-15/39. Japan provided a revised research plan (WG-FSA-15/16 Rev. 1) that incorporated a proposal to extend research block 486_4 to the west. Furthermore, during the meeting Dr K. Taki (Japan) used the method in WG-FSA-15/49 to provide bootstrap confidence intervals for the Chapman tag-recapture biomass estimates. The Working Group welcomed this analysis as it provided a basis to compare the precision of CPUE and tag-based biomass estimation, as well as enabling estimating bounds on the numbers of tags expected to be caught in the next season.

5.59 The Working Group noted that WG-FSA-15/24 proposed an extension of research block 486_4. The Working Group welcomed the analysis of sea-ice and other environmental conditions in this paper. It further noted that it was not proposed to increase the catch limit to account for the increased seabed area in the extension. It further noted that the proposed area was contiguous with an area where tags had been successfully released and recaptured, therefore there was a higher likelihood of detecting movement along the shelf in the proposed area than for research blocks separated by large distances.

5.60 The Working Group noted that there was uncertainty in the rate of mixing of toothfish in this region and this would need to be taken into account when using tag recaptures (or the lack thereof) in the proposed extension area in estimating biomass, for example, by doing separate estimates for research block 486_4 and the proposed extension. It therefore encouraged the vessels fishing in this area to endeavour to fish in the main area as a priority to ensure that a consistent time series of data is maintained.

5.61 The Working Group endorsed the extension to research block 486_4, noting that it was desirable to fish in the original research block as a priority (Figure 2).

5.62 WG-FSA-15/66 provided a summary of the data available for developing an assessment in research block 486_2, as requested by WG-SAM-15 (Annex 5, paragraph 3.3). The Working Group noted that a time series of tag recaptures has been collected, as well as reproductive, catch-at-length and length-at-age data. It noted that with the development of otolith ageing programs in South Africa and Japan a preliminary integrated assessment should be developed and submitted to WG-SAM-16 for review.

5.63 The Working Group noted that younger fish seemed to be absent in catches from research block 486_2 and encouraged the collection of length-at-age estimates to enable the estimation of the lower limb of the von Bertalanffy growth function. It also requested that research be developed to determine likely sources of recruits to this research block. It further noted that, given the time series of tag recaptures from this area, and the comprehensive sampling of the fishable area by the fishery, it was important to move away from using CPUE by seabed area biomass estimates for this research block.

5.64 The Working Group reviewed revised estimates of biomass for the research blocks in this area, taking into account new estimates of available tags, which included all tags released in the research blocks since 2008. Due to the observation that tagged fish in research block 486_2 seem to remain resident in the area for less than four years, only those tagged fish released and at liberty for less than four years in that area should be considered as being available (as is the case in SSRU 882H).

5.65 Given that the estimate of expected tag recaptures in 2015/16 was considered adequate and none of the current catch limits exceeded 4% of the mean predicted biomass in any research block, the Working Group agreed that catch limits should remain unchanged for 2015/16.

Dissostichus spp. Divisions 58.4.1 and 58.4.2

5.66 The precautionary catch limit for the exploratory fishery for *Dissostichus* spp. in Division 58.4.1 in 2015 was 724 tonnes and this was applied to research fisheries in SSRUs, including research blocks within those SSRUs. The fishery was limited to one Korean and one Spanish flagged vessel using longlines. The Republic of Korea was the only Member that conducted research fishing during the season and undertook research fishing in Division 58.4.1 with a total catch of 123 tonnes, taken as follows:

- 3 tonnes in research block 5841_1
- 16 tonnes in research block 5841_2
- 68 tonnes in research block 5841_3
- 10 tonnes in research block 5841_4
- 26 tonnes in research block 5841_5.

For 2016, a total of five vessels, one each from Australia, France, Japan, Korea and Spain, have notified their intention to participate in the exploratory fishery for *Dissostichus* spp. in Division 58.4.1.

5.67 The precautionary catch limit for the exploratory fishery for *Dissostichus* spp. in Division 58.4.2 in 2015 was 35 tonnes in SSRU E and the fishery was limited to one Korean and one Spanish flagged vessel using longlines. Only the Korean-flagged vessel undertook research fishing activity in Division 58.4.2 with a total reported catch of 11 tonnes. For 2016 a total of five vessels, one each from Australia, France, Japan, Korea and from Spain, have notified their intention to participate in the exploratory fishery for *Dissostichus* spp. in Division 58.4.2.

5.68 The Working Group considered eight papers from five Members describing research plans and a plan for the allocation of catches in Divisions 58.4.1 and 58.4.2. The Working

Group discussed the plans independently and considered how the research conducted for each plan may be harmonised to ensure the objectives of the Convention are met for the divisions overall.

5.69 A proposal by Spain (WG-FSA-15/05), proposals by Japan (WG-FSA-15/17 and 15/18), proposals by France (WG-FSA-15/73 and 15/74) and a proposal by Australia (WG-FSA-15/47 Rev. 1) for work in both Divisions 58.4.1 and 58.4.2, plus a proposal by Korea (WG-FSA-15/56) for work in Division 58.4.1 all incorporated the minor design changes requested by WG-SAM-15 (Annex 5, paragraphs 3.6 to 3.19). The Working Group noted that the presentation of standardised CPUE data for these areas should also include diagnostic plots and fits as developed for stock assessment input data (Annex 5, paragraphs 2.36 to 2.43). The Working Group also pointed out that the research capability by France may be impacted by the availability of the author named in the research plan.

5.70 The Working Group encouraged direct collaboration among Members and noted that different Members may bring different capabilities in analysis, biological study, or modelling to the effort. The Working Group also recognised that the different plans had been in effect for different amounts of time and that changes in individual research plans may influence the overall research plan design in the future. The Working Group suggested that an overarching research plan with measurable milestones for the divisions be developed intersessionally among the proponents to meet the Convention's objectives.

5.71 The Working Group noted that Members will need to coordinate vessels to work together to obtain the required samples and to conduct the appropriate analyses.

5.72 The Working Group noted the catch allocation plan presented in WG-FSA-15/54, where the catch limit in each research block was allocated among Members with the exception of Spain, which fishes outside research blocks as part of its experimental design. The allocation plan avoids Olympic fishing by allocating catch to each Member in a transparent fashion while allowing flexibility by reallocating catch after a threshold date of 30 January, or by notification that a Member no longer intends to fish.

5.73 The Working Group discussed how the allocation of catches among Members may impact the success of each individual research project and the overall objective of developing a stock assessment for the area. For example, with different objectives, catch data and biological samples may be spread among a subset of participating Members and require collaborative analysis or result in risk of not reaching the objectives of the research plan. Alternatively, vessels that change the timing or order of their fishing could impact the timing and availability of catch for other vessels. In addition, the Working Group noted that the scientist named in the French proposal was not present to discuss and advance coordination of the research plans.

5.74 The Working Group recalled that improved seabed area estimates were now available using International Bathymetric Chart of the Southern Ocean (IBCSO) data and developed in WG-SAM-15/01. The resulting changes in seabed area in each research block were used to scale the existing catch limits. The Working Group noted that the allocation of catch limits among Members for all the areas (with the exception of Spain) resulted in individual Members with small catch limits within a research block (Table 6).

5.75 Following additional consultations by Australia, the Republic of Korea and Spain, the revised catch limits were tentatively agreed as in Table 6 (noting that France was not involved in these discussions). The Working Group noted that further discussions about the catch arrangements among Members should be deferred to the Scientific Committee and that although many objectives may be specified in the plans, the priority objective is to obtain data needed to develop a stock assessment. The Working Group encouraged further intersessional coordination to optimise the research design.

5.76 The Working Group noted that with the reduction in catch limit resulting from the seabed area adjustment, it was appropriate that the Australian proposal's grid design be modified from a 5 × 5 km grid to a 4 × 4 km grid to enable an entire grid to be completed within the expected catch limit.

5.77 The Working Group noted that the additional in-season adjustment of catch allocation and the need for near real-time coordination will require enhanced communication and coordination by the Secretariat and routine coordination among vessels for the management of small catch limits.

5.78 The Working Group recommended that the proponents further coordinate the operations of their research efforts for all five research plans and that the adjusted catch limits in Table 6 for 2015/16 were appropriate for the current research objectives. The Working Group further recommended that these research plans be well coordinated and that there were opportunities to share data and biological samples to meet research objectives they have in common.

Dissostichus spp. Division 58.4.3a (Elan Bank)

5.79 Papers considered under this item included:

(i) WG-FSA-15/19 and 15/78, describing plans for research in 2015/16 to support the development of a stock assessment for toothfish in this division by Japan and France

(ii) WG-FSA-15/22, describing an updated stock assessment using CASAL.

5.80 The precautionary catch limit for *Dissostichus* spp. in the exploratory fishery in 2015 was 32 tonnes, and fishing was limited to one French and one Japanese flagged vessel using longlines in research block 5843a_1. At the time of updating this report, only the French-flagged vessel had conducted research fishing in Division 58.4.3a and less than 1 tonne of *D. eleginoides* was caught. For 2016, one vessel from France and one from Japan notified their intention to participate in the exploratory fishery for *Dissostichus* spp. in Division 58.4.3a.

5.81 The Working Group noted that the revised assessments have improved relative to those presented at WG-SAM-15. However, the Working Group also noted the very high age at maturity estimated for this area. Work undertaken during the meeting included using the maturity key and parameters for the von Bertalanffy growth curve as used in the

Division 58.5.2 assessment. The Working Group agreed that the stock assessment was currently not sufficiently robust to provide management advice using the CCAMLR decision rules.

5.82 The Working Group recommended that the points noted above for the preliminary assessments of Divisions 58.4.4a and 58.4.4b also be considered for developing assessments for this division. It further recommended that growth and maturity parameters be further developed for this area.

5.83 In the absence of information to update its advice, the Working Group recommended that the catch limit for this division remain unchanged at 32 tonnes for 2015/16.

Dissostichus spp. Divisions 58.4.4a and 58.4.4b (Ob and Lena Banks)

5.84 Papers considered under this item included:

(i) WG-FSA-15/20 and 15/67, describing plans for research in 2015/16 to support the development of a stock assessment for toothfish in research blocks C and D in this division by Japan and France

(ii) WG-FSA-15/21, describing biological information of toothfish with special reference to by-catch, depredation and spawning dynamics in Divisions 58.4.4a and 58.4.4b by the *Shinsei Maru No. 3* (Japan) from 2008 to 2014

(iii) WG-FSA-15/23, describing updated stock assessments using CASAL of the toothfish in research block C.

5.85 The Working Group welcomed the updated assessments. It noted that the revised assessments have improved relative to those presented at WG-SAM-15. Further work was undertaken during the meeting. However, this was unable to be progressed to the point of providing management advice using the CCAMLR decision rules.

5.86 The Working Group further noted that the Ob and Lena Bank area, as many areas in the Convention Area, has been subject to unquantified IUU fishing and, therefore, the relative status of the stock cannot be estimated (paragraphs 5.25 to 5.30).

5.87 In the absence of information to update its advice, the Working Group recommended that the catch limit for this division remain unchanged at 25 tonnes in research block 5844b_1 and 35 tonnes in research block 5844b_2 for 2015/16.

Dissostichus spp. Subarea 88.3

5.88 WG-FSA-15/65 presented a revised three-year research plan for the closed fishery for *Dissostichus* spp. in Subarea 88.3 in 2015/16 by the Republic of Korea. The Working Group noted that the recommendations as set out by WG-SAM (Annex 5, paragraphs 4.20 and 4.21) had been incorporated into the revised research plan.

5.89 The Working Group agreed that the research blocks within Subarea 88.3 should be prioritised. It agreed that the two primary factors that should be taken into account when prioritising research blocks are sea-ice conditions and areas where tagged fish had been released in the past.

5.90 The Working Group noted that research blocks 883_1, 883_3 and 883_4 have historically had more tagged fish released than research block 883_2. The Working Group examined an ice analysis of Subarea 88.3 and noted that research block 883_4 had the least amount of annual sea-ice, followed by research block 883_3 (Figure 3). Research blocks 883_1 and 883_2 appeared to have heavy sea-ice that may restrict access and impede the ability to conduct research.

5.91 The Working Group recommended that the priority for research should be research blocks 883_3 and _4 given the previous tagging in those areas. Research block 883_5 would be a secondary priority, with research blocks 883_1 and _2 a tertiary priority, should ice conditions allow. Dr S.-G. Choi (Republic of Korea) indicated that Korea was not planning to fish in the other research blocks in 2016.

Bottom fishing activities and vulnerable marine ecosystems (VMEs)

6.1 In 2014, the Scientific Committee requested working groups consider how advice could be routinely reported on the potential impacts on dependent and related species for proposed exploratory fisheries in order that the requirements for exploratory fisheries under CM 21-02 can be satisfied and for helping to ensure that fisheries are consistent with Article II (SC-CAMLR-XXXIII, paragraphs 3.154 and 3.155). It also requested Members to submit analyses for consideration (SC-CAMLR-XXXIII, paragraphs 5.8 to 5.10).

6.2 WG-FSA-15/62 Rev. 1 presented a generalised method for rapidly assessing spatial scales of interactions of fishing gear with user-definable ecological features and Antarctic marine living resources. The purpose of the method is to enable automatic and rapid assessments of potential spatial overlap of fishing with ecological features, for example, bioregionalisation categories, attributes of habitats, foraging areas of predators, or spatial distributions of by-catch species. The method is provided in R-markdown and uses standard R libraries for geographical and spatial analyses. It has the following automated method based on the procedures described in WG-FSA-14/P06.

6.3 WG-FSA-15/62 Rev. 1 also provided a preliminary assessment of interactions of bottom fishing with bathymetric features (depth class inside or outside canyons were identified as categories of habitats) in the east Antarctic (Divisions 58.4.1 and 58.4.2) to illustrate the method and a suite of summary statistics on the level and pattern of interactions. Results show that longline activity has occurred in few patches (contiguous areas of a depth class in or out of canyons) and that the proportion of individual patches affected was mostly less than 10% with most categories of habitats having a total interaction of less than 1%. The degree of aggregation of fishing within patches is variable.

6.4 The Working Group thanked the authors for their work and agreed that the method in WG-FSA-15/62 Rev. 1 provides a useful methodology for rapidly undertaking initial assessments of the interaction of fishing with ecological features of importance to CCAMLR. It noted the following:

(i) as in risk assessments globally, the rapid assessment can help identify potential areas of concern and where further research or management actions may be needed

(ii) this method does not replace the impact assessment method adopted for VMEs which calculates the areal extent and likely mortality resulting from possible impacts of longlines on VMEs

(iii) data layers would need to be chosen for their relevance to objectives of the risk assessment

(iv) as the method tabulates the numbers and proportions of grid cells influenced by fishing, it is dependent on the size of grid cells chosen for the analysis – the size of grid cells needs to be set relative to the scale of the interaction expected from the fishing gear in the specific case being examined

(v) inputs, calculations and results would need to be reviewed by relevant working groups as needed if they are to be presented as advice.

6.5 The Working Group agreed that the risk area tables and the maps of accumulated impact should be updated annually as part of the VME registry (SC-CAMLR-XXXIV/BG/02).

Scheme of International Scientific Observation (SISO)

7.1 Data collected by scientific observers on longline and finfish trawl vessels operating in the Convention Area during 2014/15, based on data received up to 9 October 2015 (WG-FSA-15/01 Rev. 1), were presented by the Secretariat. It was noted that seabird by-catch figures were the lowest on record and that the publishing of observer names on the CCAMLR website in an honour roll, as recommended by the SISO review panel, had been completed. The Working Group thanked all SISO observers for their contribution. The Secretariat also requested Members' advice on any format and content changes to the current annual summary paper to better present observer summary information.

7.2 Dr Söffker presented WG-FSA-15/07 on the identification of depredation marks by predator species in Southern Ocean fisheries.

7.3 WG-FSA-15/13 considered options for the hosting of observer by-catch guide information, Members' preferences for reviewing materials submitted to the Secretariat and how currently listed material should be incorporated into any updated guides. There was consensus from the Working Group on the Secretariat hosting a repository for materials. The Working Group recommended:

(i) the Secretariat collate currently available species guides online, and develop and moderate an open e-group/forum for these and any future materials' contents

(ii) the Secretariat will analyse observer data, and develop an ID guide of the most frequent by-catch and target catch taxa for review on the forum

(iii) that materials developed for by-catch identification be kept concise for use in the field by SISO observers and vessel crews.

7.4 Mr Gasco presented a series of developments in the French observer program on better training and identification of seabird species at sea (WG-FSA-15/70 and 15/75), cetacean photo ID catalogues (WG-FSA-15/71), methods to record depredation (WG-FSA-15/72) and a tool for standardised renaming of observer photographs (WG-FSA-15/76). The Working Group welcomed the developments that would potentially be useful for SISO.

7.5 The Working Group noted that the tool for training observers at sea in seabird species identification (WG-FSA-15/75) could easily be expanded to include general observer identification tasks such as by-catch species or gonad stage and has the potential to become a useful tool for use in all CCAMLR subareas within SISO, both as a training tool and as a debriefing tool to evaluate observer data accuracy and quality. The Working Group encouraged its further development and requested that the Scientific Committee consider how this can be progressed.

7.6 Dr Jones gave a short presentation to the Working Group on SC-CAMLR-XXXIV/BG/23 which presents the findings of the Technical Peer Review Group (TPRG) on the submission of the Australian observer program for CCAMLR Observer Training Program Accreditation Scheme (COTPAS) accreditation. The TPRG endorsed the findings of the Secretariat review of the Australian program and recommended the final stage of assessment by the Accredited Review Panel be undertaken. Dr Welsford thanked the members of the TPRG for their work.

Non-target catch in CCAMLR fisheries

Fish and invertebrate by-catch

By-catch

8.1 WG-FSA-15/04 Rev. 1 presented an update to a meta-analysis of by-catch in the Ross Sea toothfish fishery that was considered by WG-SAM-15 (WG-SAM-15/23). Following the presentation of that paper at WG-SAM-15 (Annex 5, paragraphs 2.25 to 2.32), the Secretariat requested via SC CIRC 15/44 information from Members in order to develop a better understanding of how by-catch data are collected and reported on the C2 forms.

8.2 The Working Group noted that the responses received to SC CIRC 15/44 indicated that there are different approaches to fulfilling the CCAMLR data collection and reporting requirements on longline vessels in the Ross Sea. Arising from these differences, there was a distinct relationship between the allocation of the task of data collection for the C2 forms and the relative by-catch rates. In particular, vessels from Flag States where the task of data collection and completion of the C2 forms (either for catch and/or by-catch) is undertaken by observers, have a mean by-catch rate that is approximately 50% lower than those vessels where the task is under the remit of the crew.

8.3 The Working Group thanked Australia, France, Japan, the Republic of Korea, New Zealand, Russia, South Africa, Spain, Ukraine and the UK for providing detailed information in response to SC CIRC 15/44 but noted that not all Members that had participated in

CCAMLR fisheries had provided the requested information. The Working Group wished to draw the attention of the Scientific Committee to the need for all Members to respond to CIRCs requesting information that is essential to the work of CCAMLR.

8.4 The Working Group agreed that data on by-catch in CCAMLR fisheries are fundamental to the aims of Article II of the CAMLR Convention and expressed its concern that these data were not being provided in a way that would allow by-catch levels in those fisheries to be addressed. Furthermore, the apparent lack of consistent reporting of by-catch data has implications for the application and compliance with elements of conservation measures that relate to by-catch, such as move-on rules and overall by-catch limits.

8.5 In considering the apparent inconsistencies in reporting of by-catch, the Working Group recognised that there needs to be a consideration of how the existing data can be used to assess by-catch rates in CCAMLR fisheries, i.e. is it possible to develop some correction factor to account for methodological difference in data collection.

8.6 The Working Group also noted that none of the Members that responded to SC CIRC 15/44 provide instructions to vessels on how the C2 data form should be completed and requested the Scientific Committee to consider how this should be achieved to ensure that reliable and accurate data can be collected and reported in the future.

8.7 In addition to providing a standard set of instructions, the Working Group recognised that there may also need to be a consideration of alternative methods for the collection of catch data, including the use of electronic/video monitoring and automated reporting systems.

8.8 The Working Group recalled that it is the responsibility of the Flag State to comply with catch reporting in conservation measures and not the responsibility of the scientific observer. It further recalled that the role of the scientific observer is to collect data on attributes (such as the fish length, weight, age etc.) of samples from that catch. The Working Group also agreed that it was not possible for observers to collect all data on catch and by-catch and conduct the range of tasks required under SISO. Furthermore, when the responsibility for the collection and reporting of C2 data on the vessel is given to the observer, that undermines the expectation of independence of observer data collected as part of SISO. The Working Group recommended that the issue of inconsistent data in the C2 forms should be directed to SCIC.

8.9 Dr Kasatkina highlighted the importance to develop a detailed manual on by-catch sampling throughout CCAMLR longline fisheries. She noted that there should be a clear understanding on how by-catch data should be collected and reported in practice. She proposed that the draft manual should be submitted for consideration by WG-SAM and WG-FSA.

8.10 WG-FSA-15/50 presented results from recent work on updating biological parameters of *C. rhinoceratus* in Division 58.5.2. The updated parameters were then used to calculate two-year and 35-year projections of *C. rhinoceratus* biomass under continuous fishing pressure as by-catch in the *C. gunnari* and toothfish trawl fishery. These calculations showed that a maximum yield of 2 208 tonnes for 2015/16 and 1 689 tonnes for 2016/17 would meet the CCAMLR decision rules in the short term. For the long-term projection, a maximum yield of 1 663 tonnes per year would meet the decision rules. These estimated limits were not expected to be reached as CM 33-02 prohibits directed fishing for *C. rhinoceratus* in

Division 58.5.2. The paper further recommended that a limit based on 1% of the biomass estimate from the survey stratum with the lowest density of *C. rhinoceratus* would be appropriate to set as a trigger level for *C. rhinoceratus* move-on rules. This would change the trigger level from 2 tonnes to 5 tonnes in Division 58.5.2.

8.11 The Working Group recommended that the move-on rule trigger limit be changed from 2 tonnes to 5 tonnes for *C. rhinoceratus* in Division 58.5.2.

8.12 The Working Group concluded that the short-term projections were consistent with the CCAMLR decision rules. After thorough examination of the long-term projections in relation to biomass estimates, the Working Group also concluded that the suggested 1 663 tonne maximum catch limit for *C. rhinoceratus* satisfied both CCAMLR decision rules and would not put the stock at risk over the projected period, thus the by-catch limit in CM 33-02 should be revised accordingly.

8.13 The Working Group recalled that the three strategies for dealing with by-catch within CCAMLR are to firstly avoid, secondly mitigate and, should these first two strategies fail, finally to develop risk assessments and that this paper formed part of that risk assessment. The Working Group stressed that this risk assessment was only an option that would be used if strategies for avoidance and mitigation failed and that it was unlikely that this maximum limit would not be taken as a by-catch of the fisheries within the projection period. A regular review of the risk assessment was suggested.

8.14 The Working Group noted that a scientific analysis and review of by-catch level limits set in exploratory research blocks should be encouraged.

8.15 WG-FSA-15/51 presented an update on the biological parameters of the grey rockcod (*Lepidonotothen squamifrons*) in Division 58.5.2. The improved ageing estimates indicated an increase in the maximum age to 24 years. Three populations with distinct geographical distribution were found in the division.

8.16 The Working Group welcomed the paper and the updated biological parameters of this formerly exploited species. The results from this initial work indicated slow but steady stock recovery, although at different rates within the three identified geographical populations. This apparent heterogeneity of the subpopulations is consistent with previous observations in this species such as highlighted in Gregory et al. (2014) for Subarea 48.3.

8.17 In WG-FSA-15/63 the biological parameters of the grenadier species *M. caml* were updated based on recent (2015) survey and longline by-catch data in Division 58.5.2. The paper presented a risk assessment for the longline by-catch, derived from a GYM for this by-catch species based on the trawl survey.

8.18 The Working Group commended the effort to scientifically evaluate the currently set by-catch limits for Macrouridae in Division 58.5.2 and noted that an assessment similar to that presented here for *M. caml* was currently not possible for the remaining macrourid species due to lack of biological data. As *M. caml* formed the vast majority of Macrouridae in the trawl survey, this species was brought through a full risk assessment, however, the remaining species were rarely caught in the survey and thus biological data was not available in sufficient quantity.

8.19 The Working Group noted that although the majority of Macrouridae caught in the trawl survey was *M. caml*, the composition of by-catch in the longline fishery is uncertain. Data from a single longline trip estimated that most Macrouridae by-caught were bigeye grenadier (*M. holotrachys*), and that *M. caml* contributed a small proportion to the longline by-catch. The Working Group thus raised concerns as to whether the maximum yield calculated for *M. caml* based on the trawl survey could be applied directly to all Macrouridae caught in the longline fishery in addition to 150 tonnes for non-identified *Macrourus* spp., given the difficulty in identifying individuals to species in this taxon.

8.20 The Working Group noted that, although the identification to species in Macrouridae is known to be difficult (see WG-FSA-02/29), the distinction into the two morphs comprising sister species is possible for crew reporting C2 data. The two morphs comprise *M. caml* and Whitson's grenadier (*M. whitsoni*) in one group, and *M. holotrachys* and ridge-scaled grenadier (*M. carinatus*) in the second group.

8.21 The Working Group reviewed the new assessment based on *M. caml* in Division 58.5.2 and compared it to the previous assessment derived from estimates of *M. carinatus* from Division 58.4.3b (SC-CAMLR-XXII, Annex 5, paragraphs 5.244 to 5.249). It concluded that the previous assessment is applicable to *M. carinatus* and its sister species *M. holotrachys* due to the likely latitudinal separation of the two grenadier morph groups, and the low likelihood that sister species *M. caml* or *M. whitsoni* were misidentified in this survey.

8.22 The Working Group agreed that the use of locally estimated life history parameters for a given by-catch species was more appropriate than the use of globally derived parameters of similar species. The Working Group agreed that the risk assessment shows no current risk to *M. caml* as by-catch in the longline fishery in Division 58.5.2. The Working Group further agreed that the long-term projections for *M. caml* under the proposed maximum catch limit of 409 tonnes would satisfy both CCAMLR decision rules.

8.23 Following the review of the risk assessment presented in WG-FSA-15/63 and the previous assessment in SC-CAMLR-XXII, Annex 5, paragraphs 5.244 to 5.249, the Working Group recommended that the maximum by-catch limit for grenadiers in Division 58.5.2 in 2015/16 be set separately for the two morphs. The limit derived from the risk assessment in WG-FSA-15/63 of 409 tonnes should apply for *M. caml* and *M. whitsoni* combined and the limit derived from the previous assessment in SC-CAMLR-XXII, Annex 5, paragraphs 5.244 to 5.249, of 360 tonnes should apply for *M. holotrachys* and *M. carinatus* combined. The morph-specific limits proposed for 2015/16 should be reviewed at WG-FSA as new by-catch information becomes available.

8.24 Stressing that the aim for by-catch management is primarily avoidance and mitigation, the Working Group noted that existing by-catch mitigation methods should be reviewed if the catch limits set for by-catch are regularly reached.

8.25 The Working Group encouraged future work planned by the authors on by-catch of *Macrourus* species representation in the Division 58.5.2 longline fishery including:

(i) historic catch composition based on genetic identification of archived otoliths

(ii) morph-specific catch composition and spatial distribution within the Division 58.5.2 longline fishery in 2015/16

(iii) validation of observer identification based upon genetic identification of otoliths collected within the Division 58.5.2 longline fishery in 2015/16.

8.26 The Working Group agreed that the change of the move-on trigger level to 3 tonnes per line for all species combined as *Macrourus* spp. is appropriate in Division 58.5.2 and should be revised accordingly in CM 33-02.

8.27 The Working Group noted the issue of autolines connected by floating sections of rope as shown in Figure 7 of WG-FSA-08/60. Each section of fishing line from anchor to anchor is currently recorded as single line in the C2 data. There is concern that this is being used as a method of circumventing the by-catch trigger level.

8.28 The Working Group recommended a review of the definition of a set line to the Scientific Committee in order for by-catch levels to be recorded and move-on rules be triggered appropriately.

Marine mammal and seabird by-catch

8.29 Australia presented WG-FSA-15/48 regarding a review of results from fishing during the season extension trials in 2013/14 and 2014/15. The paper detailed that 2.4 million hooks have been set during the season extension between 15 and 30 April, that the majority of setting occurred at night, and that one seabird was caught during the season extension trial. Australia proposed to extend the step-wise pre-season trial to include 1 to 14 April with both day and night setting allowed. The proposed criteria for assessing the effectiveness of mitigation during the new season extension are that at least 500 000 hooks have been set during daylight, with a cumulative total seabird catch not exceeding three birds per vessel over this period. Similarly, Australia proposed that a post-season extension trial continue under the condition that no more than three seabirds are caught from 500 000 hooks set in the period 15 to 30 November. If the limit of three by-caught birds per vessel is reached in either season extension, the trial will be terminated.

8.30 The Working Group noted that the recent experience of a single high seabird by-catch incident in Subarea 48.3 during the season extension trial in early April suggests that birds may be more vulnerable during this period and recalled the suggestion made in WG-FSA-14/28 to avoid setting in daylight and within three hours of nautical dusk/dawn where possible. Therefore, if this is also found to be the case in Division 58.5.2, then additional mitigation, such as night setting only, may be required in the season extension.

Biology and ecology of Antarctic fish

9.1 WG-FSA-15/08 described an initiative to monitor *D. mawsoni* movement and habitat preferences in the Ross Sea utilising pop-up archival (MiniPAT) tags deployed in January 2016 on fish within the General Protection Zone (GPZ) and Special Research Zone (SRZ) in the Ross Sea Region MPA proposal (CCAMLR-XXXIV/29).

9.2 The Working Group welcomed this initiative and was looking forward to receiving first results of this study in 2017.

9.3 From 2001 to 2013, the number of breeding pairs of Adélie penguins (*Pygoscelis adeliae*) at breeding colonies in the southern Ross Sea more than doubled from 235 000 to more than half a million. WG-FSA-15/41 tested the hypothesis that predation release of Antarctic silverfish (*Pleuragramma antarctica*) due to fishing of one of its predators, *D. mawsoni*, could have contributed to this increase.

9.4 The analysis in WG-FSA-15/41 found only a weak link between changes in toothfish biomass and changes to the biomasses of silverfish and Adélie penguins. Even if toothfish diet was composed of 100% silverfish, it was still not sufficient to explain the observed increase in the number of Adélie penguins in the southern Ross Sea.

9.5 WG-FSA-15/41 encouraged the development of further specific hypothesis mechanisms by which fishing could affect the wider Ross Sea ecosystem. The paper considered that understanding the ecosystem effects of the toothfish fishery on the demersal fish community of the Ross Sea slope, and on Weddell seals and Type C killer whales, is of high priority.

9.6 The Working Group noted that WG-EMM had considered WG-EMM-15/53 at its 2015 meeting (see Annex 6, paragraphs 2.89 and 2.90) and that the updated paper was provided to WG-FSA for information.

9.7 The Working Group noted that the biomass of silverfish was derived from acoustic observations during the 2008 International Polar Year (IPY) survey in the Ross Sea.

9.8 WG-FSA-15/46 described age determination conducted on *D. eleginoides* and *D. mawsoni* using otoliths collected during the scientific program on board the Ukrainian vessel *Simeiz* in Subarea 48.2 in 2015. Preliminary results of age determinations suggested that individuals of 15 to 35 years prevailed for both species. The Working Group welcomed this data from an area which had previously not been studied for toothfish and noted how rapidly ageing information had been made available.

9.9 WG-FSA-15/57 provided detailed information on the diet and feeding strategy of *D. mawsoni* in Divisions 58.4.1 and 58.4.2. Macrouridae were the dominant prey item in the size classes (121–140, 141–160 and 161–180 cm). Results underlined results from earlier studies that *D. mawsoni* is an opportunistic predator feeding overwhelmingly on fish.

9.10 The Working Group noted the value of such detailed studies which included the occurrence of a petrel and a penguin foot. The Working Group was reluctant to speculate where those were originating from. An apparent misidentification was *G. blacodes*, but see paragraph 2.37.

9.11 *P. antarctica* is the dominant pelagic fish in the continental shelf waters of the high Antarctic region where it plays a key role in the food web. A monitoring program was launched by Italy to obtain a better understanding of the first phases of life of *P. antarctica*. It also allowed obtaining new information on life cycle of *P. antarctica* and their early development stages. Links to toothfish ecology, under the ice, and how it relates to *P. antarctica* were drawn. DNA mapping to identify spawning grounds were undertaken (WG-FSA-15/58 and 15/61).

9.12 The Working Group underlined the key position of *P. antarctica* in the high-Antarctic food webs. As such, the species had been initially considered as a species for the CCAMLR Ecosystem Monitoring Program (CEMP). The Working Group also noted that a book is currently in preparation in Italy summarising the results of a wide range of studies on *P. antarctica* in various regions around the Antarctic continent. A number of scientists from CCAMLR Members are contributing to the book.

9.13 WG-FSA-15/06 reported preliminary age determination of *D. mawsoni* from Division 58.4.1. Comparative age readings suggest that results did not differ substantially from those of other readers such as Horn et al. (2003). Age ranged from 5+ to 26+ years. A set of reference otoliths will be made available to the authors intersessionally. Validation experiments will be continued in 2016 by comparative readings by four readers.

9.14 The Working Group recommended that the authors continued cross reading of the same set of otoliths with other laboratories to continue validation of the age readings. The high proportion of otoliths considered to be unreadable was higher than in other studies and may have been caused by readers being relatively inexperienced in reading *D. mawsoni* otoliths. Growth of males and females was found to be similar while the age of males and females of *D. eleginoides* started to diverge after attaining sexual maturity, with females growing faster and attaining a greater L_{∞}.

Future work

10.1 The Chair of the Scientific Committee drew the attention of the Working Group to SC-CAMLR-XXXIV/14 that presented a summary from each of the conveners of the priorities for each working group for the next four years. This paper is intended to provide the basis of the discussion at the Scientific Committee on the prioritisation and streamlining of its work.

10.2 In respect of the priorities for WG-FSA, the Convener of WG-FSA clarified that they remained the provision of advice on the assessed fisheries and the development of assessments in other management areas where research was currently being undertaken. He also noted that the process of biennial review of assessments should provide greater scope to review other priority issues. In particular, he highlighted the very important discussions surrounding many aspects of by-catch, from the reporting of data, the application of limits and move-on rules and the assessment of status of by-catch species. He also emphasised the cross-cutting nature of fish by-catch in the krill fishery and the potential for a joint meeting of WG-FSA and WG-EMM to address the theme of by-catch in all CCAMLR fisheries.

10.3 The Working Group agreed that the potential scope of work that could be undertaken was very broad and there was a need to manage expectations of the ability to undertake work and deliver results in a timely a manner. In progressing the work identified as important during this meeting, there was a need to identify a single issue for focus topics, noting that there are long lists of possibilities and to ensure that an appropriate sequence of tasks is put in place to maximise delivery of advice.

10.4 The Working Group agreed that it was important to identify those areas of its work where there was a standing expectation of advice to the Scientific Committee, such as on

catch limits in fisheries, in order to ensure that these issues can continue to be delivered in addition to addressing those important cross-cutting issues such as by-catch, depredation, tagging and toothfish diet that had been identified by WG-FSA.

Review and coordination of research plans

10.5 The Working Group recognised the benefit of performing a focused review of one or two specific research plans next year to assess the status of data relative to informing an assessment, to develop an overall data collection plan for the management area and to set specific milestones for future work conducted under the research plan. Subarea 48.6 and Division 58.4.4 were considered to be potentially suitable regions for a focused review at WG-FSA-16. The Working Group agreed that the outcomes of such a review would assist with developing data collection plans in all closed and exploratory fisheries in the following year.

10.6 The Working Group noted the importance of survey coordination. It noted that Members nominate chief scientists for their survey proposals and that coordination among Members could be facilitated by establishing an e-group for chief scientists involved in multi-Member surveys.

External activities in support of CCAMLR

10.7 Dr Constable informed the Working Group of a number of activities that would be of interest to the Working Group and the Scientific Committee in the coming year:

(i) Southern Ocean Observing System (SOOS)

SOOS has developed a strategic and implementation plan now available for comment (www.soos.aq). A number of elements of this plan, which were reported to WG-EMM, will be of use to CCAMLR (WG-EMM-15/61; Annex 6, paragraphs 5.12 to 5.14). Members of the Working Group are encouraged to participate in the work of SOOS to develop essential variables for monitoring change in biota, such as for habitats, krill, finfish and predators (CEMP) and to participate in regional working groups as appropriate.

(ii) Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED)

ICED is developing end-to-end ecosystem models to support management of marine ecosystems. They have been undertaking stakeholder consultations (with WWF and the krill fishing industry), developing agreed climate change and ocean acidification scenarios for use in evaluating ecosystem changes for the future and developing a toolbox of models for use by the scientific community to explore the implications of these scenarios and recovery of whales, seals and fish for Antarctic marine ecosystems as a whole. Part of their work is oriented towards models that facilitate evaluation of management strategies, such as for krill, and the consequences for human kind of long-term change in Antarctic marine ecosystems.

10.8 A conference on assessing status and trends of habitats, key species and ecosystems in the Southern Ocean will be held in Hobart, Australia, in the first half of 2018 (SC-CAMLR-XXXIV/BG/22). It has four main themes:

(i) assessments
(ii) responses of species to changing habitats
(iii) modelling and other methods for assessing status and trends
(iv) design and implementation of an observing system to estimate dynamics and change.

These themes are of direct relevance to CCAMLR. Members are encouraged to be involved in the working groups supporting these themes over the coming two years. This work aims to support the Scientific Committee on Antarctic Research Advisory Group on Antarctic Climate Change and the Environment (SCAR ACCE) and the Intergovernmental Panel on Climate Change (IPCC) processes and also provide scientific input on species and ecosystems to CCAMLR and the Committee on Environmental Protection (CEP).

Other business

11.1 Dr R. Leslie (South Africa) drew the attention of the Working Group to WG-SAM-15/51, which proposes a change to the boundary between Subareas 58.6 and 58.7 and the Working Group noted that boundaries for management areas should delineate stocks rather than split them.

Advice to the Scientific Committee and its working groups

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

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

(i) Information requirements –

(a) capacity and catch limit overruns (paragraph 3.9)

(b) quarantined data (paragraphs 3.14 and 3.15)

(c) marine debris (paragraph 3.23)

(d) release of live untagged toothfish (paragraph 3.26)

(e) VMS data quality assurance (paragraph 3.32)

(f) conversion factors (paragraph 3.36)

(g) IUU fishing (paragraphs 3.46 and 3.47).

(ii) Assessed fisheries –

(a) *C. gunnari* in Subarea 48.3 (paragraph 4.6)

(b) *C. gunnari* in Division 58.5.2 (paragraph 4.12)

(c) *D. eleginoides* in Subarea 48.3 (paragraph 4.37)

(d) *D. eleginoides* in Subarea 48.4 (paragraphs 4.20 and 4.21)

(e) *D. mawsoni* in Subarea 48.4 (paragraphs 4.25 and 4.28)

(f) *D. eleginoides* in Division 58.5.1 (paragraph 4.43)

(g) *D. eleginoides* in Division 58.5.2 (paragraphs 4.56 and 4.57)

(h) *D. eleginoides* in Subarea 58.6 at Crozet Islands (paragraph 4.48)

(i) *D. eleginoides* at Prince Edward and Marion Islands (no advice)

(j) *Dissostichus* spp. in Subarea 88.1 (paragraphs 4.68, 4.70, 4.76, 4.77, 4.79, 4.81, 4.84 and 4.92)

(k) *Dissostichus* spp. in Subarea 88.2 SSRUs A–B north (paragraphs 4.99, 4.106 and 4.107)

(l) *Dissostichus* spp. in Subarea 88.2 SSRU A south (paragraph 4.114)

(m) general advice on stock assessment (paragraphs 4.116 and 4.117).

(iii) Generic issues with research plans to inform current and future assessments in 'data-poor' fisheries –

(a) research plans (paragraph 5.14)

(b) mark-recapture data analysis (paragraphs 5.17, 5.22 and 5.24).

(iv) Management area research plan reviews for –

(a) *Dissostichus* spp. in Subarea 48.6 (paragraphs 5.61 and 5.65)

(b) *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2 (paragraph 5.78)

(c) *Dissostichus* spp. in Division 58.4.3a (paragraph 5.83).

(v) Research fishing in other areas –

(a) *Dissostichus* spp. in Subarea 48.2 (no advice)

(b) *Dissostichus* spp. in Subarea 48.5 (paragraph 5.50)

(c) *Dissostichus* spp. in Divisions 58.4.4a and 58.4.4b (paragraph 5.87)

(d) *Dissostichus* spp. in Subarea 88.3 (paragraph 5.91).

(vi) Scheme of International Scientific Observation –

(a) hosting observer by-catch guide and related information (paragraphs 7.3i–iii)

(b) observer training at sea (paragraph 7.5).

(vii) By-catch –

(a) coordination between WG-EMM and WG-SAM (paragraph 3.4)

(b) fish and invertebrate by-catch reporting (paragraphs 8.3, 8.6 and 8.8)

(c) Division 58.5.2 and proposed modifications to CM 33-02 (paragraphs 8.11, 8.12, 8.23 and 8.26)

(d) review of 'set line' definition to aid move-on rule triggers (paragraph 8.28).

Adoption of the report

13.1 The report of the meeting was adopted.

Close of meeting

14.1 In closing the meeting, Dr Belchier thanked all the participants for their contributions to constructive engagement in the Working Group's work and the subgroup coordinators who had led discussions on a range of difficult and lengthy issues. He also thanked the rapporteurs and the Secretariat for their support to the work of WG-FSA-15.

14.2 On behalf of the Working Group, Dr Jones thanked Dr Belchier for his leadership in steering the Working Group through a large, and at times challenging, work program and thanked him for the leadership he had provided over four years of serving as WG-FSA Convener.

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Horn, P.L., C.P. Sutton and A.L. DeVries. 2003. Evidence to support the annual formation of growth zones in otoliths of Antarctic toothfish (*Dissostichus mawsoni*). *CCAMLR Science*, 10: 125–138.

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Mormede, S., A. Dunn, S. Hanchet and S. Parker. 2014. Spatially explicit population dynamics models for Antarctic toothfish in the Ross Sea region. *CCAMLR Science*, 21: 19–37.

Welsford, D.C. 2011. Evaluating the impact of multi-year research catch limits on overfished toothfish populations. *CCAMLR Science*, 18: 47–55.

Table 1: Total reported catches (tonnes) of target species in fisheries in the Convention Area in 2014/15 (to 16 September 2015 unless otherwise indicated, refer to the *Statistical Bulletin* for previous years). CM – conservation measure.

Target species	Region	CM	Catch (tonnes) of target species		Reported catch (% limit)
			Limit	Reported	
Champsocephalus gunnari	48.3	42-01	2 659	277	10
	58.5.2[a]	42-02	309	4	1
Dissostichus eleginoides	48.3	41-02	2 400	2 195	91
	48.4	41-03	42	42	100
	58.5.1 French EEZ[a]	n/a	5 100	2 884	57
	58.5.2[a]	41-08	4 410	2 530	57
	58.6 French EEZ[a]	n/a	760	433	57
	58 South African EEZ[b]	n/a	575	205	46
Dissostichus mawsoni	48.4	41-03	28	28	100
Dissostichus spp.	48.6	41-04	538	189	35
	58.4.1	41-11	724	123	17
	58.4.2	41-05	35	11	31
	58.4.3a	41-06	32	<1	2
	58.4.3b	41-07	0	-	-
	88.1	41-09	2 844[c]	2 724	96
	88.2	41-10	819[c]	733	90
Euphausia superba	48.1, 48.2, 48.3, 48.4	51-01	620 000	221 048	36
	58.4.1	51-02	440 000	No fishing	-
	58.4.2	51-03	452 000	No fishing	-

[a] Reported in fine-scale data to July 2015.
[b] Whole EEZ.
[c] Including the limit and catch from the research surveys.
n/a Not specified by CCAMLR.

Table 2: *Dissostichus eleginoides* (estimated green weight) reported in Catch Documentation Scheme (CDS) fisheries operating outside the Convention Area in the calendar years 2013 to 2015 (to September 2015, refer to the *Statistical Bulletin* for previous years).

Ocean sector	FAO Area	Catch (tonnes)		
		2013	2014	2015
Southwest Atlantic	41	8 004	8 757	5 282
Southeast Atlantic	47	60	26	103
Western Indian	51	324	118	102
Eastern Indian	57	-	-	-
Southwest Pacific	81	421	424	334
Southeast Pacific	87	4 212	2 785	2 156
Total		13 021	12 110	7 977

Table 3: Notifications for exploratory fisheries for *Dissostichus* spp. in 2015/16 as of 5 October 2015 (www.ccamlr.org/en/fishery-notifications/notified).

Vessel name	Member	Division 58.4.1	Division 58.4.2	Subarea 88.1	Subarea 88.2	Subarea 48.6	Division 58.4.3a
Antarctic Chieftain	Australia	N	N	N	N		
Globalpesca II	Chile					N	
Saint André	France	N	N				N
Shinsei Maru No. 3	Japan	N	N	N		N	N
Kingstar	Korea, Republic of	N	N				
Sunstar	Korea, Republic of			N	N		
Kostar	Korea, Republic of			N	N		
Janas	New Zealand			N	N		
San Aotea II	New Zealand			N	N		
San Aspiring	New Zealand			N	N		
Orion	New Zealand			W	W		
Argos Helena	Norway			W	W		
Yantar 33	Russian Federation			N	N		
Mys Marii	Russian Federation			W	W		
Yantar 31	Russian Federation			N	N		
Palmer	Russian Federation			N	N		
Mys Velikan	Russian Federation			W	W		
Koryo Maru No. 11	South Africa					N	
Tronio	Spain	N	N	N	N		
Yanque	Spain			N	N		
Koreiz	Ukraine			N	N		
Simeiz	Ukraine			N	N		
Argos Froyanes	United Kingdom			N	N		
Argos Georgia	United Kingdom			N	N		
Total Members		5	5	9	8	3	2
Total vessels		5	5	20	19	3	2
Total fished							
Total withdrawn				4	4		

Legend: N = notified
W = withdrawn
F = fished

Table 4: Proposals for research fishing for *Dissostichus* spp. in closed areas in 2015/16.

Vessel name	Member	Meeting document	Subarea 48.2	Subarea 48.5	Subarea 88.3	Division 58.4.4b
Puerto Ballena	Chile	WG-FSA-15/10	✓			
Saint André	France	WG-FSA-15/67				✓
Shinsei Maru No. 3	Japan	WG-FSA-15/20				✓
Greenstar	Korea, Republic of	WG-FSA-15/65			✓	
Yantar 31	Russia	WG-FSA-15/29		✓		
Simeiz	Ukraine	WG-FSA-15/45	✓			

Table 5: Sequence of steps and skills required to develop stock assessments through targeted research fishing.

Step	Type of work	Skills required
Develop stock structure hypothesis	Desktop	Biologist and ecologist
Design survey proposal	Desktop	Statistician
Collect biological data (e.g. age, growth, maturity, density)	At-sea	Observer/biologist
Collect data on dependant and related species	At-sea	Skipper/observer
Acquire tagging data for abundance index	At-sea	Skipper/observer
Describe fishery (spatial and temporal patterns, tag data)	Desktop	Analyst
Develop indicative estimates of local biomass	Desktop	Modeller
Develop draft stock assessment	Desktop	Modeller
Collect more data	At-sea	Observer/skipper
Iterate to improve assessment, review	Desktop	Modeller
Identify sources of bias, uncertainty	Desktop	Modeller/ecologist
Develop medium-term research plan	Desktop	Biologist/statistician/modeller

Table 6: Adjusted proposed catch limit (in tonnes) allocations among Members after scaling for the change in seabed area using the IBCSO data (based on WG-SAM-15/64). AUS – Australia; FRA – France; JPN – Japan; KOR – Republic of Korea; ESP – Spain.

Division	SSRU	2014 catch limits	AUS	FRA	JPN	KOR	ESP	Total
58.4.1	C	180	34	34	34	34	42	178
	D	42					42	42
	E	260	65	65	65	65	-	260
	G	51	0	0	0	9	42	51
	H	42					42	42
58.4.2	E	32	32	0	0	0	-	32
Total		607	131	99	99	108	168	605

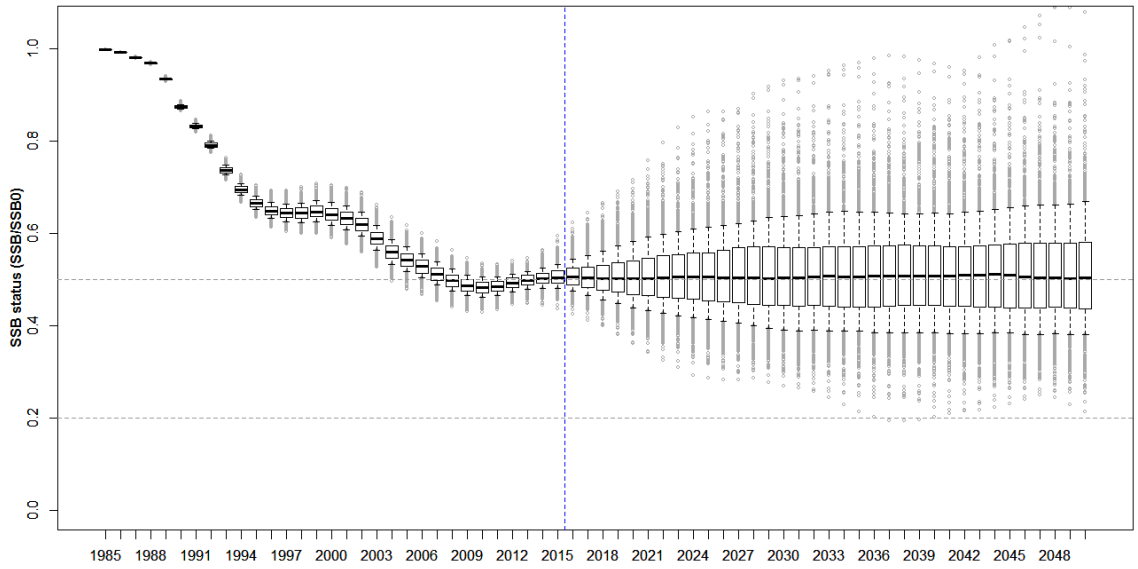


Figure 1: *Dissostichus eleginoides* in Subarea 48.3 SSB status estimated by the model described in WG-FSA-15/59. Dashed horizontal lines show a status of 0.5 and 0.2.

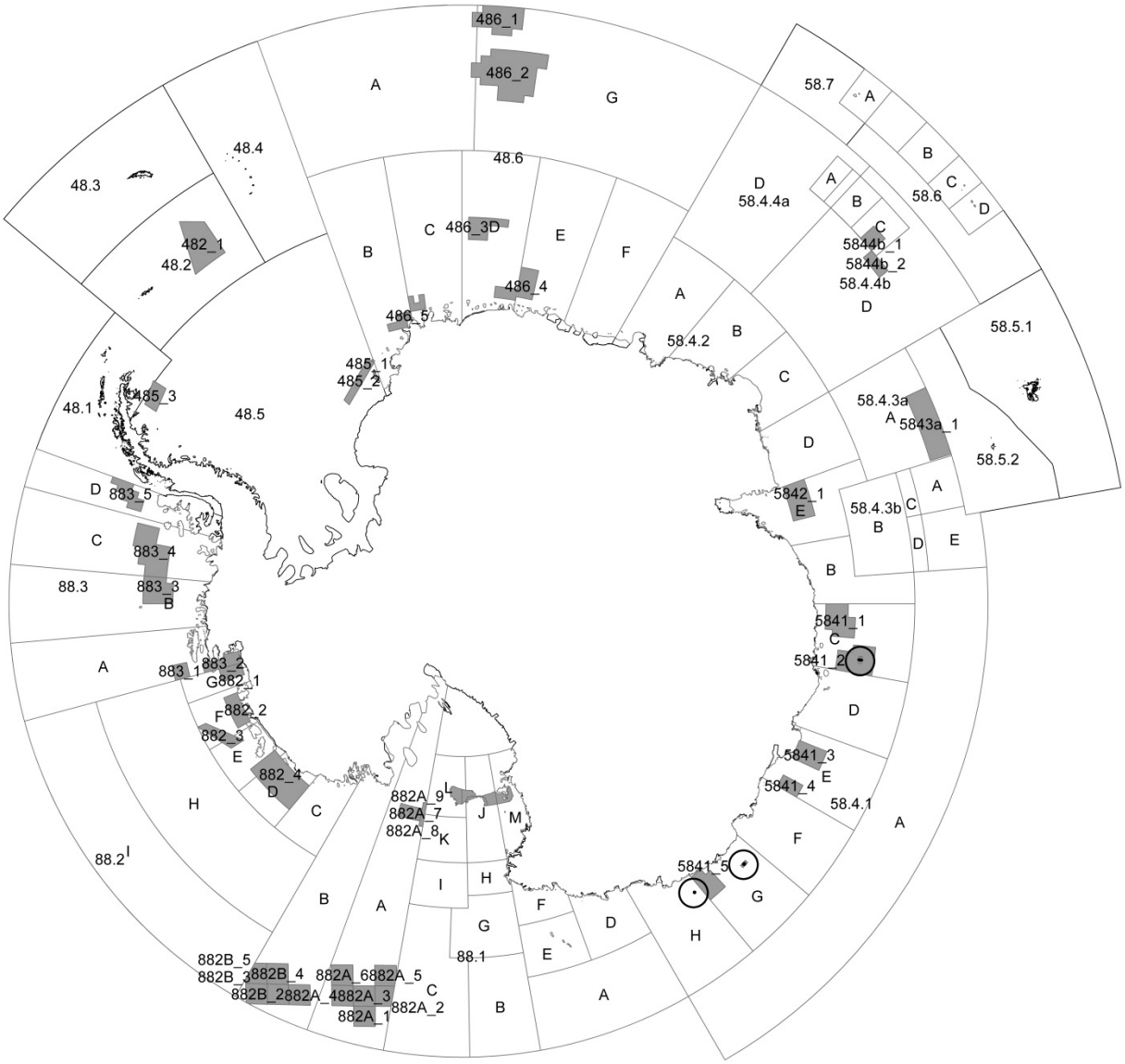


Figure 2: Location of research blocks where research fishing is proposed in exploratory fisheries for *Dissostichus* spp. and closed areas in 2015/16. The circles in Division 58.4.1 indicate the locations of the depletion experiments and stratified grids in SSRUs C and D, and the depletion experiment in SSRU H. The exploratory fisheries are located in Subareas 48.6, 88.1 and 88.2 and Divisions 58.4.1, 58.4.2 and 58.4.3a. The boundaries of small-scale research units (SSRUs) are also shown.

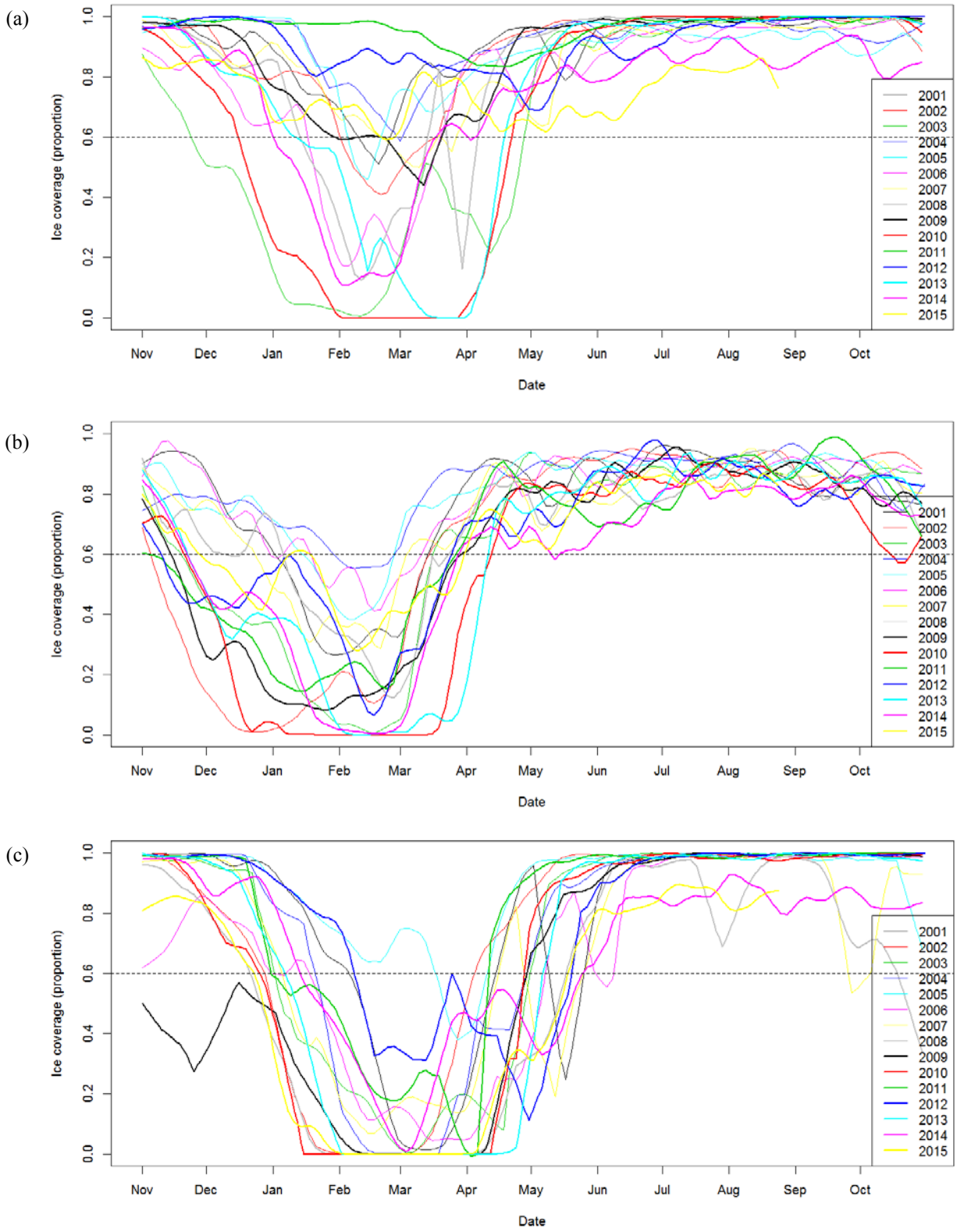
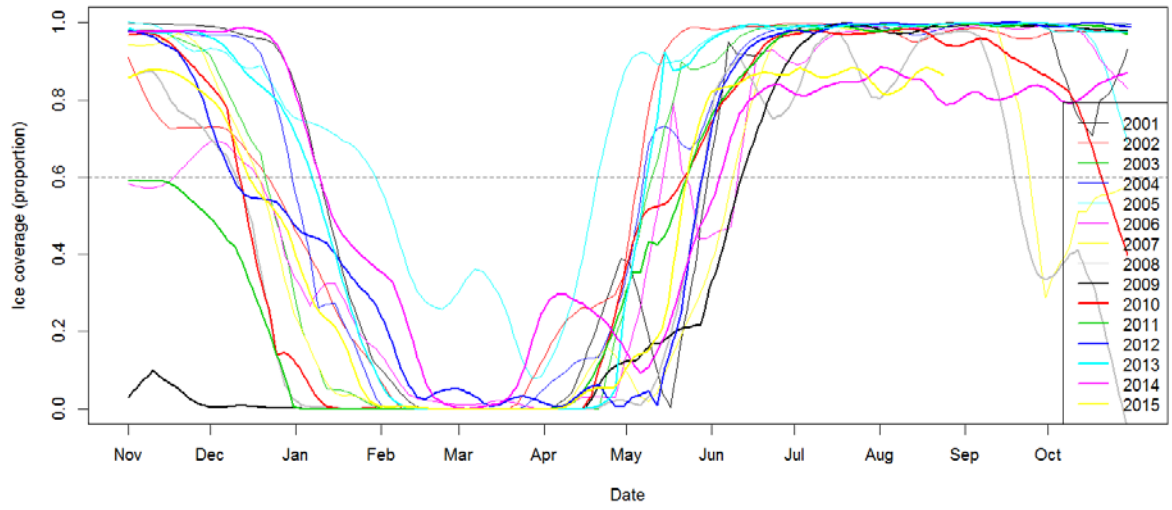


Figure 3: Daily mean sea-ice concentration within research blocks (a) 883_1, (b) 883_2 and (c) 883_3 in Subarea 88.3 (see Figure 2) for fishing years from 2001 to 2015. A threshold of 60% sea-ice concentration was considered to be the maximum level of navigable sea-ice observed for fishing vessels in the Ross Sea, although fishing typically occurs in areas with less than 15% ice coverage (WG-FSA-14/54).

(continued)

(d)



(e)

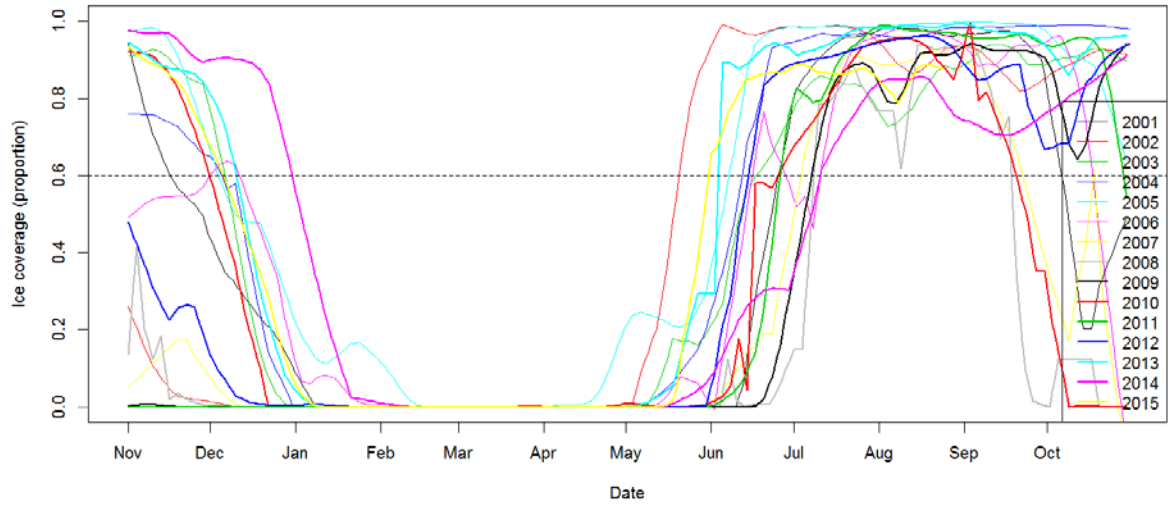


Figure 3 (continued): Daily mean sea-ice concentration within research blocks (d) 883_4 and (e) 883_5 in Subarea 88.3 (see Figure 2) for fishing years from 2001 to 2015. A threshold of 60% sea-ice concentration was considered to be the maximum level of navigable sea-ice observed for fishing vessels in the Ross Sea, although fishing typically occurs in areas with less than 15% ice coverage (WG-FSA-14/54).

Appendix A

List of Participants

Working Group on Fish Stock Assessment
(Hobart, Australia, 5 to 16 October 2015)

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Appendix B

Agenda

Working Group on Fish Stock Assessment
(Hobart, Australia, 5 to 16 October 2015)

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

3. Review of available information (all fisheries)

4. Stock assessments for fisheries for *Dissostichus eleginoides* in Subareas 48.3 and 48.4 and Division 58.5.2, for *D. mawsoni* in Subarea 48.4, for *Dissostichus* spp. in Subareas 88.1 and 88.2 and for *Champsocephalus gunnari* in Subarea 48.3 and Division 58.5.2

    4.1 Assessment by management area
        4.1.1 *Champsocephalus gunnari* Subarea 48.3
        4.1.2 *Champsocephalus gunnari* Division 58.5.2
        4.1.3 *Dissostichus eleginoides* Subarea 48.4
        4.1.4 *Dissostichus mawsoni* Subarea 48.4
        4.1.5 *Dissostichus eleginoides* Subarea 48.3
        4.1.6 *Dissostichus eleginoides* Division 58.5.1
        4.1.7 *Dissostichus eleginoides* Subarea 58.6 (French EEZ)
        4.1.8 *Dissostichus eleginoides* Division 58.5.2
        4.1.9 *Dissostichus* spp. Subarea 88.1
        4.1.10 *Dissostichus* spp. Subarea 88.2

    4.2 Model diagnostics
    4.3 Fishery Reports

5. 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

    5.1 Generic issues
    5.2 Management area research reviews
        5.2.1 *Dissostichus* spp. Subarea 48.2
        5.2.2 *Dissostichus eleginoides* Subarea 48.5
        5.2.3 *Dissostichus* spp. Subarea 48.6
        5.2.4 *Dissostichus* spp. Division 58.4.1
        5.2.5 *Dissostichus* spp. Division 58.4.2
        5.2.6 *Dissostichus* spp. Division 58.4.3
        5.2.7 *Dissostichus* spp. Division 58.4.4
        5.2.8 *Dissostichus* spp. Subarea 88.3

5.3 Fishery Reports
5.3.1 *Dissostichus* spp. Division 58.4.3b

6. Bottom fishing activities and vulnerable marine ecosystems (VMEs)

7. Scheme of International Scientific Observation

8. Non-target catch in CCAMLR fisheries

8.1 Fish and invertebrate by-catch
8.2 Marine mammal and seabird by-catch

9. Biology, ecology and interactions in fish-based ecosystems

10. Future work

10.1 Organisation of intersessional activities in subgroups
10.2 Intersessional meetings
10.3 Notification of Scientific Research

11. Other business

12. Advice to Scientific Committee

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

Appendix C

List of Documents

Working Group on Fish Stock Assessment
(Hobart, Australia, 5 to 16 October 2015)

WG-FSA-15/01 Rev. 1	Summary of scientific observer data collected in the CAMLR Convention Area during 2015 Secretariat
WG-FSA-15/02	A review of conversion factors used in CCAMLR toothfish fisheries Secretariat
WG-FSA-15/03	Update on the redevelopment of the CCAMLR database Secretariat
WG-FSA-15/04 Rev. 1	A meta-analysis of by-catch in the Ross Sea toothfish fishery Secretariat
WG-FSA-15/05	Continuation in the 2015/16 season of the research plan initiated in 2012/13 for stocks of *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2 R. Sarralde, L.J. López-Abellán and S. Barreiro (Spain)
WG-FSA-15/06	Contribution to knowledge on age and growth of Antarctic toothfish (*Dissostichus mawsoni*) from Division 58.4.1 L.J. López-Abellán, M.T.G. Santamaría, R. Sarralde and S. Barreiro (Spain)
WG-FSA-15/07	A short guide to the identification of fish, cephalopod and marine mammal depredation marks on Patagonian and Antarctic toothfish in the Southern Ocean longline fisheries V. Laptikhovsky (United Kingdom), A. Remeslo (Russia), J. Brown (United Kingdom), O. Kasnoborod'ko (Russia), N. Gasco (France) and M. Söffker (United Kingdom)
WG-FSA-15/08	Initiative to monitor Antarctic toothfish movement and habitat preferences using satellite pop-up tags C. Jones (USA)
WG-FSA-15/09	Measurement of capacity in CCAMLR exploratory fisheries in Subareas 88.1 and 88.2: Secretariat update 2015 Secretariat

WG-FSA-15/10	Revised research longline fishing proposal for *Dissostichus* spp. in Subarea 48.2 Delegation of Chile
WG-FSA-15/11	The annual random stratified trawl survey in the waters of Heard Island (Division 58.5.2) to estimate the abundance of *Dissostichus eleginoides* and *Champsocephalus gunnari* for 2015 G.B. Nowara, T.D. Lamb and D.C. Welsford (Australia)
WG-FSA-15/12 Rev. 1	A preliminary assessment of mackerel icefish (*Champsocephalus gunnari*) in Division 58.5.2, based on results from the 2015 random stratified trawl survey D.C. Welsford (Australia)
WG-FSA-15/13	Considerations for the hosting of by-catch identification guides for scientific observers Secretariat
WG-FSA-15/14	Status of WG-SAM reviews of research plans and research proposals and recommendations for streamlining Convener of WG-SAM and Chair of the Scientific Committee
WG-FSA-15/15	Report on the CCAMLR marine debris monitoring program Secretariat
WG-FSA-15/16 Rev. 1	Revised research plan for the 2015/16 exploratory longline fishery of *Dissostichus* spp. in Subarea 48.6 Delegation of Japan
WG-FSA-15/17	Revised research plan for the 2015/16 exploratory longline fishery of *Dissostichus* spp. in Division 58.4.1 Delegation of Japan
WG-FSA-15/18	Revised research plan for the 2015/16 exploratory longline fishery of *Dissostichus* spp. in Division 58.4.2 Delegation of Japan
WG-FSA-15/19	Revised research plan for the 2015/16 exploratory longline fishery of *Dissostichus* spp. with special reference to the information on spawning dynamics in Division 58.4.3a Delegation of Japan
WG-FSA-15/20	Revised research plan for toothfish in Division 58.4.4b by *Shinsei Maru No. 3* in 2015/16 Delegation of Japan

WG-FSA-15/21	Reports on biological information of toothfish with special reference to bycatch, depredation and spawning dynamics in Division 58.4.4 a & b by *Shinsei maru No. 3* during 2008–14 seasons K. Taki and T. Ichii (Japan)
WG-FSA-15/22	Revised assessment models for Patagonian toothfish in research block 58.4.3a_1 of Division 58.4.3a, Elan Bank for the years 2005–2014 K. Taki (Japan), S. Mormede (New Zealand) and T. Ichii (Japan)
WG-FSA-15/23	Revised assessment models for Patagonian toothfish in research block 58.4.4b_1 (SSRU 58.4.4bC) for the years 1990–2014 K. Taki (Japan), S. Mormede (New Zealand) and T. Ichii (Japan)
WG-FSA-15/24	Proposed expansion of research block 48.6_4 for more reliable stock assessment T. Ichii, T. Namba (Japan), D.C. Welsford (Australia) and K. Taki (Japan)
WG-FSA-15/25	Assessment of mackerel icefish *Champsocephalus gunnari* in CCAMLR Statistical Subarea 48.3 based on the 2015 demersal fish survey T. Earl and C. Darby (United Kingdom)
WG-FSA-15/26	Configuration of the FP-120 net used on UK groundfish surveys in CCAMLR Subarea 48.3 (South Georgia) M. Belchier, L. Featherstone and J. Oliver (United Kingdom)
WG-FSA-15/27	Research program on resource potential and life cycle of *Dissostichus* species from the Subarea 88.2 A in 2015–2018 Delegation of the Russian Federation
WG-FSA-15/28	An integrated stock assessment of Patagonian toothfish (*Dissostichus eleginoides*) in CCAMLR Subarea 48.4 M. Söffker, V. Laptikhovsky, T. Earl and C. Darby (United Kingdom)
WG-FSA-15/29	Plan of research program of the Russian Federation in Subarea 48.5 Delegation of the Russian Federation
WG-FSA-15/30	Report of the UK groundfish survey at South Georgia (CCAMLR Subarea 48.3) in January 2015 M. Belchier, S. Gregory, N. Fallon, J. McKenna, S. Hill, M. Söffker (United Kingdom), P. Lafite (South Africa) and L. Featherstone (United Kingdom)

WG-FSA-15/31	Preliminary tag-recapture based population assessment of Antarctic toothfish in Subarea 48.4 N.D. Walker, V. Laptikhovsky, T. Earl and C. Darby (United Kingdom)
WG-FSA-15/32	Results of the 2015 multi-Member longline survey for toothfish in the northern Ross Sea region (Subarea 88.2 SSRUs A–B) and proposal for 2016 operations S.J. Parker, R.J.C. Currey (New Zealand), M. Söffker, C. Darby (United Kingdom), O. Godø (Norway) and A. Petrov (Russia)
WG-FSA-15/33	A proposal for a standardised survey for Antarctic toothfish in McMurdo Sound S.J. Parker, S.M. Hanchet and S. Mormede (New Zealand)
WG-FSA-15/34	Revised proposal to continue the time series of research surveys to monitor abundance of Antarctic toothfish in the southern Ross Sea, 2016 and 2017 S.M. Hanchet, S.J. Parker, S. Mormede and R.J.C. Currey (New Zealand)
WG-FSA-15/35	Quantifying the impacts of ice on demersal longlining in CCAMLR Subarea 88.1 with updated information on the 2014/15 season J.M. Fenaughty and S.J. Parker (New Zealand)
WG-FSA-15/36	A characterisation of the toothfish fishery in Subareas 88.1 and 88.2 from 1997–98 to 2014–15 K. Large, S.M. Hanchet and S. Mormede (New Zealand)
WG-FSA-15/37	Descriptive analysis of the toothfish (*Dissostichus* spp.) tagging programme in Subareas 88.1 & 88.2 for the years 2000–01 to 2014–15 S.J. Parker and S. Mormede (New Zealand)
WG-FSA-15/38	Assessment models for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region for the years 1997–98 to 2014−15 S. Mormede, A. Dunn and S.M. Hanchet (New Zealand)
WG-FSA-15/39	Diagnostic plots of stock assessment models for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region for the years 1997–98 to 2014–15 S. Mormede, A. Dunn and S.M. Hanchet (New Zealand)
WG-FSA-15/40	Draft updated data collection plan for the Ross Sea toothfish fishery S.M. Hanchet, S.J. Parker and S. Mormede (New Zealand)

WG-FSA-15/41	Predation release of Antarctic silverfish in the Ross Sea: how sensitive is the conclusion to uncertainties in the diet of Antarctic toothfish over the shelf? M.H. Pinkerton, P. O'B. Lyver, D.W. Stevens, J. Forman, R. Eisert and S. Mormede (New Zealand)
WG-FSA-15/42	Using spatial population models to investigate the effects of a proposed Marine Protected Area on Antarctic toothfish in the Ross Sea region S. Mormede, A. Dunn, S.J. Parker and S.M. Hanchet (New Zealand)
WG-FSA-15/43 Rev. 1	Report on the survey in Subarea 48.2 in 2015 (the first year of the planned 3-year-old investigations) Delegation of Ukraine
WG-FSA-15/44	A review of tag-based stock assessments of the Antarctic toothfish *Dissostichus mawsoni* in Subarea 48.4 N. Walker, M. Söffker, V. Laptikhovsky and T. Earl (United Kingdom)
WG-FSA-15/45	Plan of research program of the Ukraine in Subarea 48.2 in 2016 (second season) Delegation of Ukraine
WG-FSA-15/46	Preliminary results of age determination of the *Dissostichus* spp. from the longline catches in 48.2 Subarea (2015, SIMIIZ) Delegation of Ukraine
WG-FSA-15/47 Rev. 1	Research plan for exploratory fishing for toothfish (*Dissostichus* spp.) in East Antarctica (Divisions 58.4.1 and 58.4.2) by Australia Delegation of Australia
WG-FSA-15/48	Season extensions in the longline fishery for *Dissostichus eleginoides* in Statistical Division 58.5.2 J. Barrington and T. Lamb (Australia)
WG-FSA-15/49	Quantifying uncertainty in the Chapman mark-recapture estimate of abundance P. Burch (Australia), S. Parker (New Zealand) and D. Welsford (Australia)
WG-FSA-15/50	An updated assessment of unicorn icefish (*Channichthys rhinoceratus*) in Division 58.5.2, based on results from the 2015 random stratified trawl survey D. Maschette and J. Dell (Australia)

WG-FSA-15/51	Exploring age and growth dynamics of a historically overfished Sub-Antarctic fish species: The grey rockcod (*Lepidonotothen squamifrons*) in the vicinity of Heard Island and McDonald Island D. Maschette, D.C. Welsford and C. Gardner (Australia)
WG-FSA-15/52	An integrated stock assessment for the Heard Island and the McDonald Islands Patagonian toothfish (*Dissostichus eleginoides*) fishery in Division 58.5.2 P. Ziegler and D. Welsford (Australia)
WG-FSA-15/53	Spatial and temporal patterns of sperm whale (*Physeter macrocephalus*) depredation on Australian longline vessels in the Patagonian toothfish (*Dissostichus eleginoides*) fishery at Heard Island and McDonald Islands (CCAMLR Division 58.5.2) D.C. Welsford and R. Arangio (Australia)
WG-FSA-15/54	Proposed allocation of research catches in Divisions 58.4.1 and 58.4.2 D.C. Welsford (Australia), R. Sarralde Vizuete (Spain) and T. Ichii (Japan)
WG-FSA-15/55	Updated description of Patagonian toothfish (*Dissostichus eleginoides*) tagging and ageing programs in Division 58.5.2, 1997–2015 D.C. Welsford, B. Farmer, T.D. Lamb, C. Péron, E. Woodcock and P.E. Ziegler (Australia)
WG-FSA-15/56	Revised research plan for the exploratory longline fishery for *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2 in 2015/16 Delegation of the Republic of Korea
WG-FSA-15/57	Diet composition and feeding strategy of Antarctic toothfish, *Dissostichus mawsoni* in the research blocks 58.4.2-1, 58.4.1-2, 58.4.1-3, 58.4.1-4, and 58.4.1-5 for the exploratory longline fishery in 2014/2015 of Korea Delegation of the Republic of Korea
WG-FSA-15/58	Towards an all year round monitoring the Antarctic silverfish nursery area in the Ross Sea L. Ghigliotti, E. Pisano, E. Carlig (Italy), J.H. Kim, T. Choi (Republic of Korea) and M. Vacchi (Italy)
WG-FSA-15/59	Assessment of the Patagonian Toothfish (*D. eleginoides*) in Subarea 48.3 T. Earl, M. Söffker and C. Darby (United Kingdom)

WG-FSA-15/60	Model diagnostics for the Antarctic krill assessment for Subarea 48.1 D. Kinzey, G.M. Watters and C.S. Reiss (USA)
WG-FSA-15/61	Identification of *Pleuragramma antarctica* larvae in the Ross Sea via mitochondrial DNA J.A. Caccavo (Italy), C. Brooks (USA), L. Zane (Italy) and J.R. Ashford (USA)
WG-FSA-15/62 Rev. 1	Method for rapidly assessing spatial scale of interactions of fishing gear with habitats and Antarctic marine living resources A. Constable, M. Sumner, J. Melbourne-Thomas and D. Welsford (Australia)
WG-FSA-15/63	Biology, population dynamics and preliminary assessment of the long-term yield of *Macrourus caml* by-caught by the Australian fishery at Heard Island and the McDonald Islands (CCAMLR Division 58.5.2) J. Dell, D. Maschette, E. Woodcock and D. Welsford (Australia)
WG-FSA-15/64	Modelling the circumpolar distribution of Antarctic toothfish (*Dissostichus mawsoni*) habitat suitability using correlative species distribution modelling methods Secretariat
WG-FSA-15/65	Revised research plan for the exploratory longline fishery for *Dissostichus* spp. in Statistical Subarea 88.3 in 2015/16 Delegation of the Republic of Korea
WG-FSA-15/66	Summary of data collected by Japan and South Africa in Subarea 48.6 between 2013 and 2015, and other statistics available for assessment of *Dissostichus* spp. in Subarea 48.6. R.W. Leslie (South Africa), K. Taki, T. Ichii (Japan) and S. Somhlaba (South Africa)
WG-FSA-15/67	Research plan for the exploratory longline fishery for *Dissostichus* spp. in 2015/16 in Division 58.4.4 A. Rélot-Stirnemann (France)
WG-FSA-15/68	Updated stock assessment of Patagonian toothfish (*Dissostichus eleginoides*) in the vicinity of Kerguelen Islands (Division 58.5.1) R. Sinegre and G. Duhamel (France)
WG-FSA-15/69	Updated assessment of Patagonian toothfish (*Dissostichus eleginoides*) in the vicinity of Crozet Islands (Subarea 58.6) R. Sinegre and G. Duhamel (France)

WG-FSA-15/70	New bird guide for observers at sea in southern Indian Ocean N. Gasco, K. Delord and C. Barbraud (France)
WG-FSA-15/71	New photo-identification catalogues from Crozet and Kerguelen Islands P. Tixier, N. Gasco and C. Guinet (France)
WG-FSA-15/72	Technical guide to collect data related to depredation on board longline vessels N. Gasco, P. Tixier and C. Guinet (France)
WG-FSA-15/73	Revised research plan for the exploratory longline fishery for *Dissostichus* spp. in 2015/16 in Division 58.4.1 A. Rélot-Stirnemann (France)
WG-FSA-15/74	Revised research plan for the exploratory longline fishery for *Dissostichus* spp. in 2015/16 in Division 58.4.2 A. Rélot-Stirnemann (France)
WG-FSA-15/75	Identification self training for observers N. Gasco and A. Martin (France)
WG-FSA-15/76	PiNT – a tool for renaming observer photographs at sea N. Gasco, C. Chazeau, P. Tixier (France), C. Heinecken (South Africa), J. Clark and M. Söffker (United Kingdom)
WG-FSA-15/77	Conversion Factors used for Patagonian toothfish in Division 58.5.1. and Subarea 58.6 N. Gasco (France)
WG-FSA-15/78	Revised research plan for the exploratory longline fishery for *Dissostichus* spp. in 2015/16 in Division 58.4.3a A. Rélot-Stirnemann (France)
Other Documents	
WG-FSA-15/P01	Have Antarctic toothfish returned to McMurdo Sound? S.J. Parker, S. Mormede, A.L. DeVries, S.M. Hanchet and R. Eisert *Ant. Sci.* (2015), doi: 10.1017/S0954102015000450
CCAMLR-XXXIV/07	Analysis of live untagged toothfish release Secretariat
CCAMLR-XXXIV/17 Rev. 1	Review of the CCAMLR regulatory framework and recommendations for streamlining fishery status Chair of the Scientific Committee

CCAMLR-XXXIV/32	Combatting IUU fishing in the Southern Ocean: international cooperation and information sharing Delegation of New Zealand
CCAMLR-XXXIV/37	IUU fishing activity and trends in 2014/15 and IUU Vessel Lists Secretariat
CCAMLR-XXXIV/BG/02	Implementation of conservation measures in 2014/15: fishing and related activities Secretariat
CCAMLR-XXXIV/BG/03	Fishery notifications 2015/16 Secretariat
CCAMLR-XXXIV/BG/10	Discharge of offal in the Ross Sea – follow up to COMM CIRC 15/15–SC CIRC 15/06 Secretariat
CCAMLR-XXXIV/BG/18	Analysis of catch and effort data from the IUU fishing vessel *Kunlun* Delegation of Australia
CCAMLR-XXXIV/BG/19	Status Report – Macquarie Island Toothfish Fishery Delegation of Australia