Annex 7

Report of the Working Group
on Fish Stock Assessment
(Hobart, Australia, 3 to 12 October 2016)

Contents

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Opening of the meeting

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 3 to 12 October 2016. The Convener, Dr D. Welsford (Australia), opened the meeting and welcomed participants (Appendix A). As this meeting of WG-FSA was slightly shorter than previous meetings, Dr Welsford encouraged all participants to engage in discussion and where differences of views existed that these be presented as different testable hypotheses rather an simply as statements of positions.

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

Organisation of the meeting and adoption of the agenda

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

- non-target catch in CCAMLR fisheries
- setting appropriate catch limits for research activities involving toothfish
- methods for the analysis of toothfish catch data.

Dr Welsford reminded the Working Group that, while some of the work of the meeting may be considered in subgroups, all substantive discussions, and particularly discussions leading to advice to the Scientific Committee, would be conducted in plenary.

2.2 The Working Group reviewed and adopted the agenda with the addition of an item dealing with assessments and management advice for toothfish in Subareas 48.3 and 58.6 and Divisions 58.5.1 and 58.5.2 (Appendix B).

2.3 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.

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

2.5 The report was prepared by M. Belchier (UK), P. Burch (Australia), P. Brewin and C. Darby (UK), N. Gasco (France), S. Hanchet (New Zealand), C. Jones and D. Kinzey (USA), K.-H. Kock (Germany), K. Large (New Zealand), D. Maschette (Australia), D. Ramm, K. Reid and L. Robinson (Secretariat), M. Söffker (UK), S. Somhlaba (South Africa) and P. Yates (Australia).

Review of all available information and stock assessments for fisheries

IUU activities

3.1 The Secretariat presented WG-FSA-16/24 that provided area-specific information on illegal, unreported and unregulated (IUU) activity that could be incorporated into the relevant fishery reports so that stock assessment results can be presented with information on IUU fishing activity (SC-CAMLR-XXXIV, paragraph 6.5).

3.2 The Working Group welcomed the fishery-specific updates on IUU activity and agreed that these should be included in the relevant Fishery Reports.

3.3 The Working Group noted that there has been an increase in the detection of IUU activities in Subarea 48.6 in the last three years, in particular in research block 486_3 in the area on Maud Rise, that included both unknown vessels sightings and the recovery of gillnet gear. The Working Group also noted the first evidence of IUU fishing from Subarea 48.2 reported by Ukraine who recovered gillnet gear during research fishing in March 2016.

3.4 Ms S. Lenel (Secretariat) also updated the Working Group on the ongoing investigation of IUU catch recovered from the vessel *Andrey Dolgov* (see COMM CIRCs 16/47, 16/54, 16/62 and 16/77) that had been identified as Antarctic toothfish (*Dissostichus mawsoni*) and so was, therefore, likely to have come from within the Convention Area (however, also see paragraph 3.102 on the occurrence of *D. mawsoni* in the South Pacific Regional Fisheries Management Organisation (SPRFMO) area).

Champsocephalus gunnari in Subarea 48.3 and Divisions 58.5.1 and 58.5.2

C. gunnari South Georgia (Division 48.3)

3.5 The fishery for mackerel icefish (*Champsocephalus gunnari*) in Subarea 48.3 operated in accordance with Conservation Measure (CM) 42-01 and associated measures. In 2015/16, the catch limit for *C. gunnari* was 3 461 tonnes. Fishing early in the season was conducted by one vessel using midwater trawls and the total reported catch was 2 tonnes as of 14 September 2016. Details of this fishery and the stock assessment of *C. gunnari* are contained in the Fishery Report.

3.6 The Working Group noted that catches of *C. gunnari* in Subarea 48.3 are usually higher in the second half of the season, and that lack of catch at the beginning of the season results from low effort exerted by the fishery. The Working Group also noted that the vertical distribution of *C. gunnari* has been shown to be highly dependent on krill availability in this subarea. The low observed catch is likely due to low catchability of *C. gunnari* by midwater gear, rather than a change in stock abundance in 2015/16.

3.7 Details of the stock assessment for *C. gunnari* in Subarea 48.3 for 2015/16 and 2016/17 are provided in WG-FSA-15/25 Rev. 1. The catch limits calculated from the assessment for *C. gunnari* in Subarea 48.3 were 3 461 tonnes for 2015/16 and 2 074 tonnes for 2016/17 (SC-CAMLR-XXXIV, paragraph 3.103 and CCAMLR-XXXIV, paragraph 5.19).

3.8 The Working Group agreed that a catch limit for *C. gunnari* in Subarea 48.3 of 2 074 tonnes for 2016/17 be carried forward.

C. gunnari Kerguelen Islands (Division 58.5.1)

3.9 A short-term assessment of *C. gunnari* in Division 58.5.1 was conducted after the 2015 icefish-specific biomass survey PIGE (PoIsson des GlacEs) (WG-FSA-16/53). The assessment was implemented using the generalised yield model (GYM). A bootstrap procedure was applied to the survey data to estimate the demersal biomass of *C. gunnari* in this division. The bootstrap estimated the mean demersal biomass at 130 336 tonnes for the northeast shelf and 0 tonnes for the Skiff Bank, with a one-sided lower 95% confidence interval of 58 781 tonnes for the northeast shelf. The CCAMLR harvest control rule, which ensures 75% biomass escapement after a two-year projection period, yielded a catch limit of 8 278 tonnes for 2015/16 and 6 701 tonnes for 2016/17. A second projection that considered one year of fishing only, yielded a catch limit of 14 474 tonnes in 2016/17.

3.10 The Working Group noted that the area in the south of the survey strata appears to have consistently higher catch rates across the three POKER surveys (WG-FSA-14/07) and the more recent PIGE survey and recommended a stratification of the northeast shelf stratum in future.

3.11 Upon reviewing the PIGE survey data, the Working Group noted that there was one large haul which appeared to be unduly influencing the bootstrap biomass estimates. The Working Group suggested that the assessment be revised, with this haul excluded, consistent with the approach performed in Subarea 48.3 in 2013 which showed that the bootstrap biomass estimates were highly sensitive to the inclusion of the single high-abundance station (SC-CAMLR-XXXII, Annex 6, paragraph 4.3).

3.12 The revised short-term assessment of *C. gunnari* in Division 58.5.1 was conducted. A bootstrap procedure was applied to the survey data after the removal of the high-abundance haul to re-estimate the demersal biomass of *C. gunnari* in this division. The bootstrap estimated the mean demersal biomass at 81 302 tonnes for the northeast shelf and 0 tonnes for the Skiff Bank, with a one-sided lower 95% confidence interval of 49 268 tonnes for the northeast shelf. The harvest control rule, which ensures 75% biomass escapement after a two-year projection period, yielded a catch limit of 6 938 tonnes for 2015/16 and 5 618 tonnes for 2016/17. A second projection that considered one year of fishing only in 2016/17, yielded a catch limit of 12 130 tonnes.

3.13 The Working Group noted that the 2015 estimated biomass for the northeast shelf is over 10 times higher than that estimated from the previous three surveys (2006, 2010 and 2013). The Working Group noted that this result may not be unusual as abundance of *C. gunnari* tends to be highly variable. The Working Group also noted that a 10-fold increase in estimated biomass had occurred in Division 58.5.2 between 2008 and 2009 (WG-FSA-09/33).

3.14 Dr S. Kasatkina (Russia) noted that it is necessary to use an acoustic survey for clarifying the vertical distribution of *C. gunnari* in relation to the traditional trawl survey method. The existence of pelagic fish will result in an underestimation of fish biomass where only the demersal biomass is sampled.

3.15 The Working Group requested that the Scientific Committee seek clarification from France as to whether there would be a fishery for *C. gunnari* in Division 58.5.1 in the 2016/17 CCAMLR season.

C. gunnari Heard Island (Division 58.5.2)

3.16 The fishery for *C. gunnari* in Division 58.5.2 operated in accordance with CM 42-02 and associated measures. In 2015/16, the catch limit for *C. gunnari* was 482 tonnes. Fishing was conducted by one vessel and the total reported catch up to 14 September 2016 was 469 tonnes. Details of this fishery and the stock assessment of *C. gunnari* are contained in the Fishery Report.

3.17 The Working Group noted that Australia has undertaken a random stratified trawl survey in Division 58.5.2 during April 2016 (WG-FSA-16/23). It noted that the calculated density of Patagonian toothfish (*Dissostichus eleginoides*) was half that of 2015 but similar to that of the long-term average for the survey. The *C. gunnari* density was five times that of 2015 and nearly three times the average. For the managed by-catch species, catch rates were lower than the average for macrourids, close to average for unicorn icefish (*Channichthys rhinoceratus*) and only one-third the average for grey rockcod (*Lepidonotothen squamifrons*). Conversely, the density of aggregated skates was higher than both 2015 and the long-term average. The catch of invertebrates in the 2016 survey was two times higher than average, due in part to the greater abundance of jellyfish, which was almost five times higher than average. Data for *C. gunnari* from this survey were included in the preliminary assessment for *C. gunnari* (WG-FSA-16/26) in Division 58.5.2.

3.18 The Working Group noted the usefulness of providing side-by-side length-frequency plots for Divisions 58.5.1 and 58.5.2 to investigate whether the higher catch rates of *C. gunnari* in both areas could be indicative of a single recruitment event across the area (Figure 1).

3.19 The Working Group considered that it was difficult to determine whether there was a single recruitment event in Divisions 58.5.1 and 58.5.2 from the one year of data as shown in Figure 1 and that further investigation of comparative trends in length frequencies of catches of *C. gunnari* in these divisions over time would be useful.

3.20 A short-term assessment of *C. gunnari* in Division 58.5.2 was conducted using data from the random stratified trawl survey in Division 58.5.2 during April 2016 (WG-FSA-16/23). The cohort structure was determined using CCAMLR's mixture analysis (CMIX) procedure with the best fit to the survey length distribution achieved when the population was estimated to consist of five components, i.e. year classes 1+ to 5+, with the 2+ cohort containing the largest number of fish. A GYM provides a stock projection using a one-sided lower 95% confidence bound of total biomass of 3 955 tonnes of age 1+ to 3+ fish from the 2016 survey and fixed model parameters.

3.21 Estimates of yield indicated that 561 tonnes of *C. gunnari* could be taken in 2016/17 and 402 tonnes in 2017/18, allowing 75% escapement of biomass after two years.

3.22 The Working Group recommended that the Scientific Committee consider a catch limit for *C. gunnari* in 2016/17 of 561 tonnes and of 402 tonnes in 2017/18.

Dissostichus spp. in Subareas 48.3, 48.4, 88.1 and 88.2

Dissostichus eleginoides in Subarea 48.3

3.23 The fishery for *D. eleginoides* in Subarea 48.3 operated in accordance with CM 41-02 and associated measures. In 2015/16, the catch limit for *D. eleginoides* was 2 750 tonnes. Fishing was conducted by six vessels using longlines and the total reported catch was 2 195 tonnes. Details of this fishery and the stock assessment are contained in the Fishery Report.

Management advice

3.24 The catch limit for 2016/17, as specified in CM 41-02, is 2 750 tonnes.

D. eleginoides in Subarea 48.4

3.25 The fishery for *D. eleginoides* in Subarea 48.4 operated in accordance with CM 41-03 and associated measures. The catch limit for *D. eleginoides* in Subarea 48.4 in 2015/16 was 47 tonnes. The total reported catch by two vessels was 41 tonnes. Details of this fishery and the stock assessment of *D. eleginoides* are contained in the Fishery Report.

Management advice

3.26 The catch limit in CM 41-03 for *D. eleginoides* for 2016/17 is from a biennial assessment (SC-CAMLR-XXXIV, paragraph 3.116) and, accordingly, would remain at 47 tonnes.

D. mawsoni in Subarea 48.4

3.27 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 2015/16 was 39 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.

3.28 WG-FSA-16/39 reported on the distribution of fishing and tag releases during 2015/16 and the results of the Chapman tag-based biomass estimate. Fishing occurred throughout the island chain with a predominance in the southeast on one seamount, which resulted in tag releases and recaptures coming mainly from that area in 2016. While the concentration of tags in one area can result in an underestimation bias, the authors noted that at present, the aggregation of recaptures in 2016 did not drive the results of the biomass estimation and the impact of this bias was considered to be low due to the short time of residency of the tags in the area.

3.29 In 2016, 22 tags were recaptured, of which 8 were within-year recaptures, 12 from the previous year and 1 each from the 2014 and 2013 releases. The biomass estimate for *D. mawsoni* in Subarea 48.4 was calculated first using the tag population method agreed at WG-FSA-15 (SC-CAMLR-XXXIV, Annex 7, paragraphs 4.22 to 4.27) and then limiting tag availability to three years at liberty as agreed at WG-SAM-16 for other *D. mawsoni* population estimates where the populations are located around seamounts (Subareas 48.6 and 88.2) (Annex 5, paragraph 2.28).

3.30 The Working Group noted that the observed short residence time for tagged *D. mawsoni* on the seamounts in Subarea 48.4 is similar to other *D. mawsoni* seamount stocks, and endorsed the limitation of tag availability to three years in the population estimation for *D. mawsoni* in Subarea 48.4.

3.31 The calculation 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 population estimates across years, a geometric mean of the relatively short time series was used as the basis for the final stock abundance of 1 000 tonnes. At a harvest rate of $\gamma = 0.038$, this would indicate a 2016/17 yield of 38 tonnes for *D. mawsoni* in Subarea 48.4.

3.32 The Working Group noted that the short residence time for tags on the seamounts implied that, similar to other *D. mawsoni* stocks, the Subarea 48.4 fish caught on these seamounts most likely represents part of a wider stock. The Working Group also noted that it is, therefore, important to gather additional data to enable the development of a stock hypothesis for this region and, consequently, that the proposed longline survey (see WG-FSA-16/40 Rev. 1) should be a high priority. The Working Group noted that the collection of such information is outlined within the survey plan submitted in WG-FSA-16/40 Rev. 1, which sets out to evaluate the potential links of the Subarea 48.4 *Dissostichus* spp. to the wider area.

Management advice

3.33 The Working Group recommended that the catch limit for *D. mawsoni* in Subarea 48.4 should be set at 38 tonnes for 2016/17 based on the results of this analysis.

Dissostichus spp. in Subarea 88.1

Capacity

3.34 WG-FSA-16/05 presented an update of the metrics of capacity and capacity utilisation initially 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 updated metrics show the same pattern as the metrics based on the data up to 2016 and do not indicate an excess capacity in the fishery. As indicated previously, based on a measure of potential daily fishing capacity and the catch limit for an area, the notified fishing capacity in some management areas is in excess of the level that would allow the Secretariat to forecast and issue a timely closure notice using the current fishery forecasting procedure.

3.35 The Working Group noted that, while it was evident that an excess capacity would occur if all vessels that notified for some fisheries arrived simultaneously, this situation had not occurred to date potentially because fewer vessels fished than had notified.

3.36 The current method for subarea catch forecasting and closure notification was considered to be adequate for the current fishery dynamics. Small overruns have occurred in recent years in some small-scale research units (SSRUs), but the overall catch limit for the stock has not been exceeded and, therefore, risk of stock over-exploitation has not been increased.

3.37 Nevertheless, the Working Group noted that it was important to maintain the monitoring of the capacity trends and highlight potential situations where an excess of fishing capacity might make closure forecasting difficult. For instance, overcapacity could be an issue in areas with small catch limits, high catch variability, and where substantial numbers of vessels enter simultaneously. The Working Group agreed that the Secretariat should monitor the number of vessels notifying and then subsequently fish in a subarea in each year, in order to follow any increasing capacity trend that would indicate that the current monitoring procedure is likely to be put under stress.

3.38 Dr Kasatkina noted that opening of closed areas in the offshore areas of Subarea 88.1 would help to spread the fishery wider within the subarea and reduce the potential of reaching overcapacity in the inshore fishery.

3.39 Dr Kasatkina further noted that only after the opening of all closed SSRUs, the analysis of real situation on reaching overcapacity in the fishery should be provided. She recalled that Russia provided this proposal to the Scientific Committee and Commission (CCAMLR-XXXIV, paragraph 5.41; SC-CAMLR-XXXIV, paragraph 3.201; SC-CAMLR-XXXII/06).

3.40 The Working Group noted that opening of the other SSRUs was a matter for the Commission on advice from the Scientific Committee, and WG-FSA and the Scientific Committee had previously provided advice on the spatial management of the area, including the potential for opening offshore areas.

3.41 The Working Group noted that opening closed SSRUs would not address the potential problem of a large number of vessels notifying for specific SSRUs and thus creating a situation of overcapacity on a smaller scale than that of the subarea.

Dissostichus spp. in Subarea 88.1

3.42 The exploratory fishery for *D. mawsoni* in Subarea 88.1 operated in accordance with CM 41-09 and associated measures. In 2015/16, the catch limit for *Dissostichus* spp. was 2 870 tonnes, including 40 tonnes set aside for the Ross Sea shelf survey and 100 tonnes set aside for the Ross Sea winter survey. Fishing was conducted by 13 vessels using longlines, and the total reported catch was 2 684 tonnes. Details of this fishery and the stock assessment are contained in the Fishery Report.

Ross Sea shelf survey

3.43 The Working Group noted that a report on the results of the 2016 Ross Sea shelf survey and proposal for a survey in 2017 had been presented to WG-SAM (WG-SAM-16/16).

3.44 The Working Group recalled the advice last year by the Scientific Committee (SC-CAMLR-XXXIV, paragraph 3.190) and Commission (CCAMLR-XXXIV, paragraph 5.34) that the survey be continued in 2017 with a catch limit of 40 tonnes for each of the 2015/16 and 2016/17 seasons, and that, as in previous years, the catch could be taken from the catch limit on the Ross Sea shelf.

3.45 The Working Group recommended that its advice from 2015 with a catch limit for *D. mawsoni* in Subarea 88.1 of 2 870 tonnes, including 40 tonnes set aside for the Ross Sea shelf survey, be carried forward for 2016/17.

3.46 WG-FSA-16/37 reported the results of the first winter longline survey to be conducted in Subarea 88.1 during June and July 2016. A total of 55 longline sets were completed in the four strata, and 55.2 tonnes of *D. mawsoni* and 3.4 tonnes of *D. eleginoides* were caught.

3.47 Spawning and spent *D. mawsoni* were captured during the survey on undersea features to the northwest of stratum 1. Gonad staging and gonadosomatic indices (GSIs) suggest that males in spawning condition may aggregate earlier than females and that spawning begins in early July. There was a higher proportion of male fish caught during the survey than during the summer fishery (73% vs. 60–65%), and the sex ratio varied substantially among sets.

3.48 Nineteen fish eggs (probably from *D. mawsoni*) were captured using a plankton net in the top 200 m of the water column. This is the first such record in the Convention Area. Eggs from two running ripe females were successfully fertilised and developed for several days in flow-through incubators. Egg buoyancy measurements, conducted with fertilised eggs in density gradient cylinders, are at present being analysed and compared with CTD data to indicate the depth of neutral buoyancy. The authors recommended that a survey be carried out from mid-July to August to further document the temporal extent of spawning, although much of the likely spawning habitat is under sea-ice at that time.

3.49 The Working Group noted that one 137 cm *D. mawsoni* was recaptured in SSRU 881B after it had travelled at least 674 km since its release in SSRU I in January 2016 and showed a GSI of 15.3%. This is consistent with the hypothesised autumn migration of fish from the slope to the north for spawning.

By-catch

3.50 WG-FSA-16/13 Rev. 1 presented an analysis of the by-catch reported by vessels in the Ross Sea toothfish fishery. The analysis focused on toothfish catch-per-unit-effort (CPUE) (kg/1 000 hooks), by-catch CPUE (kg/1 000 hooks) and the normalised target catch to by-catch ratio, noting distinct differences in the mean (and distribution) of the toothfish and the by-catch CPUE.

3.51 The analysis highlighted that target catch to by-catch ratios varied across years and by small-scale management unit (SSMU) and among longline gear types. The author considered

that the spatial–temporal heterogeneity in toothfish and non-target species distribution in the Ross Sea, but not the longline vessels and the Flag States, should be considered as the primary cause of the observed variability in the target catch ratio in the Ross Sea. The observed influence of the longline gear types (autoline, trotline and Spanish longlines) on CPUE and the target to by-catch ratios demonstrated varying catchability (or efficiency) among the fishing gears both in relation to toothfish and non-target taxa.

3.52 The author noted that in order to improve the estimates of by-catch in the Ross Sea in the context of achieving the objectives of CCAMLR Article II, investigations of the spatial–temporal heterogeneity in toothfish and non-target fish distributions should be conducted for the Ross Sea, as well as preparation of instructions for of methodology for standardised fishery data collection and recording on board vessels.

3.53 The Working Group discussed the analysis conducted in WG-FSA-16/13 Rev. 1 in comparison with the previous analysis conducted by the Secretariat in WG-SAM-15/23. It noted that while there were differences between areas and gear types in by-catch rates, there was also a difference between Member vessels reporting within the regions and groups as determined by a multivariate analysis of the data. How the data are collected by the vessels – by observers or the vessels – was also a significant factor in the reported rates.

3.54 Following the analysis of differences in reporting rates between Member vessels conducted for WG-SAM-15, the Secretariat had sent a request to Members for a copy of the instructions sent to the observers, on how to record by-catch; all had responded apart from Russia.

3.55 The Working Group noted that WG-FSA-16/13 Rev. 1 and WG-SAM-15/23 used different methods but also addressed different questions. The conclusions were similar, for example both indicated a high level of spatio–temporal variability in the by-catch data. In addition to the spatial effects, WG-SAM-15/23 looked specifically at vessel effects (which was a proxy for whether observers or vessels report by-catch data), taking spatio–temporal variability into account. The Working Group recommended that, in such analyses, data should be standardised, the standardisation depending again on the question asked by the analysis.

3.56 The analyses highlighted the need that instructions for by-catch reporting need to be clarified (paragraphs 5.14 and 6.19 to 6.21) to improve instructions to vessels and to make data collection more user-friendly through training tools and instructional videos. The Working Group also noted that the camera trials reported in WG-FSA-16/43 could be useful to help in this process (paragraph 5.6).

3.57 The Working Group discussed the effects of gear type on by-catch rates and recommended further analysis based on existing data. There is already advice on suitable methods for such an analysis from WG-SAM-15 (SC-CAMLR-XXXIV, Annex 5, paragraph 2.28). WG-SAM considered that CPUE standardisation and generalised linear mixed models (GLMMs), or a case-control approach as used in the Ross Sea (WG-SAM-13/34) to compare by-catch rates from vessels fishing in close proximity to each other, could be applied to account for spatial variability, however, the method would need further development to account for different bait type etc.

Fishing operation characteristics

3.58 Following analysis of catch and effort data conducted at WG-SAM-16 (Annex 5, paragraphs 4.5 to 4.20), WG-SAM had requested that during the intersessional period before WG-FSA a review be conducted with the aim of developing: 'a set of diagnostics and clear criteria to assess the likelihood that a vessel is operating as would be expected in normal research fishing activities, so that the Working Group could provide advice to the Scientific Committee. It noted characterising research fishing activities and the operation of vessels would be helpful in developing diagnostics and criteria.'

3.59 WG-FSA-16/36 described the typical steps involved in demersal longline fishing operations for toothfish in CCAMLR fisheries and linked those steps to the variables recorded as part of the CCAMLR catch and effort data reporting system. The authors described the statistical properties of the recorded variables and how they may vary among different factors that make them useful to understand fishing activities, and useful for error trapping or data validation.

3.60 The authors noted that strong functional relationships were identified between some of the variables. For example, the time taken to haul a line increases non-linearly with the increase in the number of toothfish in the catch, as each fish is required to be gaffed aboard and removed from the line. This effect is compounded by fish size and the requirement to tag fish, which further slows the hauling process. The process proved useful to detect errors during data validation. The authors suggested that analysis also identified where values were outside of the vessel's normal statistical distributions and could potentially be used to indicate a need for additional error-checking or to seek additional information using other associated vessel records. Further, the authors noted that multivariate analyses would be a useful approach to investigating these data.

3.61 The Working Group thanked the authors for helping to develop the discussions and providing examples of relationships between variables that could be evaluated for the review process initiated by WG-SAM.

3.62 The Working Group noted that the authors identified some sets where very large numbers of hooks were recorded. It was suggested that these could be from trotlines where large numbers of hooks are set in clusters, these lines might therefore have a low catch rate per hook number and that this gear type may provide an explanation for high hook count rather than errors in data recording. Dr L. Pshenichnov (Ukraine) offered to provide additional information to further assist in the understanding of the trotline method where various configurations using bunched hooks are employed.

3.63 The Working Group noted that a comparison between the C2 data and the observer data to determine whether hauls with unusually long durations were the result of interruptions to the hauling process as the latter is recorded by the observers but not in the C2 data.

3.64 Dr Kasatkina noted that it was incorrect to summarise the hauling time data from all available longline sets taken by all fishing vessels in Subareas 48.2, 48.4, 48.5, 48.6, 58.4, 88.1, 88.2 and 88.3 for all years up to, and including, the 2015/16 fishing year without reference to the gear types, catch and hook number per set. Moreover, a vessel hauling speed should be strongly dependent on catch and number of hooks as well as on vessel power and power of the on-board winch for hauling.

3.65 The Working Group noted that it was important to understand relationships within the data that were being analysed, for instance hauling time was likely to be strongly dependent on the vessel and gear characteristics. The Working Group emphasised that catch, CPUE, gear type and hook number should be included in such analyses as important variables of fishing performance as shown in this paper. The Working Group suggested that in the future, analysis of longline fishery data should be detailed by subdivision and SSRU, to improve the ability to detect relationships between variables describing catch and effort.

3.66 The Working Group discussed the patterns that might arise in catch and effort data due to fishing operations and whether routines could be developed to detect systematic errors in incoming catch and effort data. Such routines could also include review processes at vessel level, that could evaluate whether data were internally consistent. It was noted that such a screening process could contribute to the data quality control or validation rules as being developed by the Secretariat (Agenda Item 7) and also individual Members. The Working Group encouraged Members to submit details of their data quality control procedures to the Secretariat to support this work.

3.67 The Working Group also noted that the inclusion of summaries of data preparation and analysis methods provided in appendices to working papers were helpful in providing transparency and understanding of the use of CCAMLR data in presentations to the working groups (WG-SAM-16/18 Rev. 1 and 16/39) and encouraged Members to provide similar appendices in the future.

3.68 The Working Group discussed the analysis outlined in WG-FSA-16/36 where it was agreed that the descriptions of the fishing process could form the basis for the development of hypotheses to evaluate patterns in the data recorded by fishing vessels and observers. In order to develop statistical models for the fishing process, the Working Group noted that data are not available on vessel freezing capacity and fish processing rates and recommended that fishery notifications should include this information.

3.69 Dr Kasatkina presented WG-FSA-16/14, an analysis of the toothfish fishery data in the northern part of the Ross Sea (SSRUs 881B, C and G) using haul-by-haul data from the CCAMLR database for the period 1997 to 2015. The variability of catch per haul (kg) and CPUE (kg/1 000 hooks) depending on the hauling duration (min) and hauling speed (min/1 000 hooks) were analysed. She noted that her analysis showed that there is a possible presence of number of high CPUE and catches, which are outside the upper limit of 99.7% confidence interval of the data range. She considered that these CPUE and catch values are statistically unreliable and questionably high with respect to the fishery data in the year under consideration. Dr Kasatkina considered that the total catches identified as above 97.5% within SSRU as well as catches beyond the 97.5% interval obtained by State flagged vessels may be significant. She considered it is necessary to clarify how these catches and CPUE beyond the 97.5% interval were obtained and how they should be treated; also that the current approach to analyse longline fishery data in the presence of variable CPUE values does not allow revealing adequate information for decision-making.

3.70 The Working Group noted that the same analysis conducted by Dr Kasatkina had previously been presented at WG-SAM (WG-SAM-16/26 Rev. 1). WG-SAM had concluded that the statistical inferences that Dr Kasatkina had made from the distribution of the CPUE data were invalid for a number of reasons:

(i) the statistical distribution of CPUE data is generally lognormally distributed and this had not been considered by the analysis

(ii) the statistical metric that Dr Kasatkina had used to examine the CPUE data values (the 95th, 97.5th percentiles) is a quantile, not a confidence interval, and will always have data values above them as they are characteristic of all data and, therefore, there is no statistical power in inferences made using them in isolation.

3.71 The Working Group noted that in WG-FSA-16/14, Dr Kasatkina had:

(i) claimed that the analysis conducted had been requested by the Scientific Committee and Commission. The Working Group was unable to find the references to these requests in the records of those meetings

(ii) presented results from vessels flagged to the UK and New Zealand, but had failed to present results from other Members. The Working Group requested that Dr Kasatkina provide support for her conclusion that the data from these Members had differing properties to all of the other data collected.

3.72 Dr Kasatkina noted that in accordance with current practice used by WG-SAM and WG-FSA in the presence of high CPUE values (kg/1 000 hooks), those are questionable or unusual, it is recommended to analyse:

(i) reconciliation of VMS data with reported catch location data
(ii) the relationship between hauling duration and CPUE
(iii) the relationship between hauling speed and CPUE.

It is important to understand whether current approaches to analyse longline fishery provide adequate information for decision-making. She further noted that the survey proponents agreed to undertake further analysis of the data collected from the SSRUs 882A–B north survey in 2015, with a particular focus on CPUE (kg/1 000 hooks) variability, haul duration and haul speed and include comparison with all exploratory and closed area fishing and research studies and provide a report to WG-SAM-16 and WG-FSA-16.

3.73 Dr Kasatkina also noted that analysis of SSRUs 881B, C and G, as the adjacent areas to the SSRUs 882A–B north survey, was provided taking into account that 'the high CPUE values obtained at the survey area were similar to those observed in the adjacent SSRU 881C' (SC-CAMLR-XXXIV, paragraphs 3.200 and 3.201; CCAMLR-XXXIV, paragraphs 5.38 to 5.41). That analysis of CPUE values in SSRUs 881B, C and G for several years in the context of the above said was shown in WG-SAM-16/26. WG-FSA-16/14 showed analysis of catch per set and CPUE values for the period 1997–2015. In this period the main catch falls on two countries' share: New Zealand 73% and the UK 22%. The maximum catch per set and CPUE values were also achieved by these two fleets (Table 1-6). In view of this, obtained results were shown under example of vessels flagged to the UK and New Zealand.

3.74 Dr Kasatkina noted that it is very important to analyse the statistics of catch and then present the results. Confidence interval (CI) estimation is used for different types of process in stock assessment regardless of the normal distribution function. The values higher than upper 99.7 CI limits are considered statistically unreliable (Brandt, 2003). In the practice the confidence interval of 99.7% is the criterion for rejection of outlying observations.

3.75 The Working Group noted that it was unable to locate any support for the statement in paragraph 3.74 in the cited reference by Brandt (2003).

3.76 Dr Kasatkina noted that in some cases hauling rate was constant, and did not change significantly across a range of catches. In her opinion hauling time for the 50 tonnes and 40 tonnes should be significantly higher than the hauling time for the main part of catches between amount to 10 or 50 tonnes. Dr Kasatkina further indicated that longline fishery was characterised by a small dependence between the longline hauling (min and min/1 000 hooks) and the catch per haul (kg) and the CPUE (kg/1 000 hooks). The correlation coefficient was in the range 0.05–0.3 (in several seasons coefficient made up 0.4–0.6). But regardless the dependence there is a possible presence of high CPUE and catch, which are outside the upper limit of confidence interval of 99.7% CI.

3.77 Dr Kasatkina highlighted that high CPUE values in the range from 3 000 kg/ 1 000 hooks up to 8 076 kg/1 000 hooks for UK-flagged vessels (seasons 2005–2015) and from 3 000 kg/1 000 hooks up to 9 024 kg/1 000 hooks for New Zealand-flagged vessels (seasons 2001–2014) were achieved at a practically unchanged hauling speed (Figures 11 and 12). It is unclear how the hauling time remained practically unchanged, if the catch per haul varied over a wide range from 13–15 tonnes to 35 tonnes for UK-flagged fishery and up to 50 tonnes for New Zealand-flagged fishery.

3.78 Dr Kasatkina noted that she only used data from the UK and New Zealand as examples report data significant of questionable high data. She recalled that in the SSRUs 881B, C and G the main catch falls on two countries' share: New Zealand 73% and the UK 22%. The maximum catch per set and CPUE values were also achieved by these two fleets. She stated that it is very difficult to explain how the high value catches were obtained with the same hauling time.

3.79 The Working Group recalled the discussions around WG-FSA-16/36 and the results found therein, which highlighted the non-linear relationship between hauling time and catches (paragraphs 3.59 and 3.60).

3.80 The Working Group noted that the examples chosen by Dr Kasatkina, notably data from the UK and New Zealand, were at present not considered questionable, or significantly unusual, by CCAMLR or its working groups. In the examples shown in WG-FSA-16/14, for the years where high CPUE values were highlighted, there were equally very low CPUE values, including lines with zero catches, however, those were not highlighted by Dr Kasatkina in the paper.

3.81 Dr Kasatkina noted that just high CPUE values are the focus of this study as well as the CCAMLR and its working groups. Obtained results showed the high CPUE values and catches identified above 97.5% may result in significant total catch in SSRU. Therefore, it is necessary to clarify of how the questionable high catches (i.e. beyond the 99.7% CI) were obtained. How the questionable high catches and CPUE values beyond the 99.7% CI should be treated.

3.82 The Working Group noted that CCAMLR and its working groups worked towards understanding patterns in catches and catch rates, and the focus was not on high values of CPUE but rather on the pattern of CPUEs (SC-CAMLR-XXXII, Annex 4, paragraph 4.18). The values highlighted by Dr Kasatkina were neither questionable nor significantly

anomalous, as shown by the wide range of catch rates reported for all vessels operating in this region, including SSRUs 881C–G, over several years. It requested that Dr Kasatkina provide results for all vessels operating in this region to place the results shown for UK and New Zealand into the regional context.

3.83 Dr Darby noted that, as shown in WG-FSA-16/36, the relationship between hauling time and catch was not a linear relationship and that Dr Kasatkina had not tested for increasing haul time with catch, but only shown the distribution of CPUE data and highlighted high catches from her example Members. As noted by WG-SAM, there are high and low catches in the catch and CPUE data from all Members and the presence of a few high values was a natural part of the data characteristics.

3.84 Dr Kasatkina recalled her intervention in paragraph 3.64 and noted that WG-FSA-16/14 provided more corrected analysis of dependence between the hauling time and the catch per haul as well as between CPUE and hauling speed, using only normalised variables (by 1 000 hooks) for autoline gear in the northern Ross Sea.

3.85 Dr Kasatkina recalled that the main catch falls on New Zealand and UK amounted to 95%. The maximum catch per set and CPUE values were also achieved by these two fleets. Data examined together provided the same results.

3.86 The Working Group, apart from Dr Kasatkina, supported the review of the previous analysis of this approach by WG-SAM (Annex 5, paragraph 4.10) and agreed that occasional high (and often low) CPUE values occur in the data from all Member's vessels and were not anomalies. Other properties of the data such as patterns, as examined in WG-FSA-16/36, would likely provide a better approach to the identification of inconsistent datasets.

3.87 The Working Group, apart from Dr Kasatkina, agreed that her inferences concerning the data recorded by New Zealand and the UK were based on an inappropriate analysis of the statistical properties of the data. Her claims that the data were anomalous were not scientifically justified.

3.88 Dr Kasatkina stated regardless of the future consideration there are the presence of high values of catch and CPUE values being outside the upper limit of confidence interval of 99.7% CI and recorded with unchanged hauling time and speed. These data are the most high catch and CPUE over all available data from Subareas 48.2, 48.5, 88.1, 88.2. Therefore, it is important to estimate quality of these data and clarify how these data should be treated.

3.89 Dr Kasatkina noted that there was no any evidence or results of satisfactory analysis presented by WG-FSA to indicate realistic the above said data.

Future work

3.90 The Working Group discussed a general approach to the analysis of fishery data. Analyses should consider the use of standardised data to evaluate the patterns for a range of metrics and consider them together. Simple distributional analyses were considered helpful in developing an understanding of fishing patterns and screening data for errors, but typically a range of factors interact with each other, and thus multivariate analyses should be explored that take into account factors such as vessel, gear type, fishing depth, spatial distribution of

hauls, number of fish, biological information such as fish size (large fish may take longer to haul) etc. Analyses of the data should be conducted following the establishment of hypotheses that can then be evaluated statistically by fitting models using multivariate methods such as generalised linear models (GLMs), GLMMs, generalised additive models (GAMs) etc.

3.91 WG-FSA recalled the previous discussions by WG-SAM-16 (Annex 5, paragraphs 4.18 and 4.19) which highlighted the importance of:

(i) asking clear questions
(ii) developing hypotheses before analysis
(iii) using analysis with a clear methodology
(iv) showing steps and choices in model selection
(v) presenting appropriate diagnostics.

3.92 WG-FSA agreed that WG-SAM be requested to develop analytical approaches such as:

(i) metrics to screen data for transcription errors to ensure data are internally consistent

(ii) models, including diagnostics, to detect systematic patterns in data that are departures from expected distribution.

3.93 To test metrics, a dataset that includes quarantined data should be used as an example as the quarantined data have already been established as being inconsistent with the other data.

3.94 WG-FSA emphasised the importance of collaborative work and noted the offer by New Zealand to work together with others (Annex 5, paragraph 4.20) to develop the methods. The UK, Australia and Russia all agreed that they would support the process and other Members were invited to participate in the online discussions through the existing WG-SAM e-group.

Satellite tagging

3.95 WG-FSA-16/57 reported the deployment by the USA and New Zealand of 10 pop-up satellite archival tags (PSATs) of two tag types on the southern Ross Sea shelf in the austral summer, and five PSATs on the northern seamounts in the austral winter. All fish were also double tagged with standard CCAMLR dart tags. Releases were distributed across five different SSRUs within Subarea 88.1.

3.96 For the 10 tags released on the southern Ross Sea shelf, all were programmed to pop-off on 1 February 2017, about one year from release. However, one of the tags (SeaTag-MOD #1662) became detached from the fish (either shed or popped off) on 24 February 2016, about 43 miles east-southeast of the release location. Three of the northern seamount tags were programed to pop off on 1 February 2017, after about eight months at liberty. The other two were programed to pop off on 1 February 2018 or after about 20 months at liberty.

3.97 WG-SAM-16/08 presented the preliminary results of PSAT studies on *D. mawsoni* in the Mawson Sea (Division 58.4.1). Three PSATs were released in 2014/15, and one of them was retrieved on the fish in 2015/16 and the preliminary results from the retrieved tag were presented. Despite being at liberty for 366 days, the tagged fish was re-caught only 4.3 km from the position of release.

3.98 The tag recorded that the fish moved vertically in temporal patterns that appeared to show seasonal behaviour. This was characterised by average (for the recorded time series) variability in vertical movement at the depth to which it returned after release. A second period of almost no vertical movement and during the austral winter was followed by a period of intense vertical movement high in the water column or at shallow depths during the austral spring.

3.99 The Working Group thanked the authors for presenting the results of their work, noting that this is the second record from a satellite tag reported to WG-FSA. In both cases, the tags were collected from fish that had been re-caught rather than popping off. The Working Group noted that the types of vertical movement recorded by the tag have been recorded for other species where the vertical movements noted in the spring were considered to be associated with spawning behaviour.

D. mawsoni in Subarea 88.2

Research surveys in SSRUs 882A–B

3.100 The exploratory fishery for *D. mawsoni* in Subarea 88.2 operated in accordance with CM 41-10 and associated measures. In 2015/16, the catch limit for *Dissostichus* spp. was 619 tonnes. Fishing was conducted by nine vessels using longlines, and the total reported catch was 618 tonnes. Details of this fishery and the stock assessment are contained in the Fishery Report.

3.101 The Working Group discussed the proposal for a second longline survey of toothfish in the northern Ross Sea region (SSRUs 882A–B) submitted to WG-SAM (WG-SAM-16/15).

3.102 The Working Group agreed that with the recent report of catches in the SPRFMO area to the north of the proposed survey area (SC-CAMLR-XXXV/BG/32), information on the distribution of the stock in this area was a high priority. Links between the distribution of *D. mawsoni* in the CCAMLR and SPRFMO areas will need to be considered in the future, especially in relation to tracking the origin of toothfish on the commercial markets.

3.103 Dr Kasatkina stated that analysis of survey SSRUs 882A–B was incomplete and this analysis does not meet the recommendation of Scientific Committee (SC-CAMLR-XXXIV, Annex 7, paragraph 4.104; CCAMLR-XXXIV, paragraph 5.41) and WG-SAM-16 (Annex 5, paragraph 4.29).

3.104 The Working Group noted that SC-CAMLR-XXXIV, Annex 7, paragraph 4.104 was an attributed statement by Dr Kasatkina which had not been adopted by Scientific Committee; consequently, WG-FSA sought advice from the Scientific Committee as to how to proceed in the case that:

(i) an attributed statement, which was not agreed and adopted as advice, is later treated as such by a Member

(ii) analyses suggested by a Member in an attributed statement are not then conducted by that Member to its own satisfaction.

3.105 Dr Kasatkina made the following statement on the survey SSRUs 882A–B:

> 'I cannot support the proposal for a second step of longline survey of toothfish in the northern Ross Sea region (SSRUs 882A–B) in season 2016/17, the survey data in the northern region of SSRUs 882A–B from the first step in 2015 should be placed into quarantine until a satisfactory analysis of the high CPUE records has been completed.'

3.106 The Working Group, apart from Dr Kasatkina, agreed that the analyses submitted to, and reviewed by, WG-SAM and WG-FSA have not indicated any unusual patterns in the data from the survey conducted in the north of SSRUs 882A–B independently by New Zealand, the UK and Norway with observers from Spain and South Africa. Consequently, there was no case for the quarantining of data collected by the five Members.

3.107 Dr Kasatkina presented WG-FSA-16/16, a research program on resource potential and life cycle of *Dissostichus* species from SSRU 882A in 2016–2019. The paper had been presented previously to WG-SAM.

3.108 Dr Kasatkina, in a response to a request to provide details of the partner vessel, noted in the proposal that Russia invites a Member vessel to take part in research program. This invitation is shown in WG-FSA-16/16. Otherwise, Russia is able to provide research program to herself.

3.109 The Working Group noted that the design of the survey was appropriate for its objectives but requested a list of the milestones for the proposal and the time in which they were expected to be delivered so that the timescale of the project could be evaluated. There were no further comments on the survey objectives or design during WG-FSA.

3.110 The Working Group noted that WG-FSA-16/16 Rev. 1, Table 2, provided a timeline to achieving objectives. However, it did not have time to review the timeline.

3.111 WG-FSA-16/46 described a multivariate approach to examining patterns in research fishing activities using the SSRUs 882A–B north survey as an example, specifically looking at hauling times and factors affecting this. A GLM was fitted to hauling times and established that there was no significant difference in hauling times, after adjustment for other factors, between the survey vessels fishing outside of the survey and during it.

3.112 The Working Group noted that the fitted model established that line length (also a proxy for number of hooks), number of toothfish caught and weight of toothfish caught were important factors in influencing the hauling time. Significantly, it was noted that the catch and effort variables recorded could be correlated and may mask variation explained by a biological process, such as the fine-scale distribution of fish.

3.113 Dr Kasatkina noted that there are no any rationales for summarising available data in Ross Sea region regardless of types of gears. Hauling time was analysed as the indicative variable without reference to catch and hooks number and type of gear. She noted that

WG-FSA-16/46 only showed that hauling duration from the survey without reference to number of hooks and catches were within the confidence boundary estimated from all available data in the Ross Sea region. This result was predictable taking into account wide range of fishing data.

3.114 Dr Darby noted that some factors will be correlated, for example numbers of hooks being correlated to length of line, and, therefore, hook number was included in the model fit.

3.115 Dr Kasatkina recalled that the results of the first year of the two-year longline survey for toothfish in the northern Ross Sea region (SSRUs 882A–B north) showed anomaly high CPUE values, reaching to 5 280 kg/1 000 hooks (SC-CAMLR-XXXIV, Annex 7, paragraph 4.102). At the same time, the high catches were obtained from greater depths (1 900 m or more) outside the main area of *D. mawsoni* distribution.

3.116 Dr Kasatkina highlighted that CPUE values of higher than 5 000 kg/per 1 000 hooks constitute only eight sets from 2 500 sets or 0.3% of all available longline sets from exploratory fisheries in in the adjacent SSRUs B, C an G while they comprise two out of the 18 longline sets (or 22 % obtained during the 2015 survey in SSRUs 882A–B).

3.117 Dr Kasatkina emphasised that it was not provided satisfactory analysis to clarify the sources of this high questionable CPUE and correspondent catches. Analysis of the vessel monitoring system (VMS) data with reported haul locations was not conducted also.

3.118 Dr Kasatkina stated that analysis of survey SSRUs 882A–B was uncomplete and this analysis does not meet the recommendation of Scientific Committee (SC-CAMLR-XXXIV, Annex 7, paragraph 4.104; CCAMLR-XXXIV, paragraph 5.41) and WG-SAM-16 (Annex 5, paragraph 4.29).

3.119 The Working Group noted that it requested from Dr Kasatkina the hypotheses that she would like to see tested and the quantitative criteria that she would need to have addressed in order to accept data. It also noted that, despite these requests, no information has been provided by Dr Kasatkina on what these hypotheses and criteria would be. Further, given the analyses already undertaken and presented to WG-SAM and WG-FSA, the scientific basis for dissatisfaction of Dr Kasatkina with data from these surveys remains unclear to the Working Group.

3.120 Dr Kasatkina supported application of GLM by the authors for multivariate analysis of fishing data. However, she proposed to use GLMM (i.e. GLM with mixed effects) that will provide approach for more detailed analysis of fishery data.

3.121 The Working Group noted that there was a series of stages to the development of the model, before reaching the final fit, that would provide a useful point for discussion, including alternative model structures, the correlation between variables and the error model. A subgroup was convened to examine these issues.

Amundsen Sea region (SSRUs 882C–H)

3.122 WG-FSA-16/45 presented work on the characterisation of the toothfish fishery and tagging program in the Amundsen Sea region (SSRUs 882C–H) between 2014/15 and

2015/16. A total of nine inter-season tagged fish were recaptured in the southern research blocks, providing key information on the size of the population in this area. Eleven tagged fish were recaptured in the north (SSRU 882H). This paper presented data for inclusion in the stock assessment for the Amundsen Sea region.

3.123 Mrs Large explained to the Working Group that a lack of ageing data in the southern area meant that only a single age–length key (ALK) could be used in the analysis of that region, while in the northern area, enough data is available to utilise annual ALKs for some of the years. She also noted that there had been no movement of tag-recaptured fish between research blocks, and, therefore, movement across research blocks and between the north and south areas has yet to be resolved.

3.124 WG-FSA-16/44 reported on progress towards a two-area stock assessment model for *D. mawsoni* in the Amundsen Sea region (SSRUs 882C–H). The region was split into two main areas: the north (SSRU 882H) comprising large mature fish, and the south (SSRUs 882C–G) comprising a mix of large mature fish and small immature fish.

3.125 Two-area stock assessment models were first developed for the region in 2014 and refined in WG-SAM-14 and WG-SAM-15. This earlier work highlighted the need to collect mark-recapture data in the south to help inform the estimation of biomass in the south. This update developed further the two-area stock models, including two years of new data collected under the research plan.

3.126 The results suggested that the research plan has been successful in providing tags and biological data that have started to inform the model, in particular the size of the fish population in the south. The authors recommend that the current research plan be extended for a further two-year period so that additional mark-recapture data can be collected, particularly from the south, and that the models be developed further in the intersessional period. Sensitivity and simulation runs could be done to further examine the data needed to inform the estimation of biomass in the south.

3.127 Some of the assumptions behind the two-area modelling approach were discussed by the Working Group. The Working Group noted that mainly small (50–100 cm long) fish were found in the south, mainly large (130–170 cm long) fish were found in the north, and that few fish of an intermediate size had been found in the region. Thus, it might take a number of years before fish tagged in the south were large enough to mature and migrate to the north. The Working Group also noted that larger fish in the south were in quite localised locations which had only been fished in two years and so there might be a low chance of recapture of large fish in the south.

3.128 The Working Group also noted that the model estimates of biomass in the south were very sensitive to the weighting applied to the tag data from the south. It recognised that when additional tag recaptures were available from the south, it would have the effect of increasing the weighting given to the tag data from this area. In this sense, the weighting assumption should be further examined between areas.

3.129 The Working Group recalled previous requests by the Scientific Committee for further ageing of otoliths held by other Members in order to obtain full age frequencies for all years fished in the north and the south (e.g. SC-CAMLR-XXXII, paragraph 3.169). This was discussed further with respect to data-poor fisheries (paragraph 4.126).

Management advice

3.130 The Working Group noted that the aim of the two-year research plan had been to increase the amount of tagging being carried out in the area and to ensure the likely recapture of those tagged fish by the use of research blocks (SC-CAMLR-XXXIII, paragraph 3.168). On the basis of updated Chapman estimates for SSRU 882H and research block 882_2, which showed that the current catch limits were consistent with CCAMLR's precautionary approach, the Working Group agreed that a two-year extension of the research program in this region could continue.

3.131 The Working Group agreed that the number of tagged fish available for recapture would be increased by increasing the tagging rates in both the southern and northern areas. The current tagging rates are 1 tag per tonne in SSRU 882H and 3 tags per tonne in SSRUs 882C–G. It recommended that these rates should be increased to 5 tags per tonne in SSRUs 882C–G and to 3 tags per tonne in SSRU 882H.

D. eleginoides in Subarea 58.6 and Division 58.5.1

D. eleginoides Kerguelen Island (Division 58.5.1)

3.132 The fishery for *D. eleginoides* in Division 58.5.1 is conducted in the French exclusive economic zone (EEZ). In 2015/16, the catch limit for *D. eleginoides* was 5 300 tonnes. Fishing was conducted by seven vessels using longlines and the total reported catch up to 31 July 2016 was 3 814 tonnes. Details of this fishery and the stock assessment are contained in the Fishery Report.

3.133 WG-FSA-16/54 presented an updated stock assessment of *D. eleginoides* at Kerguelen Islands (Division 58.5.1 inside the French EEZ), which included new von Bertalanffy growth parameters and catch-at-age data, a new tag shedding rate parameter and the inclusion of estimated removals due to depredation.

3.134 The Working Group congratulated the authors on the continued development of the model and noted that the recommendations arising from WG-FSA-15 had been incorporated in the current assessment model. The Working Group also noted that age readings by Ifremer (France) and CEFAS (UK) had shown a lag of one year in length-at-age trends. The Working Group recommended direct age comparisons between laboratories to evaluate the reason for this lag.

Management advice

3.135 The Working Group agreed that the catch limit set by France of 5 050 tonnes in 2016/17 was consistent with the CCAMLR decision rules in the model runs presented.

3.136 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 2016/17.

D. eleginoides Crozet Islands (Subarea 58.6)

3.137 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 2015/16, the catch limit for *D. eleginoides* was 1 000 tonnes. Fishing was conducted by seven vessels using longlines and the total reported catch up to 31 July 2016 was 534 tonnes. Details of this fishery and the stock assessment are contained in the Fishery Report.

3.138 WG-FSA-16/52 presented an updated stock assessment of *D. eleginoides* at Crozet Islands (Subarea 58.6 inside the French EEZ). Outputs from a series of model runs were considered which included, inter alia, estimates of whale depredation and new von Bertalanffy growth parameters estimated from Kerguelen age data. The Working Group congratulated the authors on the continued development of the model and noted that the recommendations arising from WG-FSA-15 had been incorporated in the current assessment model.

Management advice

3.139 The Working Group agreed that the catch limit set by France of 1 300 tonnes in 2016/17 was consistent with the CCAMLR decision rules in the model runs presented.

3.140 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 2016/17.

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

Exploratory fishery notifications in 2016/17

4.1 The Working Group noted Members' notifications to fish in exploratory fisheries for *Dissostichus* spp. in 2016/17 (CCAMLR-XXXV/BG/05 Rev. 1, see also www.ccamlr.org/en/fishery-notifications/notified). These notifications followed a pattern similar to recent seasons, and notifications for 2016/17 were as follows:

(i) Subarea 48.6 – 3 Members and 3 vessels
(ii) Division 58.4.1 – 5 Members and 5 vessels
(iii) Division 58.4.2 – 4 Members and 4 vessels
(iv) Division 58.4.3a – 2 Members and 2 vessels
(v) Subarea 88.1 – 10 Members and 21 vessels (2 vessels have been withdrawn)
(vi) Subarea 88.2 – 8 Members and 19 vessels (2 vessels have been withdrawn).

There were no notifications submitted for the exploratory fishery in Division 58.4.3b or for new fisheries.

4.2 The Working Group noted that the research plans for exploratory fisheries in Subareas 48.6 and 58.4 were submitted to WG-SAM-16 for review (Annex 5).

Making activities targeting toothfish consistent
with CCAMLR's regulatory framework

4.3 The Secretariat presented two papers to the Working Group on making activities targeting toothfish consistent with CCAMLR's regulatory framework (CCAMLR-XXXV/14 and BG/09). This work follows the paper presented by the Scientific Committee Chair last year (CCAMLR-XXXIV/17 Rev. 1) that resulted in the Commission agreeing that there are analogous research activities targeting toothfish that have the same aims and review process but are either conducted under conservation measures, or under an agreement of the Scientific Committee and Commission that is captured in report text. Given the confusion this causes, the Commission requested the Secretariat work with Members in the intersessional period to ensure this inconsistency was resolved through the revision of existing conservation measures and the creation of new conservation measures (CCAMLR-XXXIV, paragraph 9.21).

4.4 The aim of the work presented in CCAMLR-XXXV/14 and BG/09 was to develop proposals for new conservation measures, or propose changes to existing measures, to ensure all activities targeting toothfish are consistent with CCAMLR's regulatory framework. Comparing research activities in Divisions 58.4.3a and 58.4.4b provided an example of the current inconsistencies. The research conducted in Division 58.4.3a is classified as an exploratory fishery and is regulated under CM 41-06, while Division 58.4.4b does not currently have its own set of regulations clearly stated in a conservation measure and is regulated under CM 24-01, which makes it exempt from other conservation measures. However, both research activities are trying to achieve the same objective of providing an assessment of toothfish biomass and catch limits consistent with the CCAMLR decision rules. Despite this similarity, the regulations are very different. For example, in Division 58.4.4b no by-catch limits apply, it is unclear how regulations on catch overruns would apply (given there are no catch limits specified in a conservation measure) and five-day reporting is required, rather than daily reporting. Additionally, a vessel engaged in research may not be required to be authorised under CM 10-02 and/or to provide VMS data.

4.5 The proposal showed that generally all the components that were necessary for resolving inconsistencies were in existing conservation measures, but some small changes were required along with the establishment of a clear hierarchical structure (see Figure 2).

4.6 The proposal also showed that if there was agreement to the changes required to create the hierarchical relationship between the relevant conservation measures, and the changes to the preliminary paragraphs of CM 21-02 were made applicable to all activities targeting toothfish, the Annex in CM 24-01 would be moved into CM 41-01 and all of these research activities will be subject to the same specifications/regulations.

4.7 The Working Group thanked the Secretariat for taking this work forward and agreed that the proposed changes would not only make the scientific advice provided by WG-FSA and the Scientific Committee more transparent, but also improve the efficiency of reviewing these research activities in WG-SAM and WG-FSA.

4.8 The Working Group also agreed that specifying the species that is being targeted (i.e. *D. mawsoni* or *D. eleginoides*) in the title and text of conservation measures, rather than the non-species specific *Dissostichus* spp. that is currently present in all relevant conservation measures, would be very beneficial in providing clarity to the Commission and any external parties on which species was being targeted and managed in particular areas. This would

mean that toothfish fisheries such as in Subarea 88.1 that have catch limits for *Dissostichus* spp. would be revised to include the target species as *D. mawsoni* and for the purpose of CMs 23-04 and 23-07 any *D. eleginoides* caught shall count towards the overall catch limit for *D. mawsoni* and 'by-catch species' are defined as any species other than *Dissostichus* spp.

4.9 The Working Group noted that it was important to remember the history of why particular areas had been closed to fishing, but recalled that this information was provided in Fishery Reports and should form an important part of the preamble in the research plan associated with an exploratory fishery.

4.10 Dr Kasatkina recalled that the CCAMLR regulatory framework was the subject of discussion during the Commission last year (CCAMLR-XXXIV, paragraphs 9.11 to 9.21) and focused on the following proposals that were taken:

(i) China suggested that a glossary of terms that describes the nomenclature and terminology would be beneficial in establishing a common understanding among Members. China also suggested that a mechanism or procedure, utilising the agreed terminology, be established to support the revision and adoption of conservation measures, noting that this would be particularly useful for Members for which English is not their first language (CCAMLR-XXXIV, paragraph 9.14).

(ii) Russia suggested providing a workshop for more detailed consideration of the regulatory framework. The report of this workshop should be presented for consideration by WG-EMM and WG-FSA (CCAMLR-XXXIV, paragraph 9.17).

Dr Kasatkina noted that these proposals were not accomplished.

4.11 The Working Group noted the need for broader consideration of ecosystem effects in research plans for both exploratory and research fisheries, as some of the plans and reports from previous seasons pertain solely to the target species.

4.12 The Working Group recalled that it was important to collect and report information on target and by-catch species, as the requirements of Article II necessitate an understanding of how the wider Antarctic ecosystem (seabirds, marine mammals, pelagic and benthic invertebrates, etc.), or relationships between ecosystem components, may be impacted by harvesting.

Long-distance movement in toothfish

4.13 Upon the request of WG-SAM-16 (Annex 5, paragraphs 4.46 to 4.48), the Secretariat presented WG-FSA-16/25 Rev. 1 on the long-distance movements of tagged *D. eleginoides* and *D. mawsoni*. Some analyses on the movements of toothfish had recently been conducted within Subarea 48.3 (WG-FSA-14/49), within Subareas 88.1 and 88.2 (WG-FSA-15/37) as well as within Division 58.5.2 (WG-FSA-14/43); WG-FSA-16/25 Rev. 1 analysed toothfish tag-recapture data (2006–2016) from across the whole Convention Area to assess long-distance movements and behaviour by species, location and sex with a focus on movements between management areas.

4.14 The results highlighted that in the management areas where most of the tagging occurs (e.g. Subareas 48.3 and 88.1) between 5% and 10% of tagged fish were found to have moved over 200 km from their release location. This is consistent with findings from previous studies looking at movements of *D. eleginoides* in Subarea 48.3 (WG-FSA-14/49). *Dissostichus eleginoides* and *D. mawsoni* that moved long distances showed a strong tendency to move in a counter-clockwise direction. In Subarea 48.4, the majority of long-distance moving *D. eleginoides* moved westerly towards Subarea 48.3 and the majority of tagged fish in Division 58.5.1 moved northwesterly. Meanwhile, *D. mawsoni* in Subarea 88.2 travelled west to northwesterly into Subarea 88.1. Long-distance movements in *D. eleginoides* also tended to be more common in males than females, which was consistent with previous findings (WG-FSA-14/43).

4.15 The Working Group noted that three toothfish were recaptured over 4 000 km from their release points. It further noted that tagging data had recently been received by the Secretariat from Australia and that these data would be migrated into the CCAMLR database so that future analyses could include data from Division 58.5.2.

4.16 The Working Group thanked the Secretariat for the interesting paper, noting that work like this can assist with informing hypotheses on stock structure. It noted that the results generally supported the assumptions made by current stock assessments that most fish are not moving great distances and/or crossing management area boundaries.

4.17 The Working Group agreed that this analysis was useful and should be performed biennially to include the most up-to-date data. Several additional factors that could be considered in future updates of this analysis were suggested, including an examination of the relationship between the long-distance movements and the depth at which fish were released and recaptured; otolith microchemistry; oceanographic patterns; different maturity stages; comparisons with data from PSATs; and long-distance movements recorded outside the Convention Area.

Local biomass estimates of *D. mawsoni* and *D. eleginoides*
in research blocks in Subareas 48.6 and 58.4

4.18 In response to the request from WG-SAM, the Secretariat presented WG-FSA-16/27 that provided the documentation of the data extracts, data cleaning and code used to produce the local biomass estimates for research blocks in Subareas 48.6 and 58.4 following the methods that were agreed at WG-SAM-16 (Annex 5, paragraph 2.28). The versions of the code used in the analyses (with the associated documentation and data) presented in WG-FSA-16/27 that have been made available to Members have been archived in the Secretariat under CCAMLR_CPUE_by_seabedarea_biomass_estimation150092016.zip and CCAMLR_Chapman_biomass_estimation15092016.zip and the data extracts and associated metadata have been archived in CCAMLR_csv_data_extract_486_5841_5842_5843a_ 5844b_2016_08_23.zip.

4.19 The Working Group thanked the Secretariat for undertaking this considerable amount of intersessional work and welcomed the increased level of documentation and transparency that this had brought to the process of providing these biomass estimates. The Working Group

agreed that, as the Secretariat is the source of the most up-to date data and now the provider of the standard method for using those data to provide biomass estimates for research blocks, these estimates should be provided by the Secretariat in the future.

4.20 The Working Group agreed that the work presented in WG-FSA-16/27 provided a clear description of the approach to providing local biomass estimates for research blocks and that this should be recommended as the default method, such that any approaches to using other methods for estimating the local biomass in research blocks should be presented in relation to, rather than simply as alternatives to, this default approach.

4.21 The Working Group noted that the agreed methods for producing the point estimates of local biomass in research blocks provided an essential basis from which to consider the uncertainty in those estimates, including through bootstrapping seasonal estimates as well as incorporating multi-year estimates. Such estimates of uncertainty, and how these estimates will be used in setting future catch limits, were identified by WG-SAM and WG-FSA as a high priority for future work in 2017.

4.22 Based on the biomass estimates provided in WG-FSA-16/27, the Working Group generated a table of proposed catch limits (Table 1). In the case of the mark-recapture Chapman biomass estimates, the Working Group agreed that, if there was no estimate in 2016, due to an absence of tagged fish recaptures and/or no fishing, the most recent Chapman biomass estimate should be considered.

4.23 Based on the biomass estimates in Table 1, the proposed catch limits were calculated using the method that had been most recently agreed by WG-FSA of selecting the lower of the two estimates and applying a 4% exploitation rate (SC-CAMLR-XXXIII, Annex 7, paragraph 5.123). The Working Group discussed the use of additional criteria that had been used in calculating catch limits in the past. These criteria included the comparison of the expected and observed numbers of tagged fish recaptures and the catch required to recapture 10 tagged fish.

4.24 The Working Group acknowledged that, even though the comparison of expected and observed numbers of tag recaptures had been used in selecting biomass estimates and setting catch limits in the past, this was a circular argument when the expected numbers of tag recaptures were based on a tag-based biomass estimation method. Additionally, calculating the catch required to recapture 10 tagged fish in the following fishing season had not been a suitable metric for setting catch limits, given that less than 10 tagged fish were being recaptured per fishing season in many of the research blocks.

4.25 The Working Group discussed the difference in the biomass estimates generated using the CPUE by seabed area analogy and the Chapman mark-recapture biomass estimation methods. It was noted that the *D. eleginoides* biomass estimates using the two different methods showed a higher degree of similarity than the *D. mawsoni* estimates. Additionally, the proposed catch limits for *D. eleginoides* were also closer to the current catch limits. The Working Group noted that the *D. mawsoni* local biomass estimates tended to show greater differences than the *D. eleginoides* estimates and discussed the potential explanations for this in relation to difference in the ecology of the two species, how the data were collected in different research blocks and the assumptions of the two biomass estimation methods given the differences in the ecology and data collected/survey methods.

4.26 The Working Group noted that the proposed catch limits in research blocks that were based on the lower of the two *D. mawsoni* local biomass estimates were much lower than the current catch limits. It also noted that most of the current catch limits had in most research blocks been based on biomass estimates generated by WG-FSA-13.

4.27 The Working Group revisited the methods and parameter values that were included in the WG-FSA-13 biomass estimates and compared these with the latest formulas and values agreed to at WG-SAM. A key difference between the most up-to-date biomass estimates and those provided in 2013 was the application of transparent and documented data quality rules in the most recent biomass estimates. Other differences between the biomass estimates provided in 2013 and the current biomass estimates using the CPUE by seabed area analogy methods could be explained by the use of:

(i) different reference areas

(ii) a more recent bathymetry dataset (e.g. Gebco 2014 rather than Gebco 2008)

(iii) the median CPUE of the last three years in which fishing had occurred

(iv) the use of the current spawning stock biomass from the integrated assessments performed in 2015 rather than the vulnerable biomass that was used in 2013

(v) fishable seabed area from all SSRUs in the Ross Sea reference area, rather than only the fishable seabed area from SSRUs that were open to fishing that was used in 2013.

4.28 The key differences between the biomass estimated in 2013 and the current estimates using a mark-recapture method were the use of:

(i) a Petersen method, rather than the Chapman method

(ii) difference in the assumptions regarding the number of tagged fish available for recapture (i.e. the current method used the last three years of tagged fish released assuming the tagged fish are a single- population and the 2013 calculations used a cohort-based approach).

4.29 The Working Group discussed the implications of recommending reduced catch limits, noting that in some cases it may not be possible to continue with existing research programs.

4.30 The Working Group agreed that, when providing advice on research on catch limits to the Scientific Committee where there are alternative options, these should be supported by scientific rationale in order to allow the Scientific Committee to evaluate each option.

4.31 While some participants of the Working Group supported the proposed catch limits based on the lower of the two latest biomass estimates given in Table 1 with the 4% exploitation rate, others did not.

4.32 Dr T. Ichii (Japan) and Mr Somhlaba made the following statement on setting catch limits:

‘In research blocks in Subarea 48.6 and Divisions 58.4.1 and 58.4.2, there are two catch limit (CL) candidates, i.e. one is based on the CPUE by seabed area analogy approach and the other on the Chapman mark-recapture approach. As a process of selecting CL, WG-FSA proposes to use the lower CL.

There are large differences between the two candidates with the CPUE-based CL being lower than the Chapman-based CL in many research blocks. If the lower CL is to be used as suggested by WG-FSA, tag-recapture experiments become very difficult to conduct in many research blocks in the next fishing season because the lower CL tends to be much lower than the current CL.

We consider that the Chapman-based approach should be more appropriate than the CPUE-based approach in research blocks where more than several tags were recaptured. This is because the CPUE-based approach has uncertainty associated with such, as selection of reference area, difference in fishing gear and bottom topography between target and reference areas. The Chapman-based approach also has uncertainty associated with it, such as the number of tagged fish available for recapture, but this can be dealt with by having reasonable scenarios of time at liberty for tagged fish.

Considering that the current CLs are considerably smaller than the Chapman-based CL and that a tag-recapture experiment with the current CL has been assisting the progress of stock assessment without apparent decline in CPUE, we propose a realistic approach, i.e. use of the current CL at least for the next fishing season. Setting such a reduced CL without scientific rationale is not an appropriate way for the development of a stock assessment using tag-recapture experiments.

As high priority work, WG-SAM-17 is supposed to discuss various important issues on both approaches and, subsequently, how to set CLs from the point of view of monitoring of stocks, development of the stock hypothesis and precautionary approach. Appropriate mechanisms for the choice of CLs should be set for research plans in Subareas 48.6 and 58.4 at WG-SAM-17.’

4.33 Mr A. Rigaud (France) made the following statement:

‘I would like to support the points raised by Dr Ichii and Mr Somhlaba about the choice of catch limits. I was thinking that the current catch limit (2016) for the next season is appropriate for Divisions 58.4.3a and 58.4.4b.

Setting a radically low CL without scientific rationale is not an appropriate way for the development of stock assessments using tag-recapture experiments.

Moreover, in the case of Ob and Lena Banks (Division 58.4.4b), the design survey (based on a grid) could explain the lower CPUE observed inside both blocks of the area. Indeed, French and Japanese vessels are fishing in all cells of the grid, even if there is no fish (or less fish) in some cells. So that can explain a lower CPUE, hence and the CPUE-based biomass estimate, in this division.

Finally, I support the idea that the setting of CLs needs to be done by the Scientific Committee.’

Management area research reviews

Dissostichus spp. in Subarea 48.2

Subarea research overview

4.34 WG-FSA-16/41 Rev. 1 provided an overview of the research proposed by Chile, Ukraine and the UK in research proposals for Subarea 48.2. This research aims to work toward regional biomass distribution for *D. mawsoni*, develop stock hypotheses for *Dissostichus* spp., obtain information on biological parameters, describe by-catch species biology and distributions and collect oceanographic and bathymetric data.

4.35 The Chilean and Ukrainian research is in the central and southern areas of Subarea 48.2. The UK research is focused on the east of the subarea and aimed at identifying links between Subareas 48.2 and 48.4. The Working Group thanked Chile, Ukraine and the UK for providing an overview of the proposed research activities in Subarea 48.2 and welcomed the Gantt chart of proposed *Dissostichus* spp. research milestones for each of the proponents. The Working Group recommended the development of species-specific timetables as this research progressed and sufficient information becomes available.

4.36 The Working Group discussed possible stock hypotheses for *Dissostichus* spp. in this subarea and their connection with other areas and agreed that tagging data, including the deployment of PSATs, will be useful to inform stock hypotheses for *Dissostichus* spp. in this subarea.

Chilean survey

4.37 WG-FSA-16/35 presented preliminary results from research activities by Chile in this subarea in 2015/16. The vessel arrived on the fishing grounds late and was only able to complete 11 of the planned 30 stations before leaving the study area to avoid overlapping with planned Ukrainian research in the same area. The report showed that tagging was not completed to the standards agreed in the original survey proposal.

4.38 The Working Group recalled Annex 5, paragraph 4.49, that while the time available to complete the survey in 2015/16 was restricted, there had been no information presented as to why the condition of toothfish was too poor for tagging. The Working Group recalled it requested further information be provided at this meeting so that it could evaluate the likelihood the vessels could provide toothfish in suitable condition for tagging if the research were to proceed successfully. WG-SAM-16 also considered that this inability to provide fish in a condition for tagging should be brought to the attention of the Scientific Committee.

4.39 The Working Group noted that the vessel had used trotlines and discussed the suitability of trotlines to obtain fish in suitable condition for tagging and recalled previous research undertaken by Japan on BANZARE Bank and Ob and Lena Banks. This research found that both trotline and Spanish longline gear could obtain sufficient fish in good condition. It also noted from research surveys by Australia and Japan on BANZARE Bank (Division 58.4.3b) that the catches from autoline and trotline gear had similar species composition in areas where *Dissostichus* spp. co-occur.

4.40 WG-FSA-16/34 presented a plan by Chile to continue the longline research survey for *Dissostichus* spp. in this subarea. The proponents acknowledged the difficulties experienced in tagging last year and advised that this year's survey would be accompanied by an experienced tagging technician and the vessel would be equipped with a reanimation tank to increase the survivability of tagged fish.

4.41 The Working Group noted that the vessel proposed for research activities in 2016/17 was the same vessel that failed to meet tagging requirements in 2015/16 and proponents were not able to satisfy the Working Group of the reason for the failure to meet the tagging requirements in 2015/16.

4.42 The Working Group recalled that WG-SAM-16 (Annex 5, paragraph 4.52) requested an analysis of the spatial distribution of grenadier by-catch be presented to WG-FSA along with any information on species composition. The Working Group noted the analysis of the spatial distribution of by-catch did not include the species composition of *Macrourus* by-catch. Chile informed the Working Group that it was not able to analyse the species composition of *Macrourus* by-catch because macrourids had not been identified to species level. Noting that identifying grenadiers to species can be difficult, the Working Group referred the proponents to training resources provided by the Secretariat to assist with this.

4.43 The Working Group recalled the advice from WG-SAM-16 (Annex 5), particularly paragraph 4.49, which requested further information be provided to WG-FSA-16 to allow evaluation of the likelihood that the vessel would be able to provide toothfish in a condition suitable for tagging if the research were to proceed and to fulfil its research commitments successfully.

4.44 Having considered the proposal, the Working Group, with the exception of the Chilean participants, agreed that the advice from WG-SAM-16 regarding this proposal was clear and that it is the view of WG-FSA-16 that the proponents of this research had not followed this advice in full and, therefore, the majority is unable to support the proposed extension of the Chilean survey in 2016/17.

4.45 Mrs P. Ruiz (Chile) recognised deviations from the original proposal and also understood the Working Group's decision to not support the continuation of research, however, requested that the proposal be revaluated by the Scientific Committee.

4.46 The Working Group encouraged Chile to submit a revised proposal to WG-SAM-17 addressing the advice above and that provided by WG-SAM (Annex 5, paragraph 4.49).

Ukrainian survey

4.47 WG-FSA-16/50 provided preliminary results from the first two years of a three-year longline survey undertaken by Ukraine that aimed at estimating the status of *Dissostichus* spp. in this subarea. The Working Group welcomed the analysis of data that Ukraine has collected over the past two years and observed that in both years *D. eleginoides* were predominately observed in the north, while *D. mawsoni* dominated catches in the south of this subarea.

4.48 The Working Group discussed potential stock hypotheses for *Dissostichus* spp. in this subarea. The stock hypothesis for *D. mawsoni* proposed that large adults move from the

Weddell Sea to the southern part of this subarea to spawn, then moved away. The Working Group suggested that this hypothesis may be validated from both conventional and archival tags and PSATs.

4.49 The Working Group noted that none of the large *D. eleginoides* sampled were in spawning condition, despite some of the largest *D. eleginoides* in the Convention Area being observed here. This situation was similar to *D. eleginoides* in Subarea 48.4, which did not exhibit signs of spawning activity when sampled between March and May. The Working Group noted that many biological reasons could contribute to this, but it was presently unknown why this may occur.

4.50 WG-FSA-16/49 presented a revised plan for the third year of the Ukrainian research in Subarea 48.2. The Working Group noted that in 2015/16 the Chilean vessel had left the research area, leaving 68 of the 75 tonne catch limit available for Ukrainian research in the subarea. The catch limit was not sufficient for Ukraine to complete the research with only 27 of the 43 stations completed, including only 3 of the 18 stations in the northern area. The proponents proposed an increase to the catch limit in this subarea to allow this research to be completed in 2016/17.

4.51 The Working Group noted the difficulties experienced by Ukraine in tagging large toothfish while undertaking this research in 2015/16. The Working Group reminded Ukraine of the request from WG-SAM-16 to discuss the problems in tagging large toothfish and referred the proponents to the tagging guide maintained by the Secretariat. The proponents assured the Working Group that they would tag large toothfish that are in good condition in research planned for 2016/17 in the proportion to which they occur in the catch.

4.52 The Working Group noted that only 3 of the 18 stations in the northern area were completed by Ukraine in 2015/16 and requested that Ukraine structure its research to maximise the likelihood of completing stations in both the northern and southern areas in 2016/17.

4.53 Noting the difficulty to evaluate different methods for setting precautionary catch limits, the Working Group recommended to follow the advice from WG-SAM-16/18 Rev. 1 (Annex 5, paragraphs 2.28 to 2.30) and use the CPUE by seabed area method to determine the level of catch that would be consistent with 4% of exploitation within the proposed survey area. This established upper catch limits of 83 tonnes for the northern area and 264 tonnes for the southern area.

4.54 The Working Group supported the proposal by Ukraine to complete the third and final year of the prospecting phase of its research in Subarea 48.2 in 2016/17. Noting that the catch limits proposed by Ukraine were less than those calculated using the 4% exploitation rate, the Working Group recommended a catch limit of 20 tonnes for the northern area and 90 tonnes for the southern area for Ukraine to undertake this research in 2016/17.

UK survey in the eastern area of Subarea 48.2

4.55 WG-FSA-16/40 Rev. 1 presented a proposal by the UK for a three-year longline survey to determine *Dissostichus* spp. population connectivity between Subareas 48.2 and 48.4, and improve the available data on bathymetry and associated distributions of

benthic by-catch species. The proposal stated that survey station locations would be reviewed annually and tag-based biomass estimates provided to the Working Group when sufficient tagged fish are recaptured.

4.56 The Working Group discussed the presentation of preliminary biomass estimates in the prospecting phase of research. The Working Group recalled that it was not a requirement to provide biomass estimates in the prospecting phase of a research plan and that some of the terminology could be confusing. The flow chart provided in WG-SAM-16/18 Rev. 1 could be useful to Members in determining the requirements of a research plan.

4.57 Dr Kasatkina noted that the UK and New Zealand survey and those of Chile and Ukraine (WG-FSA-16/34 and 16/49) are aimed at providing data on *Dissostichus* spp. population structures and highlighted that the vessels used autoline while the Chilean and Ukrainian vessels used trotline. Dr Kasatkina noted that the two gear types have significant differences in hook numbers of individual vessels and requested a standard gear type be used by all research in this subarea. Dr Kasatkina noted that there is some evidence that toothfish catch and by-catch depends on gear type and requested a standard gear type be used by all research in this subarea. She was also concerned the failure to use standardised longline gear would result in additional uncertainty in the species length composition and catch rates.

4.58 Dr Kasatkina expressed concern that there was a discrepancy in how the biomass estimate was obtained using a reference area of the southern part of Subarea 48.4 using *D. mawsoni* and that the research undertaken in Subarea 48.2 involves both *Dissostichus* species.

4.59 Dr Söffker stated that the biomass estimates were calculated using the specified reference area and were provided to demonstrate that the expected catches for this effort-limited survey were conservative. The methods used to estimate the catch limits will be improved as the survey progresses and additional information becomes available.

4.60 Dr Darby clarified for the Working Group that the survey was proposed by the UK, the initial proposal (WG-SAM-16/33) had two UK-flagged vessels undertaking this research, one of these vessels was unavailable and has been replaced with a New Zealand-flagged vessel and that both vessels were autoliners and had previously fished in the adjacent Subarea 48.4.

4.61 The Working Group noted that the main objectives in the UK proposal are different to those in the proposals by Chile and Ukraine, the objectives in the research proposed by the UK are not related to catch rates or by-catch rates, and that there is no spatial overlap with the research being undertaken by Chile and Ukraine. Therefore, the gear type is not relevant and the use of the autoline gear type is not an impediment to this research taking place. The Working Group recalled research undertaken by Australia and Japan on BANZARE Bank that compared species compositions of catches obtained using trotline and autoline gear types and found them to be very similar.

4.62 The Working Group noted that no previous catch data was available for this survey proposal and agreed to calculate biomass using the 4% of the biomass estimated using the seabed analogy method (WG-FSA-16 proposed catch limit method ii). The estimated catch limits from this method were of 235 tonnes in the eastern area of Subarea 48.2 and 271 tonnes in the southern area of Subarea 48.4.

4.63 The Working Group supported the proposal by the UK for a three-year research proposal commencing in 2016/17 to develop stock hypotheses and linkages between Subareas 48.2 and 48.4. Noting that the catch limits proposed by the survey proponents were lower than the catch limit suggested by the seabed analogy method, the Working Group recommended catch limits of 23 tonnes in the eastern area of Subarea 48.2 and 18 tonnes in the southern area of Subarea 48.4 and that these limits were sufficiently precautionary to allow the survey to proceed in 2016/17.

4.64 Based on the stock hypothesis that the established fishery in Subarea 48.4 is likely to be the northern component of a larger stock of *D. mawsoni* distributed across Subareas 48.2 and 48.4, the Working Group recommended that the catch limit for this survey area should be considered separate from the catch limit in the established fishery for *D. mawsoni* in Subarea 48.4.

4.65 The Working Group discussed a variety of methods for setting precautionary catch limits when initiating a survey, before any catch data is available, undertaking research in the subsequent years of the prospecting phase before initiating surveys in research blocks. Four potential methods to calculate precautionary catch limits were discussed; they included:

Potential upper limits to the catch –

(i) 4% of the biomass estimated using the CPUE by seabed area method (Annex 5, paragraphs 2.28 to 2.30)

(ii) 4% of the biomass estimated using the seabed analogy method where (*Bx*) defined as

$$Bx = \frac{Ax}{Ar} * Br$$

where *Ax* and *Ar* were the seabed areas of the spatial boundaries proposed by WG-FSA-16/40 Rev. 1 and the Ross Sea respectively in the depth range of 600−1 800 m using the GEBCO 2014 dataset and *Br* was the current biomass from the most recent assessment of the Ross Sea.

Potential survey total catch limits for surveys where previous catch rate data are available –

(iii) the median catch rate from previous surveys multiplied by the number of proposed stations

(iv) the 75th percentile of catch rates from previous surveys multiplied by the number of proposed stations.

4.66 The Working Group noted that it could not adequately evaluate all of these methods because some of them were developed during this meeting. The Working Group requested that WG-SAM-17 evaluate the potential of all of these methods to calculate precautionary catch limits.

4.67 The Working Group noted that the survey was intended to be effort limited in its initial prospecting phase but that in some cases catch limits have been restrictive and not allowed the surveys to be completed. The Working Group discussed whether increases in the catch limits or reducing the effort, either by reducing the number of hooks set or shortening the line length, are required in such situations.

4.68 The Working Group noted that an effort-limited survey with a spatial separation of survey stations had been suggested by WG-SAM-13 (SC-CAMLR-XXXII, Annex 4, paragraph 2.7, especially (i); SC-CAMLR-XXXII, Figure 1) as an alternative to providing a catch limit for effort-limited surveys undertaken during the prospecting phase of research. An upper catch limit should still be calculated to prevent overexploitation, while at the same time allowing the survey to be completed.

4.69 The Working Group recalled the flow chart describing key aspects of prospecting, biomass estimation and assessment (SC-CAMLR-XXXII, Annex 6, Figure 10). The Working Group recommended that WG-SAM-17 consider the methodology and assumptions underlying this figure and update it as necessary to provide a reference paper that can be used by future survey proponents.

D. mawsoni in Subarea 48.5

4.70 WG-FSA-16/15 Rev. 1 presented a Russian proposal for a three-year longline survey in the eastern region of the Weddell Sea. The survey proposed to collect biological data and undertake tagging to estimate the stock status of *D. mawsoni* in Subarea 48.5.

4.71 The Working Group recalled Annex 5, paragraph 4.71, and noted that it had yet to have the opportunity to review an analysis requested by the Scientific Committee (SC-CAMLR-XXXIII, paragraph 3.232; SC-CAMLR-XXXIV, paragraphs 3.271 and 3.272) on the catch rates in Subarea 48.5 observed in the surveys undertaken by Russia in 2013 and 2014.

4.72 The Working Group recalled that the situation with this survey proposal in Subarea 48.5 has not changed since 2014 (SC-CAMLR-XXXIII, paragraphs 3.230 to 3.233), and WG-FSA was thus still unable to evaluate this research proposal in its current or previous formats. The Working Group referred to the discussions at WG-SAM-15 (SC-CAMLR-XXXIV, Annex 5, paragraph 4.10) recommending that the data concerned remain quarantined until such time that a complete analysis has been undertaken and submitted for consideration by WG-SAM, WG-FSA and the Scientific Committee. No analysis was available for WG-FSA-16 to review.

4.73 Dr Kasatkina recommended that the present proposal should be considered because it would be undertaken by a new vessel and Russia had invited another Member to participate in the survey. Dr Kasatkina further noted that a Ukrainian observer would be on board the Russian vessel for the survey.

4.74 The Working Group noted that this proposal was identical to WG-SAM-16/25 and that it was the conclusion from WG-SAM-16 (Annex 5, paragraph 4.74) that the proposed survey design was not suitable and had been based on quarantined data.

4.75 At the time of adoption, Dr Kasatkina stated that the situation of the quarantined Russian data is the responsibility of SCIC but not of WG-FSA.

4.76 The Working Group noted that the maps provided in WG-FSA-16/15 Rev. 1 showed varied sea conditions and difficult sea-ice conditions in the proposed working areas and their access routes and questioned how likely it was that vessels would be able to return to research locations to recapture tagged fish.

4.77 Dr Kasatkina noted that an analysis of sea-ice conditions was provided in WG-FSA-16/15 Rev. 1. According to this analysis and experience from previous surveys, vessels would be able to carry out the survey with the proposed design.

4.78 The Working Group recalled the advice from WG-SAM-16 to undertake a sea-ice analysis using the method proposed by WG-FSA-14/54 and encouraged Russia to liaise with the Secretariat to undertake such an analysis.

Dissostichus spp. in Subarea 48.6

4.79 The exploratory fishery for *Dissostichus* spp. in Subarea 48.6 operated in accordance with CM 41-04 and associated measures. In 2015/16, the catch limit for *Dissostichus* spp. was 538 tonnes. Fishing was conducted by two vessels using longlines, and the total reported catch up to 14 September 2016 was 240 tonnes. Fishing was carried out in research blocks 486_1 to 486_4 and a total of 40 tagged *D. mawsoni* and four tagged *D. eleginoides* were recaptured. Details of this fishery and the stock assessment are contained in the Fishery Report.

4.80 The Working Group noted that WG-SAM-16 had considered five papers relating to research plans and results of research conducted in Subarea 48.6 and had made a number of recommendations concerning the research proposals for 2016/17 (Annex 5, paragraph 3.40). These included focusing on *D. mawsoni* in research blocks 486_2, _3 and _4 and the use of PSATs to provide data on movement between research blocks to help develop the stock hypothesis. It also recommended further analyses be carried out and a report submitted to WG-SAM-17, including analyses of sea-ice dynamics in the continental shelf region and an analysis of tag movement data to assist with the development of the stock hypothesis.

4.81 The Working Group considered three papers – an updated progress report by Japan and South Africa (WG-FSA-16/56), an updated joint proposal to continue research fishing in Subarea 48.6 submitted by Japan and South Africa (WG-FSA-16/32 Rev. 1) and a proposal for three years of planned research fishing by Uruguay (WG-FSA-16/59).

4.82 WG-FSA-16/56 showed that there had been eight between-season tag recaptures from research block 486_3 and 11 between-season tag recaptures from research block 486_4. The report also summarised the timeline for various activities for the next five years, culminating in a stock assessment in 2020.

4.83 The Working Group welcomed the development of timelines in the research plan. It noted that the research proponents had dropped research block 486_1 as requested by WG-SAM and would now focus on research blocks 486_2, _3 and _4 during 2016/17. Research fishing would now focus primarily on *D. mawsoni* which should be reflected in the conservation measure for this area.

4.84 The Working Group noted that details about PSATs were still being developed, including the number of tags to be released, who would be deploying them and where they would best be deployed. The Working Group recalled discussions at WG-SAM (Annex 5, paragraphs 3.29 and 3.30) where it was considered that deployment in ice-free areas in research blocks 486_2 and _3 might be more useful rather than research block _4 which was often covered in sea-ice.

4.85 The Working Group discussed the timeline for the development of an integrated assessment for this subarea. It noted that there had already been four years of research, and that the plan indicated that a preliminary CASAL model was planned for 2017 and a final model for 2020. The Working Group recalled that the integrated stock assessment of *D. mawsoni* in the Ross Sea had taken about six years from the onset of tagging in 2000 until the acceptance of the model by the Scientific Committee in 2006. The Working Group noted that it may be more difficult here where there is a high degree of variability in sea-ice affecting the ability to release and recover tagged fish that will provide adequate data for an integrated assessment within a specific period of time. The Working Group agreed that it was difficult to forecast the time required to achieve a full stock assessment and that the Scientific Committee and Commission should have a realistic expectation about how long this takes.

4.86 The Working Group noted that the time to develop stock assessments was longer than initially thought, and that this needs to be taken into account when considering uncertainty and setting precautionary catch limits in these areas.

4.87 The revised joint research plan by Japan and South Africa for the 2016/17 fishery (WG-FSA-16/32) included an update of the hypothetical life cycle for *D. mawsoni* in this subarea and the adjacent Divisions 58.4.1 and 58.4.2, biomass estimates for research blocks based on Chapman and CPUE by seabed analogy, and the results of a preliminary stock assessment for *D. mawsoni* in research block 486_2.

4.88 The Working Group agreed that the hypothetical life cycle was very useful and encouraged further work in this area. It noted that most tagged fish in research blocks 486_2 and _3 were recaptured within 1–2 years of liberty, whereas fish on the continental margin in research block 486_4 were still recaptured after four years at liberty. The Working Group also noted that this was similar to the situation in Subarea 88.1, where fish in the north were generally caught within 1–2 years at liberty, while fish on the slope and shelf of the Ross Sea were still recaptured after 10 years at liberty (WG-FSA-15/39).

4.89 The Working Group also discussed progress on the preliminary CASAL assessment model in research block 486_2. The Working Group noted the increasing prevalence of IUU fishing in this subarea in recent years (WG-FSA-16/24) and discussed how to incorporate the uncertainty arising from the unknown IUU catches into the stock assessment models. The Working Group noted that the lack of knowledge over IUU catches had also limited the development of CASAL stock assessments in Divisions 58.4.3a and 58.4.4 (e.g. SC-CAMLR-XXXIV, Annex 7, paragraphs 6.92 and 6.93).

4.90 The Working Group thanked Dr K. Taki (Japan) for the large amount of work that he and his colleagues had done in trying to develop stock assessments of toothfish in Subarea 48.6 and other divisions and acknowledged the difficulties that the lack of information on IUU catches posed. The Working Group also noted that if IUU catches were likely to form a substantial part of the overall catch, then it was necessary to include those IUU catches into a stock assessment so that an estimate of B_0 and hence stock status could be estimated. Estimates of B_0 and stock status are also necessary for projections to be carried out and management advice to be provided in accordance with CCAMLR decision rules. Therefore, there was a need to develop a methodology, at least in the short term, for developing an approach for providing precautionary management advice on toothfish which may not require an estimate of B_0 (SC-CAMLR-XXXIV, Annex 7, paragraph 4.117).

4.91 The Working Group also agreed that, while there might be considerable uncertainty in the estimate of B_0 from the CASAL assessments, the estimates of current biomass arising from the assessments would be less uncertain. It considered that these could potentially be used to provide estimates of recent trends in stock size.

4.92 The Working Group considered that this was a matter which needed to be addressed with some urgency and agreed that this would be a useful focus topic for WG-SAM. It requested WG-SAM consider the following questions:

(i) Can we bound the likely estimates of IUU catches in these locations?
(ii) How can we use recent trends in stock size in management advice?
(iii) How can we formalise uncertainty in IUU into the assessment?
(iv) Is there a precautionary harvest rate that can be used until a formal stock assessment can be carried out?

4.93 The Working Group noted that currently no procedure had been established on how to progress from the estimation of toothfish biomass for a research block to the development of a stock assessment for an entire division or subarea. It also noted that there may be a need to collect additional data to facilitate this procedure and that consideration of these factors could also be included in the recommended focus topic for WG-SAM-17.

4.94 Dr T. Namba (Japan) presented some preliminary options for changes to the research block boundaries in Subarea 48.6. He noted that Japan would like to retain the same catch limit for research block 486_2 but to extend or change its boundaries to better understand the distribution of *D. mawsoni* in this region and to fully utilise the existing catch limits. He presented three options for alternative research blocks which had similar underlying water temperatures at 2 000 m. He also noted that Japan had been unable to conduct fishing in research block 486_5 due to heavy ice conditions and suggested that a new research block be included in a potential spawning area in SSRU 5842A (in the southwest of Division 58.4.2).

4.95 The Working Group noted that the water temperatures in research block 486_2 were based on modelled data and recommended that conductivity temperature depth probe (CTD) data loggers be deployed on the longlines so that the relationship between water temperature and depth and catch rates could be better evaluated. Dr Namba informed the Working Group that Japan was hoping to deploy data loggers in the near future.

4.96 The Working Group noted that at the WG-SAM-16 meeting, Japan had proposed an extension of research block 486_2 to the northeast, which would increase the possibility of the catch limit being taken, but could dilute the fishing effort in the current research block (Annex 5, paragraphs 3.33 to 3.35). In one of the preliminary options presented to the meeting, the western part of research block 486_2 would be replaced by a new research block.

4.97 The Working Group noted that research block 486_5 had not been revisited in the last three years due to ice conditions and agreed that there could be few tagged fish available for recapture. However, it noted that the new proposed research block under consideration in the south was in a different division and questioned whether there were any other regions on the continental shelf/slope within Subarea 48.6 that could be used as an alternate research block. The proponents of the research plan indicated that a proposal to extend research block 486_2 and to develop a new research block on the continental shelf region would be submitted to

WG-SAM-17. The Working Group requested Japan provide information on the resulting changes in the numbers of available tagged fish in the research blocks under the various options.

4.98 The Working Group also considered an updated three-year research plan by Uruguay to conduct fishing in Subarea 48.6 (WG-FSA-16/59). The proposal is based on the joint Japanese/South African research with several additional features, including the deployment of 12 PSATs, otolith microchemistry analysis, the use of cameras to monitor target catch and by-catch species, the tagging of skates in accordance with Year-of-the-Skate protocols and an analysis of differences in skate by-catch between Subareas 48.3/48.4 and 48.6. The proposal considered that it would use up to 50% of the total catch limits currently in place for the subarea.

4.99 The Working Group noted that WG-SAM had requested several revisions to the previous proposal, including clarification of the science objectives, plans for analysis of samples, and other data inputs for stock assessments (Annex 5, paragraphs 3.38 and 3.39). It had also recommended that Uruguay collaborate with Japan and South Africa over both on-water and off-water activities.

4.100 The Working Group noted that the scientific objectives in the revised plan were essentially unchanged from that submitted in the paper to WG-SAM (WG-SAM-16/12). However, the revised plan had included a timetable of the various on-water and off-water activities, including analysis of samples and data analysis continuing out to 2019.

4.101 The Working Group also discussed the level of cooperation that occurred amongst research proponents. It noted that there was evidence of close collaboration between South Africa and Japan in WG-FSA-16/32 Rev. 1 and 16/56, while an independent proposal had been submitted by Uruguay (WG-FSA-16/59). The Working Group noted that the proposal by Uruguay was not available for consideration by the Working Group until 10 days after the paper submission deadline.

4.102 The Working Group noted that the proposal by Uruguay stated that it would work with Japanese and South African scientists to ensure there was no spatial or temporal overlap between the vessels. The Working Group questioned whether this was a useful aspect of the survey design and noted that research designs that allowed for comparisons between different vessels when taking into account spatial and temporal variability could also be considered.

4.103 The Working Group noted that only two skates had been reported as by-catch from this subarea since 2004 (Fishery Report 2016: Exploratory fishery for *Dissostichus* spp. in Subarea 48.6, Table 4). It agreed that it would be useful to collect data from the subarea using another vessel and gear type to better understand the reason for the lack of skate by-catch in this subarea.

4.104 The Working Group examined trends in unstandardised CPUE in each of the research blocks and noted that there had been a decline in CPUE in research block 486_3 over the last three years. Dr Taki noted that this was partly because the *Koryo Maru No. 11* had started fishing in this research block in which it had less experience and a lower CPUE and there had also been fishing on an eastern seamount in the research block which also had a lower CPUE. When the CPUE was recalculated excluding these data, the trend increased and then declined in the final year.

4.105 Dr A. Constable (Australia) considered that if the time series of CPUE is rejected, then the time series of tag data should also be rejected.

4.106 The Working Group noted that the catch limit of 50 tonnes in this research block had been taken in each of the last three years. It also considered that if the research catch was set at 7 tonnes (the lowest value from Table 1) then this was unlikely to provide sufficient tag recaptures to develop an assessment for this research block.

4.107 Dr Ichii noted that in some research blocks there have been sufficient tags recaptured to have reliable Chapman estimates. For example, in research block 486_3, five between-season tagged fish had been recaptured in 2014/15 and eight between-season tagged fish had been recaptured in 2015/16. The median biomass and 95% confidence intervals of the Chapman biomass estimates from this research block were calculated by Dr Taki in WG-FSA-16/32 Rev. 1 for each year of recapture. Even when only the first year of recaptures was considered, the biomass estimate at the lower 95% confidence intervals for each of the past two years equalled 1 256 (2015) and 1 303 (2016) tonnes and suggested a catch limit of 50 to 52 tonnes at an exploitation rate of 4%. He therefore considered that the retention of the existing catch limit of 50 tonnes was sufficiently precautionary.

4.108 The Working Group supported WG-SAM in its desire to progress the development and consideration of variance and associated confidence intervals when using these biomass estimates for providing advice (Annex 5, paragraphs 2.44 and 2.45) and noted that this is important to the development of WG-FSA's advice to the Scientific Committee (paragraph 4.21).

Dissostichus spp. in Divisions 58.4.1 and 58.4.2

4.109 The exploratory fisheries for *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2 operated in accordance with CMs 41-11 and 41-05 respectively, along with associated conservation measures, in 2015/16.

4.110 In 2015/16, the catch limit for *Dissostichus* spp. was 660 tonnes in Division 58.4.1 and 35 tonnes in Division 58.4.2. Fishing in Division 58.4.1 was conducted by three vessels using longlines, with the total reported catch up to 14 September 2016 of 402 tonnes. No fishing had been conducted in Division 58.4.2 to 14 September 2016. Details of these fisheries are contained in the Fishery Reports.

4.111 For 2016/17, a total of five vessels, one each from Australia, France, Japan, the Republic of Korea and Spain, have notified their intention to participate in the exploratory fishery for *Dissostichus* spp. in Divisions 58.4.1 or 58.4.2.

4.112 WG-FSA-16/30 described the recent history of exploratory fishing between 2011/12 and 2015/16 in Divisions 58.4.1 and 58.4.2. Four of the notifying Members have conducted research fishing during this period, Australia (commenced 2015/16), Japan (commenced 2012/13), Korea (commenced 2011/12) and Spain (commenced 2012/13), while France plans to start in 2016/17.

4.113 WG-FSA-16/29 described the coordinated research objectives, milestones and a plan for the allocation of catches in Divisions 58.4.1 and 58.4.2 among the five notifying

Members. This coordinated proposal includes updated research plans of Australia, France, Japan, Korea and Spain, as discussed in WG-SAM-16 (Annex 5, paragraphs 3.12 to 3.14).

4.114 Research fishing has occurred in all research blocks in Division 58.4.1 (i.e. 5841_1 to 5841_5) and research block 5842_1 in Division 58.4.2. Spain has conducted additional sampling outside of research blocks across multiple years within SSRUs 5841C, D, G and H to collect data for the estimation of local biomass using depletion experiments and tagging.

4.115 Research activities in six existing research blocks (5841_1, 5841_2, 5841_3, 5841_4, 5841_5, 5842_1) plus a new proposed research block (5841_6) were proposed for 2016/17. The new proposed research block is to recapture fish tagged by Spain (from 2012 to 2016) and Australia (2016). These locations are expected to contain the highest concentration of previously tagged fish and are likely to be accessible.

4.116 Four research objectives and associated annual milestones were described in WG-FSA-16/29:

(i) collect data required for an assessment of the status and productivity of toothfish stocks in Divisions 58.4.1 and 58.4.2

(ii) collect and utilise environmental data to inform spatial management approaches

(iii) collect data on the spatial and depth distributions of by-catch species

(iv) improve understanding of trophic relationships and ecosystem function.

4.117 WG-FSA-16/29 proposed that notifying Members will confirm whether they intend to pursue research by SC CIRC by 1 January 2017. If any Members are not able to confirm that they will pursue research, their allocation will be evenly redistributed amongst the other notifying Members that have confirmed they will pursue research. If any Members have not commenced research fishing by 28 February 2017, their allocation will also be evenly redistributed amongst the other Members that have commenced research fishing, or in another way agreed by all of these other Members.

4.118 The Working Group recommended that the new proposed research block 5841_6 should be opened on an interim basis, with the results to be reviewed by WG-SAM and WG-FSA in 2017.

4.119 The Working Group welcomed plans for increased coordination between all proponents of research in Divisions 58.4.1 and 58.4.2 to facilitate progress towards stock assessment in these divisions, as requested by WG-SAM-16. The joint, multi-Member research proposal reduced the number of proposals for these divisions from several papers submitted by each proponent to WG-SAM-16, to one paper covering the same research at WG-FSA-16.

4.120 The Working Group agreed that the research plan in WG-FSA-16/29 was appropriate to achieve its objectives.

4.121 WG-FSA-16/06 presented information on the diet composition of *D. mawsoni* in Divisions 58.4.1 and 58.4.2 inferred from fatty acid stable isotope analysis. This study found no significant difference of isotope ratios among sampling area, body size, sex and gonadal maturity groups, indicating the captured fish occupied a similar trophic level.

4.122 WG-FSA-16/07 summarised research by the Republic of Korea concerning the occurrence of perfluorinated compounds in muscle tissues of *D. mawsoni* in Divisions 58.4.1 and 58.4.2. The Working Group requested the Scientific Committee consider a review of bioaccumulation in Antarctic fauna, particularly its potential effects on toothfish reproduction.

4.123 WG-FSA-16/08 summarised the results of a PSAT study on *D. mawsoni* in the Mawson Sea. Information representing the vertical movements from one tagged fish over 366 days was separated into four periods representing different ranges in vertical movements during each period.

4.124 The Working Group discussed whether some of the vertical movements reported in the Korean study might be related to spawning behaviour, such as depth of spawning, because it occurred during late winter when *D. mawsoni* are known to spawn, and further noted that Japan is planning to conduct experiments using PSATs in Subarea 58.4 in the future. The Working Group also noted that behavioural data from PSAT studies could be combined with oceanographic models in the future to evaluate stock hypotheses in these divisions.

4.125 WG-FSA-16/58 presented work on the age and growth of *D. mawsoni* in Division 58.4.1 by Spain from otoliths collected on research fishing in 2012/13, 2013/14 and 2015/16. Preliminary age–length keys have been presented from over 1 000 otoliths collected in the first two seasons. Spain intends to age the otoliths collected in 2015/16 as well as re-read the otoliths from 2013/14 to evaluate inter-reader variation in age estimation. It expects to present the final results to WG-SAM-17.

4.126 The Working Group discussed the merit in having a coordinated and/or centralised ageing program for *D. mawsoni* in the CCAMLR area. It noted that a coordinated and/or centralised ageing program could be particularly important for exploratory fisheries and requested that the Scientific Committee consider mechanisms to facilitate funding and implementing a coordinated and/or centralised ageing program for *D. mawsoni*.

D. eleginoides in Division 58.4.3a

4.127 The exploratory fishery for *D. eleginoides* in Division 58.4.3a operated in accordance with CM 41-06 and associated measures. In 2015/16, the catch limit for *D. eleginoides* was 32 tonnes and no fishing had been conducted to 14 September 2016. Details of this fishery and the stock assessment are contained in the Fishery Report.

4.128 WG-FSA-16/55 presented the research plan for the exploratory longline fishery for *D. eleginoides* in 2016/17 in Division 58.4.3a by France and Japan. The biomass in Division 58.4.3a was estimated at 603 tonnes using the Chapman method with a single-population approach. In response to WG-SAM-16 (Annex 5, paragraph 3.18), WG-FSA-16/55 highlighted plans of France and Japan to develop a procedure to estimate IUU removals in Division 58.4.3a for presentation to WG-SAM-17.

4.129 The Working Group noted that, due to technical issues with the *Saint André*, France does not intend to fish in Division 58.4.3a in the end of the 2015/16 season. France noted that the catch limit for the end of 2015/16 would be available to Japan.

4.130 The Working Group thanked the proponents for their multi-Member research plan and considered that the coordination between proponents will accelerate progress towards the development of robust management advice. The Working Group welcomed plans for an intersessional meeting between France and Japan in January 2017.

4.131 The Working Group noted that the variable timing of fishing in Division 58.4.3a towards the end of the fishing season can create a situation where the vessels fish the catch limits for two fishing seasons back-to-back within the same voyage. The Working Group noted that:

(i) such a seasonal fishing pattern could cause a high fishing mortality on the fish stock within a short period

(ii) this should be considered when making assumptions about the timing of natural mortality and tag recapture within models that utilise tagging data

(iii) tagged fish were unlikely to mix between release in the first fishing season and recapture in the subsequent season.

4.132 The Working Group recommended that a monthly time step be used in tag-recapture models to estimate biomass that can account for variable timing of fishing and that a minimum period of time at liberty between tagging and recapture of a fish should be introduced (such as the six months currently used in the toothfish assessment in Division 58.5.1). The Working Group also recommended that further investigations on the implications of double fishing mortality in fish stocks during a short time be undertaken in the intersessional period, such that the potential for spatial and temporal concentration of fishing mortality can be considered when setting catch limits.

4.133 The Working Group noted that the 4% exploitation rate for research block 5843a_1, based on the Chapman biomass estimate, was 52 tonnes (Table 1).

Management advice

4.134 The Working Group supported the continuation of the proposed research in Division 58.4.3a. The Working Group recommended that the catch limit for this division remain unchanged at 32 tonnes for 2016/17.

D. eleginoides in Divisions 58.4.4a and 58.4.4b

4.135 The Working Group noted one French- and one Japanese-flagged vessel conducted research fishing in Division 58.4.4b in 2015/16 under CM 24-01, with a research catch limit for *D. eleginoides* of 25 tonnes in research block 5844b_1 and 35 tonnes in research block 5844b_2 for 2015/16 (SC-CAMLR-XXXIV, paragraphs 3.265 and 3.267). No research fishing had taken place in this division in 2015/16 by the time of the meeting of WG-FSA-16.

4.136 WG-FSA-16/33 Rev. 1 presented the revised research plan for the 2016/17 toothfish fishery in Division 58.4.4b by Japan and France. Median stock sizes in research

blocks 5844b_1 and 5844b_2 were estimated using both the Chapman and seabed analogy methods. Biological data were discussed in the context of toothfish stock hypotheses for this region. WG-FSA-16/33 Rev. 1 also presented data on the spatio–temporal occurrence of whales (mainly killer whales (*Orcinus orca*)) and observed interactions between whales and fishing operations. The proponents intend to continue this research in 2016/17 with the same survey design.

4.137 The Working Group noted that, due to technical issues with the *Saint André*, France does not intend to fish in Division 58.4.4b in the end of the 2015/16 season. France noted that the catch limit for the end of 2015/16 would be available to Japan.

4.138 The Working Group noted that orcas are photographed on an opportunistic basis for the purpose of identification of individuals, and that depredation rates have been considered, however, no recent estimates are currently available. The Working Group also highlighted the need to consider whether depredation would affect availability of tagged fish in this fishery (e.g. if tagged fish are released when killer whales are near the fishing vessel).

4.139 WG-FSA-16/33 Rev. 1 outlined the intention of Japan and France to investigate toothfish movements using PSATs and to provide a tagging plan to WG-SAM-17. The Working Group welcomed plans for ongoing investigation of toothfish movements in this area.

4.140 The Working Group noted that, while providing new knowledge on vertical movement of toothfish, satellite tagging has to date given very little information on the horizontal movements of toothfish due to the difficulty of establishing fish positions. The Working Group recommended intersessional discussion between interested Members about methods to estimate the geographic locations of tagged fish, necessary numbers of satellite tags and the most appropriate tagging regimes.

4.141 The Working Group noted that candidate catch limits for this division for 2016/17 are 14 tonnes in research block 5844b_1 (based on a Chapman biomass estimate) and 20 tonnes in research block 5844b_2 (based on a CPUE by seabed area biomass estimate). These candidate catch limits are based on (i) the approaches to estimating biomass that were agreed at WG-SAM-16, (ii) an exploitation rate of 4%, and (iii) selection of the smaller candidate catch limit (Table 1).

4.142 Mr Rigaud suggested that the current catch limit be carried forward to the forthcoming season (paragraphs 4.32 and 4.33).

4.143 Mr Rigaud noted that the method for determining catch limits should be consistent across research blocks 5844b_1 and 5844b_2.

Management advice

4.144 The Working Group supported the continuation of this research program. Paragraphs 4.18 to 4.34 summarise the discussion across the Working Group regarding research catch limits.

D. mawsoni in Subarea 88.3

4.145 The Scientific Committee agreed to one Korean-flagged vessel conducting research fishing in Subarea 88.3 in 2015/16 under CM 24-01, with a total research catch limit for *D. mawsoni* of 171 tonnes across five research blocks in 2015/16 (SC-CAMLR-XXXIV, paragraph 3.288). Research fishing took place in February and March 2016 with a catch of 106 tonnes of *D. mawsoni* (WG-SAM-16/29).

4.146 WG-SAM-16 reviewed the results from research activities undertaken by the Republic of Korea (WG-SAM-16/29) and the proposal for continuation of this research (WG-SAM-16/11). No issues were identified with these submissions at WG-SAM-16. Therefore, WG-SAM-16/29 and 16/11 were resubmitted to WG-FSA-16.

4.147 The Working Group supported the proposal presented by Korea on the basis that (i) there were no issues identified in the proposal at WG-SAM-16 (Annex 5, paragraph 4.37) and (ii) that no changes have been made to the proposal since WG-SAM-16.

4.148 The Working Group recommended that advice from the Scientific Committee (SC-CAMLR-XXXIV, paragraph 3.290) on this research proposal would remain in place such that the priority for research should be research blocks 883_3 (with a catch limit of 31 tonnes) and 883_4 (52 tonnes) given the previous tagging in those areas. Research block 883_5 (38 tonnes) would be a secondary priority, with research blocks 883_1 (21 tonnes) and 883_2 (29 tonnes) a tertiary priority, should ice conditions allow.

Notothenioids in Subarea 48.1

4.149 The Working Group considered five papers that reported on the results and proposal for a Chilean research survey around Elephant Island and the South Orkney Islands in Subareas 48.1 and 48.2 which included the results of the hydroacoustic survey (WG-FSA-16/21), analysis of bird assemblages (WG-FSA-16/20), analysis of spawning patterns of notothenioids (WG-FSA-16/22), report on cetacean survey (WG-FSA-16/19) and the proposal for the continuation of the research of fish distribution into the second year around Subareas 48.1 and 48.2 (WG-FSA-16/31).

4.150 WG-FSA-16/31 reported on the proposal for the trawl and midwater research plan for the second year around Elephant Island and the South Orkney Islands by Chile. A revised version of this plan was also presented during the meeting where catches that were proposed in the original paper were unchanged from 50 tonnes in Subarea 48.1 and 50 tonnes in Subarea 48.2 and the increase in number of trawls (from 40 to 80) to be sampled around both islands.

4.151 The Working Group recalled the discussion and a recommendation by WG-SAM-16 regarding the plan as presented in WG-FSA-16/31, particularly the difference between what was proposed by Chile in its 2015 research proposal and agreed by the Scientific Committee in 2015 and the outcome from the survey that took place when the research was conducted in 2016 (Annex 5, paragraphs 4.63 to 4.67).

4.152 The Working Group noted the proposed changes made to the proposal during WG-FSA-16. It noted a lack of clarity in rolling over catch limits which were set based on the

particular design of the research plan, and the long-term objectives of the research and their relevance to CCAMLR work. It further noted concerns about spatial scale in which the research is to be conducted (Subareas 48.1 and 48.2) where the catchability of both midwater and bottom trawl are to be compared and the Working Group noted that this research could be focused in one subarea. The Working Group recalled previous demersal fish bottom trawl research that has been conducted by Germany and the USA in these areas and that there could be value to CCAMLR if Chile could initiate a similarly designed survey.

4.153 The Working Group thanked Chile for presenting the revised plan and recommended that the revised research plan be presented to WG-SAM-17 and WG-FSA-17 for a full revaluation due to the limited time available to investigate various changes that have been made to the plan.

4.154 The Working Group welcomed, and thanked Chile for presenting, the analysis of the ancillary data (WG-FSA-16/20, 16/22 and 16/19) and it highlighted the importance of recording and analysis of data on various components of the ecosystem when it is possible to do so during the fish surveys. The Working Group further expressed its desire for this kind of work to be shared with other CCAMLR working groups such as WG-EMM and possibly other management organisations such as the International Whaling Commission (IWC).

4.155 The Working Group noted the results of the acoustic and trawl surveys presented by Chile (WG-FSA-16/21). It also noted that there could be a benefit if acoustic data were presented to SG-ASAM and other acoustic surveys previously done be taken into account when *C. gunnari* acoustic survey data are analysed.

Scheme of International Scientific Observation (SISO)

5.1 Data collected by scientific observers on longline and finfish trawl vessels operating in the Convention Area during 2015/16, based on data received up to 19 September 2016 (WG-FSA-16/01), were presented by the Secretariat. The Secretariat noted that this season the French seabird mortality data were analysed in a format consistent with other subareas and divisions, which allowed the seabird mortality tables to be simplified. Overall, it was noted that seabird by-catch figures for this season were slightly higher than in the past few reporting periods, however, they were still at low levels compared with historic data.

5.2 Preliminary results on conversion factor data collection trials voluntarily carried out by South African observers were also presented. While the results were limited due to a low number of comparable processing codes and cut types between vessels, they did show significant variability in conversion factors between a small number of vessels, with the position of the cut on the fish a significant explanatory variable in conversion factor differences. The Working Group thanked the South African observers for the voluntary collection of extra data. The Secretariat noted that more data are required to assess conversion factor variability across the fleet, and invited more Members to participate in the trial in the coming season. Mr Maschette noted that observers on Australian vessels would be willing to assist in further data collection trials.

5.3 The Working Group thanked all Scheme of International Scientific Observation (SISO) observers for their contribution to scientific data collection this season. Collectively, the observers in the Convention Area have collected over 500 000 biometric measurements in 2015/16.

5.4 A new guide for by-catch taxa in the longline and krill trawl fisheries was presented by the Secretariat (WG-FSA-16/17) after development with Members during the last intersessional period. The Working Group thanked the Secretariat for collating various identification guides and commented favourably on the content and format of the new guide. The Secretariat noted that this guide can be developed more if Members desired and requested Members to provide more images and materials to contribute to future editions.

5.5 Dr Söffker presented WG-FSA-16/43 detailing a camera monitoring trial for collection of catch and by-catch data in Subarea 48.3. The system showed advantages for the observer in terms of safety and reducing time spent collecting data during hauling. Comparison between numbers recorded at hauling and numbers seen whilst viewing the video showed very consistent agreement, other than for small organisms with more small taxa noted by observers. It was noted that the use of video analysis software was likely to allow for data analysis automation.

5.6 The Working Group noted that camera monitoring may help reduce variability in proportions of target species to non-target species reported within some fisheries. For example, it noted that a trial of this kind of monitoring may be useful in other areas such as Subarea 88.1 where there appear to be different by-catch rates across gear types and Members (WG-FSA-15/04 Rev. 1). The Working Group noted that any progress towards a trial would require a 'step-wise' approach with regard to implementation.

5.7 Mr Gasco presented an updated tool for observer training in identification of a range of broad taxonomic groups including benthos, fish species, whales and birds (WG-FSA-16/11). The tool allows the observer to train at their own pace and is currently being used by French observers.

5.8 The Working Group noted that this updated tool for training, along with all of the images from the CCAMLR by-catch guide, are available for Members' use from the CCAMLR website.

5.9 The Working Group thanked Mr Gasco for developing and providing this new tool, and noted that Mr Gasco has provided a number of valuable tools to Members at no cost, which have helped standardise the training of, and data collection by, observers across the Convention Area.

5.10 Consideration of additional observer matters in relation to by-catch identification is set out in paragraphs 5.11 to 5.14 and 6.21.

5.11 The Working Group welcomed the continuous effort to improve the quality of data collected by scientific observers. To facilitate this and to validate the data for by-catch species currently being submitted, the Working Group considered that more dedicated efforts to compile a photographic catalogue of fish was of high importance in all fisheries, especially for icefish species in krill trawl fisheries.

5.12 The Working Group encouraged national coordinators to provide SISO observers with cameras that allow close-up photography of fish, so that observers can take photographs of good-quality specimens of each species identified in a trip using the following guidelines:

(i) high-quality specimens of identified by-catch fish species encountered should be photographed in fresh condition

(ii) one or two photographs of each species should be taken on a neutral background and with the CCAMLR tag photo template in view

(iii) additional photographs should be taken of any unknown species, or if specimens are taken outside their known geographic, depth or size range

(iv) verified photos should then be submitted to the CCAMLR Secretariat through the observer's technical coordinator

(v) for national observer programs that are collecting samples of by-catch species for genetic analysis, the Working Group requested that national observers take photographs of fresh specimens prior to their analysis in the laboratory, and these photographs be supplied to the Secretariat along with the verified species identification from the genetic or morphometric analysis.

5.13 The Working Group also noted that many national programs already make use of reference collections, especially for the smaller fish species taken in krill and trawl fisheries. The Working Group encouraged all national programs to maintain such a reference collection to assist with training national and SISO observers.

5.14 The Working Group noted that SISO requirements and issues are relevant to the agendas of a number of working groups. This can result in delays in implementing changes on the forms or the instructions for observers, particularly for SISO discussions undertaken during WG-FSA, as any changes are not able to be circulated in time for the new season. The Working Group recommended the Scientific Committee consider the establishment of a dedicated SISO Working Group that could potentially convene in parallel to the other working groups and report to WG-FSA and the Scientific Committee, similar to the operation of the ad hoc Technical Group for At-Sea Operations (TASO) (SC-CAMLR-XXXIV, Annex 6, paragraph 2.43).

Non-target catch and interactions in CCAMLR fisheries

Fish and invertebrate by-catch

6.1 The Secretariat presented WG-FSA-16/04 that provided an update on the fish by-catch in the krill fishery using data from SISO and commercial data to examine the frequency of occurrence, proportion by mass, length-frequency distribution and geographic provenance of the key fish taxa reported. The estimated total annual mass of fish by-catch in a 300 000 tonne krill fishery would be 370 tonnes, comprising 40% *C. gunnari* and 30% *L. larseni*. The length-frequency distribution of all taxa for which >100 fish were measured had a modal size class of <10 cm. The fish species taken as by-catch in the krill fishery are the same species (and size classes) as those reported in the diet of 'krill-dependent' predators.

6.2 The Working Group noted that the recent data indicated that the structured and systematic data collection on fish by-catch in the krill fishery now provides the opportunity for the quantification of fish by-catch and may enable the population dynamics of those finfish species taken in the krill fishery to be monitored more effectively. The Working Group also noted that there may be some difficulties in scaling up total fish by-catch estimates from observer samples on vessels using the continuous fishing system where the catch reported for the two-hour period when the fish by-catch samples was collected may not actually reflect the catch in that period (Annex 6, paragraphs 2.18 and 2.19).

6.3 The Working Group reiterated the need for correct species identifications, including for the early juvenile stages of species that closely resemble each other (e.g. ocellated icefish (*Chionodraco rastrospinosus*) and crocodile icefish (*C. hamatus*)), for which correct identification remains difficult (paragraph 5.12).

6.4 The Working Group recalled that identification guides to improve the identification of fish species that occur as by-catch in krill fisheries are available, including those compiled by CCAMLR in its SISO (WG-FSA-16/17), and guides produced in Japan and the Republic of Korea. The most comprehensive account describing the early life stages of Antarctic fish is still the work of Kellermann (1989). Modern techniques (e.g. microphotography and genetics) may also allow for improved identification and the Working Group encouraged efforts by Members to continue to refine tools available to vessels and observers to provide accurate identification and quantification of by-catch.

6.5 WG-EMM-16/P09 examined the potential relationships between historic fishing on notothenioid taxa and Antarctic shag (*Phalacrocorax bransfieldensis*) by considering the diet of shag as a method of understanding fish dynamics. Results obtained through this method were consistent with results obtained during the US AMLR Program and the German demersal fish program in the South Shetland Islands that used net sampling for marbled rockcod (*Notothenia rossii*) and humped rockcod (*Gobionotothen gibberifrons*) over a period of almost 30 years. The Working Group suggested that research on tracking recruits of *N. rossii* on their way to the offshore adult population would be augmented through a tagging program.

6.6 WG-FSA-16/02 provided an update of a time series of trammel net catches in Potter Cove (King George Islands). The Working Group noted that interpreting these data was difficult as the causes of the patterns seen are likely to be multifactorial, for example, trajectories may differ considerably between species such as *N. rossii* and *G. gibberifrons*. The current development of the two stocks provides no indication that a fishery on the two stocks could be reopened and, therefore, the Working Group agreed with the conclusions of the paper that the current conservation measures preventing targeting of these stocks should remain in place.

6.7 Three species of skate, Eaton's skate (*Bathyraja eatonii*), Kerguelen sandpaper skate (*B. irrasa*) and Murray's skate (*B. murrayi*), are commonly taken as incidental by-catch in fisheries for *D. eleginoides* and *C. gunnari* on the Kerguelen Plateau in the southern Indian Ocean (WG-FSA-16/P03). Data from fishery observations from 1997 to 2014 show that the three skates were distributed widely across the Kerguelen Plateau, showing different spatial distributions, linked mainly with depth. The catch rates of skates from the trawl fisheries in the Australian EEZ surrounding Heard Island and McDonald Islands (HIMI) have shown little evidence of depletion on the main trawl fishing grounds. There was evidence of a decrease in

the average total length of *B. eatonii* and further studies of this are required. The paper concluded that the marine reserves and the conservation measures employed by CCAMLR in the HIMI fisheries appear to provide effective protection for skates.

6.8 WG-FSA-16/12 summarised information on the species composition, spatial and vertical distributions, size composition and abundance of morids in the Southern Ocean. The main goal of this work was to contribute to the conservation of these species and minimise the risk from causing adverse effects in stocks of these vulnerable and little-studied species that are a regular by-catch in fisheries for *Dissostichus* spp. The Working Group thanked the authors for providing valuable information to better understand the biology and demography of morid fishes.

6.9 Dr Hanchet gave a presentation on the implementation of the New Zealand data collection plan discussed by WG-FSA in 2015 (SC-CAMLR-XXXIV, Annex 7, paragraph 4.69). He noted that the approach had been successful for icefish (*Chionobathyscus dewitti*) in 2015/16, but required additional focused data collection from other vessels to achieve the target coefficients of variation (CVs) for the other species.

6.10 In addition to the accuracy of species identification, the Working Group noted that the collection of data by three-letter codes could also result in typographical errors. The current CCAMLR data forms do not have appropriate validation at the data inputting stage and any future developments of data forms could usefully incorporate routine data checks (e.g. validation of unusual species, specimens outside known length range; see also paragraphs 7.10 and 7.11).

6.11 CM 33-03 describes the limits for by-catch taken in new and exploratory fisheries. This conservation measure provides catch limits for non-target fish (excluding individuals released alive), currently defined for skates (5% of the catch limit of *Dissostichus* spp., or 50 tonnes, whichever is larger), *Macrourus* spp. (16% of the catch limit of *Dissostichus* spp., or 20 tonnes, whichever is larger) and 'all other species combined' (20 tonnes).

6.12 The Working Group noted that the catch limits for *Dissostichus* spp. are applied at varying spatial scales, depending on the different management areas applied. However, the catch limits for by-catch in CM 33-03 are not applied at the same spatial scales as the catch limits for *Dissostichus* spp. This can result in a lack of clarity on the actual by-catch limit for a research block, as well as catch limits for by-catch actually being higher than the target species in some areas, without any formal assessments supporting these limits.

6.13 The Working Group also noted that CM 33-03 includes additional by-catch mitigation measures (by-catch move on rules, release of live skates and catch limits on *Macrourus* spp.) that aim to minimise by-catch. Consequently, while there are management areas where catch limits for by-catch species are set higher than for target species, these catch limits are unlikely to be attained.

6.14 The Working Group considered that there should be consideration of removing the absolute limits and applying percentage thresholds, including extending the 16% catch limit in place for *Macrourus* spp. to the category 'all other species combined', so that by-catch limits are:

(i) skates and rays: 5% of the catch limit of *Dissostichus* spp.

(ii) *Macrourus* spp.: 16% of the catch limit for *Dissostichus* spp.
(iii) all other species combined: 16% of the catch limit for *Dissostichus* spp.

The Working Group recognised that other consequential changes, including to move-on rules, would need to be introduced into CM 33-03.

6.15 The Secretariat provided details on the catches of *Dissostichus* spp. and associated by-catch in new and exploratory fisheries (Table 2) that indicated that the percentage by-catch limits alone should be a sufficient measure to avoid large by-catch in most SSRUs and research blocks.

6.16 It was noted that 'all other species combined' may also include Somniosidae (sleeper sharks). Whilst these large-bodied sharks are caught very infrequently and accidental catch should 'as far as possible, be released alive' (CM 32-18), there is a potential for the retention of dead specimens to trigger a by-catch limit, if taken in a management area with a low catch limit for *Dissostichus* spp. The Working Group requested that the Secretariat separately report on the by-catch of sleeper sharks in compiling Fishery Reports to enable monitoring of this issue.

6.17 The Working Group considered that the utility of the catch limit CPUE by seabed area method (developed for toothfish) could usefully be explored for by-catch species in the future. Furthermore, analyses of reported by-catch in relation to target catch could usefully be explored to better understand the factors (e.g. depth, location, gear type) that influence by-catch rates. It also recalled that stock assessments had informed catch limits, e.g. the Ross Sea slope and Division 58.5.2 *Macrourus* spp. limits, and encouraged further evaluation of by-catch limits in other areas.

6.18 The Working Group recalled that by-catch reporting is a requirement of the Flag State per CMs 23-01 to 23-07 (SC-CAMLR-XXXIV, paragraph 3.165; SC-CAMLR-XXXIV, Annex 7, paragraph 8.8). However, there are often arrangements between the vessel operators and scientific observers to facilitate identification of by-catch species.

6.19 It was also noted that there was a variety of methods that could be used to fulfil the requirements for reporting the catch weight and number of fish by species on a haul-by-haul basis. Examples of these methods could range from weighing and counting the entire catch of each species in the case of small catches, to the estimation of total catch based on scaling up from the total number of fish counted by the mean weight of a subsample of fish. In order to further understand the reported data on by-catch used for CCAMLR management and regulation, it is requested that Contracting Parties document the procedures used by vessels to satisfy the requirements of CM 23-04 and other measures, such as CM 33-03, which rely on accurate reporting of target and by-catch species.

6.20 The Working Group also noted that CM 23-04 states 'The catch of all target and by-catch species must be reported by species'. Catches of some taxa are, however, often reported at genus or family level. Consequently, there should be consideration of modifying this requirement which also applies to related measures (e.g. 'The catch of all target and by-catch species must be reported by species, or to the lowest taxonomic level possible (e.g. species or genus)').

6.21 The Working Group discussed current CCAMLR data collection methods and protocols (paragraph 7.10) and how they may be improved with the implementation of the new CCAMLR data management systems (SC-CAMLR-XXXV/BG/25), including for recording by-catch. The Working Group agreed that the current Excel-based data forms provide minimal data validation during entry and recommended that in-built validation tools to minimise input and other potential errors at source should be developed in the new forms to improve data quality. The Working Group requested that the Secretariat discuss changes to all CCAMLR data collection forms using an e-group that includes national technical coordinators and representatives from those Members that submit commercial fishing data to the Secretariat.

Bottom fishing activities and vulnerable marine ecosystems (VMEs)

6.22 The Working Group noted that there was one notification of a vulnerable marine ecosystem (VME) risk area in Subarea 88.1 during 2015/16, which brings the total number of VME risk areas to 76 in Subareas 88.1 and 88.2. The VME registry can be found at www.ccamlr.org/node/85695.

6.23 Mr Maschette informed the Working Group that Australia will be investigating seafloor communities and potential VMEs with underwater cameras mounted on longlines in 2016/17. Deployments will be made in toothfish research blocks and exploratory fisheries in Subareas 88.1 and 88.2 and Divisions 58.4.1 and 58.4.2. The Working Group further noted that camera deployments without associated fishing gear may be a valuable method to confirm the presence of VMEs in areas currently closed as a VME risk area under CM 22-07.

6.24 Dr Darby informed the Working Group that UK vessels will be deploying cameras on longlines in Subarea 48.3 to collect information on seafloor communities.

6.25 Dr Jones informed the Working Group that the BBC Blue Planet series will be undertaking 28 days of manned submersible deployments to film several CCAMLR-registered VMEs along the Antarctic Peninsula in December 2016 for an upcoming series on the deep sea.

6.26 Dr Welsford informed the Working Group that an Australian vessel undertook a multi-beam survey in the HIMI region in 2015/16 to explore volcanic activity and detected deep-sea hydrothermal vents (which are considered VMEs) in the region. He further noted that these vents occur in the area protected within the HIMI Marine Reserve.

Marine mammal and seabird by-catch

Marine mammal depredation

6.27 WG-FSA-16/09 presented a data collection framework suitable across different fisheries interacting with odontocetes. The paper provided basic guidelines for observer programs that are new to depredation data collection or wish to expand their observation efforts and data collection, based on 10 years of experience around Kerguelen and Crozet Islands. The Working Group thanked Mr Gasco for the development of this guide, which not

only provided a useful guide on data collection but also contributed to standardising data collection across fisheries. The Working Group asked the Secretariat to provide this guide as a reference on the CCAMLR website.

6.28 WG-FSA-16/10 presented an update of depredation estimates in the fisheries around Kerguelen and Crozet Islands, to address a request by SC-CAMLR-XXXIV (paragraph 3.318). This method built on previous work on the CPUE method, including a small-scale spatial cell grid to consider spatial variation in depredation rates. While a large dataset allows to almost always have both true presence and absence observations within a grid cell, when data availability decreases, the CPUE method becomes increasingly difficult to be applied as true presence and absence observations may not both occur within the same grid cell. To achieve annual estimates of depredation, this method calculated the overall catch losses per grid cell and the overall catch losses without the given year per grid cell. The difference provided an estimate of catch loss in a given year.

6.29 The Working Group noted that this novel approach allowed the estimation of a catch loss time series in these fisheries for the first time and would prove useful for other fisheries in the future too.

6.30 The authors clarified that in the case of the Kerguelen and Crozet Islands, the method given here captured the spatial variation better than the GLM CPUE method estimation, due to high spatial variability in the data. However, this would be different for each fishery with different characteristics. The updated time-series estimations were included in the integrated assessments for these fisheries (paragraphs 3.132 to 3.140).

6.31 The Working Group noted that there is an apparent decrease in losses due to depredation around Crozet Islands, which may be tied to the introduction of mitigation measures such as short lines, faster hauling times and strict move-on rules. The Working Group suggested that the data could be examined for correlations between changes in depredation and introduction of mitigation measures, which would also prove useful in evaluating which management measures are most effective. This could also inform management strategies in other fisheries.

6.32 WG-FSA-16/42 summarised the first depredation workshop held by the Coalition of Legal Toothfish Operators (COLTO). The workshop brought together researchers, fishers and industry representatives from Southern Ocean toothfish fisheries and the Alaskan sablefish fishery with experience in depredation from odontocetes.

6.33 The workshop included discussion on longline fisheries mitigation methods, data collection and effects on stock assessments, and concluded with several action points that are further given in SC-CAMLR-XXXV/BG/23. Key outcomes included the establishment of a COLTO-funded postdoctoral fellowship to study depredation and mitigation worldwide, guidance documents on mitigation methods for stakeholders (see WG-FSA-16/09 as an example), and a framework for experimentally testing and scientifically evaluating mitigation methods, in collaboration between fishers and researchers.

6.34 The Working Group welcomed work being progressed in this area, and recalled the similar approach used by the Working Group on Incidental Mortality Associated with Fishing (WG-IMAF) to mitigate seabird by-catch by including fishers, scientific experts and managers together in discussions.

6.35 The Working Group encouraged continuing engagement in the CCAMLR Depredation e-group as a means to exchange information and collaboration. It noted that Dr Söffker created a mailing list for marine mammal depredation (mm-depredation@jiscmail.ac.uk) which also allows non-CCAMLR researchers to exchange information.

Seabird by-catch and mitigation

Hook marking scheme

6.36 WG-FSA-16/03 was a response by the Secretariat to a request from CCAMLR-XXXIV on the requirements of vessel-specific hook markings as a means to identify the origin of recovered offal containing hooks, or hooks found in seabird colonies (CCAMLR-XXXIV, Annex 6, paragraph 223; SC-CAMLR-XXXIV, paragraphs 3.86 and 3.87). The Secretariat discussed these issues with fishing industry representatives, those with experience in hook-marking schemes and gear manufacturers, and presented the conclusions for consideration by the Working Group (WG-FSA-16/03, paragraph 14). Overall, the Secretariat concluded that the administrative, financial (burden on vessels) and implementation burden would be substantial while the issues of offal discarding and hooks in seabird colonies may remain unresolved.

6.37 The Working Group noted that if there are issues with offal discharge as a compliance issue, then this would need to be addressed, however, hooks found in toothfish stomachs may not be definitively indicative of offal discharge. Toothfish are apparently capable of 'grazing' off the longline, ripping hooks and bait off and thus ingesting hooks, and similarly, marine mammals may ingest hooks through depredation. Furthermore, hooks as part of clearly identified offal discharge have been observed on a few occasions only.

6.38 The Working Group noted that feedback from scientific observers deployed in fisheries with hook-marking schemes suggested that hook-marking had a distinct positive effect on the behaviour of the crew and the attitude towards offal management.

Season extensions

6.39 At CCAMLR-XXXIV, a further pre- and post-season extension trial in the longline fishery in Division 58.5.2 was endorsed. This trial is in addition to an existing pre- and post-season trial. WG-FSA-16/28 Rev. 1 summarised information on fishing effort and seabird interactions in the periods 1–14 November 2015, 1–14 April 2016 and 15–30 April 2016. Overall, there was one white-chinned petrel (*Procellaria aequinoctialis*) caught during the new extension trial period (1–14 April 2016), and one grey-headed albatross (*Thalassarche chrysostoma*) was entangled in the streamer line during the trial period 15–30 April 2016. The Working Group recommended that the trial be extended for another season and an update be provided to WG-FSA-17.

Seabird by-catch

6.40 The Working Group noted the table prepared by the Secretariat on the fishery-specific total for the extrapolated seabird by-catch in longline fisheries throughout the Convention Area (Table 3).

6.41 Dr Darby noted that the extrapolated numbers of seabird deaths shown in Table 3 for Subarea 48.3 did not reflect the actual bird by-catch numbers for this subarea, as the vessels operating here report actual bird by-catch. Therefore, the additional scaling by percentage of hooks observed inflates the number of seabird by-catch reported by CCAMLR for Subarea 48.3.

6.42 The Secretariat clarified that the method to estimate total seabird by-catch was developed by WG-IMAF and used the number of seabird deaths reported by observers and the percentage of hooks observed, to extrapolate the total number of seabird by-catch.

6.43 The Working Group acknowledged that application of this method was consistent throughout the time series, and acknowledged that how seabird by-catch is reported to CCAMLR may vary geographically. It noted that in the case of Subarea 48.3, incidental mortality of seabirds was observed on six hauls from two vessels in April 2016.

Net monitoring cable mitigation

6.44 WG-FSA-16/38 introduced a new design for the use of a net monitoring cable in the trawl fishery. Net monitoring cable systems have been prohibited in CCAMLR trawl fisheries since 1994 to minimise bird strikes. The proposed layout of the net monitoring cable in this paper should reduce the aerial extent of the cable by submerging the cable below the surface close to the stern of the vessel through the use of a snatch block. The paper noted that this method follows ACAP's best-practice advice, where no practicable method for avoiding using a third line is available, with the exception of requiring streamer lines.

6.45 The Working Group recalled that when the initial prohibition was declared in 1994, there was no advantage between cable or wireless in terms of the transmitted signal. ACAP had, at the time, been consulted on best practice. Technology has developed significantly since, however, and today the information transmitted through a cable is of better quality and quantity than the use of wireless, which is dependent on e.g. weather or krill density deflecting the signal. Use of a net-monitoring cable allows much finer control over the fishing gear, and for increasingly sophisticated net monitoring activities. The Working Group also recalled that the krill fishery in the CCAMLR area usually trawls at slow speeds, which in itself already reduces the risk of warp strikes.

6.46 The Working Group recommended that a one-season trial be carried out with the proposed design on any krill trawl vessel using a net monitoring cable, and that results of this trial be reported to WG-EMM, WG-FSA and ACAP to further evaluate the safety of the use of this cable. It noted that the usefulness and conditions of such trials needs to be evaluated on a case-by-case basis. The slower speed of krill vessels, as opposed to finfish vessels, was considered lowering the risk of interaction with the third cable during this trial.

6.47 The Working Group recommended the following requirements for the season trial, in order to monitor and mitigate potential interactions with seabirds and marine mammals effectively:

(i) 100% observer coverage for the trial vessel(s)

(ii) the use of a camera monitoring system that records the full aerial length of the cable and the seaward entry point

(iii) during trawling operations, the mandatory use of two streamer lines as per the specifications set out in CM 25-02, Annex 25-02/A

(iv) the observer(s) conduct IMAF observations on the net monitoring cable twice daily, following the current standard warp strike observer protocols outlined in the SISO krill logbook instructions

(v) the 'snatch block' (WG-FSA-16/38) should be set so that the distance from the stern of the vessel to the point where the net monitoring cable enters the water is less than 2 m

(vi) if there are more than three (3) 'heavy' bird strikes (www.ccamlr.org/node/74769) on the net monitoring cable, recorded during the warp strike protocol observations, then the vessel will remove the cable, this number of birds being consistent with the mitigation measures given in CMs 41-03 to 41-11.

6.48 The Working Group also recommended that the observers provide details of the system and effectiveness of protocols, including safety implications, in their cruise reports and this information be provided to WG-FSA. While the standardised protocols outlined are to be applied at the beginning of the trial, the Working Group considered that observers should have the ability to adapt protocols, if required, to ensure effective data collection and safety are not compromised.

6.49 WG-FSA-16/38 also noted that net monitoring cable systems allowed for the 'continuous flow of information from trawl sonars and cameras' for both commercial operations (e.g. gear performance) and research (e.g. interactions between marine life and the gear). More details on the latter could usefully be provided in the observer report.

Other issues

6.50 The Working Group noted that some national programs collect additional data on marine mammal sightings and encouraged the continuation of these programs. It noted that without a specific scientific question regarding marine mammals and seabirds, it was not appropriate to implement additional data collection protocols as their design could not be adequately assessed. The Working Group encouraged the development of specific data collection protocols for collecting data on the presence of marine mammals and seabirds by observers in trawl fisheries.

6.51 The Working Group noted that the issue of marine mammal and seabird by-catch and interactions spans the terms of reference of several working groups. It further noted

discussions in Agenda Item 5 (paragraph 5.14) to establish a WG-SISO, which would be a suitable place to recommend the design and implementation of data collection protocols for marine mammals and seabirds.

Future work

Secretariat's data management systems

7.1 The Working Group noted the key achievements to date, and the proposed work plan, for the redevelopment of the Secretariat's data management systems (SC-CAMLR-XXXV/BG/25). The work plan for the next two years includes the advice of the Scientific Committee and its working groups on data traceability, system testing and evaluation, user training, data extracts with corresponding metadata and establishing a data management group. Data users can expect improvements in data quality assurance, database documentation and ease of use as the new system is progressively rolled out, and prototype data extracts and associated metadata will be available to WG-FSA for evaluation in 2017.

7.2 The Secretariat acknowledged that in the current data management system there were inconsistencies in naming standards and the level of data quality assurance processes and the move to the new system would introduce common standards and increased rule-based rigour in data quality assurance processes. The Secretariat noted that much of the development that has been undertaken to date was essential foundational work with limited impact on current data users.

7.3 The Working Group discussed the implications of this redevelopment on the data extracts provided by the Secretariat for the work of WG-FSA, recalling that the Working Group will be conducting biennial assessments in 2017. The Working Group noted that:

(i) Data extracts based on the current system will continue to be produced in 2017, and that prototype new extracts and associated metadata will be made available to data users for review prior to WG-FSA-17. These extracts would not be adequately tested with enough lead time to support the 2017 assessments for toothfish fisheries.

(ii) New data extracts will be developed in consultation with users and will require changes in the way users use the data in their analyses. This will require a plan for the transition to extracts from new databases with different data quality and naming rules in order to ensure that unexpected differences in assessments do not arise as an artefact of changes in the data management system.

(iii) Metadata will accompany data extracts and provide users with information on data structure (data dictionary), processing (data quality rules) and change history from previous extracts of the same data (data change log).

7.4 The Working Group noted the importance of having metadata that was searchable to make external users aware of what data are available (and also what are not available) from CCAMLR. The discoverability of this metadata is also important in increasing transparency and understanding of the work of CCAMLR.

7.5 The Working Group noted that the proposed Data Management Group (Annex 5, paragraph 2.20 and Annex 6, paragraph 6.21) could provide a mechanism for data providers and data users to contribute to the design and testing of the new data management systems, priority setting and reviews of progress with achieving project outcomes. However, in order to achieve this remit it would be essential for the Data Management Group to have access to the project plan for the Secretariat data management system redevelopment.

7.6 The Working Group thanked the Secretariat for the update on the considerable amount of work that has been undertaken and recognised the challenges faced in redeveloping the entire Secretariat data management systems. The Working Group recognised that the implementation of the work was taking longer than desirable but expressed concern that there was little information available on an expected completion date.

7.7 The Working Group agreed that high-quality data are crucial to all aspects of the work of the Scientific Committee and noted the discussion of issues related to data management this year at WG-SAM (Annex 5, paragraphs 2.15 to 2.20, 2.51 to 2.54, 5.7, 5.14, 5.15 and 6.8) and WG-EMM (Annex 6, paragraphs 6.18 to 6.21) and encouraged the presentation of a timeline for the proposed work plan to the Scientific Committee, in order that Members may better understand the project milestones and contribute to setting priorities and implementing relevant elements of the work.

7.8 Noting the increased length of time that it was taking to implement the project to the stage where data users, such as those involved with WG-FSA, could expect to benefit from the new systems and processes, the Working Group discussed the level of Secretariat resources allocated to the redevelopment. The Secretariat noted that since 2015, the project has benefitted from additional funding from the Korean Contribution Fund and that this fund was sufficient to support planned project activities for at least another 18 months.

7.9 The Working Group agreed that the data management systems redevelopment work outlined by the Secretariat was central to the role and function of the Secretariat and if the allocation of additional resources to the project would assist in a more timely completion of the work, then a means to facilitate this should be considered by the Scientific Committee.

7.10 The Working Group reviewed the revised in-season catch and effort reporting form that will be used in CCAMLR fisheries in 2016/17, including daily reporting in exploratory fisheries for toothfish (refer CMs 23-01, 23-02, 23-03 and 23-07). The Working Group noted the improvements that will be implemented with the new form, particularly the development of validation rules applied in the automated data load procedure that will improve data quality.

7.11 The Working Group also noted that currently the instructions for the completion and submission of commercial catch and effort forms were limited in their description and utility and recommended:

(i) the further development of all the commercial and observer data forms applying analogous data validation and formatting improvements outlined in the daily catch and effort form

(ii) the development of comprehensive instructions for the commercial forms that include a glossary of CCAMLR definitions of fishing terminology, to ensure standardised recordings of times and positions across vessels for fishing events

(iii) the formation of an e-group to review the new commercial forms and instructions as they are developed and to identify further data validation rules (e.g. for species, catch and effort data) that may be applied, noting that the role of this e-group may change depending on the terms of reference of the proposed Data Management Group.

Organisation of intersessional activities

7.12 Mrs Large noted that the CCAMLR e-groups provide a very useful platform to discuss and develop ideas associated with an issue being considered by the Working Group. She also noted that, while the e-groups are open to all Members, it is not always possible for this involvement to take place and, therefore, non-involvement in an e-group should not automatically confer consensus of the material being considered. She suggested that any material that is required to be considered by all Members be submitted in a scientific paper to the Working Group for review.

Notification of scientific research

7.13 The Working Group noted the proposal by the UK for a randomised stratified trawl survey in Subarea 48.3 during January/February 2017 that had been distributed as SC CIRC 16/60.

7.14 Dr P. Ziegler (Australia) indicated that Australia also intended to conduct its annual randomised stratified trawl survey in Division 58.5.2 in 2017.

Other business

8.1 At its annual meeting in 2016, WG-EMM recalled its obligation to review and advise on CM 51-07, which is due to lapse at the end of the 2015/16 fishing season, and presented its discussions on this subject in paragraphs 2.201 to 2.244 of its Working Group report (Annex 6). WG-EMM recommended that work be undertaken to further develop a risk assessment approach (WG-EMM-16/69) to spatially subdivide the trigger level through the Conservation Measure 51-07 WG-EMM review e-group and to deliver these outputs to the Scientific Committee (Annex 6, paragraphs 2.230 to 2.244). These outputs would first be provided to WG-FSA for review, which in turn should pass these with a commentary on to the Scientific Committee to support the review and advice on CM 51-07 to the Commission.

8.2 Discussions at WG-EMM included consideration of WG-EMM-16/69. An updated version of the approach is presented in WG-FSA-16/47 Rev. 1 and 16/48 Rev. 1 which also includes advice from the intersessional e-group.

8.3 Drs Constable and Söffker presented WG-FSA-16/47 Rev. 1 and 16/48 Rev. 1 on behalf of the intersessional e-group. The risk assessment approach presented in WG-FSA-16/47 Rev. 1 and 16/48 Rev. 1 aims to minimise the risk of predator populations, in particular land-based predators, being inadvertently or disproportionally affected by the krill fishery (see CM 51-07, first preambular paragraph). It assesses the localised risk of such effects, according to the requirements in the preamble of CM 51-07, and is based on the best available science. This risk assessment is then combined with an expected, or desired, fishing pattern to distribute the catch in such a way that the risks will also be spread. The overall risk of localised effects on predators is also calculated for the fishing pattern. It can be used to compare alternative fishing patterns in order to help minimise risk.

8.4 The Working Group agreed that a brief description of the risk assessment method along with the summary of information requested by WG-EMM in paragraph 2.239 of its 2016 report (Annex 6) would be provided to the Scientific Committee in a background paper.

8.5 The Working Group noted that comparisons with the risks associated with a baseline distribution of the trigger level would provide a means of assessing how much the risks of a scenario may deviate from an ideal distribution of catch that spreads the risks. The baseline scenario is determined by the relative abundance of krill driving the location of the fishery, combined with the calculated risk based on predation pressure and proportion of juvenile krill (see Figures 3 to 6). The desirability of areas by the fishery is not included in the baseline calculation, i.e. all areas are equally desirable. The results of the baseline scenario are given in Table 4.

8.6 The emphasis of this approach lies in evaluating scenarios and determining where risks are increased or decreased relative to other scenarios and can be ranked. This will enable the Scientific Committee to evaluate the direction of change in regional risk using a data-limited approach. It can then be used to provide management advice on whether scenarios may be less or more precautionary than the baseline scenario.

8.7 Tables 5 and 6 present several scenarios of risk associated with different historical catch patterns (Table 5), and variations of patterns based on CM 51-07 as well as adjusted catch for keeping the relative risk for different scenarios similar to the calculated baseline risk (Table 6). The Working Group noted that the baseline risk is calculated at 0.387, and that all other scenarios have a higher risk than the baseline risk. It further noted that increases in regional risk can be offset spatially or temporally.

8.8 Table 5 shows risk associated with changes in historical fishing patterns throughout several scenarios, with some having higher regional risks than others. It summarises patterns observed in the past, and considers the risk of a possible pattern where the fishery is solely concentrated in Bransfield Strait. The table also presents catches adjusted to maintain the regional risk level at the baseline level ((1/relative risk)*catch allocation).

8.9 Table 6 shows several scenarios based on the existing CM 51-07, with different allocations of the proportional regional catch to subareas. The table shows that certain scenarios have a higher regional risk because of catch being concentrated in areas where there are higher concentrations of krill predators and juvenile krill. The adjusted catches to maintain regional risk at the baseline level means that accumulation of risk from catches in the high-risk areas is offset by catches in lower risk subareas that would then have little or no krill fishing. The table provides catch limits for each scenario for the area and subareas that would keep the overall regional risk in line with the baseline risk.

8.10 The Working Group noted that as Subarea 48.4 has had no recent fishery, in the scenarios looking at current catch distributions, the catch for Subarea 48.4 was distributed according to the relative size of its SSMUs.

8.11 The Working Group also considered how the local risks of each scenario have changed from the local risks of the baseline scenario, i.e. whether the local risks have increased or decreased in their contributions to the regional risk. The contribution of local areas (local catch-weighted risk) to the regional risk (regional catch-weighted risk) in the baseline scenario is given in Table 4. The relative changes in these local catch-weighted risks for the different scenarios are given in Table 7.

8.12 The Working Group thanked those involved in the development of the risk model framework and the calculation of different scenarios, noting that this was an important step forward and that it would provide a useful additional tool to help decision-making in regard to CM 51-07. The Working Group recalled that this process of using best-available science to create management options in data-limited fisheries follows approaches from other regional fishery management organisations (RFMOs) around the globe. The Working Group noted that the method would improve as knowledge about the local ecosystems improves.

8.13 The Working Group discussed the results presented, and agreed that the risk assessment allows to identify and focus on areas of concern. The Working Group considered that the presented scenarios were informative and agreed that as the fishery patterns are relatively flexible, the use of the most recent three years of fishery operations in the provision of advice was sensible.

8.14 The Working Group noted that at present it is difficult to establish whether there are direct effects of the fishery on predators because of a lack of data at appropriate spatial and temporal scales. The Working Group noted that krill-dependent predators have been observed on the same grounds as krill vessels, but at the moment there are very few systematic observations of those feeding close to, or in the same, krill aggregation being fished by the krill fishing vessels.

8.15 The Working Group discussed the use of buffers as a scenario to offset potential increasing fishing pressure in Subarea 48.1, and noted that at present, the spatial scale of land-based predator habitat use is only at SSMU level. Thus, the inclusion of a buffer zone would not change the risk level in these calculations unless the fishing pressure were to be shifted into another SSMU entirely. It recommended that buffer zones should be investigated as a means to offset increasing regional risk once better spatial data for habitat use of land-based predators are available.

8.16 The Working Group noted that such buffer zones could be valuable for reducing risk during particular times of year, for example during the penguin breeding season. It also noted, however, that the value of buffer zones would differ for different predator species. Species which forage coastally would receive benefit to a greater extent than other species which spend time foraging further offshore.

8.17 Some Members noted that the risk assessment model could be used for directly providing krill catch distribution in case of other equal conditions, such as equal krill density and space distribution and prevailing conditions for fishing.

8.18 The Working Group noted that the risk analysis should be updated periodically as more data become available, and that this update does not require a full reassessment. The update can be partial or complete depending on data improvements. The Working Group also noted that once an integrated assessment for krill is developed, a method for spatially distributing catch limits will still be needed so the two approaches are complementary.

8.19 The Working Group discussed the data contributing to the model, in particular data on krill density distribution, and agreed that, while currently the model uses best available science, this can be reviewed periodically and data updated. The Working Group recommended that a standard way by which data be accepted or rejected in future revisions be established, and that the standard datasets used in the assessment should be made available to Members once agreed as input to the risk model.

Advice

8.20 The Working Group recalled that there needs to be consideration by the Scientific Committee and Commission of this work to support their decisions in the evolution of CM 51-07 this year.

8.21 The Working Group endorsed the risk assessment framework as presented in WG-FSA-16/47 Rev. 1 and 16/48 Rev. 1 for use as a tool for providing advice to the Scientific Committee in regard to CM 51-07.

8.22 The Working Group wished to draw the attention of the Scientific Committee to its consideration of the risks associated with historical fishing patterns as well as those that may be associated with plausible subdivisions of the trigger level and recommended that the Scientific Committee consider, inter alia, the results of the scenarios presented in Tables 4 to 7 as well as Figures 3 to 7 in providing advice to the Commission for its review of CM 51-07. The Working Group requested that the Scientific Committee consider the contents of the background paper on this topic to be provided by the Working Group (SC-CAMLR-XXXV/BG/37).

8.23 In addition, it recommended that the model be further developed within the Scientific Committee working groups and that a standard way to include or reject data be part of that development.

8.24 The Working Group noted that a number of factors will be important to consider in revising CM 51-07, in particular for distributing the trigger level, including factors influencing the krill fishery, such as the spatial distribution of krill, conditions affecting the krill fishery, and the amount of the catch limit being taken.

Future work

8.25 The Working Group made several recommendations for future work to update the risk assessment model:

(i) krill density distribution could be evaluated in relation to local biomass of land-based krill predators

(ii) inclusion of a measure of temporal variability in krill density, such as through confidence intervals associated with data from surveys, should be progressed

(iii) the risk analysis should look at including a layer for data gaps, for example lack of monitoring effort near the fishery, or lack of data regarding pelagic predators in winter months

(iv) inclusion of historical fishing patterns in the calculation of regional risk was suggested

(v) the role of buffer zones for off-setting increased catches in high-risk areas should be investigated as better spatial data becomes available

(vi) a sensitivity analysis should be conducted on the baseline risk level

(vii) identify strategies for obtaining data that could improve the risk assessment, such as updating estimates of abundance of krill

(viii) how to include as a component of risk, the ability to manage spatial dynamics of the fishery.

Species profiles

8.26 The Working Group discussed a proposal to develop a detailed description of target and by-catch species which are, or have been, subject to exploitation in the Southern Ocean (WG-FSA-16/51). The Working Group recalled that species profiles are currently available for *C. gunnari* (Kock and Everson, 2003), *D. eleginoides* (Collins et al., 2010), *D. mawsoni* (Hanchet, 2010) and Antarctic krill (*Euphausia superba*) (Miller, 2003); however, only one of these profiles (*D. eleginoides*) has been published, and the other three profiles are CCAMLR meeting documents. The Working Group agreed that such species profiles, when published, would provide an authoritative source of information for use by the CCAMLR community as well as other groups such as the Scientific Committee on Antarctic Research (SCAR), the Committee for Environmental Protection (CEP), the Food and Agriculture Organization of the United Nations (FAO), FishBase and the public (e.g. Wikipedia). The profiles and related fishery reports will also provide comprehensive and up-to-date information on fishery species in the Convention Area.

8.27 The project will be coordinated by Dr Kock and would take four years to complete, with an annual budget of approximately A$9 000 to support the project coordinator's attendance at the meeting of WG-FSA. Additional funding would be required if the profiles were translated to CCAMLR languages (costed at 10–20 pages per profile).

8.28 The Working Group encouraged the development of the species profiles, however, it noted that the budget to support the project would need to be considered in the context of other priorities. It also discussed publication options and the need to use an appropriate medium for each target audience. The material developed for each profile will need to be tailored to the intended audience and this may require various approaches such as CCAMLR publication, contributions to the Antarctic Environments Portal (www.environments.aq) or a wikibomb event (https://en.wikipedia.org/wiki/Wikipedia:Meetup/SCAR_2016).

8.29 The Working Group agreed to establish an e-group to develop this proposal intersessionally and:

(i) identify the target audiences and appropriate publication media

(ii) define the publication mechanism and peer-review process

(iii) develop a list of species and a work plan, and identify potential contributors

(iv) develop a generic table of contents for the species profiles, including taxonomy, vertical and horizontal distribution, age and growth, reproduction and diet

(v) develop species profiles for *N. rossii* and *C. dewitti* – these species were chosen because the available information on these two species is representative of many of the species for which profiles will be developed.

8.30 The Working Group agreed to review progress at WG-FSA-17.

8.31 The Working Group noted that the species profiles could also be developed for species such as krill-dependent species, and VME taxa, and these possible inclusions were referred to WG-EMM for consideration.

Parasites and lipid metabolism features of *D. mawsoni*

8.32 The Working Group noted a study on parasites of *D. mawsoni* from the exploratory longline fisheries in Subareas 88.1 and 88.2 (WG-FSA-16/P01). The study identified 14 species of parasites using standard parasitological methods and genetic analysis, and the results contributed to baseline data on the parasitofauna of *D. mawsoni*. The authors noted that an earlier study of the parasites of *D. eleginoides* reported that the parasitofauna of that species from Heard Island, Macquarie Island and the Prince Edward Islands were the most similar, while the parasitofauna from the Ross Sea was the most dissimilar. The Working Group noted that the genetic and tagging studies apparently provided better discrimination of stock structure in toothfish than parasites.

8.33 The Working Group also noted a study on the lipid metabolism features of *D. mawsoni* from Subareas 88.1 and 88.2 (WG-FSA-16/P02). Samples were studied for the content of total lipids and lipid composition, products of lipid peroxidation and level of antioxidant protection. The authors noted that future research will evaluate changes in the physiological state of toothfish that may arise as a result of pollution and other forms of anthropogenic impact.

8.34 The Working Group thanked the authors of these papers and agreed that these publications raised the profile of science based on datasets collected in CCAMLR in the broader scientific community.

Marine debris

8.35 The Working Group noted the Secretariat's report on the CCAMLR marine debris monitoring program (WG-FSA-16/18). Overall, the occurrence of plastic debris on beaches

and in seabird colonies remains an issue in the CAMLR Convention Area. The global issue of plastic pollution in the world's oceans, in particular the prevalence of plastics in seabirds, receives increasing attention in the popular and scientific literature and monitoring of additional sites, including those where marine debris/plastics have not previously been recorded, would add to the ability of CCAMLR to contribute to global monitoring of marine pollution.

8.36 The Working Group noted the increased recent global attention on plastic pollution in the marine environment, and the UN Environment Programme (UNEP)-led Global Partnership on Marine Litter (GPML). The Working Group also noted that CCAMLR is now a partner in the GPML. The Secretariat recently contributed to GPML's review on global marine plastic debris and the CCAMLR marine debris monitoring program will continue to contribute information on the occurrence of macro plastics in the Southern Ocean. The CCAMLR program has also recently contributed information on marine mammal entanglements to the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Australia) for their work on the Global Ghost Gear Project, which is developing a global picture of fishing gear loss with an ultimate aim of reducing ghost fishing in the marine environment.

8.37 The Working Group noted that the CCAMLR program of marine debris monitoring is land-based, and that fishing vessels and scientific observers also record fishing gear lost at sea. However, there was no at-sea monitoring of marine debris in the Convention Area.

8.38 The Working Group encouraged Members to further develop collaborative programs for monitoring plastics in the marine environment, including collaboration with other groups (e.g. CEP, SCAR or the International Association of Antarctica Tour Operators (IAATO)), in order to collect data which may be used to evaluate the likely impact of plastics on the growth and reproductive success of marine living resources in the Convention Area. The Working Group recommended that this matter be referred to the Scientific Committee for further consideration.

Advice to the Scientific Committee and its working groups

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

9.2 The Working Group provided advice on the following topics:

(i) Assessments –

(a) catch limit for *C. gunnari* in Subarea 48.3 (paragraph 3.8)

(b) catch limit for *C. gunnari* in Division 58.5.2 (paragraph 3.22)

(c) catch limit for *D. eleginoides* in Division 58.5.1 (paragraphs 3.135 and 3.136)

(d) catch limit for *D. eleginoides* in Subarea 58.6 (Crozet Islands) (paragraphs 3.139 and 3.140)

(e) catch limit for *D. eleginoides* in Subarea 48.3 (paragraph 3.24)

(f) catch limits for *D. eleginoides* and *D. mawsoni* in Subarea 48.4 (paragraphs 3.26 and 3.33)

(g) catch limits for *D. mawsoni* in Subarea 88.1 (paragraphs 3.44 and 3.45)

(h) research plan and tagging rates for *D. mawsoni* in Subarea 88.2 (paragraphs 3.130 and 3.131)

(i) monitoring fishing capacity (paragraph 3.37).

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

(a) setting species-specific catch limits (paragraphs 4.8 and 4.83)

(b) research on catch limits (paragraph 4.30)

(c) assessment focus topic for WG-SAM (paragraphs 4.92 and 4.93)

(d) setting catch limits in research blocks (paragraph 4.104)

(e) coordinated and centralised ageing program for *D. mawsoni* (paragraph 4.126)

(f) research in a new, proposed research block 5841_6 (paragraph 4.118)

(g) research fishing in Divisions 58.4.1 and 58.4.2 (paragraph 4.120)

(h) research fishing in Division 58.4.3a (paragraphs 4.132 and 4.134).

(iii) Research fishing on *Dissostichus* spp. in other areas –

(a) setting research catch limits (paragraphs 4.66 and 4.69)

(b) research fishing in Subareas 48.2 and 48.4 (paragraphs 4.54, 4.63 and 4.64)

(c) research fishing in Division 58.4.4b (paragraph 4.144)

(d) research fishing in Subarea 88.3 (paragraphs 4.147 and 4.148).

(iv) Scheme of International Scientific Observation –

(a) establishing a dedicated SISO Working Group (paragraph 5.14).

(v) By-catch –

(a) by-catch limits in new and exploratory fisheries in CM 33-03 (paragraph 6.14)

(b) reporting of catch by species, or to the lowest taxonomic level possible in CM 23-04 and related measures (paragraph 6.20)

(c) pre- and post-season extension trial in the longline fishery in Division 58.5.2 (paragraph 6.39)

(d) trial use of net monitoring cables during krill fishing (paragraphs 6.46 to 6.48).

(vi) Data –

(a) reporting on vessel freezing capacity and fish processing rates in fishery notifications (paragraph 3.48)

(b) redevelopment of the Secretariat's data management systems (paragraphs 7.5 to 7.7 and 7.9).

(vii) Spatial subdivision of the trigger level for *E. superba* in Subareas 48.1 to 48.4 –

(a) revision of CM 51-07 (paragraphs 8.20 to 8.24).

(viii) Marine debris –

(a) collaborative programs for monitoring plastics in the marine environment (paragraph 8.38).

(ix) Meeting report –

(a) attributed statements (paragraph 10.2).

Adoption of the report

10.1 The report of the meeting was adopted.

Attributed statements

10.2 At the time of report adoption the Working Group noted that there were a large number of attributed statements in the report that raised points that had not been raised during the plenary session and often contained errors of fact. The Working Group noted that this practice was counter to the purpose of having a meeting to discuss the issues, counter to the spirit of seeking Working Group consensus, counter to the need to keep our reports concise and creates a public view of CCAMLR that is confusing, repetitive and contradictory. The Working Group also noted that the accommodation of such large numbers of attributed statements requires significant time within the Working Group to organise and respond to. It requested that the Scientific Committee consider providing advice to its working groups on approaches to manage this issue.

Close of the meeting

11.1 In closing the meeting, Dr Welsford thanked all the participants for their hard work that had enabled the Working Group to complete its work in the shorter time that was available this year. He also thanked the rapporteurs and the Secretariat for their support to the work of WG-FSA-16.

11.2 On behalf of the Working Group, Dr Belchier thanked Dr Welsford for his humour and zeal that had made a huge contribution to leading his first meeting as Convener to a successful conclusion.

References

Brandt, S. 2003. *Statistical and computational methods for science and engineers*. Springer-Verlag, New York.

Collins, M.A., P. Brickle, J. Brown and M. Belchier. 2010. The Patagonian toothfish: biology, ecology and fishery. *Adv. Mar. Biol.*, 58: 227–300.

Hanchet, S.M. 2010. Updated species profile for Antarctic toothfish (*Dissostichus mawsoni*). Document *WG-FSA-10/24*. CCAMLR, Hobart, Australia: 34 pp.

Kellermann, A. 1989. Catalogue of early life stages of Antarctic notothenioid fishes. *Ber. Polarforsch.*, 67: 45–136; *BIOMASS Sci. Ser.*, 10: 44−136.

Kock, K.-H. and I. Everson. 2003. Bibliography on mackerel icefish. Document *WG-FSA-03/5*. CCAMLR, Hobart, Australia: 11pp.

Miller, D. 2003. *Krill Species Profile*. Unpublished CCAMLR document drafted by Denzil Miller, May 2003.

Table 1: Table of the biomass estimates based on the methods agreed to at WG-SAM-16 (Annex 5, paragraph 28) and presented in WG-FSA-16/27, catch limits for the current season, catch that has been taken in the past three years and the proposed catch limits based on the two biomass estimates provided in this table with the 4% exploitation rate applied.

Research block	Species	CPUE by seabed area estimated biomass – three year median CPUE (tonnes)	Chapman estimated biomass most recent (tonnes)	Catch limit current 2016 season (tonnes)	Catch 2014 (tonnes)	Catch 2015 (tonnes)	Catch 2016 (tonnes)	CPUE by seabed area catch limit (4%)	Chapman catch limit (4%)
486_2	TOA	600	9369	170	95.22	82.20	83.16	24	375
486_3	TOA	182	4456	50	49.92	48.86	49.74	7	178
486_4	TOA	870	5147	100	0	56.45	99.18	35	206
486_5	TOA	2039	n/a	190	0	0	0	82	n/a
5841_1	TOA	911	831	80	0	0	79.68	36	33
5841_2	TOA	841	6909	81	54.15	15.40	42.57	34	276
5841_3	TOA	1052	5285	233	0	71.33	65.81	42	211
5841_4	TOA	149	n/a	13	0	9.95	12.10	6	n/a
5841_5	TOA	286	404	35	0	25.70	34.91	11	16
5841_6 (proposed)	TOA	3675	n/a	90	24.34	0	84.23	147	n/a
5842_1	TOA	291	n/a	35	0	9.62	0	12	n/a
5843a_1	TOP	1740	1310	32	32.08	15.19	0	70	52
5844b_1	TOP	481	351	26	12.00	18.22	0	19	14
5844b_2	TOP	509	765	35	14.94	16.33	0	20	31

Table 2: Catch of by-catch taxa by small-scale research unit (SSRU) and research block in exploratory fisheries and research fishing for toothfish in 2015/16 (Source: in-season catch and effort reports). Instances where the reported by-catch levels would have exceeded the relevant percentage of target catch are highlighted. MA – management area; RB – research block. Note: Divisions 58.4.2 and 58.4.3a are not included as no fishing has occurred this season.

Season	Subarea/ division	Region/ MA	RB	2016 catch limit for toothfish	Reported catch of			By-catch percentage	
					Skates	Macrourids	Other species	Macrourids (%)	Other species (%)
2015/16	48.2	482		75		0.4	0.0	0.53	0.00
2015/16	48.6	AG	486_1	28		0.8	0.2	2.86	0.71
2015/16	48.6	AG	486_2	170		2.6	0.3	1.53	0.18
2015/16	48.6	D	486_3	50		1.6	0.1	3.20	0.20
2015/16	48.6	E	486_4	100		4.8	0.6	4.80	0.60
2015/16	58.4.1	C	5841_1	80		0.4	0.0	0.50	0.00
2015/16	58.4.1	C	5841_2	170		0.7	0.1	0.41	0.06
2015/16	58.4.1	E	5841_3	50		8.2	0.5	**16.40**	1.00
2015/16	58.4.1	E	5841_4	13		5.0	0.1	**38.46**	0.77
2015/16	58.4.1	G	5841_5	35		0.7	0.0	2.00	0.00
2015/16	88.1	BCG	B	360		0.7	0.4	0.19	0.11
2015/16	88.1	HIK	H	2 050	5.9	81.7	19.2	3.99	0.94
2015/16	88.1	JL	J	320	0.6	6.3	1.0	1.97	0.31
2015/16	88.2	CDEFG	882_2	200	0.0	2.0	0.2	1.00	0.10
2015/16	88.2	CDEFG	882_3	200	0.3	46.0	1.4	**23.00**	0.70
2015/16	88.2	CDEFG	882_4	200	0.0	2.1	0.2	1.05	0.10
2015/16	88.2	H	H	200		2.0	0.8	1.00	0.40
2015/16	88.3	883_1	883_1	21		0.5	0.1	2.38	0.48
2015/16	88.3	883_3	883_3	31	0.0	0.5	0.1	1.61	0.32
2015/16	88.3	883_4	883_4	52	0.1	1.8	0.5	3.46	0.96
2015/16	88.3	883_5	883_5	38		0.6	0.3	1.58	0.79

Table 3: Summary of extrapolated seabird mortality (where the mortality rate is in birds/1 000 hooks) figures for the past five seasons across the CAMLR Convention Area. This table should be considered in relation to the discussions contained in this report (paragraphs 6.40 to 6.43).

Area	Mortality	2012	2013	2014	2015	2016
48.3	Extrapolated	6	3	123	3	98
	Mortality rate	0.0006	0.0003	0.013	0.0007	0.012
58.6, 58.7 (South Africa)	Extrapolated	0	3	0	0	6
	Mortality rate	0	0.009	0	0	0.008
58.6 (France)	Extrapolated	68	55	24	41	20
	Mortality rate	0.022	0.019	0.009	0.012	0.005
88.1, 88.2	Extrapolated	0	0	2	0	0
	Mortality rate	0	0	0.0002	0	0
58.4.1, 58.4.2, 58.4.3a, 58.4.3b	Extrapolated	0	0	0	0	0
	Mortality rate	0	0	0	0	0
58.5.1 (France)	Extrapolated	190	102	24	49	64
	Mortality rate	0.012	0.004	0.001	0.004	0.005
58.5.2	Extrapolated	0	0	2	2	4
	Mortality rate	0	0	<0.001	0.0002	0.007
Total		222	163	175	95	192

Table 4: Baseline distribution of the trigger level based on density of krill and risk of effects on predators and krill in small-scale management units (SSMUs). Regional risk (R_risk) is the accumulated risk across Area 48 of localised effects on predators and krill. Relative risk (R_relative) is the regional risk relative to the baseline regional risk. For Subarea 48.1, Bransfield includes Bransfield SSMUs, Drake includes Drake Passage plus Elephant Island SSMUs, Pelagic is the pelagic SSMU, and E_W includes the East and West SSMUs.

Scenario		Regional risk		Distribution in Subarea 48.1				Subareas				Total catch
#	Name	R_risk	R_relative	Bransfield	Drake	Pelagic	E_W	48.1	48.2	48.3	48.4	
1	Baseline Alpha			0.001	0.002	0.044	0.002	0.049	0.456	0.434	0.061	
	Catches			1	1	28	1	31	283	269	38	620
	Local catch-weighted risk	0.387	1	000.1	000.1	0.018	0.002	0.022	0.168	0.184	0.013	

Table 5: Distribution of the trigger level for scenarios based on historical catch distributions plus a scenario for all catch to be taken from Bransfield Strait. Catches (thousand tonnes) are calculated as the alpha level multiplied by the trigger level of 620 000 tonnes. The adjusted catches (thousand tonnes) for a scenario give catches for each area that would result in the regional risk of the scenario being equal to the baseline regional risk (calculated by pro-rating the alphas for a scenario in order to achieve a regional risk equal to the baseline). The total catch indicates what the total catch for Subareas 48.1, 48.2, 48.3 and 48.4 that would correspond to the regional risk indicated. See Table 4 for definitions.

Scenario		Regional risk		Distribution in Subarea 48.1				Subareas				Total catch
#	Name	R_risk	R_relative	Bransfield	Drake	Pelagic	E_W	48.1	48.2	48.3	48.4	
	Alpha											
2	Catch 2013–2016	0.650		0.430	0.057	0	0.075	0.562	0.205	0.233	0	
3	Catch 2010–2013	0.625		0.362	0.114	0.001	0.054	0.531	0.26	0.21	0	
4	Catch 2000–2010	0.48		0.076	0.202	0.002	0.006	0.286	0.429	0.285	0	
5	Catch 1990–2000	0.679		0.01	0.595	0.017	0.011	0.633	0.147	0.221	0	
6	Catch 1980–1990	0.823		0.001	0.763	0.055	0.005	0.824	0.176	0	0	
7	Bransfield only	0.942		1	0	0	0	1	0	0	0	
	Catches											
2	Catch 2013–2016	0.65	1.68	266	35	0	47	349	127	145	0	620
3	Catch 2010–2013	0.625	1.61	224	70	1	34	329	161	130	0	620
4	Catch 2000–2010	0.48	1.24	47	125	1	4	178	266	177	0	620
5	Catch 1990–2000	0.679	1.75	6	369	10	7	392	91	137	0	620
6	Catch 1980–1990	0.823	2.13	1	473	34	3	511	109	0	0	620
7	Bransfield only	0.942	2.43	620	0	0	0	620	0	0	0	620
	Adjusted catches											
2	Catch 2013–2016	0.387	1	159	21	0	28	208	76	86	0	369
3	Catch 2010–2013	0.387	1	139	44	0	21	204	100	81	0	384
4	Catch 2000–2010	0.387	1	38	101	1	3	143	214	142	0	500
5	Catch 1990–2000	0.387	1	3	210	6	4	224	52	78	0	353
6	Catch 1980–1990	0.387	1	0	222	16	2	240	51	0	0	292
7	Bransfield only	0.387	1	255	0	0	0	255	0	0	0	255

Table 6: Distribution of the trigger level for scenarios based on Conservation Measure (CM) 51-07, along with the resulting catches from the trigger level of 620 000 tonnes. Adjusted catches for a scenario give catches for each area that would result in the regional risk of the scenario being equal to the baseline regional risk. The scenarios relate to the following: 'CM_' indicates the scenario based on CM 51-07. '_25' or '_35' indicate scenarios where Subarea 48.1 has 25% or 35% of the trigger level with the remaining subareas divided according to the relative proportions in other subareas according to the existing conservation measure. Catches between seasons and between small-scale management units (SSMUs) in groups of SSMUs (either subareas or, in Subarea 48.1, within subarea groups) for Subareas 48.1, 48.2 and 48.3 are divided according to the catch distributions of the most recent period in the fishery. Subarea 48.4 is divided between pelagic and island SSMUs according to the proportion of the subarea in each SSMU. 'even481' relates to having one third of the catch in each of Drake Passage SSMUs (including Elephant Island), Bransfield Strait SSMUs and the Pelagic Area, with no catch in the other SSMUs in Subarea 48.1. 'current481' indicates distribution amongst SSMUs according to the most recent fishing period. 'D&B' is where half the catch from Subarea 48.1 is taken from the Drake Passage SSMUs and half from the Bransfield Strait SSMUs. See Table 4 for definitions.

Scenario		Regional risk		Distribution in Subarea 48.1				Subareas				Total catch
#	Name	R_risk	R_relative	Bransfield	Drake	Pelagic	E_W	48.1	48.2	48.3	48.4	
	Alpha											
8	CM_even481_25	0.467		0.083	0.083	0.083	0	0.25	0.32	0.32	0.11	
9	CM_current481_25	0.457		0.191	0.025	0	0.034	0.25	0.32	0.32	0.11	
10	CM_D&B_481_25	0.466		0.125	0.125	0	0	0.25	0.32	0.32	0.11	
11	CM_even481_35	0.532		0.117	0.117	0.117	0	0.35	0.28	0.28	0.09	
12	CM_current481_35	0.518		0.267	0.035	0	0.047	0.35	0.28	0.28	0.09	
13	CM_D&B_481_35	0.53		0.175	0.175	0	0	0.35	0.28	0.28	0.09	
	Catches											
8	CM_even481_25	0.467	1.21	52	52	52	0	155	198	198	68	620
9	CM_current481_25	0.457	1.18	118	16	0	21	155	198	198	68	620
10	CM_D&B_481_25	0.466	1.20	78	78	0	0	155	198	198	68	620
11	CM_even481_35	0.532	1.37	72	72	72	0	217	174	174	56	620
12	CM_current481_35	0.518	1.33	166	22	0	29	217	174	174	56	620
13	CM_D&B_481_35	0.53	1.37	109	109	0	0	217	174	174	56	620
	Adjusted catches											
8	CM_even481_25	0.387	1	43	43	43	0	129	165	165	57	514
9	CM_current481_25	0.387	1	100	13	0	18	131	168	168	58	525
10	CM_D&B_481_25	0.387	1	64	64	0	0	129	165	165	57	515
11	CM_even481_35	0.387	1	53	53	53	0	158	126	126	41	451
12	CM_current481_35	0.387	1	124	16	0	22	162	130	130	42	463
13	CM_D&B_481_35	0.387	1	79	79	0	0	158	127	127	41	452

Table 7: Local relative catch-weighted risks for groups of small-scale management units (SSMUs) in Subarea 48.1 and for Subareas 48.1, 48.2, 48.3, and 48.4 for each scenario shown in Table 5 and Table 6. These local relative catch-weighted risks are the local catch-weighted risks divided by the local catch-weighted risk for that area in the baseline scenario (Table 4). See Table 4 for definitions.

Scenario		Local relative risk within Subarea 48.1				Local relative risk by subarea				Relative regional risk
#	Name	Bransfield	Drake	Pelagic	E_W	48.1	48.2	48.3	48.4	
2	Catch 2013–2016	392	56	0	33.5	23.41	0.32	0.44	0	1.68
3	Catch 2010–2013	340	93	0.06	24.5	21.91	0.39	0.42	0	1.61
4	Catch 2000–2010	67	161	0.06	2.5	10.64	0.64	0.76	0	1.24
5	Catch 1990–2000	9	513	0.78	5	24.82	0.23	0.52	0	1.75
6	Catch 1980–1990	1	710	2.89	2.5	34.95	0.32	0	0	2.13
7	Bransfield only	942	0	0	0	42.82	0	0	0	2.43
8	CM_even481_25	76	82	4.44	0	10.82	0.51	0.6	2.54	1.21
9	CM_current481_25	174	25	0	15	10.41	0.51	0.6	2.54	1.18
10	CM_D&B_481_25	114	124	0	0	10.82	0.51	0.6	2.54	1.20
11	CM_even481_35	106	115	6.22	0	15.18	0.44	0.53	2.08	1.37
12	CM_current481_35	244	35	0	21	14.55	0.44	0.53	2.08	1.33
13	CM_D&B_481_35	159	173	0	0	15.14	0.44	0.53	2.08	1.37

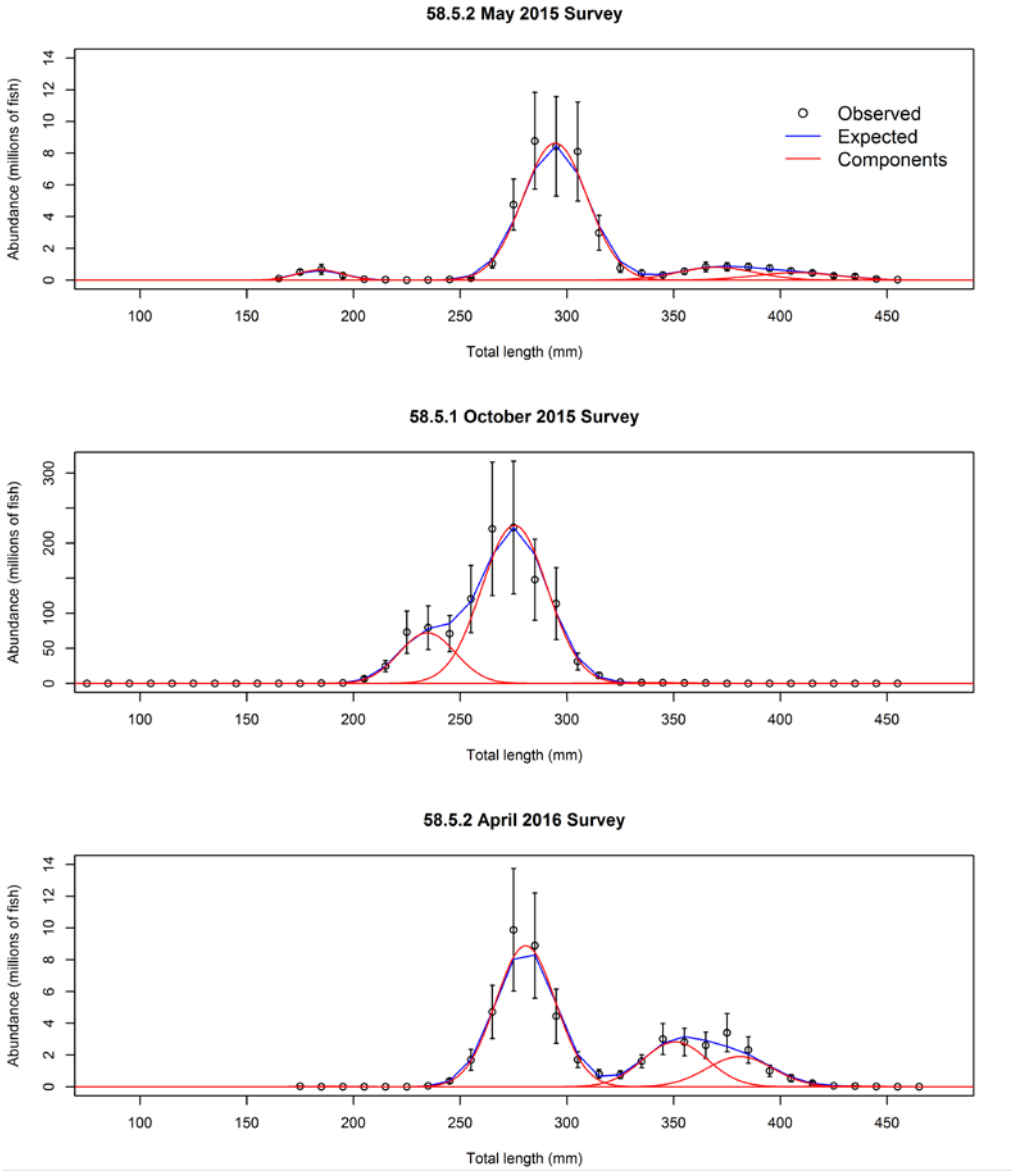


Figure 1: Fit to length-density data from the 2015 and 2016 surveys conducted within Divisions 58.5.1 (WG-FSA-16/53) and 58.5.2 (WG-FSA-16/26) using CMIX. Points are mean (+SE) abundance at length, the blue line is the expected length distribution arising from the best fit and the red lines are the abundances at length of the different components.

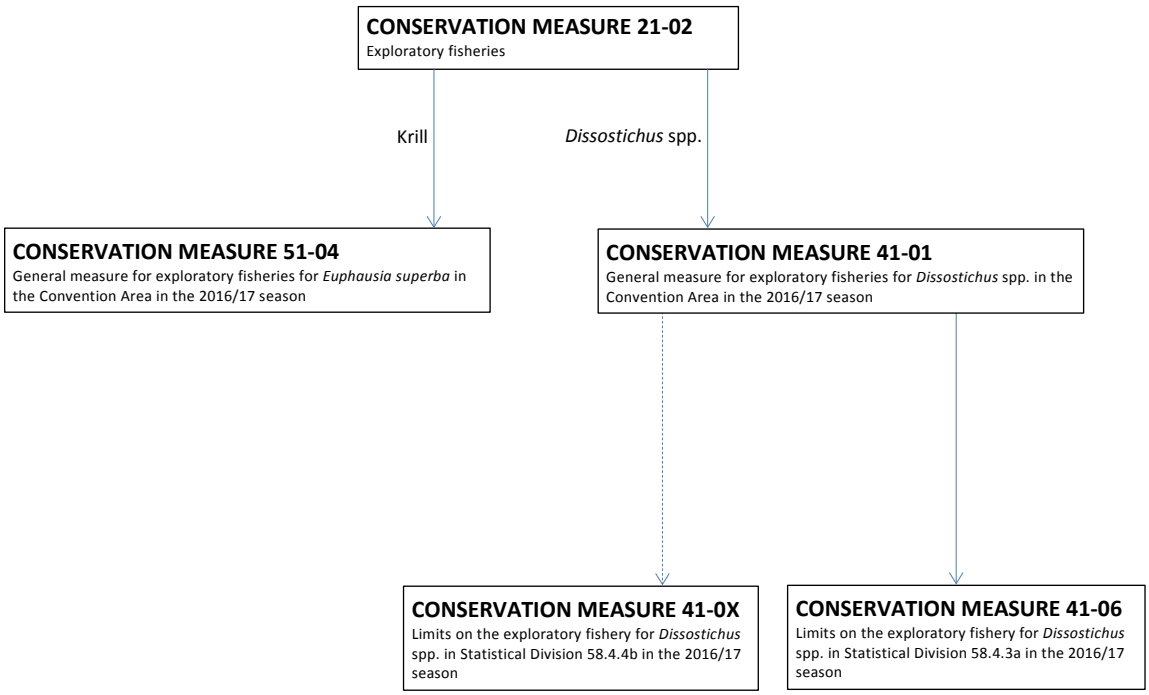


Figure 2: Hierarchy of conservation measures relating to exploratory fisheries.

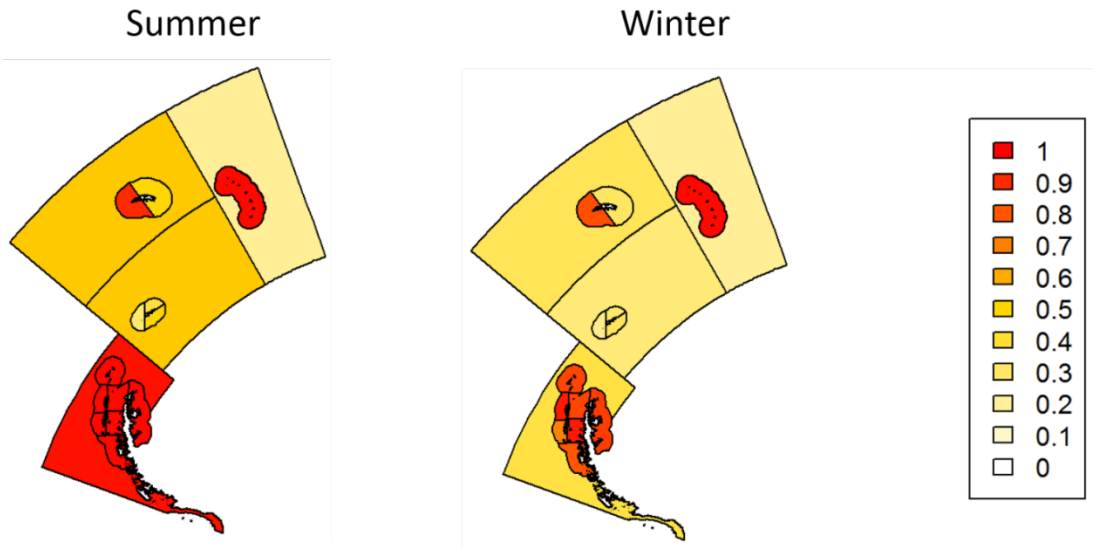


Figure 3: Baseline risk based on distribution of juvenile krill and land-based and pelagic predators in Area 48.

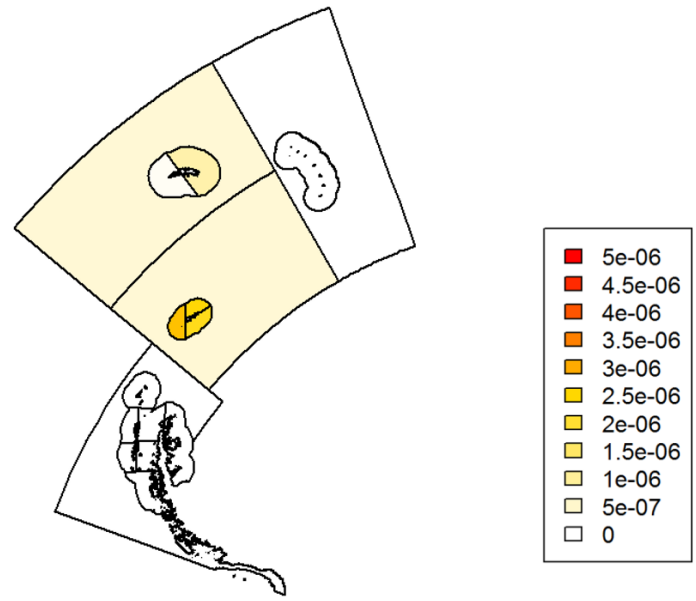
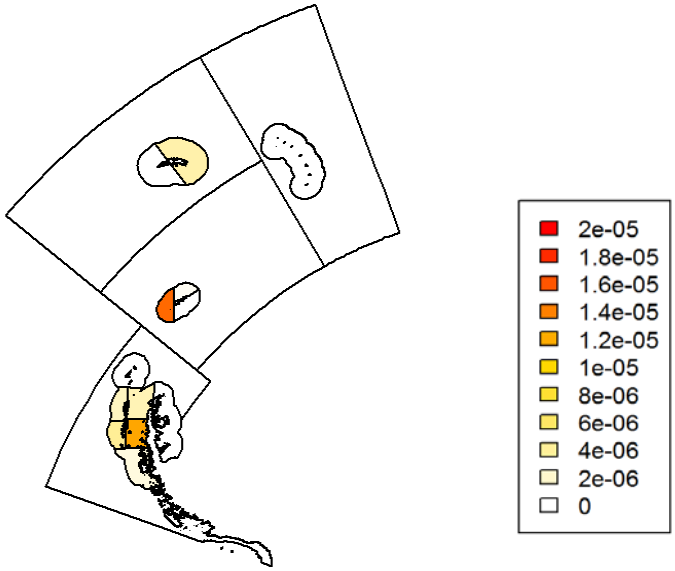


Figure 4: Baseline alpha and regional risk (0.39) for Area 48 and its subareas calculated based on the risk shown in Figure 3.

Scenario 2: Catches 2013–2016 (R_Risk = 0.65)

Figure 5: Proportions of the trigger level calculated for each SSMU (plotted as a density) in Scenarios 2–6 in Table 5. Regional Risks (R_risk) are given for scenarios. (continued)

Scenario 3: Catches 2010–2013 (R_Risk = 0.62)



Scenario 4: Catches 2000–2010 (R_Risk = 0.48)

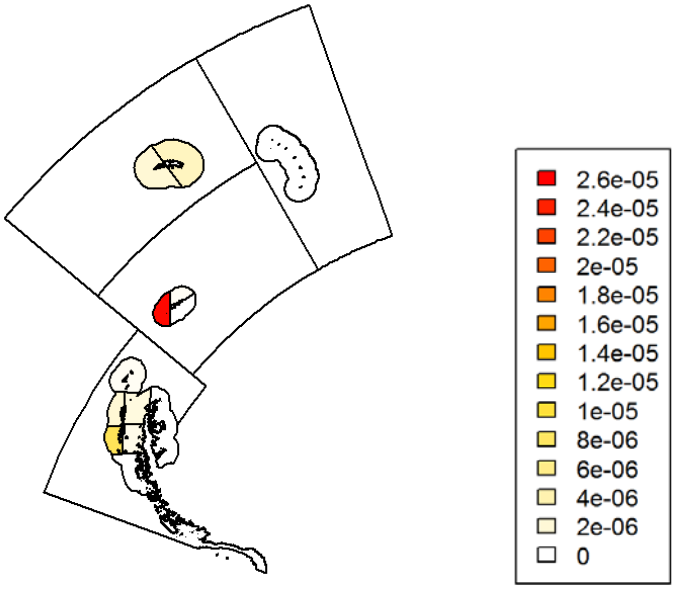
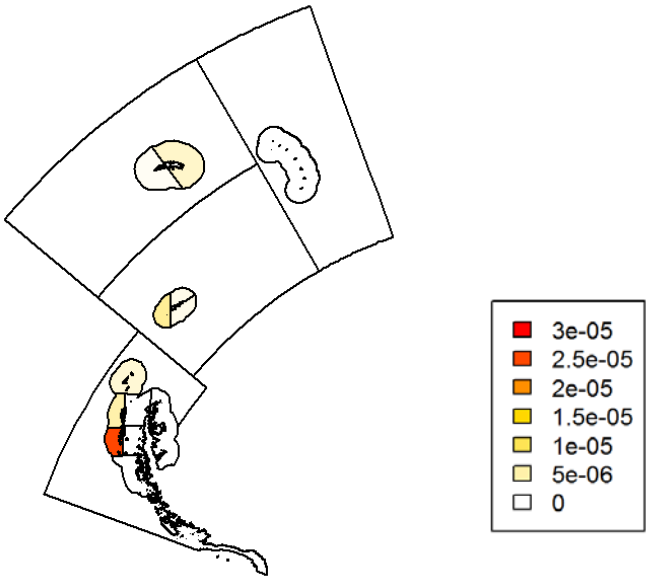


Figure 5 (continued)

Scenario 5: Catches 1990–2000 (R_Risk = 0.68)



Scenario 6: Catches 1980–1990 (R_Risk = 0.82)

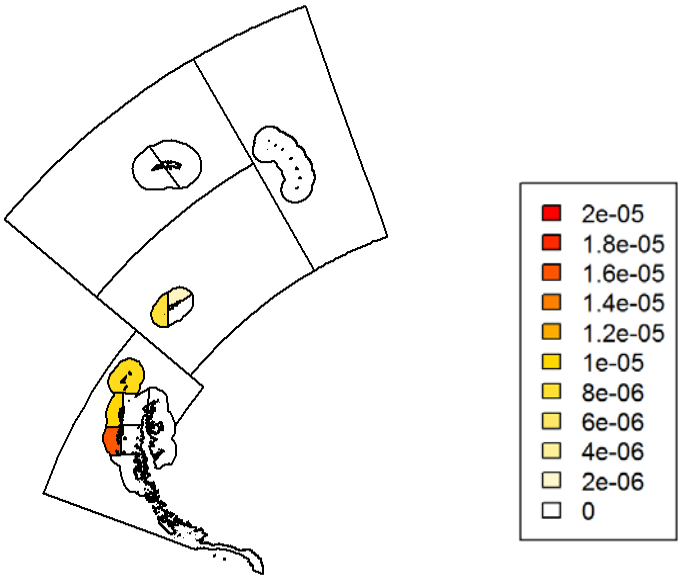


Figure 5 (continued)

Scenario 7: Catches Bransfield Strait (R_Risk = 0.94)

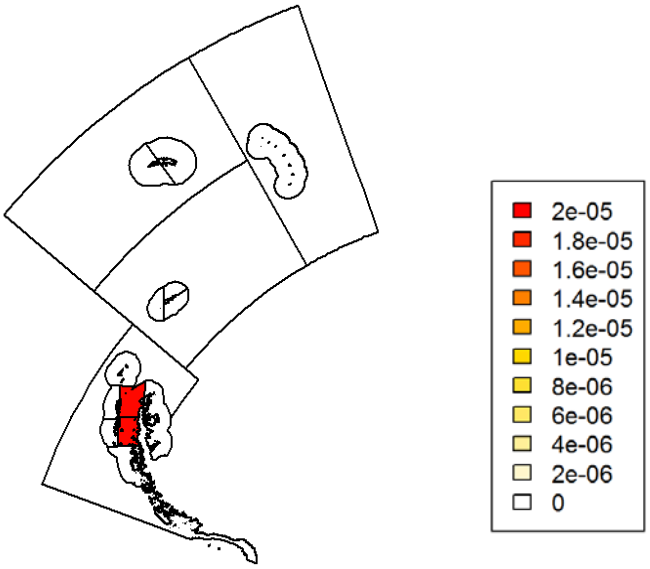


Figure 5 (continued)

Scenario 8: CM_even481_25 (R_Risk = 0.47)

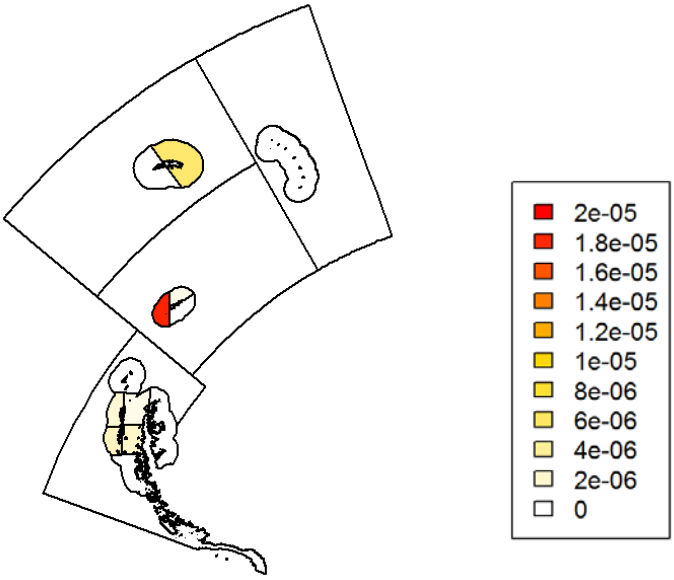
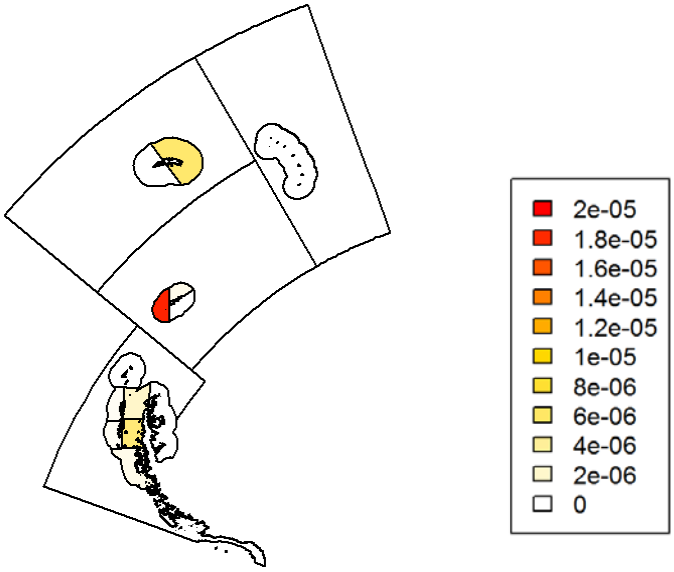


Figure 6: Proportions of the trigger level calculated for each SSMU (plotted as a density) in Scenarios 8–13 in Table 6. Regional Risks (R_risk) are given for scenarios. (continued)

Scenario 9: CM_current481_25 (R_Risk = 0.46)



Scenario 10: CM_D&B_481_25 (R_Risk = 0.47)

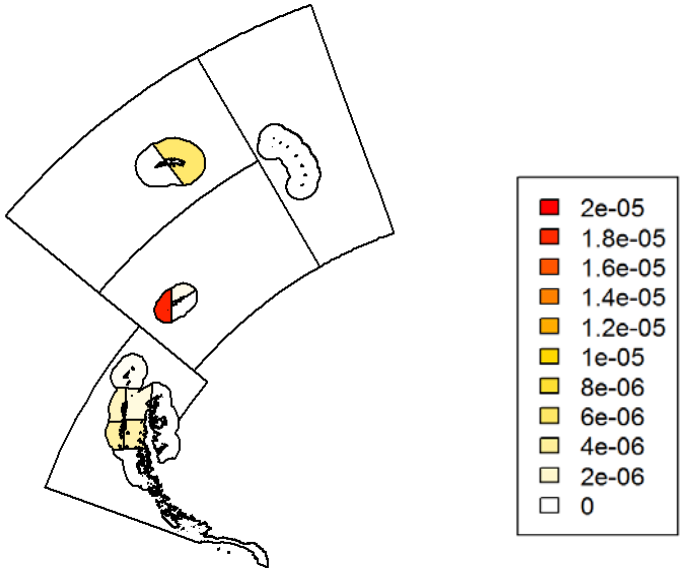
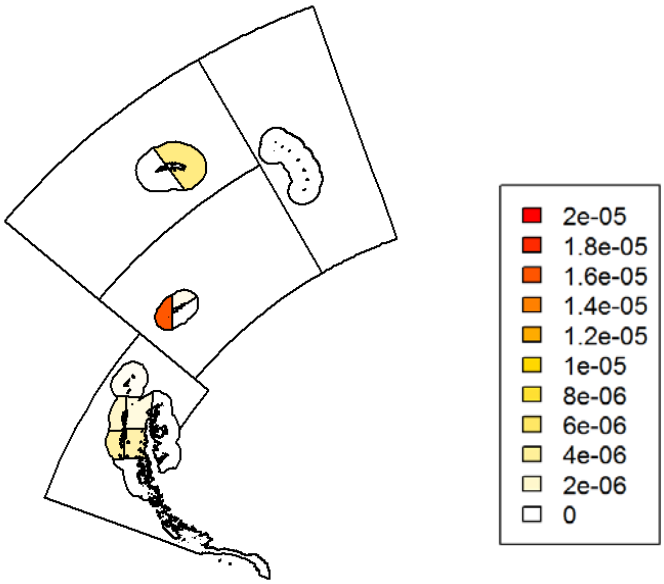


Figure 6 (continued)

Scenario 11: CM_even481_35 (R_Risk = 0.53)



Scenario 12: CM_current481_35 (R_Risk = 0.52)

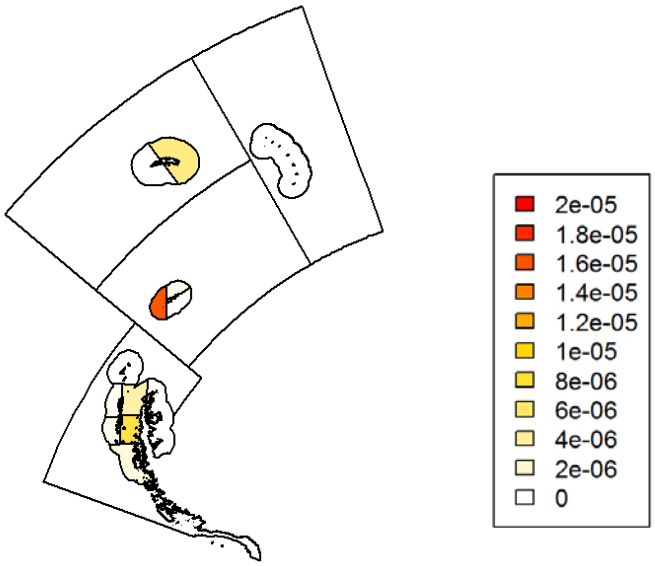


Figure 6 (continued)

Scenario 13: CM_D&B_481_35 (R_Risk = 0.53)

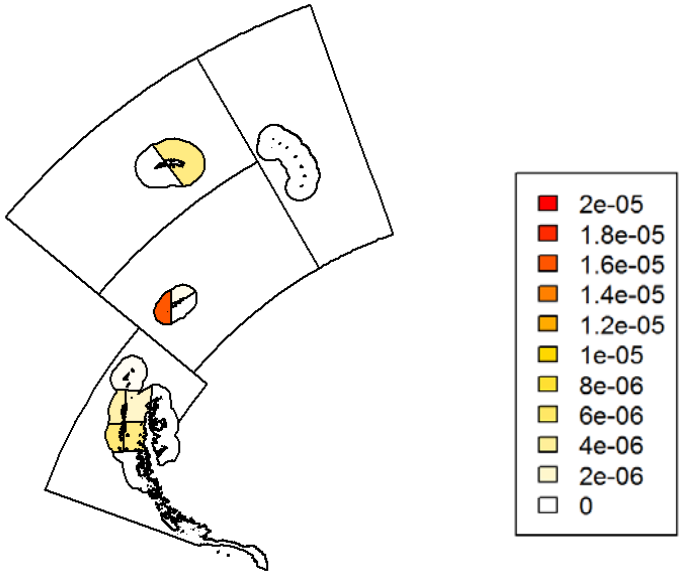


Figure 6 (continued)

Appendix A

List of Participants

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(Hobart, Australia, 3 to 12 October 2016)

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IT Manager	Tim Jones
Systems Analyst	Ian Meredith
Intern	
Jung-Ju Lee	

Appendix B

Agenda

Working Group on Fish Stock Assessment
(Hobart, Australia, 3 to 12 October 2016)

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)

    3.1 *Champsocephalus gunnari* in Subarea 48.3 and Divisions 58.5.1 and 58.5.2

        3.1.1 Champsocephalus gunnari Subarea 48.3
            3.1.1.1 Review of available information
            3.1.1.2 Review of stock assessment
            3.1.1.3 Management advice and revisions to fishery reports

        3.1.2 *Champsocephalus gunnari* Division 58.5.1
            3.1.2.1 Review of available information
            3.1.2.2 Review of stock assessment
            3.1.2.3 Management advice and revisions to fishery reports

        3.1.3 *Champsocephalus gunnari* Division 58.5.2
            3.1.3.1 Review of available information
            3.1.3.2 Review of stock assessment
            3.1.3.3 Management advice and revisions to fishery reports

    3.2 *Dissostichus* spp. in Subareas 48.4, 88.1 and 88.2

        3.2.1 *Dissostichus* spp. in Subarea 48.4
            3.2.1.1 Review of available information
            3.2.1.2 Review of stock assessment
            3.2.1.3 Management advice and revisions to fishery reports

        3.2.2 *Dissostichus* spp. in Subarea 88.1
            3.2.2.1 Review of research proposals
                3.2.2.1.1 88.1 Shelf
                3.2.2.1.2 88.2 AB North
                3.2.2.1.3 88.2 AB South

            3.2.2.2 Management advice and revisions to fishery reports

3.2.3 *Dissostichus* spp. in Subarea 88.2
- 3.2.3.1 Review of available information
- 3.2.3.2 Review of stock assessment
- 3.2.3.3 Management advice and revisions to fishery reports

3.2.4 *Dissostichus eleginoides* in Subarea 58.6 and Division 58.5.1
- 3.2.4.1 Review of available information
- 3.2.4.2 Review of stock assessment
- 3.2.4.3 Management advice and revisions to fishery reports

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

4.1 Generic issues
4.2 Management area research reviews

4.2.1 *Dissostichus* spp. Subarea 48.2
- 4.2.1.1 Review of available information and data quality
- 4.2.1.2 Review of progress towards a stock assessment and research proposals
- 4.2.1.3 Management advice and revisions to fishery reports

4.2.2 *Dissostichus eleginoides* Subarea 48.5
- 4.2.2.1 Review of available information and data quality
- 4.2.2.2 Review of progress towards a stock assessment and research proposals
- 4.2.2.3 Management advice and revisions to fishery reports

4.2.3 *Dissostichus* spp. Subarea 48.6
- 4.2.3.1 Review of available information and data quality
- 4.2.3.2 Review of progress towards a stock assessment and research proposals
- 4.2.3.3 Management advice and revisions to fishery reports

4.2.4 *Dissostichus* spp. Division 58.4.1
- 4.2.4.1 Review of available information and data quality
- 4.2.4.2 Review of progress towards a stock assessment and research proposals
- 4.2.4.3 Management advice and revisions to fishery reports

4.2.5 *Dissostichus* spp. Division 58.4.2
- 4.2.5.1 Review of available information and data quality
- 4.2.5.2 Review of progress towards a stock assessment and research proposals
- 4.2.5.3 Management advice and revisions to fishery reports

4.2.6 *Dissostichus* spp. Division 58.4.3a
- 4.2.6.1 Review of available information and data quality
- 4.2.6.2 Review of progress towards a stock assessment and research proposals
- 4.2.6.3 Management advice and revisions to fishery reports

4.2.7 *Dissostichus* spp. Division 58.4.4a and b
- 4.2.7.1 Review of available information and data quality
- 4.2.7.2 Review of progress towards a stock assessment and research proposals
- 4.2.7.3 Management advice and revisions to fishery reports

4.2.8 *Dissostichus* spp. Subarea 88.3
- 4.2.8.1 Review of available information and data quality
- 4.2.8.2 Review of progress towards a stock assessment and research proposals
- 4.2.8.3 Management advice and revisions to fishery reports

4.2.9 Notothenioid spp. Subarea 48.1
- 4.2.9.1 Review of available information and data quality
- 4.2.9.2 Review of progress towards a stock assessment and research proposals
- 4.2.9.3 Management advice and revisions to fishery reports

5. Scheme of International Scientific Observation

6. Non-target catch and interactions in CCAMLR fisheries

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

7. Future work

- 7.1 Organisation of intersessional activities
- 7.2 Intersessional meetings
- 7.3 Notification of Scientific Research

8. Other business

9. Advice to Scientific Committee

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

Appendix C

List of Documents

Working Group on Fish Stock Assessment
(Hobart, Australia, 3 to 12 October 2016)

WG-FSA-16/01	Summary of scientific observer data collected in finfish fisheries in the CAMLR Convention Area during 2016 CCAMLR Secretariat
WG-FSA-16/02	Updated status of *Notothenia rossii*, *Gobionotothen gibberifrons* and *Notothenia coriiceps* in inshore sites of the South Shetland Islands: results of a long-term monitoring program (1983–2016) at Potter Cove E. Barrera-Oro, E. Marschoff and D. Ainley
WG-FSA-16/03	Consideration of requirements for a CCAMLR hook-marking scheme CCAMLR Secretariat
WG-FSA-16/04	Fish by-catch in the krill fishery: 2016 update CCAMLR Secretariat
WG-FSA-16/05	Measurement of capacity in CCAMLR exploratory fisheries in Subareas 88.1 and 88.2: Secretariat update 2016 CCAMLR Secretariat
WG-FSA-16/06	Diet composition of Antarctic toothfish Delegation of the Republic of Korea
WG-FSA-16/07	Perfluorinated compounds in muscle tissues of Antarctic toothfish in Division 58.4.1 and 58.4.2 of Antarctic Sea Delegation of the Republic of Korea
WG-FSA-16/08	Preliminary results of pop-up satellite tag study on Antarctic toothfish in the Mawson Sea Delegation of the Republic of Korea
WG-FSA-16/09	Whale depredation data collection guidelines N. Gasco, P. Tixier, M. Söffker and C. Guinet
WG-FSA-16/10	Update on Patagonian toothfish (*Dissostichus eleginoides*) losses in the bottom longline fishery due to the depredation by killer whales and sperm whales off the Kerguelen and Crozet Islands N. Gasco, P. Tixier, G. Duhamel and C. Guinet

WG-FSA-16/11	Identification self training N. Gasco and A. Martin
WG-FSA-16/12	By-catch of morid cods (Gadiformes: Moridae) in the CCAMLR area and adjacent areas during commercial fishing and research surveys A. Orlov and I. Gordeev
WG-FSA-16/13 Rev. 1	Integrated analysis of the by-catch data in the Ross Sea toothfish fishery S. Kasatkina
WG-FSA-16/14	Analysis of the longline fishery data in the Ross Sea (SSRUs 881B, C and G) S. Kasatkina
WG-FSA-16/15 Rev. 1	Plan of research program of the Russian Federation in Subarea 48.5 Delegation of the Russian Federation
WG-FSA-16/16 Rev. 1	Research program on resource potential and life cycle of *Dissostichus* species from the Subarea 88.2 A in 2016–2019 Delegation of the Russian Federation
WG-FSA-16/17	A by-catch guide for commonly caught species in CCAMLR longline and trawl fisheries CCAMLR Secretariat
WG-FSA-16/18	Report on the CCAMLR marine debris monitoring program CCAMLR Secretariat
WG-FSA-16/19	Report on an Antarctic cetacean survey on board a Chilean fishing vessel in February 2016 S. Viquerat, H. Herr, K.-H. Kock and P. Arana
WG-FSA-16/20	Part 1. Seabird assemblages during trawling operations J.A. Arata
WG-FSA-16/21	Hidroacustics survey around Elephant Island (Subarea 48.1) and South Orkney Islands (Subarea 48.2), austral summer 2016 N.A. Landeros and P.M. Arana
WG-FSA-16/22	Spawning pattern and type of fecundity in notothenioids collected around the Elephant and South Orkney Islands G. Plaza, P.M. Arana, F. Becker, A. Zavatteri and V.H. Castillo

WG-FSA-16/23	The random stratified trawl survey to estimate the abundance of *Dissostichus eleginoides* and *Champsocephalus gunnari* in the waters of Heard Island (Division 58.5.2) for 2016 G.B. Nowara, T.D. Lamb and D.C. Welsford
WG-FSA-16/24	IUU summaries for inclusion in Fishery Reports CCAMLR Secretariat
WG-FSA-16/25 Rev. 1	Long-distance movements of tagged Patagonian (*Dissostichus eleginoides*) and Antarctic toothfish (*D. mawsoni*) CCAMLR Secretariat
WG-FSA-16/26	A preliminary assessment of mackerel icefish (*Champsocephalus gunnari*) in Division 58.5.2, based on results from the 2016 random stratified trawl survey D. Maschette and D. Welsford
WG-FSA-16/27	Local biomass estimates for Antarctic (*Dissostichus mawsoni*) and Patagonian (*Dissostichus eleginoides*) toothfish in research blocks in Subareas 48.6 and 58.4 CCAMLR Secretariat
WG-FSA-16/28 Rev. 1	Report on season extension trials in the Patagonian toothfish longline fishery in CCAMLR Statistical Division 58.5.2 T. Lamb
WG-FSA-16/29	Joint research proposal for the *Dissostichus* spp. exploratory fishery in East Antarctica (Divisions 58.4.1 and 58.4.2) by Australia, France, Japan, Republic of Korea and Spain Delegations of Australia, France, Japan, Republic of Korea and Spain
WG-FSA-16/30	Joint report on exploratory fishing in Divisions 58.4.1 and 58.4.2 between the 2011/12 and 2015/16 fishing seasons Delegations of Australia, France, Japan, Republic of Korea and Spain
WG-FSA-16/31	Finfish distribution and abundance in Subareas 48.1 and 48.2, 2016–2018. Research proposal for the second year Delegation of Chile
WG-FSA-16/32 Rev. 1	Revised research plan for the 2016/17 exploratory longline fishery of *Dissostichus* spp. in Subarea 48.6 by South Africa and Japan Delegations of Japan and South Africa

WG-FSA-16/33 Rev. 1	Revised research plan for the 2016/17 toothfish fishery in Division 58.4.4b by Japan and France Delegations of Japan and France
WG-FSA-16/34	Revised research longline fishing proposal for *Dissostichus* spp. in Subarea 48.2. Second Season 2017 Delegation of Chile
WG-FSA-16/35	Final report on the survey for *Dissostichus* spp. in Subarea 48.2 (Phase one 2016) A. Zuleta, S. Hopf and P. Ruiz
WG-FSA-16/36	Fishing for structure; can we describe normal patterns in toothfish fishing operations using catch and effort data? J.M. Fenaughty and K. Large
WG-FSA-16/37	Results of the first winter longline survey to the northern Ross Sea region to investigate toothfish reproductive life history D. Stevens, D. Di Blasi and S. Parker
WG-FSA-16/38	Proposal to allow the use of net monitoring cable in CCAMLR krill trawl fisheries Delegation of Norway
WG-FSA-16/39	Preliminary tag-recapture based population assessment of Antarctic toothfish in Subarea 48.4 S. Wright, N. Walker, M. Söffker and T. Earl
WG-FSA-16/40	Proposal for a longline survey to determine toothfish population connectivity between Subareas 48.2 and 48.4 Delegation of the United Kingdom
WG-FSA-16/41	Subarea 48.2 research proposals – overview M. Söffker, C. Cardenas, L. Pshenichnov, D. Marichev, A. Zuleta, S. Ajiumerov and C. Darby
WG-FSA-16/42	Report on the 1st COLTO depredation workshop in Punta Arenas, Chile M. Söffker and D. Welsford
WG-FSA-16/43	The use of an electronic monitoring camera system for the toothfish fishery in CCAMLR Subarea 48.3: A study case to help CCAMLR scientific observers R. Benedet, D. Barnes and M. Collins

WG-FSA-16/44	Progress towards an assessment of Antarctic toothfish (*Dissostichus mawsoni*) in Subarea 88.2 SSRUs 882C–H for the years 2002–03 to 2015–16 using a two-area model S. Mormede, K. Large and S. Hanchet
WG-FSA-16/45	A characterisation of the toothfish fishery and tagging programme in the Amundsen Sea region (SSRUs 882C–H) through 2015–16 K. Large, S. Parker and S. Hanchet
WG-FSA-16/46	A multivariate approach to examining patterns in research fishing activities using the SSRUs 882A–B North survey as an example S. Mormede, A. Dunn, S.J. Parker, T. Earl, C. Darby, M. Söffker and O.R. Godø
WG-FSA-16/47 Rev. 1	Scientific contribution to the 2016 review of Conservation Measure 51-07: Part 1 – rationale, method and data for a risk assessment framework for distributing the krill trigger level A. Constable (on behalf of the e-group on CM 51-07 WG-EMM review)
WG-FSA-16/48 Rev. 1	Scientific contribution to the 2016 review of Conservation Measure 51-07: Part 2 – outcomes from the application of the risk assessment framework for distributing the krill trigger level in Area 48 A. Constable (on behalf of the e-group on CM 51-07 WG-EMM review)
WG-FSA-16/49	Revised plan of research program of the Ukraine in Subarea 48.2 in 2017 (third season) Delegation of Ukraine
WG-FSA-16/50	The report on the survey in Subarea 48.2 in 2016 (second season) Delegation of Ukraine
WG-FSA-16/51	Species profiles: Target species and common by-catch species K.-H. Kock, C.D. Jones and D. Welsford
WG-FSA-16/52	Updated assessment of Patagonian toothfish (*Dissostichus eleginoides*) in the vicinity of Crozet Islands (Subarea 58.6) R. Sinegre and G. Duhamel
WG-FSA-16/53	Stock assessment of mackerel icefish (*Champsocephalus gunnari*) in the vicinity of Kerguelen Islands (Division 58.5.1) after the 2015 Icefish Biomass survey R. Sinegre and G. Duhamel

WG-FSA-16/54	Updated stock assessment of Patagonian toothfish (*Dissostichus eleginoides*) in the vicinity of Kerguelen Islands (Division 58.5.1) R. Sinegre and G. Duhamel
WG-FSA-16/55	Research plan for the exploratory longline fishery for *Dissostichus* spp. in 2016/17 in Division 58.4.3a by France and Japan Delegation of France and Japan
WG-FSA-16/56	Revised progress report for the fourth year of the research fishery for *Dissostichus* spp. in Subarea 48.6 being jointly undertaken by Japan and South Africa S. Somhlaba, R. Leslie, K. Taki, T. Ichii and T. Namba
WG-FSA-16/57	Pop-off satellite tagging in the Ross Sea region in 2016 C.D. Jones, S.J. Parker, A. Dunn, D. Di Blasi and D. Stevens
WG-FSA-16/58	Update of ongoing work on age and growth of Antarctic toothfish (*Dissostichus mawsoni*) (2013/14 season) from Division 58.4.1 by Spain L.J. López-Abellán, M.T.G. Santamaría, R. Sarralde and S. Barreiro
WG-FSA-16/59	Proposal for research fishing in CCAMLR Subarea 48.6 during the three-year period 2016/17–2018/19 Delegation of Uruguay

Other documents

WG-FSA-16/P01	Parasites of the Antarctic toothfish (*Dissostichus mawsoni* Norman, 1937) (Perciformes, Nototheniidae) in the Pacific sector of the Antarctic I.I. Gordeev and S.G. Sokolov *Polar Res.*, 35 (2016): 29364, http://dx.doi.org/10.3402/polar.v35.29364
WG-FSA-16/P02	Lipid metabolism features of Antarctic toothfish *Dissostichus mawsoni* (Nototheniidae) I.I. Gordeev, D.V. Mikryakov, N.I. Silkina and A.S. Sokolova *Issues of pathology, immunology and health protection of fishes and other hydrobionts*. Extended materials of the IV International Congress, Borok, 24–27 September 2015: 280–286 (in Russian)

WG-FSA-16/P03	Distribution and abundance of skates (*Bathyraja* spp.) on the Kerguelen Plateau through the lens of the toothfish fisheries G.B. Nowara, P. Burch, N. Gasco, D.C. Welsford, T.D. Lamb, C. Chazeau, G. Duhamel, P. Pruvost, S. Wotherspoon and S.G. Candy *Fish. Res.*, 186 (2017): 65–81, http://dx.doi.org/10.1016/j.fishres.2016.07.022
WG-SAM-16/11	Korean research plan in Subarea 88.3 in 2016/17 Delegation of the Republic of Korea
WG-SAM-16/14	Results of the fifth Ross Sea shelf survey to monitor abundance of sub-adult Antarctic toothfish in the southern Ross Sea, February 2016, and notification for continuation in 2017 A. Dunn, C. Jones, S. Mormede and S. Parker
WG-SAM-16/15	Proposal for a second longline survey of toothfish in the northern Ross Sea region (SSRUs 882A and B) S.J. Parker, R.J.C. Currey, M. Söffker, C. Darby, D. Welsford and O.R. Godø
WG-SAM-16/29	Progress report on the Korean research fishing by longline fishery for *Dissostichus* spp. in Subarea 88.3 in 2015/16 Delegation of the Republic of Korea
WG-EMM-16/P09	Linking population trends of Antarctic shag (*Phalacrocorax bransfieldensis*) and fish at Nelson Island, South Shetland Islands (Antarctica) R. Casaux and E. Barrera-Oro *Polar Biol.*, (2015), doi: 10.1007/s00300-015-1850-5
CCAMLR-XXXV/14	A proposal to make activities targeting toothfish consistent with CCAMLR's regulatory framework Secretariat
CCAMLR-XXXV/BG/05 Rev. 1	Fishery notifications 2016/17 Secretariat
CCAMLR-XXXV/BG/09	Proposal to revise conservation measures related to activities targeting toothfish consistent with CCAMLR's regulatory framework Secretariat
SC-CAMLR-XXXV/BG/01	Catches of target species in the Convention Area CCAMLR Secretariat
SC-CAMLR-XXXV/BG/25	Developing the Secretariat's data management systems CCAMLR Secretariat