Annex 7

Report of the Working Group
on Fish Stock Assessment
(Hobart, Australia, 6 to 17 October 2014)

Contents

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Opening of the meeting

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 6 to 17 October 2014. The Convener, Dr M. Belchier (UK), opened the meeting and welcomed participants (Appendix A). Mr A. Wright (Executive Secretary) extended the Secretariat's warm welcome to all participants.

Organisation of the meeting and adoption of the agenda

2.1 The meeting's agenda addressed the priorities and topics identified by the Scientific Committee and Commission in 2013 and during the recent 2014 meeting of WG-SAM, including:

(i) provision of advice on fisheries for Patagonian toothfish (*Dissostichus eleginoides*), Antarctic toothfish (*D. mawsoni*) and mackerel icefish (*Champsocephalus gunnari*) which are assessed annually and on the fishery for *D. eleginoides* in Division 58.5.2, which is usually assessed biennially (SC-CAMLR-XXXII, paragraphs 3.115 and 3.116)

(ii) development of standard diagnostic tools for integrated assessments

(iii) further development of protocols for validating and approving updates for assessment software

(iv) development of mechanisms to partition research plan catches in the exploratory fishery for *Dissostichus* spp. in the Ross Sea (Subarea 88.1 and small-scale research units (SSRUs) 882A–B)

(v) evaluation of progress in developing stock assessments of *Dissostichus* spp. in exploratory fisheries, closed areas and areas with zero catches, including review of research proposals and advice on catch limits in 2014/15.

2.2 Other matters considered at the meeting included:

(i) CCAMLR's Scheme of International Scientific Observation (SISO) and outcomes from the recent SISO Review

(ii) non-target catch in CCAMLR fisheries, including by-catch of rajiformes and macrourids in longline fisheries, and a review of the efficacy of season extensions in the fisheries for *D. eleginoides* in Subarea 48.3 and Division 58.5.2

(iii) biology and ecology of target and non-target fish species and interactions in fish-based ecosystems.

2.3 The Working Group renamed Agenda Items 4 and 5 to better reflect the organisation of discussions of items listed above and the revised agenda was adopted (Appendix B).

2.4 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.

2.5 The Working Group discussed the development of a 'fishery dashboard' containing agreed fishery indicators and a summary of the status, assessment and catch limits in place for each fishery (Annex 5, paragraph 5.7). The dashboard would also outline progress in the development of CCAMLR fisheries, including data-poor fisheries and research fishing, within the context of the Commission's regulatory framework for CCAMLR fisheries (www.ccamlr.org/node/74615). Templates were developed and are available for consideration by the Scientific Committee. The 'dashboard' is intended to provide summary information for use by the Commission, as well as a web-based overview of information contained in the Fishery Reports.

2.6 In this report, paragraphs dealing with advice to the Scientific Committee and other working groups have been highlighted. These paragraphs are listed in paragraph 11.2. The information used in developing assessments and other aspects of the Working Group's work is included in the Fishery Report for each fishery (www.ccamlr.org/node/75667).

2.7 The Working Group was introduced to a new, web-based system to support the development of the meeting's report. The system, developed by the Secretariat, provides a secure platform which allows rapporteurs and participants to develop and edit report text and track comments, contributed text and versions. The system may be accessed remotely by meeting participants and integrates the Secretariat's workflow associated with the production of the meeting report.

2.8 The report was prepared by Drs R. Currey (New Zealand), C. Darby, T. Earl, J. Ellis (UK), Mr I. Forster (Secretariat), Mr N. Gasco (France), Dr S. Hanchet (New Zealand), Mr C. Heinecken (South Africa), Drs C. Jones, D. Kinzey (USA), K.-H. Kock (Germany), S. Mormede (New Zealand), G. Nowara (Australia), S. Parker (New Zealand), D. Ramm, K. Reid (Secretariat), K. Ross, M. Soffker (UK), D. Welsford and P. Ziegler (Australia).

Review of available information

Data requirements

3.1 The Working Group reviewed data submitted to the Secretariat from CCAMLR fisheries and fishery-based research in 2013/14, including information relevant to stock assessments. These data were used in the assessments described in Items 4 and 5 and other work conducted during the meeting.

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

3.3 The Working Group noted that management areas in five exploratory fisheries for *Dissostichus* spp. were closed by the Secretariat in 2013/14. These closures were triggered by catches of *Dissostichus* spp. approaching the relevant catch limits (CCAMLR-XXXIII/BG/01), and the catch limits in the fishery in Subarea 88.2 were exceeded. The Working Group noted that up to 14 vessels had fished in Subarea 88.2 in January 2014 and the fishery had experienced a rapid increase in fishing effort following the closure of the fishery in Subarea 88.1 on 17 January 2014 (Figure 1).

3.4 The Working Group noted the Secretariat's developments in data management and related matters in 2013/14, including:

(i) implementation of an information management framework

(ii) revision of the data management strategy

(iii) further development of the CCAMLR data model

(iv) improvements in data quality assurance, including tagging data

(v) implementation of the CCAMLR Geographic Information System (GIS) (see paragraph 3.5)

(vi) preparation of a web-based VME registry

(vii) further development of the nautical twilight calculator (www.ccamlr.org/node/74642)

(viii) scoping options for 'smart' data forms

(ix) implementation of the online submission of fishery notifications (www.ccamlr.org/node/78963)

(x) upload of historic conservation measures and resolutions (www.ccamlr.org/node/57043)

(xi) publication of the CCAMLR *Statistical Bulletin*, Volume 26 (www.ccamlr.org/node/74362).

CCAMLR GIS

3.5 The Working Group noted that the Secretariat had worked closely with the British Antarctic Survey (BAS) to create the CCAMLR GIS in 2014 (www.ccamlr.org/node/82341). The GIS facilitates improved access to CCAMLR spatial data and enables a variety of data formats to be visualised along with other Antarctic datasets. Users with log-in access to the CCAMLR website have the ability to upload their own datasets for display on the GIS. These datasets can remain private or be shared selectively with other CCAMLR users. The Secretariat has also developed a CCAMLR GIS R Package to convert georeferenced data into

shapefiles. The resulting files can then be uploaded to CCAMLR GIS or any other GIS. The Secretariat will continue adding CCAMLR-related content to the GIS, including maps of fishery catch limits and catches of target species (as reported in the *Statistical Bulletin*).

Data quarantine

3.6 The Working Group noted the outcomes of the investigation on anomalous CPUE which had been conducted by the Republic of Korea (COMM CIRC 14/93, September 2014). The Working Group acknowledged the efforts made by Korea to address and resolve this issue and agreed that the process undertaken by Korea is a good template for future investigations.

3.7 The Working Group drew the attention of the Scientific Committee to the need for a wide-scale analysis of CPUEs which would be useful to identify any other potential issue related to anomalous CPUE. It was noted that observer reports may contain information which may inform such analysis.

3.8 The Working Group requested the Scientific Committee advise on how to deal with data that is quarantined, particularly in relation to attributing the catches for stock assessment purposes.

3.9 The Working Group also noted that the Secretariat had implemented the Scientific Committee's advice that all data, including tagging data, collected from three Insung longline fishing vessels operating in the exploratory fisheries for *Dissostichus* spp. in seasons with anomalous CPUE data should be flagged as not suitable for routine analysis (SC-CAMLR-XXXII, paragraph 3.228). In addition, data from the *Paloma V* fishing in Divisions 58.4.1 and 58.4.3b in 2006/07, which had been identified by WG-FSA in 2008 (SC-CAMLR-XXVII, Annex 5, paragraph 3.4), have also been flagged as not suitable for routine analysis.

3.10 As a result, the following fishery and observer data will be quarantined and excluded from future data requests and analyses, and metadata provided with data extracts will include details of any quarantined data, which would be available on specific request:

(i) *Insung No. 2* in Subarea 48.6 and Divisions 58.4.1 and 58.4.2 in 2009/10
(ii) *Insung No. 7* in Subareas 48.6 and 88.1 and Divisions 58.4.1 and 58.4.2 in 2010/11
(iii) *Insung No. 22* in Subarea 48.6 and Divisions 58.4.1 and 58.4.2 in 2008/09
(iv) *Paloma V* in Divisions 58.4.1 and 58.4.3b in 2006/07.

Toothfish trade

3.11 The Secretariat reported on an analysis of global patterns of trade volume and price of *Dissostichus* spp. using United Nations Commodity Trade Statistics (CCAMLR-XXXIII/BG/14 Rev. 1). Initial results revealed a strong relationship between supply and demand within international markets, as well as the influence of country-specific factors. This analysis aims to identify trends in the global market and assist in the management of fisheries for *Dissostichus* spp. The Working Group thanked the Secretariat for this initiative and referred this analysis to the Scientific Committee for further consideration.

3.12 The Secretariat informed the Working Group that during the meeting the EU had provided a clarification on imports by Greece that had been incorrectly coded and referred to cod (*Gadus* spp.) not toothfish.

IUU fishing activity

3.13 The Working Group discussed the spatial characterisation of illegal, unreported and unregulated (IUU) fishing activity within the Convention Area based on recent sightings of fishing vessels and gear, and satellite data from vessels' Automatic Identification Systems (CCAMLR-XXXIII/BG/28 Rev. 1). These data provide limited information on vessel movements and fishing activities, however, this information cannot currently be used to estimate IUU catches.

3.14 In 2013, the Working Group had considered the requirement under Conservation Measure (CM) 10-02 that vessels report all other vessel sightings in the Convention Area to their Flag State and that the provision of these data may be useful in developing a vessel detection model (CCAMLR-XXXII, Annex 6, paragraph 3.5). The Working Group noted that these data had not been provided in 2014 and requested that the Scientific Committee and Commission develop a mechanism for implementing such a requirement. The Working Group noted greater effort was needed to ensure all information required by CM 10-02, Annex 10-02/A, was provided to the Secretariat.

3.15 The Working Group noted the joint proposal submitted by France and the Secretariat to implement a pilot initiative to use satellite-derived imagery to detect the presence of IUU fishing vessels in the Convention Area (CCAMLR-XXXIII/07). The Working Group noted that sightings data from vessels were generally restricted to the times when areas are open to fishing and agreed that the proposed use of a satellite-based method was a positive step towards improving estimates of IUU fishing activity.

Fishery surveys

3.16 WG-FSA-14/41 presented the annual random stratified trawl survey in Division 58.5.2 that was conducted in June 2014. The random stratified trawl survey consisted of 158 stations and included an additional five stations at Shell Bank, which had not been sampled since 2005. Hauls were conducted at randomly selected points within the designated strata. Most of the *C. gunnari* were taken on Gunnari Ridge and the plateaus in the southeast and west. The Working Group noted that catches in the survey were within the range of the values that had been observed over the history of the survey. In 2014, while the catches of *C. gunnari* were less than half of those in 2013, the catches of both *D. eleginoides* and *C. gunnari* were higher than the average since 2006. Catches of *Channichthys rhinoceratus* and *Lepidonotothen squamifrons* were also higher than average.

3.17 The Working Group recalled that the most recent comparison of trends between surveys of *C. gunnari* across the entire Kerguelen Plateau (random stratified trawl and POKER surveys) was presented in WG-SAM-11/20 in 2011 and noted that this may be a useful analysis to undertake in the near future. The Working Group also noted that, while abundance declined since the 1970s and increased in recent years, the relative distribution had

appeared stable since the 1980s. It was noted that the changes in abundance may be related to water temperature, given the apparent relationship between temperature and fish condition. The Working Group noted that while *C. gunnari* in the South Shetland Islands remain within a given depth range and move in response to krill availability, the Kerguelen Plateau is not a krill-dominated ecosystem and myctophids, amphipods and other zooplankton are more likely to be important components of the diet. The Working Group requested biomass trend information and associated coefficients of variation (CV) over time be presented for the survey for all species, but noted that trends for toothfish had been presented in WG-SAM-14/23.

Data on sea-ice

3.18 WG-FSA-14/54 presented an automated method to summarise sea-ice concentration dynamics. The method used passive microwave radiation data available from 1978 and allowed data to be summarised in both spatial and temporal views while linking sea-ice concentration to fishing events. From this, sea-ice concentrations can be summarised to aid research planning by predicting fishery feasibility in specified areas as well as understanding potential bias in tag recoveries from inaccessible areas due to sea-ice (e.g. Figure 12). The spatial animations were illustrated with an example 'bad' ice year in Subarea 88.1 in 2007/08, and temporal views were illustrated for Mawson Bank from 2000. Over 86% of fishing events took place in ice conditions where the concentration was less than 20%. Comparing the fishing and ice concentration in Subarea 88.1 showed a reduction in the fishing events as ice concentration values increased from 40% to 60%, although fishing at high ice concentrations occurred in areas such as those adjacent to ice shelves where there was little ice movement. Annual ice concentration trends in SSRUs 881H, I, K showed either an early December or early January pattern in summer ice melt indicative of 'good' or bad ice years. Future developments are planned that will automate characteristics of access to areas.

3.19 The Working Group noted that the spatial data of sea-ice concentration could be incorporated into the CCAMLR GIS and be used to characterise areas that had research fishing proposals. The Working Group congratulated the authors on the paper and recommended its further development.

3.20 The Working Group noted that passive microwave radiation can underestimate sea-ice concentration when ice becomes waterlogged, and that the bias may differ spatially and suggested that it may be useful to look at the approaches taken by Murase et al. (2012) to correct satellite-derived data when estimating sea-ice extent. Dr Parker noted that while passive microwave data were not precisely calibrated with surface observations, they could still be used as a relative index when linked with observed vessel activity; however, calibration would be useful if the data were to be applied for ecological applications. The Working Group also noted that future analysis could consider vessel ice class, although the experience and motivation of the captain and situational circumstances may also be influential in the decision to fish in particular sea-ice conditions.

3.21 WG-FSA-14/55 Rev. 1 provided a method for indexing the effects of ice on fishing operations and used the toothfish fishery in Subarea 88.1 as a case study. The paper showed how ice can impact fishery performance and its management by displacing effort and spatially restricting its activities. The analysis involved overlaying >15% sea-ice extent spatial layers

with polygons that reflect historical fishing effort and used this to assess the areal proportion of polygons available to be fished. The fishing polygons reflected established fishing grounds that were bounded to encompass the operational extent of area required to set multiple lines. Comparing these values across months and years yielded an index of good and bad ice years in Subarea 88.1.

3.22 The Working Group thanked the authors for the paper and noted that it presented information in a manner that complemented the method developed in WG-FSA-14/54. Future directions for this work might include assessment of vessel access, assessing the proportions of tags available for inclusion in assessments or looking at buffer zones in the high-Antarctic zones for a number of tagging programs.

3.23 The Working Group recommended that sea-ice analyses be broadened to encompass other areas, and may be useful to identify trends in ice coverage and access of areas available to fishing – particularly in light of the Intergovernmental Panel on Climate Change (IPCC) findings of changing sea-ice conditions in the Ross Sea. Combined analysis of sea-ice analysis and fish habitat modelling might also provide insights that could assist the design of research and assessment programs.

Tag-overlap statistic

3.24 WG-FSA-14/31 reported on the false positive in the CCAMLR tag-overlap statistic arising from low catch volume and the resulting limited sample size. In 2013/14 in Subarea 88.2, the tagging rate by the FV *Argos Georgia* was higher than the required minimum set by the Commission but the achieved tag-overlap statistic was 52%. The paper recalled that CM 41-01 requires a tag-overlap statistic of at least 60% for catches of at least 10 tonnes, but noted that in this case the tag-overlap statistic was sensitive to moving a single fish from one 10-centimetre size bin to the adjacent size bin when the catch was slightly above 10 tonnes.

3.25 The Working Group noted that the required tag-overlap statistic was not achieved for the *Argos Georgia*, *Palmer* and *Yantar 31* in Subarea 88.2 in 2014 and agreed that these three events represented sampling artefacts, rather than compliance concerns, due to the tag-overlap statistic being calculated on a small number of fish tagged and released. The Working Group agreed that this information should be passed to SCIC in order that it be included in the consideration of the CCEP.

3.26 The Working Group recommended that the fifth sentence in CM 41-01, Annex 41-01/C, paragraph 2(ii), be revised as follows:

> '**For any vessel the** minimum tag-overlap statistic of 60% **shall not apply** from **2014/15** onward for each species of *Dissostichus* **where** a catch of **less** than 10 tonnes**; and less than 30 fish tagged, provided the vessel has achieved the required tagging rate;** in a fishery.'

3.27 The Working Group noted that this change in criteria would not have resulted in a different evaluation of historic tag-overlap statistic compliance issues as the only situations where vessels have caught more than 10 tonnes of *Dissostichus* spp., achieved the required tagging rate (but tagged less than 30 fish) and had a tag-overlap statistic of <60%, were the three events identified in Subarea 88.2 in 2013/14.

3.28 The Working Group recalled the importance of the tag-overlap statistic (SC-CAMLR-XXIX, paragraph 3.139) and emphasised its importance for vessels with small catches. Accordingly, the Working Group requested that the Secretariat continue to calculate the tag-overlap statistics for all vessels and provide those estimates to the Working Group.

Depredation

3.29 Killer and sperm whale depredation occurs in a number of sub-Antarctic toothfish longline fisheries with economic and, potentially, conservation impacts. Three papers described aspects of depredation in the Crozet EEZ. The findings were relevant to other areas with depredation and some members of the Working Group were keen to adopt the monitoring and avoidance approach described.

3.30 WG-FSA-14/10 presented two indirect methods of assessing fish losses due to depredation: CPUE comparisons and a novel method examining differences in the proportion of by-catch (*Macrourus* spp.). The assessment methods gave consistent results and indicated very high levels of depredation (27% to 29% of the total catch) compared with estimates for other subareas. The results highlighted the importance of accounting for depredation when assessing and managing fish stocks.

3.31 WG-FSA-14/P04 showed that killer whales (*Orcinus orca*) can quickly become habituated to a proprietary acoustic harassment device (AHD) intended to deter depredation. In addition, it was suggested that this AHD could cause harmful hearing disturbance to killer whales. The use of alternative mitigation measures was therefore recommended.

3.32 Methods of mitigating killer whale depredation by changing fishing practices were described in WG-FSA-14/P03. Models using data from fishery observers and killer whale monitoring indicated that the frequency of interactions with whales could be decreased by: (i) increasing the number of vessels operating simultaneously in an area, (ii) fishing deeper (as in the absence of vessels, whales primarily inhabit shallow waters). CPUE was predicted to increase if vessels (iii) used relatively short lines, and (iv) increased hauling speed (to over 50 hooks per minute) in the presence of killer whales. The tendency of a specific pod to follow a vessel was reduced if (v) vessels move more than 100 km between sets (lines).

3.33 The Working Group reflected that the findings of these studies on mitigation (including the inefficacy of AHDs) are consistent with observations in other subareas where depredation occurs. The occurrence of depredation and rates were noted to vary wildly across the Convention Area and differences in depredation behaviour between killer whale ecotypes was recalled.

3.34 The Working Group encouraged the collection of similar information on whale depredation in other fisheries.

3.35 In his capacity as the SC-IWC Observer to the Scientific Committee, Dr Currey suggested that the Scientific Observer Scheme Coordinator (SOSC) contact the Southern Ocean Research Programme (SORP) coordinator to determine how photo libraries of Southern Ocean cetaceans being used in CCAMLR and in the IWC could be coordinated.

Established fisheries

Dissostichus eleginoides Subarea 48.3

4.1 The fishery for *D. eleginoides* in Subarea 48.3 operated in accordance with CM 41-02 and associated measures. In 2013/14, the catch limit for *D. eleginoides* was 2 400 tonnes. Fishing was conducted by six vessels using longlines and the total reported catch was 2 180 tonnes.

Management advice

4.2 The Working Group recommended that its advice from 2013 with a catch limit for *D. eleginoides* in Subarea 48.3 of 2 400 tonnes be carried forward in its entirety for 2014/15.

Dissostichus eleginoides and *D. mawsoni* Subarea 48.4

4.3 The catch limit for *D. eleginoides* in 2013/14 for Subarea 48.4 was 45 tonnes. The total reported catch was 44 tonnes. The catch limit for *D. mawsoni* in Subarea 48.4 in 2013/14 was 24 tonnes. The total reported catch was 24 tonnes.

4.4 WG-FSA-14/29 Rev. 1 presented a preliminary CASAL population assessment of *D. eleginoides* in Subarea 48.4 based on data for the 2009–2014 fishing seasons. The fishery is still largely based on a range of strong recruitment events that occurred around 1994–1996. The Working Group noted the importance of ageing data in estimating these recruitment events and recommended stratified sampling of length data to spread the lengths across the entire age and length distribution, removing the clustering of observations within the dominant ages and allowing greater influence of the shorter and larger fish. The Working Group also noted that without future strong recruitment events, the future catch is likely to be reduced to research catch only.

4.5 WG-FSA-14/30 Rev. 1 implemented a tag-based Petersen estimator to provide the species-specific biomass estimates for *D. mawsoni* in Subarea 48.4. The Petersen estimator was calculated as the geometric mean of all estimates from annual tag-release events and annual recaptures. The stock of *D. mawsoni* was estimated to be 1 023 tonnes during 2013/14. The catch limit for 2014/15 was estimated by applying the same harvest rate as in previous years, which is based on the harvest rate of *D. eleginoides* in Subarea 48.3 ($\gamma = 0.038$).

4.6 The Working Group recommended that γ be estimated using biological parameters for *D. mawsoni* from this area in the future.

4.7 Based on discussion developed during WG-FSA-14 about the desirability of using the Chapman estimator instead of the Petersen estimator where the number of annual recaptures is lower than 10, the biomass was re-estimated with the Chapman estimator during the meeting. Using the Chapman estimator, the stock of *D. mawsoni* was estimated to be 725 tonnes during 2013/14. Accordingly, a total catch limit of 28 tonnes was recommended for 2014/15.

Management advice

4.8 The Working Group recommended that the catch limit for *D. eleginoides* in Subarea 48.4 should be set at 42 tonnes for 2014/15 based on the outcome of this assessment.

4.9 The Working Group recommended that the catch limit for *D. mawsoni* in Subarea 48.4 should be set at 28 tonnes for 2014/15 based on the outcome of the this assessment.

By-catch limits for Subarea 48.4

4.10 The Working Group recommended catch limits for by-catch species in Subarea 48.4 for macrourids of 11.2 tonnes (16% of the catch limit for *Dissostichus* spp.) and a limit for skates of 3.5 tonnes (5% of the catch limit for *Dissostichus* spp.).

4.11 The Working Group also recommended the maintenance of a move-on rule for by-catch species, with a minimum macrourid trigger of 150 kg and 16% of the catch by weight of *Dissostichus* spp. per line, and a trigger for skates set at 5% of the catch by weight of *Dissostichus* spp. per line.

D. eleginoides Heard Island (Division 58.5.2)

4.12 The fishery for *D. eleginoides* in Division 58.5.2 operated in accordance with CM 41-08 and associated measures. In 2013/14, the catch limit for *D. eleginoides* was 2 730 tonnes. Fishing was conducted by one trawl and three longline vessels and the total reported catch up to 20 September 2014 was 1 909 tonnes.

4.13 A series of research papers presented new information for consideration in the development of the Division 58.5.2 stock assessment, centred around recommendations on the assessment from WG-FSA-13, SC-CAMLR-XXXII and WG-SAM-14. WG-FSA-14/42 described the spatial distribution of *D. eleginoides* using data collected from the fishery and research surveys in Division 58.5.2 since 1997. Statistical analyses examined the effect of bathymetry in structuring the spatial distribution of different length classes and sex composition after controlling for gear selectivity, year and sex. The results allow further development of hypotheses about the spatial segregation of life stages and sex in the Division 58.5.2 part of the Kerguelen Plateau.

4.14 WG-FSA-14/43 analysed data from tagged and recaptured *D. eleginoides* within Division 58.5.2 between 1997 and 2014 in view of estimating population parameters for the *D. eleginoides* stock assessment in Division 58.5.2. The paper reviewed spatial structure, mortality, movement rates and growth.

4.15 The Working Group noted that 4.3% of all tag recaptures of fish tagged in Division 58.5.2 had been caught in Division 58.5.1, demonstrating movement of toothfish between the stocks. It also noted that since France commenced tagging in 2006, over 22 tags have been recorded moving from Division 58.5.1 to 58.5.2. The Working Group was unable to determine whether this rate of tag emigration would bias the assessment to any great extent. It recalled that a joint population model had been presented in 2011 (WG-SAM-11/20) and

encouraged France and Australia to continue to collaborate to improve understanding of the impacts of fishing in Division 58.5.2 and 58.5.1, and the implications for management advice.

4.16 Dr Welsford noted that tagged toothfish had been recaptured up to five times in the same area, indicating high site fidelity similar to that seen within Subareas 48.3, 48.4 and the Ross Sea. He noted that the Australian research program was working to determine the effects of restricted fish movement on the potential bias in the assessment and that they were further collaborating with France towards research to account for toothfish dynamics at a range of scales across the Kerguelen Plateau.

4.17 WG-FSA noted that although the inclusion of tagging data within the Division 58.5.2 assessment model results in some bias in the assessment (Annex 5, paragraph 2.29) and the lower tag-overlap in the longline fishery prior to 2012, the increased spread of fishing effort and high tag overlap since 2012 is likely to have reduced that bias. It was also noted that inclusion of tag data into the assessment helps the model improve the precision of the estimate of B_0 relative to models that do not include tagging data.

4.18 WG-FSA-14/45 presented recent information gained from new ageing data for *D. eleginoides* in Division 58.5.2. The paper outlined procedures for quality control in age reading, including re-reading of otoliths where two readers disagreed in their initial reads, and a check against the otolith weight–age relationship for identifying systematic interpretation errors. The new age data from over 2 000 fish sampled from the 2012–2014 random stratified trawl surveys and from the 2013 commercial fishery were included in the stock assessment presented in WG-FSA-14/34, which improved the information available on fish older than 20 years and led to a re-estimation of the von Bertalanffy growth parameters. Changes in the way in which otoliths are processed had reduced the cost of ageing by 31%.

4.19 WG-FSA-14/46 presented a revised estimated ageing error matrix, which specifically addressed ageing errors at the extremes of the matrix and included 50 new otoliths with an average age of >25 years. The new matrix aggregated positive errors into a plus group and truncated negative errors below the minimum age. The new ageing error matrix was evaluated against other methods for specifying the errors in ageing within the CASAL model, such as assuming a normal distribution of ageing errors with a constant CV, and was found to be more appropriate. It was concluded that the revised error matrix should be included within future assessment of this stock.

4.20 The Working Group welcomed the considerable amount of work that had been put into the ageing of the Division 58.5.2 otoliths and the development of the stock-specific ageing error matrix. The Working Group considered that the methodology could be used as an example for research conducted in other assessment areas. The Working Group recommended that the Australian Antarctic Division (AAD) otolith image reference collection be made available electronically to CCAMLR Members via the CCAMLR website and requested the Secretariat work with Dr Welsford to expedite this.

4.21 The Working Group noted that the work conducted by Australia had considerably extended the number of year classes observed in recent years and that this has resulted in a substantially improved characterisation of growth in older age classes. The introduction of the new ageing error matrix was considered to be an important step. The Working Group noted that it would be useful to investigate how the ageing error matrix may influence the assessment estimates and decision-rule projections and considered that this topic could be

presented to WG-SAM. One approach to explore this issue would be by simulating one assumption about ageing errors in an operating model and evaluating a stock assessment that assumes alternative ageing error structures.

4.22 WG-FSA-14/34 presented a step-wise development of models starting from the previous assessment presented in WG-FSA-13/24. The paper took into consideration the recommendations made at WG-FSA-13, SC-CAMLR-XXXII and WG-SAM-14. It incorporated new ageing data (WG-FSA-14/45), a Beverton-Holt stock recruitment relationship, an updated error matrix (WG-FSA-14/46), an updated growth model (WG-FSA-14/45) and an externally estimated prior for survey catchability q (WG-FSA-14/43). The new proposed model was simpler and more stable than the 2013 assessment and resulted in an estimate of B_0 at 137 000 tonnes and an estimated current SSB status of 0.72.

4.23 The Working Group congratulated Australia on embarking on the work required to address the concerns of WG-FSA-13 and considered that it had addressed all the recommendations. It particularly noted the overall improved stability of the Division 58.5.2 CASAL assessment (Figure 2) and that, with and without tagging data, the median trajectory of the stock did not move below the target levels during the projection period, in contrast to the assessment presented to WG-FSA-13.

4.24 The Working Group also noted the conclusion by the authors of WG-FSA-14/43 that bias would be introduced by the inclusion of historic tagging data due to the spatially restricted distribution of fishing effort and agreed that the addition of the more recent and future tagging data from the expanding longline fishery in Division 58.5.2, and development of methods for accounting such patterns in historical tagging data, should have a high priority.

4.25 The Working Group noted that the method of estimating q using tag recaptures in the main survey ground indicated that it was likely that q had been too high in previous assessments, where it had been assumed to be 1.

4.26 The Working Group noted that the base-case model presented in WG-FSA-14/34 indicated the very high correlation between q and B_0. It further noted that the likelihood profile indicated that B_0 is most likely to have been above 80 000–90 000 tonnes, however, there was relatively poor precision of B_0. This contrasted with the well-defined B_0 estimate that resulted from the inclusion of the two most recent years of tagging data as presented in WG-FSA-14/43. In addition, following a review of the data available from the early years of the assessment to estimate year-class strength (YCS), the Working Group considered that the low YCS estimated by the model presented in WG-FSA-14/34 for the years 1982–1985 were poorly determined in the observations. Consequently, two new assessment models in addition to those listed in WG-FSA-14/34 were evaluated during the meeting:

(13) estimating YCS for 1986–2009
(14) estimating YCS for 1986–2009 and including tag release data for 2012 and 2013.

4.27 The Working Group noted that without the addition of the tag data to the model, the upper bound of B_0 is still poorly defined (Figure 2). Adding the tagging data allowed B_0 and q to be estimated with higher precision, with comparable estimates of B_0 indicated by both years of tagging. The Working Group recommended that the model including tag data for 2012 and 2013 and fixing year class strength before 1986 to 1.0 (Figure 3) should be used to provide management advice.

4.28 The assessment results from the revised model estimated median B_0 to be 108 586 (92 263–132 167; 95% CI) tonnes, with the median SSB status in 2013 at 0.65 (0.59–0.71) of B_0 (Figure 4). The Working Group agreed to use the average recruitment and CV from 1992 to 2009 for the stock projections with a lognormal empirical randomisation method of recruitment. This projection indicated a precautionary catch limit of 4 410 tonnes resulting from the application of the CCAMLR decision rule (Figure 5).

4.29 For future work, the Working Group noted that, because toothfish movements and spatial patterns of fishing effort can generate bias in tag-based biomass estimates, actual fishing effort patterns and apparent fish movements in this area should be considered when using tag-release and recapture data as an index of abundance for adult toothfish in the assessment. The Working Group welcomed the current research project undertaken by Australia to address these issues and to enable the unbiased inclusion of tag-recapture data into stock assessments (Annex 5, paragraph 2.6). The Working Group noted that tag-recapture data were likely to improve the precision of the estimation of spawning stock biomass and recommended that tag-recapture data for as many years as possible be developed for inclusion in the assessment.

4.30 The Working Group also welcomed the ongoing ageing of otoliths from Division 58.5.2 which is intended to include otoliths of the most recent fishing seasons as well as those from earlier seasons. The Working Group recommended to re-estimate growth parameters, particularly as more data characterising size at age in older year classes become available.

4.31 With regard to survey data, the Working Group recommended that the method to estimate survey catchability q in the model be presented to WG-SAM along with sensitivities around these calculations, and that the inclusion of survey data as biomass and proportions at age should be investigated in the future model runs.

Management advice

4.32 The Working Group recommended a catch limit of 4 410 tonnes for 2014/15. The Working Group noted that an updated assessment will be presented in 2015.

Dissostichus eleginoides Division 58.5.1 and Subarea 58.6

D. eleginoides Kerguelen Island (Division 58.5.1)

4.33 The fishery for *D. eleginoides* in Division 58.5.1 is conducted in the French EEZ. In 2013/14, the catch limit for *D. eleginoides* was 5 100 tonnes. Fishing was conducted by seven vessels using longlines and the total reported catch up to 20 September 2014 was 3 017 tonnes.

4.34 WG-FSA-14/36 Rev. 1 presented an updated stock assessment of *D. eleginoides* at Kerguelen Island (Division 58.5.1 inside the French EEZ), which included the results of the POKER 3 survey and fishery data up until September 2014. The Working Group congratulated the authors on progress achieved on this stock assessment in the last few years

and on their commitment to carry out ageing, which is currently under way. The Working Group recommended that YCS should not be estimated until age data were available.

4.35 The Working Group noted that the annual pattern in the number of tags recaptured, showing consistently lower numbers of recaptures in the first year compared to the second year, requires further investigation. The Working Group recommended that age frequencies be included for both the survey and commercial data once age data are available and that YCS be then estimated as a sensitivity analysis. The Working Group also recommended that estimated YCS could be compared with that estimated in the stock assessment of *D. eleginoides* in Division 58.5.2, due to their proximity and potential connectivity. The Working Group welcomed the ongoing investigations into the connectivity and interaction of fish within the wider Kerguelen Plateau area (SC-CAMLR-XXXII, paragraph 3.110ii).

Management advice

4.36 The Working Group agreed that model KR3.3 with fixed YCS as described in WG-FSA-14/36 Rev. 1 could be used to provide management advice for 2014/15. Although the long-term yield was not calculated, the current catch limit of 5 100 tonnes satisfied the CCAMLR decision rules.

4.37 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.

D. eleginoides Crozet Islands (Subarea 58.6)

4.38 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 2013/14 the catch limit for *D. eleginoides* was 700 tonnes. Fishing was conducted by six vessels using longlines and the total reported catch up to 20 September 2014 was 382 tonnes.

4.39 WG-FSA-14/36 Rev. 1 presented the results of an updated stock assessment of *D. eleginoides* at Crozet Islands (Subarea 58.6 inside the French EEZ). The model included estimated levels of depredation by killer whales from generalised additive model (GAM) analyses of the fishery data. The Working Group welcomed this updated stock assessment, which addressed stability issues with data weighting in the model, model fits and some parameters estimated at bounds present in the previous iteration (SC-CAMLR-XXXII, Annex 6, paragraph 4.63). The Working Group recommended that age frequencies be included once age data are available and that YCS be estimated as a sensitivity analysis. It further recommended that alternative estimates of whale depredation, as estimated in WG-FSA-14/10 (see also paragraph 3.30), be investigated further in future models.

Management advice

4.40 The Working Group agreed that model CR2.1 with fixed YCS as described in WG-FSA-14/36 Rev. 1 could be used to provide management advice for 2014/15. Although a

maximum catch limit was not calculated, the current catch limit of 700 tonnes, with the addition of an allowance for 60 tonnes of killer whale depredation, satisfied the CCAMLR decision rules.

4.41 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 2014/15.

South African EEZ (Subareas 58.6 and 58.7)

4.42 Mr S. Somhlaba (South Africa) informed the Working Group that the catch limit for 2013/14 in the Prince Edward and Marion Islands (PEMI) was 450 tonnes and that two vessels were allowed to conduct fishing in this area. An assessment model used to set the catch limit has recently been updated in South Africa, enabling the model to incorporate more data and it was used to set the 2014/15 catch limit. Mr Somhlaba indicated that the catch limit for 2014/15 is likely to be similar to last season's catch limit.

C. gunnari South Georgia (Subarea 48.3)

4.43 The fishery for *C. gunnari* at South Georgia (Subarea 48.3) operated in 2013/14 in accordance with CM 42-01 and associated measures. The fishing season started on 1 December 2013 and remains open. The catch of *C. gunnari* in Subarea 48.3 up to 20 September 2014 was 4 tonnes.

4.44 Details of the stock assessment for *C. gunnari* in Subarea 48.3 for 2013/14 and 2014/15 are provided in WG-FSA-13/27. The catch limits calculated from the assessment for *C. gunnari* in Subarea 48.3 were 4 635 tonnes for 2013/14 and 2 659 tonnes for 2014/15.

Management advice

4.45 The Working Group agreed that a catch limit for *C. gunnari* in Subarea 48.3 of 2 659 tonnes for 2014/15 be carried forward.

C. gunnari Kerguelen Island (Division 58.5.1)

4.46 In the French EEZ of Kerguelen, trawl fisheries have been closed since 1994/95 (see CCAMLR *Statistical Bulletin*) due to the decline of stocks prior to those years. The Working Group was requested by France to review the potential yields for 2013/14 and 2014/15 estimated by a new stock assessment based on the 2013 POKER biomass survey for *C. gunnari* in Division 58.5.1 (WG-FSA-14/11).

4.47 The assessment method followed that agreed by CCAMLR (SC-CAMLR-XVI, paragraph 5.70) for assessing yield in *C. gunnari*. Biomass estimates and weight at length

were obtained from the random trawl survey. Densities at age were estimated with CMIX and supplied to the GYM. The lower one-sided 95% confidence bound of the biomass estimate was used as the estimate of the standing stock at the start of the projection period.

4.48 Only the 1+ to 3+ cohorts were projected for evaluating whether proposed catches met the CCAMLR decision rules. These projections indicated that catches of 840 tonnes in the 2013/14 season and 580 tonnes in the 2014/15 season or 0 tonnes in the 2013/14 season and 1 490 tonnes in the 2014/15 season satisfied the CCAMLR decision rules.

Management advice

4.49 The Working Group agreed that a catch limit for *C. gunnari* in 2014/15 of 1 490 tonnes would meet the CCAMLR decision rules, based on no catch being taken in the remainder of the 2013/14 season.

C. gunnari Heard Island (Division 58.5.2)

4.50 The fishery for *C. gunnari* at Heard Island (Division 58.5.2) operated in 2013/14 in accordance with CM 42-02 and associated measures. Fishing was conducted by one vessel with a total catch of 1 123 tonnes.

4.51 The results from the annual random stratified trawl survey to estimate the abundance of *D. eleginoides* and *C. gunnari* in Division 58.5.2 for 2014 were described in WG-FSA-14/44. The Working Group noted a continuation in the 2014 survey of a pattern first noted in 2011 of multiple apparent cohorts of *C. gunnari* in the survey catches. This is a change from years previous to 2011 when a single cohort dominated the survey catches.

4.52 The assessment method followed that agreed by CCAMLR (SC-CAMLR-XVI, paragraph 5.70) for assessing yield in *C. gunnari*, and was identical to that used to estimate yields for *C. gunnari* on the Heard Island and McDonald Islands Plateau in previous years. Biomass estimates and weight at length were obtained from the random trawl survey. Densities at age were estimated with CMIX and supplied to the GYM. The lower one-sided 95% confidence bound of the biomass estimate was used as the estimate of the standing stock at the start of the projection period.

4.53 With the expectation that the current 4+ and 5+ cohorts are fully exploited, only the 1+ to 3+ cohorts were projected for evaluating whether proposed catches met the CCAMLR decision rules. These projections indicated that catches of 309 tonnes in 2014/15 and 275 tonnes in 2015/16 satisfied the CCAMLR decision rules.

Management advice

4.54 The Working Group recommended that the Scientific Committee consider a catch limit for *C. gunnari* in 2014/15 of 309 tonnes and 275 tonnes for 2015/16.

Exploratory and other fisheries in 2013/14

5.1 Exploratory longline fisheries for *Dissostichus* spp. were conducted in Subareas 48.6, 88.1 and 88.2 and Divisions 58.4.1, 58.4.2 and 58.4.3a in 2013/14; the season's catches from these fisheries are summarised in Table 1 and activities in these fisheries are detailed in the relevant Fishery Reports. No new fishery was conducted in 2013/14.

5.2 The exploratory fisheries operated as follows in 2013/14:

(i) In Subarea 48.6 (CM 41-04) the catch limit for *Dissostichus* spp. was 538 tonnes. Research fishing was conducted in two research blocks by two vessels using longlines and the total reported catch up to 20 September 2014 was 153 tonnes.

(ii) In Division 58.4.1 (CM 41-11) the catch limit for *Dissostichus* spp. was 724 tonnes. Research fishing was conducted in the areas designated for a depletion experiment by one vessel using longlines and the total reported catch up to 20 September 2014 was 101 tonnes.

(iii) In Division 58.4.2 (CM 41-05) the catch limit for *Dissostichus* spp. was 35 tonnes. Research fishing was planned in the research block by two vessels using longlines. The total reported catch up to 20 September 2014 was 0 tonnes.

(iv) In Division 58.4.3a (CM 41-06) the catch limit for *Dissostichus* spp. was 32 tonnes. Research fishing was conducted in the research block by two vessels using longlines and the total reported catch up to 20 September 2014 was 32 tonnes.

(v) In Subarea 88.1 (CM 41-09) the catch limit for *Dissostichus* spp. was 3 001 tonnes. Fishing was conducted by 20 vessels using longlines and the total reported catch was 2 900 tonnes. In addition, a research catch limit of 43 tonnes was set aside in SSRUs J, L and M to enable completion of the 2014 sub-adult survey (paragraphs 5.107 to 5.110).

(vi) In Subarea 88.2 (CM 41-10) the catch limit for *Dissostichus* spp. was 390 tonnes. Fishing was conducted by 14 vessels using longlines and the total reported catch was 426 tonnes, which exceeded the catch limits (paragraph 5.3).

5.3 The Secretariat monitored all fisheries in 2013/14 using the catch and effort reporting system and notifications of vessel movements (CCAMLR-XXXIII/BG/01; see also paragraph 3.3). During that season, management areas in the exploratory fisheries in Division 58.4.3a and Subareas 48.6, 88.1 and 88.2 were closed by the Secretariat when the catches of *Dissostichus* spp. approached the relevant catch limits:

(i) in Division 58.4.3a, the whole fishery was closed on 31 August 2014 following completion of research fishing and the total catch of *Dissostichus* spp. was 32 tonnes (100% of the catch limit)

(ii) in Subarea 48.6, SSRU D was closed on 10 February 2014 following completion of research fishing and the total catch of *Dissostichus* spp. in that SSRU was 50 tonnes (100% of the catch limit)

(iii) in Subarea 88.1, SSRUs B, C and G were closed on 19 December 2013, SSRUs H, I and K were closed on 11 January 2014 and SSRUs J and L and the whole fishery were closed on 17 January 2014; the total catch of *Dissostichus* spp. in these management areas ranged from 87% to 100% of the catch limits

(iv) in Subarea 88.2, SSRU H was closed on 24 January 2014 and SSRUs C, D, E, F and G and the whole fishery were closed on 26 January 2014; the catch limits for *Dissostichus* spp. in that fishery were exceeded (paragraph 3.3 and Figure 1) and the total catch of *Dissostichus* spp. in the management areas ranged from 103% to 122% of the catch limits.

5.4 All vessels fishing in exploratory fisheries are required to tag and release *Dissostichus* spp. in accordance with the tagging protocol and requirements (CM 41-01) and rates specified in CMs 41-04 to 41-07 and 41-09 to 41-11. In 2013/14, all vessels met the required tagging rates, and all but three vessels achieved, or exceeded, the required tag-overlap statistic (see relevant Fishery Reports). The requirements for the tag-overlap statistic were reviewed in paragraphs 3.24 to 3.28.

Exploratory fishery notifications for 2014/15

5.5 Notifications for exploratory fisheries for *Dissostichus* spp. were submitted by nine Members for a total of 24 vessels in Subarea 88.1, nine Members and 23 vessels in Subarea 88.2, two Members and two vessels in Division 58.4.3a, four Members and four vessels in Subarea 48.6, four Members and four vessels in Division 58.4.1 and three Members and three vessels in Division 58.4.2 (Table 3 and CCAMLR-XXXIII/BG/02; details of vessels including withdrawn notifications can be viewed at www.ccamlr.org/en/fishery-notifications/notified). There were no notifications submitted for the exploratory fishery in Division 58.4.3b or for new fisheries.

5.6 The Working Group noted that these notifications followed a pattern similar to previous seasons with most notifications being for fishing in Subareas 88.1 and 88.2 (nine Members and 19 vessels in Subarea 88.1 and eight Members and 18 vessels in Subarea 88.2). The Working Group noted the relatively large number of notifications in Subarea 88.2 and agreed that information on vessels' priorities for fishing in Subareas 88.1 and 88.2 would be informative in order to evaluate the notifications. This matter was referred to the Scientific Committee and Commission for further consideration.

5.7 The research plans associated with the notifications for exploratory fisheries in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a were submitted to WG-SAM and that Working Group's consideration of these plans is reported in Annex 5. Revised research plans were reviewed during this meeting.

5.8 The Working Group recalled that the requirements for notifications for exploratory fisheries (CM 21-02) were implemented in order to:

(i) evaluate the distribution, abundance and demography of the target species, leading to an estimate of the fishery's potential yield

(ii) review the fishery's potential impacts on dependent and related species

(iii) allow the Scientific Committee to formulate and provide advice to the Commission on appropriate harvest catch levels, as well as effort levels and fishing gear, where appropriate.

5.9 At this meeting, the Working Group reviewed the research and fishing plans provided in notifications for exploratory fisheries in 2014/15 for the purpose of developing stock assessments in these fisheries (i.e. requirements (i) and (iii) above). However, the Working Group did not have sufficient time to review each fishery's potential impacts on dependent and related species (requirement ii).

5.10 The Working Group sought advice from the Scientific Committee on the priorities and elements of work associated with reviewing the potential impacts of exploratory fisheries on dependent and related species. The Working Group also noted that extensive developments have taken place in recent years in relation to research fishing in exploratory fisheries, closed fisheries and other areas, and that the requirements of CM 21-02 and related measures (e.g. CMs 21-01 and 24-01) may require review.

Dissostichus spp. Subarea 88.1

5.11 The exploratory fishery for *Dissostichus* spp. in Subarea 88.1 operated in accordance with CM 41-09 and associated measures. In 2013/14, the catch limit for *Dissostichus* spp. was 3 044 tonnes including 43 tonnes set aside within the SSRUs 881J, L catch limit for the sub-adult survey.

5.12 Fishing was conducted by 20 vessels using longlines. The fishery closed on 17 January 2014 and the total reported catch was 2 900 tonnes plus 25 tonnes from the sub-adult survey.

Management advice

5.13 The Working Group recommended that its advice from 2013 with a catch limit for *D. mawsoni* in Subarea 88.1 of 3 044 tonnes be carried forward in its entirety for 2014/15.

Dissostichus spp. SSRU 882H

5.14 The exploratory fishery for *Dissostichus* spp. in Subarea 88.2 operated in accordance with CM 41-10 and associated measures. In 2013/14, the catch limit for *Dissostichus* spp. was 390 tonnes. Fishing was conducted by 14 vessels using longlines. The fishery closed on 26 January 2014 and the total reported catch was 426 tonnes.

5.15 WG-FSA-14/52 summarised data from the historic toothfish fishery for *Dissostichus* spp. in Subareas 88.1 and 88.2 from 1997 to 2014. The main SSRUs fished during 2014 were 881C, 881J and 882H. Fish of the strong mode of 90–120 cm, observed previously on the shelf area (C–G) in 2010–2013, were not observed in the catches during 2014, but fish in SSRU 882H were on average caught slightly younger. Further otolith readings were

recommended to ascertain this trend. The Working Group noted that the observed decline in median age could be due to the low number of fish aged in the earlier years and that this issue was being investigated further.

5.16 WG-FSA-14/56 responded to the request from WG-SAM-14 to investigate alternative assessment models to fit the declines recorded in tagged fish recaptured in SSRU 882H (Figure 6). The paper investigated several options for population dynamics through simulation of scenarios that included emigration, immigration and various rates of exploitation. It concluded that a model with a single area was not able to replicate the observed tag-recapture patterns. However, a model that included two areas, immigration, emigration and high exploitation was the only model that was able to capture the observed patterns.

5.17 The Working Group agreed that the two-area-model described in WG-FSA-14/56 (option H3b), which included a constant emigration and immigration biomass and high exploitation rate, described the observed trends in tag recapture within SSRU 882H well and that the requirements to reconstruct the observed tag-recapture patterns are relatively specific. In the analysis, the exploitation rate needed to replicate observed tag-recapture patterns is around 20%, which is substantially higher than the recommended exploitation rate for exploratory research at 4%.

5.18 The Working Group requested further development of the two-area model but noted that in order to provide data to determine the immigration and emigration rates, more tagging information from SSRUs 882C–G was required, as currently this was considered to be the area to which tagged fish were moving, but none had been recaptured.

5.19 WG-FSA-14/58 presented a Petersen-based biomass estimate for SSRU 882H based on the recommendation of WG-SAM-14 to use only tag recaptures of 1–3 years at liberty in the seamount fishery of SSRU 882H. The estimated biomass trends declined on the seamounts over time, with a slight increase since 2012. The observed patterns indicated that tag dilution was taking place due to immigration of untagged fish, which would also contribute to a progressive upward bias of biomass estimates from mark-recapture data. It concluded that the biomass estimates would be most accurate for recaptures after one year at liberty but noted that this estimate is already biased upwards.

5.20 The Working Group evaluated the paper and validated its calculations. It noted that biomass estimates are biased upward by around 1 800 tonnes each successive year of tag liberty and that even recaptures after one year result in an upward bias in biomass estimate. The most plausible cause of the bias is immigration onto the seamounts, which dilutes the tagged population proportions over time.

5.21 The biomass estimation bias is lowest for populations calculated after one year of tag liberty. Therefore the Working Group suggested that the advised catch limit should be derived from an exploitation rate of 4% of the biomass calculated using tags recaptured after one year. The resulting catch limit was 200 tonnes for SSRU 882H.

5.22 The Working Group also highlighted that this assumption of one year of tag liberty for inclusion in the Petersen estimate is specific to the stock in SSRU 882H, for which evidence of a violation of the assumption of a closed population is unambiguous.

5.23 The Working Group agreed that there is evidence for immigration and emigration which will require a two-area model and that there is currently the need to consider how residence time of tags is biasing the Petersen population estimates, and that the level of emigration is confounded with additional possible factors that may be occurring in SSRU 882H such as IUU fishing and predation.

5.24 WG-FSA-14/14 Rev. 1 also presented a stock assessment of *D. mawsoni* in SSRU 882H. The stock assessment was calculated employing the Petersen tag-recapture method using all years of tag releases. The estimated stock biomass in 2014 was 20 649 tonnes. Applying an exploitation rate of 3%, 5% or 10%, the catch limit for 2014/15 would be 619, 1 032 and 2 064 tonnes respectively.

5.25 The Working Group noted that the method used all of the years of tag release rather than the WG-SAM-14 recommendation to use 3, 2 or 1 year of tag-at-liberty data.

5.26 Dr A. Petrov (Russia) suggested that the catch limit recommended by WG-FSA should be 619 tonnes in SSRU 882H and scientific investigation into this matter should be continued. In response to questions on the difference between his assumptions and those of WG-SAM-14, he noted the calculations in WG-FSA-14/14 Rev. 1 used all years of tag recaptures to derive a total biomass for the whole stock caught and released in Subarea 88.2. He considered that the resulting catch limit of 619 tonnes (based on a 3% exploitation rate) should be taken on the seamounts in SSRU 882H, with an additional catch limit set for areas C–G. The Working Group asked Dr Petrov to provide a scientific rationale for the suggested catch limit of 619 tonnes being applied to just SSRU 882H as this was likely to result in substantial fishing mortality rates on the seamounts.

5.27 The Working Group reviewed all of the information available to it provided by the submitted papers and within the discussions and advice from WG-SAM-14. The datasets indicate:

(i) declining recaptures by year of release in SSRU 882H indicating a loss of tagged fish from the seamounts and annual immigration of untagged fish

(ii) increasing rate of decline in recaptures by year of release, i.e. recaptures of tags released in more recent years are declining at a faster rate in the recaptures than the declines observed in tags released in earlier years (Figure 6)

(iii) estimates of biomass on the seamounts – the least biased are those recaptures at liberty of one year

(iv) simulations indicate that the trends observed in the data are difficult to replicate but could be replicated with an exploitation rate on the seamounts of around 20% and loss of tagged fish at around 20%.

5.28 The Working Group noted that the level of emigration is confounded with additional possible factors that may be occurring in SSRU 882H such as IUU fishing and predation.

5.29 Discussions on stock structure (see WG-SAM-14/26) identified the following points:

(i) toothfish can move a long way in the season and that the seamounts are only part of the stock area

(ii) the stock is assumed to be part of an Amundsen Sea stock where the stock moves from the coast to the seamounts and returns. The scale of the area is not known but the seamounts are central (WG-SAM-14/26). This is similar to the stock in the Ross Sea Region and in East Antarctica

(iii) the tag estimate of abundance determined by WG-FSA-14/14 Rev. 1, using all years of tagging, assumes the tags are present in the whole stock area rather than on the seamounts only.

5.30 The discussion then considered how to harmonise the hypotheses and to make them consistent with the data.

5.31 The decline on tags on the seamounts will be a combination of immigration, emigration, fishing and/or predation and possibly IUU. Thus the population estimate will be biased high if it is based on total tag releases and only discounting by natural mortality. The least biased estimate is that based on tags only one year after release. The Working Group can therefore conclude the following:

(i) the recent harvest rate was higher than required for the abundance on the seamounts to be stable

(ii) the number of historical tags in the water is currently unknown because of the extra sources of mortality or population dynamics. This means that a catch determined on the basis of all released tags is too high

(iii) the recent exploitation rate was likely to be around 20% rather than 4%, although it has decreased in 2013/14 due to a reduction in the catch limit.

Management advice

5.32 The Working Group concluded that it could not reach consensus in recommending a catch limit for SSRU 882H due to differences of opinion. Two options for the catch limit for the sea mounts in SSRU 882H were put forward.

(i) A catch limit of 200 tonnes in SSRU 882H based on the advice of WG-SAM-14, using the least-biased estimate of the seamount population abundance derived from tag recaptures after one year at liberty. This option was supported by the Working Group with the exception of Drs Petrov and L. Pshenichnov (Ukraine).

(ii) A catch limit of 619 tonnes, based on all tags and the biomass estimate for the whole stock in Subarea 88.2, should be taken in SSRU 882H only. This option was supported by Drs Petrov and Pshenichnov.

Dissostichus spp. SSRUs 882C–G

5.33 WG-FSA-14/59 outlined a strategy to improve data availability for an assessment of *D. mawsoni* stock abundance estimation in SSRUs 882C–G. The poor tag-recapture rates (of

0.0025 per released fish) in the region are likely due to poor spatial overlap of tag releases and subsequent fishing. The paper recommended mandatory set completion in four identified fishing grounds (Figure 7) and an increase in the tagging rate to 3 tags per tonne in the short term. These measures aim to improve the estimate of abundance and increase information on fish movement from SSRUs 882C–G.

5.34 The Working Group discussed the problem of minimal data available on stock structure in SSRUs 882C–G and recalled that a priority for Scientific Committee 2013 was to estimate stock size in SSRUs 882C–G. The Working Group recognised that operations in the area are affected by varying ice conditions, which prevent consistent fishing every year. However, the ice condition analysis carried out in WG-FSA-14/54 showed that at least two of four fishing grounds are usually available and recommended to increase the tagging rate in SSRUs 882C–G to 3 fish per tonne.

5.35 The Working Group requested that the Scientific Committee consider relevant approaches for these SSRUs given the limited availability of data.

5.36 The increase in the tagging rate recommended in WG-FSA-14/59 for SSRUs 882C–G to 3 tags per tonne differs from the tag rate in SSRU 882H at 1 tag per tonne, and this difference could possibly trigger false positives in the tag-overlap statistic. The Working Group recognised that the size composition in SSRUs 882C–G is substantially different from SSRU 882H, consisting of high numbers of small fish in the catch. The Working Group recognised the issue, but referred to the conclusions drawn from WG-FSA-14/31 and agreed that similarly, the Working Group looks at potential overlap statistic violations individually and advises accordingly.

5.37 The Working Group discussed the suggested tag rate of 3 tags per tonne. It noted that there is currently no assessment for Subarea 88.2 and recalled the decision by the Scientific Committee that an assessment for this area is a priority (SC-CAMLR-XXXII, paragraph 3.167).

5.38 Most of the Working Group therefore agreed to a tag rate of 3 tags per tonne in SSRUs 882C–G in order to progress towards a stock assessment in Subarea 88.2, noting the proposed flexibility needed in the location of fishing because of sea-ice.

5.39 Drs Petrov and Pshenichnov disagreed that an increase in tagging rate would improve the biomass estimate in SSRUs 882C–G as ice conditions prevent recapture, and suggested that in order to increase the tagging rate, the status of the SSRUs 882C–G fishery should be changed from ‘exploratory fishery’. Both members were concerned that an increased tagging rate could impact research fishing because of the need for compliance with the tag-overlap statistic.

5.40 The Working Group noted that there is a requirement for a suitable tagging rate that achieves an assessment of abundance in this area, regardless of the classification of the fishery and noted:

(i) a tag rate of 1 fish per tonne in areas where accessibility is known to be impacted by sea-ice is unlikely to produce an assessment for many years

(ii) the experience in Subareas 48.6 and 58.4 shows how fishing in designated research blocks with high tagging rates can yield good tag-recapture rates

(iii) the constraints of undertaking research for assessment purposes in areas affected by sea-ice has been identified as a topic of high priority for WG-SAM.

5.41 The Working Group was unable to reach consensus on a recommendation of an increase in tagging rate in this management area.

5.42 In the course of discussion, the Working Group learned that in some instances small fish were released alive without tags. The Working Group expressed concern that this was occurring but insufficient information is currently collected to understand the extent of bias that this practice may introduce into the assessments considered by the Working Group and requested this be considered further at the Scientific Committee.

Management advice

5.43 The Working Group recommends all fishing sets be completed within the boxes that define the bounds of the four identified fishing grounds (Figure 2; Table 4).

5.44 The Working Group agreed that the catch limit for SSRUs 882C–G be retained as that agreed for 2013/14 at 124 tonnes in SSRUs 882C–G.

Research to inform current or future assessments

Subarea 48.2 – South Orkney Islands

5.45 The Working Group considered WG-FSA-14/08, a proposal by Ukraine to undertake research fishing for *Dissostichus* spp. in Subarea 48.2. The aim of the program is to provide CCAMLR with the data necessary to estimate biomass of *Dissostichus* spp. by undertaking a longline research survey during February–April over a 3-year period (2015–2017).

5.46 An earlier proposal had been reviewed at the meeting of WG-SAM (WG-SAM-14/22), where a number of suggestions for improving the survey were made and resubmission was encouraged (Annex 5, paragraphs 4.1 to 4.5). The Working Group agreed that the revised proposal adequately incorporated the recommendations set out by WG-SAM. However, it was also noted that there was no indication as to how biomass would be estimated and reported using the existing research design. There were further uncertainties with respect to how ageing would be undertaken by Ukraine for the two species of *Dissostichus*.

5.47 Dr Pshenichnov noted that results and analysis for the first year's research would be reported to WG-SAM-15, and that this would include work toward ageing otoliths for the two species. Ukraine was encouraged to collaborate with other Members who currently have otolith ageing programs. It was noted that the issue of methodology to estimate biomass would be referred to WG-SAM-15.

5.48 The Working Group recalled the advice from WG-FSA-13, paragraph 6.76(i), that the target tag-overlap statistic be increased to at least 80%. The Working Group endorsed the research plan for *Dissostichus* spp. in Subarea 48.2. The survey sets in 2015 year shall be effort limited (a total of 30 sets) with a research catch limit of 75 tonnes.

Subarea 48.6

5.49 WG-FSA-14/67 provided an updated progress report on research fishing activities for *Dissostichus* spp. undertaken in 2012/13 and 2013/14 in Subarea 48.6 being jointly undertaken by Japan and South Africa.

5.50 The Working Group noted that effort in four research blocks and tagging efforts appear to be yielding encouraging results, with a total of 42 tagged toothfish having been recaptured during the first 19 months of the research program. However, a substantial number of the recaptures were within season, with 17 recaptured *D. mawsoni* and four *D. eleginoides* from the northern part of Subarea 48.6 and three *D. mawsoni* from the southern area suitable for use in a tag-based assessment model. The paper contended that at the present rate of recaptures, there should be sufficient data to undertake a tag-based assessment of *D. mawsoni* in the northern part of Subarea 48.6 by the end of 2015.

5.51 The Working Group expressed concern with respect to the possible increase in IUU activity in the area, which could have negative impacts on the research being undertaken.

5.52 WG-FSA-14/17 and 14/37 provided revised research plans for the exploratory fisheries for *Dissostichus* spp. in Subarea 48.6 in 2014/15 by Japan and the Republic of Korea respectively. The Working Group noted that South Africa intends to collaborate with Japan on research activities in 2014/15 as well.

5.53 The Working Group noted that predicted numbers of recaptures and estimated stock size using the Petersen and CPUE methods (using SSRU 882H as a reference area) were relatively consistent with the observed numbers for *D. mawsoni* in research block 486_2 for 2012/13 and 2013/14, though were inconsistent for *Dissostichus* spp. in other blocks.

5.54 WG-FSA-14/17 proposed to continue the current research operation for at least three years with the same sample size as decided at the last CCAMLR meeting in the current research blocks. It also proposed to allow flexibility (i.e. enlarged buffer zone) in cases of research operations under extraordinary adverse ice conditions.

5.55 The Working Group undertook to update the Petersen estimates for research block 486_2. The new estimates of biomass for this research block are set out in Table 5.

5.56 The Working Group agreed that providing advice with respect to increased flexibility in terms of enlarging buffer zones is very difficult, as there is the potential that the probability of recapturing tags may be reduced.

5.57 The Working Group noted that sea-ice analysis in some of the southern research blocks of Subarea 48.6 indicated that consecutive-year research activities may be difficult. The Working Group acknowledged that rolling over catch limits would be associated with a high degree of uncertainty and associated risks, as there is an absence of knowledge relative

to biomass and productivity in these areas and thus a risk for the stock to be negatively impacted. In the absence of an analysis characterising the potential risk that carrying over research catch limits will not overly impact the stock, the Working Group felt that it was not appropriate to advise on this at this stage.

5.58 The Working Group discussed the proposal set out in WG-FSA-14/17 to increase the research catch limit in research block 486_3 from 50 tonnes to 100 tonnes. The rationale for this proposed change was based on a significantly lower number of recaptured tagged fish than those predicted, owing to a limited number of hauls (only 13 and 14 hauls in 2013 and 2014 respectively) and a research catch limit of 50 tonnes in the research block, which corresponds to 1.4% of the estimated biomass.

5.59 The Working Group agreed that it was important to remain consistent when undertaking a planned multiyear research activity. Consistency across survey seasons will ensure that the signals coming from the research will not be compromised by alterations of the research design during the course of the planned activity. At the end of the planned research, changes to the attributes of the design or recommendations that other approaches should be explored can be advised.

5.60 The Working Group agreed that the priority research areas in Subarea 48.6 should be the two northern research blocks 486_1 and 486_2, followed by the three southern research blocks 486_3, 486_4, and 486_5. The Working Group recommended that the research catch limits from last year be retained for this year. These catch limits are set out in Table 5.

Subarea 48.5 – Weddell Sea

5.61 WG-FSA-14/03 Rev. 2 presented a progress report on stage II of the Weddell Sea research program. The Working Group noted that options 1 and 2 of the survey were carried out from 10 to 22 February 2014 with a total of 34 longlines set. Within the option 1 area, 30 longlines were set (10 in the east of the research block, 20 outside) and four longlines were set within the option 2 area. The total catch of *D. mawsoni* was 228 tonnes, with a by-catch of approximately 2 tonnes. The Working Group thanked Russia for the detailed report of biological sampling and analyses.

5.62 The Working Group identified several inconsistences while reviewing this report, including:

(i) hauling times
(ii) tag-overlap statistic
(iii) tagging rate.

5.63 These inconsistencies were investigated by the Secretariat, at the request of the Working Group. The Working Group expressed concern that some of the data used to compile the report differed in several critical respects from that provided to the Secretariat and expressed concern that there may be other errors in the report which had not been identified.

5.64 Dr Petrov explained that the tagging overlap figure that was presented in WG-FSA-14/03 was unintentionally attributed to Subarea 48.5 but was in fact from Subarea 88.1. He reiterated that the data which had been provided to the Secretariat were correct.

5.65 The Working Group then went on to review aspects of the data that had been submitted to the Secretariat and compared them to catches and catch rates in other parts of the Convention Area.

5.66 The Working Group agreed that it would be valuable to develop a stock hypothesis for *D. mawsoni* in the Weddell Sea, as has been done for the Ross Sea, Amundsen Sea and the Indian sector of the Southern Ocean. It agreed it would be useful to look at the hydrography, bathymetry and oceanographic features of the Weddell Sea, noting the likely relationships of these areas to the shelf areas in Subarea 48.6, to start building these hypotheses. Following on from this, it was noted that a comparison between option 1 and option 2 areas would be useful, as the former appears to have larger fish, and the latter has early stage recruits.

5.67 The Working Group noted the remarks in relation to by-catch at WG-SAM-14 (Annex 5, paragraph 4.7), where it was noted that the proportion of by-catch to target catch was low compared with other toothfish fisheries elsewhere in the CCAMLR area. Further analysis by the Working Group indicated that the by-catch rates per set were similar to those observed in the southern areas of Subarea 48.6 (Figure 8) and that the low ratio of by-catch was a function of the high catches of target species.

5.68 It was acknowledged that this was the first two years of research in an area which has never had a CCAMLR fishery for toothfish before, and had exceptionally high catch rates (among the highest in the Convention Area). These high catch rates could be because the area had not been previously fished. However as this was 'research fishing' as opposed to 'commercial fishing' (i.e. the station coordinates had been supplied to the vessel), the catch rates may be expected to be lower and more variable than when vessels were actively targeting known hot spots.

5.69 The Working Group considered some potential hypotheses as to what may give rise to the high catch rates in Subarea 48.5:

(i) there could be the potential that Subarea 48.6 has been impacted by IUU fishing, although it was noted that known IUU fishing activities in this subarea have not been as high as in other regions of the Convention Area

(ii) there could be substantial movement of fish to the areas where option 1 and option 2 have been sampled. However, it was noted that tagging results of *D. mawsoni* elsewhere have not demonstrated large movements within the first few years

(iii) there may be very different fine scale densities at these locations, as there are clear differences in CPUE spatial structure for the *D. mawsoni* stock in the Ross Sea

(iv) the vessel achieved these high catch rates simply by chance.

5.70 The Working Group also reviewed the pattern of catch rates seen during the survey. It noted that toothfish catch rates in the Convention Area typically show a frequency distribution where the highest frequency of catch rates are in the bins of lowest catch rates (first one or two bins/columns of a frequency distribution plot) with a long right-hand tail of occasional high catch rates. However, the data for Subarea 48.5 showed a complete absence

of low catch rates. To determine whether this pattern was unusual, the Working Group asked the Secretariat to carry out an analysis of CPUE frequency distributions for all vessel*area combinations and some of the highest catch rates recorded in the Convention Area. This analysis indicated that of the 992 year*vessel*management area combinations for longline fisheries in the Convention Area, there were 16 for which the maximum frequency of CPUE (kg/hook) was not in the first three bins (Table 7 and Figure 9).

5.71 In seeking to understand the operational implications of such high catch rates, the Working Group also reviewed the catch rates in fish landed per minute for all autoline vessels operating in the exploratory and research fisheries in Subareas 88.1, 88.2, 48.4 and 48.5 in the last three years. It would be expected that with high catches it would take a longer time than average to retrieve the gear. However, it appeared that the *Yantar 35* had taken relatively little time to haul each set considering the very large toothfish catches. To determine whether this pattern was unusual, the Working Group asked the Secretariat to carry out an analysis of haul times for various vessel*area combinations. The analysis was restricted to autoline vessels to ensure consistency between gear types. The Secretariat conducted the analysis by calculating the number of fish hauled per minute during each set of the survey and compared that with other autoline vessels fishing in Subareas 48.4, 48.5, 88.1, and 88.2 combined across all years (Figure 10).

5.72 The Working Group noted that almost all vessel*area combinations in Subareas 48.4, 88.1 and 88.2 had a mean haul rate of less than 0.5 fish per minute. The exception was the *Yantar 31* in Subarea 88.2 but this was based on only seven sets (Table 7). In contrast, the *Yantar 35* had a mean haul rate of over 1 fish per minute when fishing in Subarea 48.5 compared to a mean haul rate of less than 0.5 fish per minute when it was fishing in Subareas 88.1 and 88.2. The difference in hauling speeds between vessels is also demonstrated clearly in Table 7, where it shows that the *Yantar 35* hauled 52% of its sets at a speed of over 1 fish per minute compared to all other vessels (excepting *Yantar 31*), which hauled less than 6% of their sets at that speed.

5.73 The Working Group also considered the effect of a higher tagging rate on the haul rates by comparing the hauling rate (fish per minute) for vessels which had fished in both Subareas 48.4 where the tagging rate is 5 fish per tonne, and Subareas 88.1 and 88.2 where the tagging rate is 1 fish per tonne (Figure 10). All three vessels which have fished one or more of these three subareas have a substantially lower hauling rate in Subarea 48.4, even though the catch rate is also lower. However, the *Yantar 35* had a much higher hauling rate in Subarea 48.5 than it did in either of the other two subareas.

5.74 The Working Group reviewed the spatial location of catches conducted in 2013 and 2014 as part of the research program and noted that there was limited overlap between the location of fishing in 2013 and 2014 and also between the proposed location of research in 2014 and the actual location of catches in 2014 (Figure 11).

5.75 The Working Group further noted that although the *Yantar 35* released a total of 1 792 tags in Subareas 48.5, 88.1 and 88.2, none of these tags have been recaptured.

5.76 WG-FSA-14/09 described a plan of research in Subarea 48.5 for the 2014/15 season submitted by the Russian Federation. The Working Group noted the schedule and research plan with respect to the third stage of a multiyear research program in the Weddell Sea, as well as the plan to continue the research for a total of five years.

5.77 The plans and activities undertaken in Subarea 48.5 were examined in detail by the Working Group.

5.78 The Working Group noted that the proposed research in 2014/15 included setting 50 lines in the option 1 area (30 outside the block, 20 inside), 40 lines in the option 2 area (plus four lines on each of two seamounts) and 40 lines within the option 3 area (20 lines in western region, 20 lines in eastern region). It was noted that the proposed catch required to complete the survey in year 3 (2014/15) was specified as 383.3 tonnes in the option 1 area (240 tonnes inside the research block, 143.3 tonnes outside the block), 58 tonnes in the option 2 area (48 tonnes in the option 2 area, 5 tonnes on each of 2 seamounts) and 110 tonnes in the option 3 area. The overall proposed research catch totals 551 tonnes.

5.79 The Working Group noted that the spatial design of the research within the option 2 area comprises a prospecting phase that includes four lines at each elevation on two seamounts in the eastern part of the Weddell Sea. Dr Kock informed the Working Group that recent bathymetric swath mapping of this region by the RV *Polarstern* indicates that these two seamounts may not exist.

Management advice

5.80 Because of the problems with the inconsistencies in the data presented in WG-FSA-14/03 and the data provided to the Secretariat and also the anomalous nature of these data when compared to data from other vessels fishing in the Convention Area, most members of the Working Group were unable to complete the review of the proposed research program for 2014/15 and were therefore unable to endorse the further proposal to continue the research in 2015. They recommended that a thorough review of all aspects of the data be carried out by the Secretariat during the intersessional period.

5.81 Some members further considered that these data should be quarantined until this review had taken place.

5.82 Dr Petrov made the following statement:

> ‘Russian research programs in the Weddell Sea was adopted by the CCAMLR Commission on the Thirty-first (CCAMLR-XXXI, paragraphs 5.37 to 5.43) and Thirty-second (CCAMLR-XXXII, paragraphs 5.59 and 5.60) Meetings. The research programs were carry out by Russia within two years (2012/13 and 2013/14). Data on biology and fishing for toothfish have been collected for the first time ever from the area which has not been investigated for 31 years and was a gap for CCAMLR and a data-poor area. Progress report of performed Research program of Russia was presented and considered at WG-SAM-2014 (Chile, Punta Arenas) and received positive assessment of the Working Group as evidenced by the corresponding entries in the report (WG-SAM-2014, paragraphs 4.6 to 4.12). In the same report on the results of research in Subarea 48.5 presented at WG-FSA-2014 some participants of the Group found insignificant, minor mistakes which in general do not affect the overall result of the studies. In accordance with the procedure discussed mistakes were corrected and placed on the web-site of the Working Group and were marked as revision. But some participants put in doubt the findings, which were reviewed and

discussed at the WG-SAM-2014 (WG-SAM-2014, paragraphs 4.6 to 4.12) and stated that they doubt the results and data presented by us. Then I offered to convene independent working group for discussion of the arisen questions related to the presented by us data using the data submitted by us to the CCAMLR Secretariat, but did not receive general support. As long as the group has not been created and procedure for the consideration of the dispute issue was not complied in accordance with the procedure. Also during the plenary session I did not receive the data from the opponents where they could show the factual differences.

I reserve my opinion on that issue. The research program presented by Russian Federation in document WG-FSA-14/09 must be considered by the Scientific Committee. I believe that it is necessary to continue Russian research programs adopted by the Commission (CCAMLR-XXXI, paragraphs 5.37 to 5.43) at the Thirty-first Meeting, planned for season 2014/15 by us.

I would like to note that we fully support proposal made by the WG-SAM-2014 to open the Subarea 48.5 for exploratory fishing after the stock assessment for toothfish in this area is completed. We are sure that when the Subarea 48.5 will be open for everyone then CCAMLR will get confirmation of our results.'

5.83 Many members noted that:

'The assertion from Dr Petrov, that he "offered to convene independent working group for discussion of the arisen questions related to the presented by us data using the data submitted by us to the CCAMLR Secretariat, but did not receive general support" is not factually accurate.

This offer was not made during the proceedings of WG-FSA-14 to any other participant's knowledge. Dr Petrov did offer to look at the data held by the Secretariat in plenary, but did not offer that opportunity to others. Were it to have been made, the Working Group would have welcomed and fully supported the opportunity to address the questions relative to the data presented. The Working Group had agreed that it would review a revision of the analyses if they were made available for consideration in the subgroup and later in plenary.'

Division 58.4.4a and 58.4.4b (Ob and Lena Banks)

5.84 Papers considered under this item included:

(i) WG-FSA-14/04 and 14/21, describing plans for research in 2014/15 to support the development of a stock assessment for toothfish in blocks C and D in this division by the *St André* (France) and the *Shinsei Maru No. 3* (Japan)

(ii) WG-FSA-14/06 and 14/23, describing updated stock assessments using CASAL of the toothfish in blocks C and D.

5.85 The Working Group noted the advice by WG-SAM-14 on refining research plans and preliminary assessments for this division, including reconciling MPD and MCMC estimates of biomass, the impact of IUU fishing on the stock and seeking consistency in the development of input files for CASAL (Annex 5, paragraphs 2.18 to 2.25).

5.86 The Working Group noted that the revised assessments presented have improved relative to those presented at WG-SAM-14. Work undertaken during the meeting, including reweighting data using the Francis (2011) method, estimating IUU fishing of 30–50 tonnes in 2012 and fitting standardised CPUE further improved the robustness of the models conducted, however, this was unable to be progressed to the point of providing management advice using the CCAMLR decision rules. The Working Group recommended that the assessments continue to be refined independently, including:

(i) development of catch at age and growth based on fish aged from this division

(ii) estimation of YCS where ageing data is available

(iii) fitting standardised CPUE

(iv) investigation of the impact of effective sample size

(v) alternative assumptions of selectivity (e.g. longline versus gillnet) for IUU fishing

(vi) runs of simulations to detect sources of bias in the models.

5.87 The Working Group also recommended that an intersessional e-group[1] be convened to progress the items noted above and requested that the Scientific Committee consider the inclusion of a focus topic on the preparation of data for inclusion in integrated assessments at WG-SAM-15.

5.88 Noting the progress towards an assessment in this area and the broad consistency between the expected tag-recapture estimates from WG-FSA-13 (SC-CAMLR-XXXII, Annex 6, Table 13) and those observed, the Working Group recommended that the research fishing proposed by France and Japan in this division proceed in 2014/15, with a catch limit of 25 tonnes in block C and 35 tonnes in block D.

Division 58.4.3a (Elan Bank)

5.89 Papers considered under this item included:

(i) WG-FSA-14/05 and 14/20, describing plans for research in 2014/15 to support the development of a stock assessment for toothfish in this division by the *St André* (France) and the *Shinsei Maru No. 3* (Japan)

(ii) WG-FSA-14/22, describing an updated stock assessment using CASAL.

5.90 The Working Group noted the advice by WG-SAM-14 on refining research plans for this division, including accounting for tag recaptures in 2014 in updated estimates of biomass, establishment of research blocks, analysis of skate by-catch and facilitating collaborative research (Annex 5, paragraphs 3.32 to 3.38).

5.91 Following review of the scenarios in WG-FSA-14/22, the Working Group agreed that the CASAL assessment was currently not sufficiently robust to provide management advice

[1] CCAMLR e-groups can be accessed from the CCAMLR homepage and are available to authorised users.

using the CCAMLR decision rules. It recommended that the points noted above for the preliminary assessments of Divisions 58.4.4a and 58.4.4b also be considered for developing assessments for this division. In addition, analysis of the penalties applied to tagging data seen in the stock assessment models should be evaluated.

5.92 In the absence of an assessment using the CCAMLR decision rules, the Working Group agreed that re-estimation of the geometric mean of Petersen biomass estimates be used as the estimate of biomass for this division, including the 24 tags recaptured during research fishing in 2013/14 by the *Shinsei Maru No. 3* and the *St André*. Given this analysis estimated biomass at 386 tonnes, which was similar to the 372 tonnes, the Working Group recommended that the catch limit for this division remain unchanged at 32 tonnes for 2014/15.

5.93 The Working Group reviewed the spatial, vessel- and gear-specific patterns of skate and macrourid by-catch in this division. Patterns of by-catch varied across all of these factors. The Working Group noted the analysis in WG-FSA-14/05 indicating that for soak times of less than 24 hours, soak time did not seem to influence skate by-catch rates on the *St André*, as well as that the great majority of skates caught by that vessel in 2013/14 were deemed likely to survive and were released.

5.94 The Working Group agreed that it was unnecessary to prescribe soak times or spatial locations for the research fishing proposed by France and Japan in this division in 2014/15. However, the Working Group agreed that further analysis of skate condition in relation to soak time and spatial distribution of fishing was needed and requested an updated analysis to be submitted to WG-FSA-15. It welcomed the offer from France to tag and release skates.

Divisions 58.4.1 and 58.4.2

5.95 Papers considered under this item included:

(i) WG-FSA-14/35 and WG-SAM-14/09, describing the results of the depletion experiment conducted by the *Tronio* (Spain) in Division 58.4.1 in 2012/13 and 2013/14, and the proposal to continue this research through to 2017/18

(ii) WG-FSA-14/18 and 14/19 describing plans for research in 2014/15 by the *Shinsei Maru No. 3* (Japan) to support the development of a stock assessment for toothfish in Divisions 58.4.1 and 58.4.2

(iii) WG-FSA-14/38 and 14/39 describing plans for research in 2014/15 by the *Kingstar* (Republic of Korea) to support the development of a stock assessment for toothfish in Divisions 58.4.1 and 58.4.2.

5.96 The Working Group noted the advice by WG-SAM-14 on refining research plans for Divisions 58.4.1 and 58.4.2, including the need for evaluation of the CV of the biomass resulting from the depletion experiment and the area to which estimates are applied, the need for a review of the depletion experiment at WG-SAM-15 prior to research continuing and the need for prioritisation of research activities in these proposals, given the large spatial coverage of research activities proposed by Japan and the Republic of Korea across these divisions and Subarea 48.6 (Annex 5, paragraphs 3.25 to 3.31).

5.97 The Working Group noted that Spain had been unable to complete the depletion experiments within SSRU C in 2013/14 within the 42 tonne limit allocated. It noted that Spain had continued the research after discussion with the Secretariat and Japan, and that the research had concluded after 54 tonnes were taken, therefore without exceeding the overall catch limit for this SSRU. It further noted that Spain had requested that 50 tonnes be allocated to reduce the risk that research would be curtailed in 2014/15.

5.98 It requested that the Commission consider a mechanism that would provide the flexibility to the *Tronio* to complete depletion experiments if more than 42 tonnes is required to complete it in 2014/15.

5.99 The Working Group agreed that the priority for the depletion experiment should be to return to locations where depletions had been observed previously in an attempt to recapture tagged fish and to estimate the rate at which toothfish may replenish areas where local depletion has occurred, prior to prospecting outside these areas. It further noted that lines should be set close together to ensure that the variability in CPUE observed can be attributed to local depletion rather than variation in toothfish density across an area. It also encouraged the development of an ageing program by Spain to enhance the information on population dynamics of toothfish in the region.

5.100 The Working Group agreed with the recommendation from WG-SAM-14 that the results from the depletion experiment be reviewed prior to further research fishing in 2015/16. Such a review would consider the following questions:

(i) How does the precision and magnitude of biomass estimated from Leslie depletion analysis compare with that estimated from tag recaptures?

(ii) What is the relationship between the initial CPUE in an area and the resulting biomass in an area derived from a depletion experiment?

(iii) What is the area to which the biomass estimate derived from a Leslie depletion analysis applies?

(iv) How can the results of depletion experiments be used to develop a stock assessment that uses the CCAMLR decision rules?

5.101 The Working Group noted the revised research proposal by the Republic of Korea detailed in WG-FSA-14/38 and 14/39, which provided additional details on the schedule of work planned over five years of research. The Working Group noted that the proposal included a plan to release one satellite pop-up tag in each of Divisions 58.4.1 and 58.4.2 and Subarea 48.6. The Working Group recommended that, given the reliability of these tags, releasing all tags in one location was more likely to result in useful data on toothfish behaviour, as well as the feasibility of using this technology in areas seasonally covered by sea-ice.

5.102 The Working Group welcomed the development of an ageing program by Korean scientists and encouraged continued correspondence between the Republic of Korea and established toothfish ageing programs such as that undertaken by New Zealand, and developing quality control procedures as described by the Ageing Workshop for *D. eleginoides* and *D. mawsoni* at WG-FSA-12 (SC-CAMLR-XXXI, Annex 7, paragraphs 10.1 to 10.19).

5.103 The Working Group noted that the proposals by Spain, and Japan and the Republic of Korea, both included research blocks located in areas that are periodically covered by sea-ice. It recalled that in 2013, Korea had been unable to complete planned research due to problems with sea-ice encountered during January, and sea-ice had impacted on the ability of the *Tronio* to set lines in 2014.

5.104 Analysis of historical sea-ice conditions using the methods described in WG-FSA-14/54 and 14/55 Rev. 1 indicated that research blocks 5841C_a and 5841C_b most reliably have some fishable area clear of sea-ice (Figure 12). In some years, other research blocks were partly or entirely occluded by sea-ice, however, February was consistently the month that sea-ice was at its minimum extent. The Working Group therefore agreed that research be focused on those blocks at times where sea-ice was likely to permit multiyear tag-recapture experiments. Noting that the time window for operating adjacent to the Antarctic coast in Divisions 58.4.1 and 58.4.2 was around one month, this meant that it was unlikely that a single vessel was likely to be able to conduct research in all of the block proposed.

5.105 The Working Group recommended that research by Japan and the Republic of Korea in 2014/15 be focused on those block(s) designated in 2013 that have a high number of tags available for recapture and that are likely to be accessible. Given that no further information on stock status or productivity was available, the Working Group recommended that the same catch limits apply in 2014/15.

5.106 The Working Group acknowledged that sea-ice posed a significant obstacle to progressing stock assessments based on tag recaptures in many exploratory fisheries. It therefore requested that the Scientific Committee task WG-SAM-15 with reviewing research methods to develop stock assessments in these areas, taking into account the experience and data collected from research activities conducted in exploratory toothfish fisheries in areas affected by sea-ice, habitat modelling of toothfish, sea-ice maps and the operational capabilities of fishing vessels.

Subarea 88.1 and SSRUs 882A–B

Ross Sea sub-adult survey

5.107 Results of the 2014 Ross Sea sub-adult survey were presented in WG-FSA-14/51. The three completed surveys were summarised and showed that the survey was tracking age-class progression of fish of 6–9 years old. The 2014 survey also showed that high catch rates of large toothfish were observed in McMurdo Sound relative to the other survey areas.

5.108 The Working Group noted that the recommendations from WG-SAM (Annex 5, paragraphs 4.24 and 4.25) were incorporated in the updated report and that further progress on including the index of YCS in the stock assessment will be presented at WG-SAM-15. The Working Group also noted that there was no evidence to date that commercial fishing was influencing the survey CPUE data. The Working Group agreed that the age structure and standardised CPUE derived from commercial data do not index the age structure or abundance in the area and that the survey is necessary to collect that information. The Working Group also agreed with WG-SAM that monitoring the size composition in the McMurdo Sound area would be useful in the future (Annex 5, paragraph 4.26).

5.109 The proposal to continue the Ross Sea sub-adult survey in 2015 was presented in WG-SAM-14/25. The proposed survey strata for 2015 include a stratum near Terra Nova Bay, as that area has been identified as an area of high juvenile abundance and fish tagged in the southern Ross Sea may have moved to this area.

5.110 The Working Group endorsed the recommendations from WG-SAM-14 to carry out the survey in 2015 with an exploratory stratum near Terra Nova Bay and recommended that the proposed survey be carried out in 2015. The Working Group also agreed that the survey should be comprised of 60 sets with a catch limit of 68 tonnes.

SSRUs 882A–B

5.111 A multinational survey to map bathymetry and collect biological data from toothfish in the northern part of SSRUs 882A–B was proposed in WG-FSA-14/61. The Working Group noted that the proposal was improved by the incorporation of recommendations from WG-SAM-14 (Annex 5, paragraphs 4.16 to 4.23). The Working Group agreed that the proposal would provide information that was relevant both to the development of spatial population models (SPMs) and will also inform the understanding of stock structure in the region. The Working Group encouraged the participating vessels to fish in SSRU 881C adjacent to SSRU 882A using the standardised gear configuration to enhance the comparison between the two areas and also noted that the participating vessels have a good tagging performance history.

5.112 The Working Group recommended the bathymetry mapping and survey go ahead as an effort limited 'prospecting' phase research design with a maximum of 6 900 hooks per set and 17 250 hooks per cluster, a minimum cluster separation of 10 n miles and a total effort limit of 244 950 hooks set per vessel and a tagging rate of 3 fish per tonne of catch. The Working Group agreed that an upper catch limit of 50 tonnes per vessel deducted from the catch limit from the Ross Sea region was appropriate for the scope of the research and recommended that the Scientific Committee consider appropriate options to account for the survey catches, noting that a proposal for this purpose was submitted by New Zealand (SC-CAMLR-XXXIII/09).

5.113 In the southern area of SSRU 882A, an updated proposal to conduct research on the continental slope and shelf was presented in WG-FSA-14/13. Previous versions of the proposal have been discussed in 2013 (see discussion of a previous version of the proposed research in SC-CAMLR-XXXII, paragraphs 3.151 to 3.160), by the Commission (CCAMLR-XXXII, paragraphs 5.33 to 5.37) and by WG-SAM-14 (Annex 5, paragraph 4.17). The objective is to sample a previously fished area to recover tagged toothfish that were either tagged in the area or have moved into the area, hypothesised to be mainly from the Ross Sea slope. The focus area consists of a central box and three smaller areas either to the northwest, southwest or east of the main area (options 1, 2, 3), with the smaller areas fished to be chosen depending on ice conditions.

5.114 The Working Group noted that the proposed design would allow the data to be used by the Ross Sea spatial population model but also noted that it proposed a different life-history hypothesis and stock structure for the fish inhabiting the southern part of SSRU 882A that would entail an eastward migration from the Ross Sea into SSRUs 882C–H (SC-CAMLR-XXXII, paragraph 3.158).

5.115 The Working Group noted that this proposal has been presented under CM 24-01. It agreed that the catch would be taken from the Ross Sea stock. It also noted that the proposal was for the research catches to be taken additional to the catch limit. In view of the catch limit for the Ross Sea stock being set according to the CCAMLR decision rules, then additional catch for the research would mean that the total catch would not satisfy the decision rules. The Working Group agreed that there was no information to complete a review of the implications for the stock of taking a research catch greater than the catch limit set according to the decision rules. It noted that should the catch be taken as part of the catch limit for the Ross Sea stock, then the research need not be undertaken under CM 24-01.

5.116 The Working Group noted that discussions surrounding activities in respect of toothfish in SSRUs 882A–B would be clearer if these SSRUs were more clearly identified with the Ross Sea stock. It recalled the discussion of the Commission in 2013 regarding the rationale for the revision of the boundary between Subareas 88.1 and 88.2 (CCAMLR-XXXIII, paragraphs 5.34 and 5.37). The Working Group also recalled that the Commission had revised boundaries of management areas in the past to more clearly be associated with whole stocks (e.g. Division 58.4.3b; CCAMLR-XX, paragraphs 7.16 to 7.20).

5.117 In reference to whether closed SSRUs represented unexploited areas and that catches in open SSRUs were only applicable to sustainable yields in those SSRUs, the Working Group noted that the Commission has developed spatial management strategies to help improve data collection during exploratory fisheries (CCAMLR-XXII, paragraphs 9.16 to 9.23; CCAMLR-XXIII, paragraphs 10.57, 10.58 and 10.70; CCAMLR-XXIV, paragraphs 10.11 to 10.16). These measures were aimed at concentrating fishing activities but not affecting catch limits for whole divisions and subareas; some SSRUs were closed and the catch limits from those closed SSRUs were added to adjacent SSRUs. This approach was undertaken in the knowledge that the fish were likely to move between SSRUs.

5.118 The Working Group concluded that the issue of the boundaries of Subareas 88.1 and 88.2 is a matter for the Commission but that toothfish inhabiting SSRUs 882A–B are included in the Ross Sea region stock assessment and therefore catch from those areas should be subtracted from the Ross Sea region catch limit to satisfy the CCAMLR decision rules (SC-CAMLR-XXIV, paragraph 4.162; CCAMLR-XXIV, paragraph 11.72).

5.119 The Working Group recommended that if the research proposal was undertaken under the catch limit for the Ross Sea region, then a catch limit of 60 tonnes would be appropriate inside the main box and 40 tonnes in the area outside the box, for a total of 100 tonnes for the SSRU 882A shelf and slope survey.

Multiyear research plan

5.120 A multinational multiyear research plan for the Ross Sea was developed in WG-FSA-14/60. The research plan aims to address information needs for management of the Ross Sea region *D. mawsoni* population focusing on improved biological parameters for stock assessment and improved understanding of ecosystem effects of fishing. The Working Group welcomed the plan, encouraged other Members to review and operationally support the plan and looked forward to progress on the topics identified. The Working Group agreed with the

report of WG-EMM (Annex 6, paragraphs 5.21 and 5.22) that work on the ecosystem effects of fishing was important and that future work should consider how the Scientific Committee could use such information in advising the Commission.

Summary of advice on the catch limits of exploratory and other fisheries

5.121 The Working Group discussed the results of research fishing in 2013/14 and reviewed the number of recaptures of tagged fish predicted at its 2013 meeting (SC-CAMLR-XXXII, Annex 6, paragraphs 6.26 to 6.28 and Table 13).

5.122 In 2013, the Working Group defined research catch limits that would achieve 10 or more recaptures in 2013/14 without exceeding local exploitation rates of approximately 0.04. Where multiple plausible local biomass estimates were available, the more precautionary option was selected, unless other evidence supported a higher local biomass (SC-CAMLR-XXXII, Annex 6, paragraph 6.26 and Table 13).

5.123 The Working Group recalled that the following criteria had been used in formulating the information and advice contained in SC-CAMLR-XXXII, Annex 6, Table 13:

(i) Local biomass was estimated using available data (Petersen, CPUE seabed analogy) and the lowest estimate (B) was selected.

(ii) The minimum catch required to catch 10 tags in the next season (C_1) was

$$C_1 = \frac{10B}{T}$$

where T is the estimated number of tagged fish available for recapture.

(iii) The catch that would result in a local exploitation rate of 0.04 (C_2) was

$$C_2 = 0.04B.$$

(iv) The lower value of C_1 and C_2 as selected as the upper limit of catch for research activities in a given block (i.e. the recommended catch limit).

5.124 The Working Group also recalled that the number of tagged fish available for recapture within each research block was based on a subset of data representing ‘effective tag releases’. Only tagged fish from vessels from which at least one of their tagged fish had subsequently been recaptured (from effective tag releases, and excluding tagged fish which had been released and recaptured in the same season) are used for the estimation of local abundance using the Petersen estimator and for subsequent calculations on expected recaptures under different catch limits and in stock assessments (SC-CAMLR-XXXII, Annex 6, paragraph 6.13). This method has been applied to vessels in each subarea where research fishing occurs, pending development of alternative methods.

5.125 The Working Group noted the following points in relation to SC-CAMLR-XXXII, Annex 6, Table 13:

(i) the boundaries of research blocks in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a are defined in CMs 41-04, 41-11, 41-05 and 41-06 respectively

(ii) the boundaries of research block 485_1 (Subarea 48.5) were defined at WG-FSA-13 (SC-CAMLR-XXXII, Annex 6, paragraph 6.86)

(iii) the boundaries of research blocks 5844b_1 and 5844b_2 (Division 58.4.4b) are 52°45'S–54°00'S and 47°30'E–49°15'E and 54°00'S–54°45'S and 49°15'E–52°00'E respectively

(iv) estimation methods follow the advice of WG-SAM (SC-CAMLR-XXXII, Annex 4, paragraph 2.7) regarding the framework and approaches for research plans in data-poor fisheries

(v) the local exploitation rate for *D. mawsoni* in research block 486_4 was incorrectly reported in Table 13; the correct rate is 0.04–0.06.

5.126 The Working Group also noted that the research blocks used at WG-FSA-13 were renamed by the Commission in 2013 to avoid confusion with SSRU nomenclature (CCAMLR-XXXII, paragraph 7.88) and the mapping of current names to the names used at WG-FSA-13 is as follows:

Current name	Name used at WG-FSA-13
485_1	Option 1-a
486_1	A
486_2	B
486_3	C
486_4	D
486_5	E
5841_1	C-a
5841_2	C-b
5841_3	E-a
5841_4	E-b
5841_5	G
5842_1	E
5843a_1	A
5844b_1	C
5844b_2	D.

5.127 The Working Group estimated the number of tags available for recapture in each research block in 2014 (using only ‘effective tag releases’) and compared the number of observed recaptures in 2014 with the number that would be expected under different assumptions of local biomass estimated using alternate methods (Table 5). The number of tagged fish available in a given season (n) was calculated taking into account the number of available tagged fish in the previous season ($n - 1$), tag induced mortality, natural mortality, the number of tagged fish recaptured in season $n - 1$ and the number of tagged fish released in season $n - 1$.

5.128 The Working Group noted that the estimates of local biomass used in the calculations in Table 5 were those estimated by WG-FSA-13, except for the estimates for *D. mawsoni* in research block 486_2 and *D. eleginoides* in blocks 5843a_1 and 5844b_1, which were revised in 2014 (see paragraphs 5.55, 5.86 and 5.90).

5.129 The Working Group agreed that the catch limits in Table 5 are appropriate to achieve the aims of the research programs proposed in exploratory and other fisheries and recommended that these be considered as management advice by the Scientific Committee for catch limits for 2014/15. It is also clarified that those limits are expected to remain for the duration of the proposed research programs, provided that they are reviewed by the Working Groups in light of information derived from research activities and no significant sign of adverse impact on the stock is detected.

5.130 The Working Group also discussed the feasibility of research programs which include a large number of research blocks that are unlikely to be able to be surveyed in a single year by the proposed number of vessels due to the limited time window of access due to sea-ice. The Working Group noted that the inclusion of multiple blocks as proposed increases the feasibility of the research in at least a subset of the proposed research blocks. The Working Group agreed that, with the exception of the proposed research areas in SSRUs A and C in Division 58.4.2, where no research blocks are currently identified, Japan and the Republic of Korea could conduct research fishing in the research blocks designated by the Commission in 2013. In order to advance the research in an efficient manner, the Working Group further agreed that the two programs focus on priority areas and recommended that Japan focus its research in Subarea 48.6 while Korea focus in Division 58.4.1, and schedule research at a time when sea-ice is likely to be at a minimum in the research blocks.

Vulnerable marine ecosystems (VMEs)

Review of VMEs notified in 2013/14

6.1 No notifications of VMEs were made under CM 22-06 in 2014 (SC-CAMLR-XXXIII/BG/01). The VME registry is being developed to be available online via the CCAMLR website. One VME indicator notification was received under CM 22-07 for SSRU 882H, but no new VME Risk Areas were identified.

6.2 The Working Group agreed with the Secretariat's plan to develop a web-based interface to provide an annually updated repository of the VME registry which would include information about currently designated VMEs (defined as both lines and areas), VME Risk Areas and VME fine-scale rectangles. The Secretariat also indicated that VME locations and metadata would be added to the CCAMLR online GIS using the same terminology as in the registry. The web-based interface would provide updated information about the status of VMEs in the Convention Area without the need to update an annual report. The Working Group also agreed that until formal reviews of CMs 22-06 and 22-07 were conducted, the current management advice regarding the management of impacts to VMEs has been compiled and provided in the 2013 Report on Bottom Fisheries and Vulnerable Marine Ecosystems.

6.3 Dr Welsford notified the Working Group of the availability of an extensive final report (WG-FSA-14/P06), entitled 'Vulnerability of Benthic Habitats to Impact by Demersal Gears', detailing work on the estimated levels of disturbance to 17 groups of vulnerable benthic organisms within the Australian EEZ in Division 58.5.2. The report will be made available in hard copy to the Scientific Committee. It included a proposed framework for risk categorisation and monitoring of bottom fishing impacts and concluded that the majority of the benthos in Division 58.5.2 were classified as either relatively low vulnerability or relatively high vulnerability but substantially protected in the marine reserve. The authors estimated that less than 1.5% of all the biomass in waters less than 1 200 m are estimated to have been damaged or destroyed by all bottom fishing activities since 1997 in this division. Furthermore, the Heard Island and McDonald Islands Marine Reserve, established in 2003, is estimated to contain over 40% of the biomass of the groups of benthic organisms considered as most vulnerable to bottom fishing in Division 58.5.2.

Scheme of International Scientific Observation (SISO)

7.1 Data collected by scientific observers on vessels operating in the Convention Area during 2013/14, based on data received by the Secretariat up to 1 October 2014 (WG-FSA-14/01 Rev. 2), were presented by the Secretariat. Points noted were improved data quality through better checking procedures developed by the Secretariat with Member technical coordinators, the publishing of observer names on the CCAMLR website in an honour roll as recommended by the SISO review panel and the requirement of a revision of this paper due to late data submissions.

7.2 The Working Group appreciated the thorough presentation of results and thanked all observers for the data collection, noting specifically the usefulness of by-catch data and the impressive reduction in the seabird by-catch in the French EEZ.

7.3 WG-FSA-14/27 provided a description of the use of an electronic monitoring camera system on board a longline vessel operating in the toothfish fishery in Subarea 48.3. It noted that since the study took place in 2012, some vessels have voluntarily adopted similar systems in the fishery and that these could assist with vessels' by-catch reporting.

7.4 There was consensus within the Working Group of the potential usefulness of such a system, particularly for reducing the workload on observers or providing more time for additional data collection. Several participants mentioned that similar systems had been, or are currently being, trialled in their national fisheries. The Working Group noted the value of electronic monitoring (EM) in providing a verification record for particular events. The Working Group suggested it would be important to look at including some IT components in observer training and developing infrastructure for archiving EM records. The Secretariat indicated that there was currently no system in place for it to archive EM records but that the portal for uploading photographic material may be modified to do this.

7.5 Dr Petrov presented a paper commenting on the SISO review (SC-CAMLR-XXXIII/BG/18). The following statement was provided:

> 'Whilst Russia supports changes to logbook forms, we do not see the necessity for an accreditation scheme, and would like to seek the opinion of the Scientific Committee

and the Commission. Institute VNIRO held a two-day workshop (29 and 30 September 2014) specifically for the preparation of scientific observers, for work in a zone of Convention CCAMLR. The workshop program includes such questions as observance of measures on conservation, correct filling of CCAMLR forms, a directory of the scientific observer and tagging module and many other questions connected with work of scientific observers in the Convention zone. Thirty-seven research assistants of profile Russian institutes have taken part in a workshop. Following the results of a workshop, certificates on the work right in CCAMLR zone on systems the international scientific observer are given out to 24 research assistants.'

7.6 The Working Group thanked Russia for its response. The coordinator of the e-group for the CCAMLR SISO review presented a table which broke down responsibilities of decision-making for each recommendation in the report, noting that the only relevant section for WG-FSA was the prioritisation of observer data collection.

7.7 The Working Group discussed the SISO review (SC-CAMLR-XXXII/07 Rev. 1) relevant to WG-FSA and:

(i) recommended that all recommended revisions detailed in Annex 1 be accepted and adopted in 2014

(ii) noted that much of the data collection done by observers is not done independently from the vessel, and should therefore be removed from observer tasks and logbook reporting requirements

(iii) agreed that development of new logbooks and the cruise report to reflect the proposed changes detailed in Appendices 2 and 3 will be progressed further intersessionally through the Scheme of International Scientific Observation e-group, for adoption in 2015

(iv) noted the importance of observers collecting independent conversion factor data, however, variability in conversion factor calculation between vessels has been identified (WG-FSA-13/68 Rev. 1)

(v) requested that the Secretariat undertake an analysis of the factors that influence variability in the product to green-weight conversion factors used in the toothfish fishery

(vi) noted the discussion regarding the recommendation requiring observer data to be submitted one month after the end of fishing and considered that operational and practical constraints for vessels operating in areas both inside and outside the Convention Area were a major impediment to meeting this recommendation and concluded to keep the current submission deadlines

(vii) sought clarification from the Scientific Committee as to the utility of the observer data collected on board vessels for which data had been quarantined (see paragraph 3.10).

Non-target catch in CCAMLR fisheries

Fish by-catch

8.1 The Secretariat summarised recent catches from the CCAMLR area (SC-CAMLR-XXXIII/BG/01). Fish by-catch reported in landings data included sleeper shark (*Somniosus* spp.), skates (Rajiformes), morid cods (*Antimora rostrata*) and various species of grenadier (Macrouridae) and icefish (Nototheniidae). Fish species landed only in small quantities (<1 tonne) included occasional sharks (*Lamna nasus*, *Etmopterus* spp.) and a range of teleosts (e.g. Muraenolepididae, Myctophidae, Channichthyidae, Liparidae and Zoarcidae).

8.2 The Secretariat also analysed commercial catch data (2006–2013) for one research fishery (South Sandwich Islands, Subarea 48.4) and seven exploratory toothfish fisheries: Bouvet (Subarea 48.6), Ross Sea (Subareas 88.1 and 88.2), East Antarctica (Divisions 58.4.1 and 58.4.2), Elan Bank (Division 58.4.3a) and BANZARE Bank (Division 58.4.3b) (WG-FSA-14/16). Data on by-catch quantity (kilograms and numbers) were standardised as a proportion of toothfish catch (hauls with either no toothfish or no by-catch were excluded). Toothfish were the main catch component (by biomass), but by-catch species were numerically dominant. Subareas 48.4, 88.1 and 88.2 and Division 58.4.2 showed significant differences in by-catch landings per haul between years and a general decline by weight. In Subarea 48.6 and Division 58.4.1, by-catch levels in 2013 were similar to those observed in 2006, but lower in intervening years. In Division 58.4.3b by-catch landings per haul generally increased over time. The ratio of macrourids or skates to target catch varied between years and areas. Subareas 48.4 and 88.2 had the highest ratio of macrourids to target catch. The proportion of skates to target catch was lower than for macrourids and the area with the highest ratio of skate to target catch was Division 58.4.3a.

8.3 The Working Group welcomed this preliminary study and encouraged that further studies be undertaken. Such studies could usefully involve (i) further analyses to examine data quality, (ii) comparisons between observer data and C2 catch data reported by vessels, and (iii) finer-scale analyses (e.g. between vessels operating within the same area; between areas fished by the same vessels).

8.4 WG-FSA-14/47 Rev. 1 investigated factors affecting the by-catch of skates and grenadiers in the longline fishery in Subarea 48.3. Reported by-catch was greater for vessels using autolines than for those using the Spanish line system, which may relate to proximity of the gear to the seabed, bait type and other factors. In the years 1996–1999, prior to the change of the start of the fishing season to the beginning of May, skate by-catch was higher in February and March, and grenadier by-catch lower in July and August. Grenadier by-catch was higher along the southern slope of South Georgia to Shag Rocks and skate by-catch was generally greater along the northern slope of South Georgia. Bathymetric variation in the by-catch of skates and grenadiers was noted, with grenadier catches highest in waters 600–1 400 m deep, and skate by-catch greater in shallower and deeper zones.

8.5 The Working Group encouraged further studies examining the influence of gear, bait, fishing location and bottom topography on the CPUE of by-catch species to be undertaken. Studies examining the rates at which different species were attracted to bait may help in the interpretation of species-specific CPUE.

8.6 WG-FSA-14/25 provided information for the improved identification of four grenadier species (*M. caml*, *M. carinatus*, *M. holotrachys* and *M. whitsoni*) that are a by-catch in longline fisheries in Subareas 48.3 and 48.4.

8.7 The Working Group recognised that the taxonomy and identification of some by-catch species remains problematic. The development of user-friendly keys to improve the accuracy of species-specific data recording is encouraged and could be undertaken intersessionally (see paragraph 8.18).

8.8 The Working Group noted other national initiatives to improve identification in the field, including the recently completed 'Fishes of the Ross Sea region: a field guide to common species caught in the longline fishery' (McMillan et al., 2014) and welcomed such initiatives.

8.9 The Secretariat summarised the commercial catch and observer data available for skates and held in the CCAMLR database (WG-FSA-14/12). These data relate to seven species, one variant species and three higher taxonomic groups (RAJ, SRX and BHY). The highest catches (by number) occurred in the early 2000s. Reported landings have declined since 2005 as more skates have been released in recent years. Overall, 78% of landed skates have come from Kerguelen (Division 58.5.1) and Crozet (Subarea 58.6). Biological data held by CCAMLR were also summarised. Tagging data show that of the skates tagged (n = 17 004), 333 (2%) have been recaptured. Most were recaptured within a few kilometres of the release position. Correct species identification remains problematic, and 31% of the recaptures had different taxonomic codes between tagging and recapture. The spatial distributions were mapped for all species and higher taxa. Two species that are considered endemic to the Kerguelen Plateau showed records from other areas, which warrant further investigation. Morphometric data also showed some inconsistencies.

8.10 The Working Group noted that CCAMLR data is a valuable source of information for Southern Ocean skates. Given recent changes in skate taxonomy, improved guidance as to which three-letter codes should be used could usefully be circulated. In order to minimise incorrect data being submitted, data should only be collected and submitted at the lowest taxonomic level possible. Observer data should provide the best data on species composition, with vessel catch data probably better collected at a higher taxonomic level (e.g. SRX) (Table 8).

8.11 The Working Group noted that further quality checks of skate data are required to improve data quality. Improved quality-check routines for data submitted in the future could also usefully be developed. The Working Group recognised the need to (i) conduct further checks of skate data, (ii) improve taxonomic knowledge and field identification guides for skates, and (iii) provide information to the Secretariat on the differences between *Amblyraja georgiana* (SRR) and *A. georgiana* (var.) (SR2). It was agreed that this work should be undertaken intersessionally (see paragraph 8.18).

8.12 WG-FSA-14/48 presented results from a preliminary stock assessment for skates (species complex) based on the Petersen method. Over the period 2006–2014, a total of 7 866 skates were tagged and released. Of the 167 recaptures analysed, most were recaptured within two years (maximum time at liberty was 6.9 years). Most were taken within 20 km of the release position. The assessment suggested a relatively stable population, albeit with large confidence intervals. This study also showed a preponderance of males in surveys.

8.13 The Working Group encouraged further studies of this nature. The significant difference in sex ratio was intriguing and, while sexual segregation is reported widely in elasmobranchs, further investigations on this were suggested, including more detailed analyses by depth, area and observer.

8.14 The Working Group noted that this preliminary assessment of skate by-catch was to provide information on the population dynamics of the skate complex, from which by-catch is taken in the Subarea 48.3 toothfish fishery. This is in support of the evaluation of the ecosystem effects of the toothfish fishery and there is no intention to develop a skate fishery.

8.15 Further data on the condition of skates were also presented (WG-FSA-14/05). Catches of two species (*Bathyraja eatonii* and *B. irrasa*; n = 4 174) from 91 longline sets from around the Kerguelen Islands indicated that <3% were classed as condition 1 or 2 (dead or poor health). Similar results were also obtained from the Elan Bank area, where about 3% of *A. taaf* (n = 6 625) were classified as condition 1 or 2. This study did not find any effect of depth or soak time on condition, but soak times were of limited duration on the latter survey (ca. 24 hours) (paragraph 5.93).

8.16 Additional biological data on skates were also collected during the Australian trawl survey around Heard Island (WG-FSA-14/41). This survey caught *B. eatonii* (659 kg; 315–1 115 mm total length), *B. irrasa* (254 kg; 235–1 185 mm) and *B. murrayi* (92 kg; 125–545 mm) and skate egg cases. Skate abundance was slightly higher than the 2006–2013 average.

8.17 Options for updating CCAMLR skate maturity keys were also presented (WG-FSA-14/33) and this is commented on under Item 9 and paragraph 8.18.

8.18 The Working Group recommended that the following work could usefully be undertaken by an intersessional group:

(i) Photographic identification guides: while identification guides have been developed for problematic taxa by various nations, intersessional work could usefully compare these guides (including their consistency), collate representative photographs and develop a draft guide that could be used across the CCAMLR area. Initial work should focus on one taxonomic group (e.g. skates), before including further taxa in the future.

(ii) Photographic maturity key for skates: photographs of the different maturity stages of Antarctic skates could also usefully be collated.

(iii) Develop a targeted program to facilitate the collection of relevant identification material and samples for skates (e.g. photos of diagnostic characters and tissue samples) to allow for improved taxonomic studies in the future.

(iv) Checking of morphometric and other biological data for skates on the CCAMLR database: given the discrepancies on the CCAMLR database, an intersessional group should work with the Secretariat to identify (and correct where possible) errors and suggest ways of improving data checks in the future.

Members were asked to send relevant photographs and any regional/national guides to the Secretariat (observer.scheme@ccamlr.org).

8.19 The Working Group considered WG-FSA-14/66, which documented the history of discussion of fish by-catch in the krill fishery and included a proposal to examine the fish by-catch in the krill fishery, in order to review the potential for that fishery to impact fish populations.

8.20 The Working Group agreed that the issue of fish by-catch in the krill fishery had been considered periodically for the past 25 years and remained a concern that had not been adequately addressed. However, the Working Group recognised that the increased coverage and scientific observer data collection in the krill fishery, including fish by-catch (e.g. WG-EMM-14/31 Rev. 1), meant that CCAMLR was in a better position to address this issue than previously.

8.21 The Working Group requested that the Secretariat work with SISO technical coordinators to improve awareness of the sampling methods and data reporting for observers collecting fish by-catch data, including the collection of photographs to confirm species identification in the by-catch, and encouraged summary analyses of fish by-catch in the krill fishery (e.g. as presented in WG-EMM-14/31 Rev. 1) to be presented to WG-FSA as well as to WG-EMM.

Marine mammal and seabird by-catch

8.22 WG-FSA-14/28 reported a single seabird mortality event in the Subarea 48.3 toothfish longline fishery, when 74 white-chinned petrels (*Procellaria aequinoctialis*) were caught on a single longline on 13 April (during the season extension period 6 to 16 April). The paper highlighted a number of potential contributing factors, including the setting time (close to and just after dawn), time of year and gear type (Spanish system). As a result of this incident, and in accordance with CM 41-02, the season in 2014/15 will commence on 16 April. The authors of WG-FSA-14/28 suggested that future season extensions would require careful consideration and potentially extra mitigation measures.

8.23 The Working Group reflected that the seasonal closure of the toothfish fishery in Subarea 48.3 was introduced to reduce the overlap in the period of high risk for seabirds such as white-chinned petrels) (during the November to April period). Although the incident occurred at dawn, the extent to which this was a contributory factor was questioned, as white-chinned petrel feeding is not limited to daylight. The Working Group recalled that albatrosses feed predominantly during daylight and that night setting requirements were introduced primarily in response to this risk factor. The Working Group recognised that while this incident was very unfortunate, the fact that it was a single incident highlighted the effectiveness of existing mitigation measures in comparison to the risk to seabirds that still existed in areas where mitigation measures were not fully implemented.

8.24 WG-FSA-14/40 reported on trials of daytime fishing during a pre-season extension in the *D. eleginoides* longline fishery in Division 58.5.2. Two vessels fished during this period but no daytime setting was carried out. No seabirds were caught. Any fishing that occurs in the post-season extension period (1 to 14 November) or in April 2015 will be reported to WG-FSA-15.

8.25 The Working Group congratulated France on the significant reductions in incidental seabird mortality in their national EEZs in Subarea 58.6 and Division 58.5.1.

8.26 WG-FSA-14/24 addressed a comment highlighted in the SISO review (SC-CAMLR-XXXII/07 Rev. 1) regarding the effectiveness of bottle tests. The paper concluded that bottle tests (which check line sink rates) are no longer necessary due to the line-weighting specification set out in CM 25-02. The paper also recommended a review of elements of CMs 41-02 to 41-11 to improve their clarity with regard to night-setting requirements.

8.27 The Working Group recommended that:

(i) The general requirement for night setting in CM 25-02 should be removed and replaced with specific night-setting requirements where necessary in CMs 41-02 to 41-11.

The Working Group noted that this revision would remove the need for vessels to meet the requirements of CM 24-02 for daytime setting in CMs 41-02 to 41-11 and in any area where night-time setting is required, this will need to be included in the relevant conservation measure.

(ii) Vessels using gear types not included in CM 24-02 should be required to demonstrate gear sink rates of 0.3 m/s or greater using the methods set out in CM 24-02.

(iii) To simplify this process, the Secretariat will enhance the 'gear library' to include validated sink-rate data for each gear type recorded.

(iv) To facilitate these changes, when vessels notify their intention to fish, they will be required to describe their gear type and confirm that it meets the requirement of CM 25-02. Where a vessel intends to use gear not currently specified in CM 25-02, it should provide documentation which indicates that this gear will meet the minimum sink rates set out in CM 24-02.

8.28 The Working Group noted that these changes will necessitate alterations to CMs 41-02 to 41-11 and are an opportunity to increase the clarity of these conservation measures with regard to night-setting requirements.

Marine debris

8.29 Data on surveys of beached debris, marine debris associated with seabird colonies, marine mammal entanglements and hydrocarbon soiling of seabirds (WG-FSA-14/68) were presented by the Secretariat. The Working Group noted that the types of marine debris collected have remained fairly constant over time, and although marine mammal entanglement has declined since records were first collected, over the last decade numbers have remained static. Members are requested to also provide additional data sets from other sites for comparison with the limited number of CCAMLR sites.

Biology, ecology and interactions in fish-based ecosystems

9.1 Fifteen papers were submitted for consideration by the Working Group under this agenda item. They dealt with *D. mawsoni* (6), *D. eleginoides* (2), surveys (2), macrourids (2) and rajiformes (3). In addition, one paper from WG-EMM-14 was presented.

9.2 The Working Group noted that a fish identification guide for the Ross Sea has been developed by New Zealand and hard copies are available from the Secretariat. Electronic copies have been made available to the Secretariat for use by Members.

Dissostichus mawsoni

9.3 WG-FSA-14/02 provided detailed information on the reproduction of *D. mawsoni* collected from around the Antarctic continent. Reproductive parameters such as gonadosomatic index (GSI) and absolute and relative fecundity were remarkably similar in all areas. Larger fish tend to live in deeper water and were in more advanced stages of gonad development than smaller fish. The similar reproductive state of fish in all areas indicated that spawning takes place in all areas at about the same time of the year. Relative fecundity was comparable to its congener *D. eleginoides*.

9.4 WG-FSA-14/15 described the technique utilised in VNIRO (Moscow) to prepare ototliths for age reading and how annular structures on polished otolith sections are interpreted. The method used appears to underestimate age of fish by up to 4 or 5 years. The paper noted that it seems unlikely that fish grow up to 50 cm in the first two years while the congener *D. eleginoides* grows at most 10 cm per year (Evseenko et al., 1995). Observations on pelagic juveniles suggest that the pelagic phase is similar to that of *D. eleginoides* (Yukhov, 1970, 1971). Resulting values of L_∞ and K are comparable to those obtained by other age readers.

9.5 The Working Group recommended that comparative age readings between labs should be continued to verify age readings.

9.6 WG-FSA-14/53 described results of a New Zealand–Russia experiment of comparative age reading for *D. mawsoni*. The resulting four-way comparison enabled differences in preparation method to be distinguished from differences in interpretation of otolith banding patterns. Results suggest broad agreement in ages determined by each reader and with each method. However, there remained enough inconsistency in preparation technique and in interpretation of the break and burn preparation method to warrant further coordination and comparisons before merging data. The Working Group noted that the experiment highlighted the importance of monitoring and comparing ageing protocols within and between fish ageing programs.

9.7 The paper recommended four criteria to determine if significant differences existed between the readings compared for Antarctic toothfish. These were a paired *t*-test of the differences in age readings, no more than 25% of comparisons being greater than two years apart, a linear regression slope of the age bias plot statistically equal to 1 and an overall CV of less than 10%. The Working Group agreed that it is important to monitor for consistency and age drift in generating age data.

9.8 The Working Group stressed the importance of these inter-calibration experiments in order to identify the most reliable method of ageing and develop more precise age estimates as one of the bases for assessments. It encouraged New Zealand and Russia to continue and expand such experiments.

9.9 The Working Group noted that the Republic of Korea was actively collaborating with New Zealand to develop its *D. mawsoni* ageing program and looked forward to further analysis of age composition from its research program.

9.10 WG-FSA-14/64 reported on the retrieval of an archival tag on *D. mawsoni* deployed in the Ross Sea in January 2013 and recovered 335 days later on 24 December 2013, providing data (temperature, depth, acceleration and magnetic field strength) archived at 10-minute intervals. Summaries of raw data show contrasting patterns in the variables throughout the time series, with several periods containing distinct behavioural profiles suggesting significant activity throughout the winter period. Current efforts focus on developing a Bayesian modelling approach to fit the most likely movements of the tagged fish during its time at liberty based on the environmental variables recorded by the tag compared with spatial environmental data.

9.11 Similar data as those recorded from toothfish are also recorded from elephant seals, which conduct long-term migrations from sub-Antarctic islands to the Antarctic continent and back. The Working Group suggested that the analytical processes to analyse the elephant seal data may be applicable to the similar data types recorded by the toothfish tags.

9.12 The Working Group noted that a number of nations were considering deploying archival tags and recommended international collaboration on that topic.

Dissostichus eleginoides

9.13 WG-FSA-14/49 and 14/50 presented analyses of data gained from tagging *D. eleginoides* in Subareas 48.3 and 48.4 respectively, including spatial movements and regional connectivity. Information on the tagging procedure, biology, growth and local movement had been presented in WG-SAM-14/35. The characterisation of tag-recapture data shows that the tagging program has been successful in providing substantial information for the stock assessment. It can provide a first indication of areas of particular biological interest, such as potential spawning and nursery grounds. It also showed evidence for movement between the South Sandwich Islands and South Georgia and hypothesised that *D. eleginoides* in the South Sandwich Islands may be a non-spawning portion of the population living around South Georgia (no gonad maturation has been observed in these fish). The Working Group agreed that while there is uncertainty in the stock structure of toothfish in this area, the approach of managing fish in each area separately is considered precautionary.

9.14 Analysis of catch data from a deepwater trawl survey conducted at South Georgia and Shag Rocks in 2003 indicated that depth and region have a marked influence over demersal fish assemblage structure (WG-FSA-10/26). Three distinct depth-stratified fish assemblages were identified. The demersal fish assemblage found on the shelf to depths of around 400 m is dominated by nototheniids and channichthyids. It is comprised largely of species endemic to the Southern Ocean. At increasing depths (400–600 m), diversity increases with the presence

of many benthopelagic species. Below 600 m, the demersal fish community is dominated by gadiform fishes, including members of the Macrouridae and Moridae families and endemism was reduced compared with shallower areas. Clear regional differences in the shelf assemblage are apparent with differences observed between South Georgia and Shag Rocks to depths of around 400 m. The biogeographic patterns observed in demersal fishes show similar trends to those seen in a range of other taxa, such as crustaceans.

Surveys

9.15 WG-FSA-14/07 reported on results from three surveys conducted in the northern part of the Kerguelen Plateau (POKER 1, 2006; POKER 2, 2010; POKER 3, 2013) with the chartered trawler FV *Austral* repeating the same 202 random and stratified sampling stations in the bathymetric range 100–1 000 m. Estimated fish biomass ranged from 247 000 to 268 000 tonnes for a bottom area of about 183 000 km^2. *Dissostichus eleginoides* was the dominant species, with up to 40% of the total biomass in the depth range 100–1 000 m. Juvenile individuals of up to 60 cm occur primarily in the 100–500 m depth range, where commercial fishing is prohibited. Other species (*Notothenia rossii*, *C. rhinoceratus*, *Zanclorhynchus spinifer*, *L. squamifrons*, *C. gunnari*, *B. eatonii*) formed the bulk of the remaining biomass. Previously overexploited species, such as *N. rossii* and *C. gunnari*, show clear and recent strong recovery. The drivers of changes in biomass of unexploited species (i.e. *C. rhinoceratus*), unrelated to fishery impacts, remain unclear. The Working Group noted that the study was rare in that it analysed all the fish species encountered in a large surveyed area in the Southern Ocean.

9.16 The paper noted a strong recovery of *N. rossii* in the last decade resulting in hauls up to 20 tonnes/15 min during the surveys. The recovery paralleled the recovery of *N. rossii* at South Georgia which was apparent from regular surveys by the UK during the last decade.

9.17 The importance of the depths shallower than 500 m was stressed as a nursery ground for juvenile *D. eleginoides*, which appears to be similar at South Georgia and Kerguelen Islands.

9.18 Changes have occurred over the last two to three decades, such as the recovery of stocks of species such as *N. rossii* and *C. gunnari* (at different time scales) and the substantial increase in the number of fur seals at South Georgia. The Working Group noted that extensive surveys, such as the POKER survey series, may help to inform the processes and time frames required for the recovery of particular species and may be informative to the Commission in meeting its objectives under Article II of the Convention.

9.19 The Working Group recommended that detailed descriptions of the trawl configurations and standard survey procedures be submitted to the CCAMLR gear library, which so far only holds descriptions of longline gear used in the Convention Area.

Macrourids

9.20 Automated acoustic analysis methods were developed (WG-FSA-14/62) to estimate grenadier distribution and abundance in parts of the Ross Sea based on single echo

identification and tracking. Trials using data from SSRU 881I showed positive correlations between acoustic targets and longline catches of grenadiers and toothfish. Single targets revealed consistent spatial patterns in density and in height off the bottom. The acoustic target strength distribution of single targets was similar to that predicted, based on the expected size range of grenadiers. Variability in spatial coverage between years meant that it was not possible to obtain a consistent time series of relative abundance estimates for grenadiers from acoustic data collected opportunistically by New Zealand vessels in SSRU 881I. The next step in the development will be to apply these methods to data spanning the Ross Sea region. The Working Group noted that increased coverage could be achieved if other vessels recorded such data.

9.21 Two species of grenadier are predominantly taken as by-catch in the Ross Sea region, *M. whitsoni* and *M. caml* (WG-FSA-14/62). A linear function of fish total length (cm), depth of the whole otolith (depth, mm) and maximum cross-sectional area of the otolith (area, mm^2) gave 92% discrimination between the two species. This work suggested that historic otolith collections may be used to examine the ratio of the two species in the catch from previous years where most macrourids were identified as *M. whitsoni*. The Working Group noted that it may also be possible to use DNA collected from various tissues, including otoliths, to retrospectively determine species.

Rajiformes

9.22 WG-FSA-14/33 provided suggestions for updating the maturity keys used by CCAMLR for skates. Currently, CCAMLR observers use a three-stage maturity key (immature, maturing and mature). Reproductively active stages are not recorded separately, but such data can be useful in identifying areas important for reproduction. The inclusion of a fourth stage ('active') in the maturity scale would allow such data to be collected. It was also indicated that the current scale has potential ambiguity between 'maturing' and 'mature' stages, which could be resolved by replacing 'maturing' with 'developing'.

9.23 The Working Group did not consider that the skate maturity scales used in the *Scientific Observers Manual* should be changed at the present time. The Working Group noted that improved user-friendly maturity keys could usefully be developed and that modifications to maturity keys should be introduced only after appropriate supporting information and training is available. The Working Group suggested that photographic maturity keys could be developed intersessionally (see paragraph 8.27).

Modelling approaches

9.24 WG-EMM-14/51 described the development of a spatially explicit minimum realistic model of demersal fish population dynamics, predator–prey interactions and fishery removals based on the spatial population model (SPM) for toothfish in the Ross Sea. The model includes *D. mawsoni* as well as macrourids and channichthyids, the two groups that make up ~50% of *D. mawsoni* prey. The model indicates that channichthyids, with a relatively high productivity, would be expected to substantially increase in abundance within fished locations

as predation pressure by toothfish is decreased, particularly in SSRU 881H where historical fishery removals have been most concentrated. Macrourids would be expected to show a modest increase in biomass.

9.25 The Working Group noted that WG-EMM-14/51 was discussed by WG-EMM-14 with recommendations in Annex 6, paragraphs 2.97 to 2.100 and 5.22. The Working Group endorsed the recommendations from WG-EMM. It further noted that CCAMLR currently has no framework to manage large changes in abundance of non-target species due to the effects of fishing on other ecosystem components. The Working Group recommended that the Scientific Committee consider future work items to include a consideration for how these types of potential effects could be monitored, evaluated and managed.

Future work

Steepness and stock-recruit relationship

10.1 The Working Group considered the analyses presented in WG-FSA-14/32 and 14/P05 on the importance to stock assessments of assumptions about the productivity of a stock (as reflected in the steepness parameter in stock-recruitment relationships), yet the sensitivity of the outcomes of stock assessments to these assumptions was rarely tested.

10.2 The Working Group noted that in the hypothetical distribution of steepness parameters, based on expected life-history characteristics presented in WG-FSA-14/P05, most estimates were higher than 0.75, the value used in toothfish assessments, and therefore CCAMLR was likely to be using a conservative steepness parameter.

10.3 The Working Group agreed that while a change in the steepness parameter would not have a large impact on the historical stock status it would influence projections of yield into the future and that it was important to periodically review information about stock status and productivity to ensure that the assumptions are consistent with the ecosystem-based approach adopted by CCAMLR. Members were encouraged to present analyses of the influence of productivity on toothfish stock assessments, in particular on the influence of density-dependent mortality and the influence of assumptions about stock-status and stock-recruit relationships in the projection of yields used by CCAMLR to WG-SAM-15.

External review of assessments

10.4 The Working Group recalled discussion last year on the desire for periodic external review of CCAMLR assessments and endorsed the recommendations of WG-SAM (Annex 5, paragraphs 2.31 to 2.33) on the adoption of an assessment benchmarking process similar to the one used by ICES. For a biennial assessment, such a review would take place early in a non-assessment year in order that the outcomes of the review could be considered by WG-SAM and recommendations agreed by the Scientific Committee for the assessment in the following year.

Communication of the work of WG-FSA

10.5 The Working Group noted that the amount and complexity of information considered at its meetings meant that there was a need to find a mechanism for increasing engagement and understanding of the work of WG-FSA and CCAMLR in general and requested that the Scientific Committee give consideration to how this might be addressed.

10.6 The Working Group discussed the development of a 'data dashboard' that could be used to summarise information about CCAMLR fisheries and associated management advice and provide this in an interactive format using the CCAMLR website.

Prioritisation of future work

10.7 The Working Group agreed that next year there would be a particularly heavy workload, including the biennial assessments and the review of research programs in data-poor exploratory fisheries, and requested that the Scientific Committee consider how this workload could be effectively managed. This includes a process to develop a more efficient prioritisation and allocation of tasks to the respective agendas of WG-SAM and WG-FSA.

10.8 The Working Group noted the following priorities for its work related to:

(i) tagging programs – including the history of tagging, movement of tagged fish, the degree of spatial overlap of the fishery with tagged fish and the need to determine how to incorporate these data into new assessments. The Working Group suggested a focused workshop might be an appropriate mechanism to progress such a complex topic

(ii) research reviews – there are a number of multiyear research programs that will require review after 3 years in 2015 (paragraphs 5.23 and 5.106)

(iii) preparation of data for input into CASAL assessments (paragraph 5.87)

(iv) advice on the use of mark-recapture estimators.

CASAL course

10.9 The Working Group noted that a CASAL course had taken place at the CCAMLR Secretariat prior to the meeting of WG-FSA (SC-CAMLR-XXXII, Annex 6, paragraph 11.1, SC CIRCs 14/41 and 14/46) and had been attended by a total of 12 participants from Chile/Australia, Japan, Republic of Korea, New Zealand, Spain, UK, USA and the Secretariat. All participants of the course agreed that the course had helped them make substantial progress in understanding the assessment process using CASAL.

10.10 The Working Group extended its thanks to Dr A. Dunn (New Zealand) for running the course (and to NIWA for making his time available) and agreed that similar courses, potentially focusing on the preparation of data for input into CASAL, would be helpful in increasing capacity in fishery assessments in CCAMLR.

Advice to the Scientific Committee and its working groups

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

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

(i) Information requirements –

  (a) quarantined data (paragraph 3.8, see also paragraph 7.7)

  (b) evaluation of fishery notifications (paragraphs 5.6 and 5.10)

  (c) vessel sightings (paragraph 3.14)

  (d) tag overlap statistic (paragraphs 3.25 and 3.26).

(ii) Assessed fisheries –

  (a) *C. gunnari* in Subarea 48.3 (paragraph 4.45)

  (b) *C. gunnari* in Division 58.5.1 (paragraph 4.49)

  (c) *C. gunnari* in Division 58.5.2 (paragraph 4.54)

  (d) *D. eleginoides* in Subarea 48.3 (paragraph 4.2)

  (e) *Dissostichus* spp. in Subarea 48.4 (paragraphs 4.8 to 4.11)

  (f) *D. eleginoides* in Division 58.5.1 (paragraph 4.37)

  (g) *D. eleginoides* in Division 58.5.2 (paragraph 4.32)

  (h) *D. eleginoides* at Crozet Islands (paragraph 4.41)

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

  (j) *Dissostichus* spp. in Subarea 88.1 (paragraph 5.13)

  (k) *Dissostichus* spp. in Subarea 88.2 SSRU 882C–G (paragraphs 5.41 to 5.44)

  (l) *Dissostichus* spp. in Subarea 88.2 SSRU 882H (paragraph 5.32).

(iii) Data-poor fisheries for *Dissostichus* spp. –

  (a) development and revision of research plans (paragraphs 5.60, 5.105, 5.106 and 5.130)

  (b) by-catch in research blocks (paragraph 5.94)

(c) research catch limits for *Dissostichus* spp. (paragraphs 5.23, 5.88, 5.92, 5.98, 5.110, 5.112, 5.118, 5.119, 5.129 and Table 5).

(iv) Research fishing in other areas –

(a) *Dissostichus* spp. in Subarea 48.2 (paragraph 5.48)

(b) *Dissostichus* spp. in Subarea 48.5 (no advice)

(c) *Dissostichus* spp. in Divisions 58.4.4a and 58.4.4b (paragraph 5.88 and Table 5).

(v) Scheme of International Scientific Observation –

(a) recommendations from the SISO review (paragraph 7.7)

(b) utility of observer data from vessels where fishery data have been quarantined (paragraph 7.7).

(vi) By-catch –

(a) intersessional work on skates (paragraph 8.18)

(b) requirements for night setting and longline sink rates (paragraph 8.27).

(vii) Other matters –

(a) submission of trawl configurations and survey procedures to the gear library (paragraph 9.19)

(b) development of spatially explicit minimum realistic models (paragraph 9.25)

(c) communicating the work of WG-FSA (paragraph 10.5).

(viii) Future work –

(a) priorities for future work (paragraph 10.7).

Adoption of the report

12.1 The report of the meeting was adopted.

Close of meeting

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

13.2 On behalf of the Working Group, Drs Ellis and Reid thanked Dr Belchier for his leadership in steering the Working Group through a large, and at times challenging, work program.

References

Evseenko, S.A., K.-H. Kock and M.M. Nevinsky. 1995. Early life history of the Patagonian toothfish, *Dissostichus eleginoides* Smitt, 1898 in the Atlantic sector of the Southern Ocean. *Ant. Sci*., 7: 221–226.

McMillan, P.J., P. Marriott, S.M. Hanchet, J.M. Fenaughty, E. Mackay, H. Sui and F. Wei. 2014. Fishes of the Ross Sea region: a field guide to common species caught in the longline fishery. *New Zealand Aquatic Environment and Biodiversity Report*, 134: 54 pp. (available from http://fs.fish.govt.nz/Page.aspx?pk=113&dk=23687).

Murase, H., N. Kelly, T. Kitakado, K.-H. Kock, R. Williams and L. Walløe. 2012. Review of technical aspects of sea-ice data which will be used to bound or estimate the abundance of Antarctic minke whales in the south of the ice edge during the period of IWC IDCR/SOWER. IWC Document *SC/64/IA3*: 13 pp.

Yukhov, V.L. 1970. New data on the distribution and biology of *Dissostichus mawsoni* Norman in Antarctic high latitudes. *J. Ichthyol*., 10: 422–424.

Yukhov, V.L. 1971. The range of *Dissostichus mawsoni* Norman and some features of its biology. *J. Ichthyol*., 11: 8–18.

Table 1: Total reported catches (tonnes) of target species in fisheries in the Convention Area in 2013/14 (to 20 September 2014 unless otherwise indicated; refer to the *Statistical Bulletin* for previous years). CM – conservation measure.

Target species	Region	CM	Catch (tonnes) of target species		Reported catch (% limit)
			Limit	Reported	
Champsocephalus gunnari	48.3	42-01	4 635	4	<1
	58.5.2	42-02	1 267	1 123	89
Dissostichus eleginoides	48.3	41-02	2 400	2 180	91
	48.4	41-03	45	44	98
	58.5.1 French EEZ[a]	n/a	5 100	3 017	-
	58.5.2	41-08	2 730	1 909	70
	58.6 French EEZ[a]	n/a	700	401	57
	58 South African EEZ[b]	n/a	450	178	40
Dissostichus mawsoni	48.4	41-03	24	24	100
Dissostichus spp.	48.6	41-04	538	154	59
	58.4.1	41-11	724	101	29
	58.4.2	41-05	35	no fishing	-
	58.4.3a	41-06	32	32	100
	58.4.3b	41-07	0	no fishing	-
	88.1	41-09	3 001[c]	2 900	97
	88.2	41-10	390	426	109
Euphausia superba	48.1, 48.2, 48.3, 48.4	51-01	620 000	291 370	47
	58.4.1	51-02	440 000	no fishing	-
	58.4.2	51-03	452 000	no fishing	-

[a] Reported in fine-scale data to July 2014.
[b] Whole EEZ.
[c] Excluding the limit and catch from the research survey.
n/a Not specified by CCAMLR.

Table 2: Landings of *Dissostichus eleginoides* (estimated live weight) reported in Catch Documentation Scheme (CDS) fisheries operating outside the Convention Area in the calendar years 2012 to 2014 (to September 2014; refer to the *Statistical Bulletin* for previous years).

Ocean sector	FAO area	Estimated live weight (tonnes)		
		2012	2013	2014
Southwest Atlantic	41	7 579	8 004	4 942
Southeast Atlantic	47	126	60	26
Western Indian	51	298	324	77
Eastern Indian	57	-	-	-
Southwest Pacific	81	377	423	424
Southeast Pacific	87	5 685	4 211	1 998
Total		14 066	13 021	7 467

Table 3: Notifications for exploratory fisheries for *Dissostichus* spp. in 2014/15.

Vessel name	Member	Subarea 88.1	Subarea 88.2	Division 58.4.3a	Subarea 48.6	Division 58.4.1	Division 58.4.2
Antarctic Chieftain	Australia	N	N				
St André	France			N			
Shinsei Maru No. 3	Japan	N		N	N	N	N
Kingstar	Korea, Republic of				N	N	N
Hong Jin No. 701	Korea, Republic of	N	N				
Kostar	Korea, Republic of	N	N				
Sunstar	Korea, Republic of	N	N				
San Aspiring	New Zealand	N	N				
Janas	New Zealand	N	N				
San Aotea II	New Zealand	N	N				
Seljevaer	Norway	N	N		W	W	
Mys Marii	Russia	N	N				
Palmer	Russia	N	N				
Yantar 31	Russia	N	N				
Yantar 35	Russia	N	N				
Sparta	Russia	W	W				
Ugulan	Russia	W	W				
Yantar 33	Russia	N	N				
Tarpon	Russia	W	W				
Tomkod	Russia	W	W				
Koryo Maru No. 11	South Africa				N		
Tronio	Spain	N	N			N	N
Simeiz	Ukraine	N	N				
Koreiz	Ukraine	W	W				
Polus 1	Ukraine	N	N				
Argos Froyanes	United Kingdom	N	N				
Argos Georgia	United Kingdom	N	N				
Total Members		9	8	2	4	4	3
Total vessels		24	23	2	4	4	3
Total fished							
Total withdrawn		5	5		1	1	

Legend: N = notified
W = withdrawn
F = fished

Table 4: Latitude and longitude (dd.00) of the corner coordinates of the areas shown in Figure 7.

Area	Latitude	Longitude
1	73.8°S	108.0°W
	73.8°S	105.0°W
	75.0°S	105.0°W
	75.0°S	108.0°W
2	73.3°S	119.0°W
	73.3°S	111.5°W
	74.2°S	111.5°W
	74.2°S	119.0°W
3	72.2°S	122.0°W
	70.8°S	115.0°W
	71.7°S	115.0°W
	73.2°S	122.0°W
4	72.6°S	140.0°W
	72.6°S	128.0°W
	74.7°S	128.0°W
	74.7°S	140.0°W

Table 5: Local biomass estimation methods and recommended research catch limits (from SC-CAMLR-XXXII, Annex 6, Table 13) for *Dissostichus eleginoides* (TOP) and *D. mawsoni* (TOA) in research blocks, catch reported in 2014, number of tagged fish available and the expected and observed recaptures.

Subarea/ SSRU	Research block	Species	Estimation method	Local biomass (tonnes)	Tagged fish in 2013			Recommended catch limit (tonnes)	Local exploitation rate	Catch in 2014		Tagged fish in 2014				Tagged fish in 2015	
					Available number	Recaptures				(tonne)	% limit	Available number	Recaptures			Available number	Recaptures expected number
						Expected number	Observed number						Expected number	Observed			
														Number	% expected		
Subarea 48.5*																	
Subarea 48.6																	
486AG	486_1 + 486_2	TOP	Petersen	351	257	2.9	3	14	0.040	9	64	366	14.6	1	7	325	13.0
486AG	486_1 + 486_2	TOP	CPUE 484N	697	257	1.5	3	28	0.040	9	32	366	14.7	1	7	325	13.0
486AG	486_2	TOA	CPUE 882H	7221**	947	8.7	6	170	0.023	95	56	1079	26.6	11	41	1006	23.1
486D	486_3	TOA	CPUE 882H	3624	621	8.4	2	50	0.014	50	100	752	10.4	1	10	589	8.3
486E	486_4	TOA	CPUE RSR	2515	343	15.3	0	100–150	0.040–0.060	-	-	743	29.5–44.3			582	23.3–34.9
486BC	486_5	TOA	CPUE RSR	6622	405			190	0.029	-	-	352	10.1			276	8.0
Subarea 58.4																	
5841C	5841_1	TOA	CPUE RSR	3140	131			125	0.040	-	-	114	4.5			89	3.6
5841C	5841_2	TOA	CPUE RSR	2337	687			90	0.039	-	-	598	23.0			663	25.9
5841E	5841_3	TOA	CPUE RSR	7061	259			280	0.040	-	-	226	9.0			177	7.1
5841E	5841_4	TOA	CPUE RSR	930	83			35	0.038	-	-	72	2.7			56	2.1
5841G	5841_5	TOA	CPUE RSR	674	424			26	0.039	-	-	369	14.2			289	11.3
5841C	n/a	TOA	depletion	n/a				42	n/a	54	-						
5841D	n/a	TOA	depletion	n/a				42	n/a	6	-						
5841G	n/a	TOA	depletion	n/a				42	n/a	24	-						
5841H	n/a	TOA	depletion	n/a				42	n/a	17	-						
5842E	5842_1	TOA	CPUE RSR	877	227	1.0	0	35	0.040	-	-	214	8.5			168	6.7
5843aA	5843a_1	TOP	Petersen	386**	349	15.0	11	32	0.083	32	100	318	30.4	24	79	304	25.2
5843aA	5843a_1	TOP	CPUE 484N	2798	349	2.0	11	32	0.011	32	100	318	4.0	24	600	304	3.3
5844bC	5844b_1	TOP	CASAL	705**	215	6.8	3	25	0.035	12	48	216	8.5	5	59	219	7.8
5844bD	5844b_2	TOP	CPUE 5844-C	786**	73	0.8	0	35	0.045	15	43	39	1.6	4	250	93	4.1

* See discussion in paragraphs 5.61 to 5.83.
** Local biomass updated during WG-FSA-14.

Table 6: The total catch and number of sets for vessels for which the peak of the frequency distribution of CPUE was greater than 0.75 kg/hook (in an analysis of all vessels fishing in the Convention Area (see paragraph 5.70)). The frequency distributions for each vessel are shown in Figure 9.

Season	Management area	Vessel	Catch (tonnes)	*N* (sets)
1996	58.6	*Alida Glacial*	10	2
1997	58.6	*Alida Glacial*	12.64	2
1996	58.7	*Alida Glacial*	234.87	20
1997	58.7	*Alida Glacial*	8.48	1
1996	58.6	*American Champion*	75.48	26
1996	58.7	*American Champion*	247.66	113
2009	48.6	*Insung No. 22**	172.65	20
2011	48.6	*Insung No. 7**	43.32	6
1996	58.7	*Koryo Maru No. 11*	80.45	12
2012	88.1	*San Aspiring*	474.82	84
2012	58.6	*Ship 7*	102.18	26
2013	88.2	*Sunstar*	7.4	2
2012	88.1	*Tronio*	523.42	47
2006	88.2	*Yantar*	29.08	3
2013	48.5	*Yantar 35*	59.53	8
2014	48.5	*Yantar 35*	228.6	34

* Data is quarantined.

Table 7: Summary of the number and proportion of sets where the hauling rate was more than 1 fish per minute (fpm) for all autoline vessels fishing in management areas 88.1, 88.2 and 48.5 in 2012–2014.

Vessel	Management area	*N* (sets)	sets >1fpm	% >1 fpm
Antarctic Chieftain	88.1	36	2	5.6
Antarctic Chieftain	88.2	271	0	0.0
Argos Froyanes	88.1	201	3	1.5
Argos Froyanes	88.2	169	2	1.2
Argos Georgia	88.1	386	21	5.4
Argos Georgia	88.2	12	0	0.0
Janas	88.1	193	2	1.0
Janas	88.2	93	0	0.0
Mys Marii	88.1	23	0	0.0
Palmer	88.1	45	0	0.0
Palmer	88.2	78	0	0.0
San Aotea II	88.1	384	2	0.5
San Aspiring	88.1	241	14	5.8
Seljevaer	88.1	371	11	3.0
Seljevaer	88.2	30	1	3.3
Yantar 31	88.1	239	0	0.0
Yantar 31	88.2	7	3	42.9
Yantar 35	48.5	42	22	52.4
Yantar 35	88.1	106	1	0.9
Yantar 35	88.2	5	0	0.0

Table 8: Taxonomic ranking of skates indicating which higher taxonomic codes should be used when accurate species-specific data cannot be provided. Skates (Order Rajiformes, SRX) are broadly divided into soft-nose skates (Family Arhynchobatidae; Genus *Bathyraja*, BHY) and hard-nose skates (Family Rajidae, RAJ).

Order	Code	Genus or family	Code	Species	Code
Rajiformes	SRX	*Bathyraja* spp.	BHY	Eaton's skate *Bathyraja eatonii*	BEA
				Kerguelen sandpaper skate *Bathyraja irrasa*	BYR
				McCain's skate *Bathyraja maccaini*	BAM
				Dark-belly skate *Bathyraja meridionalis*	BYE
				Murray's skate *Bathyraja murrayi*	BMU
		Rajidae	RAJ	Antarctic starry skate *Amblyraja georgiana*	SRR
				Antarctic starry skate (variant) *Amblyraja georgiana* (var)	SR2
				Whiteleg skate *Amblyraja taaf*	RFA

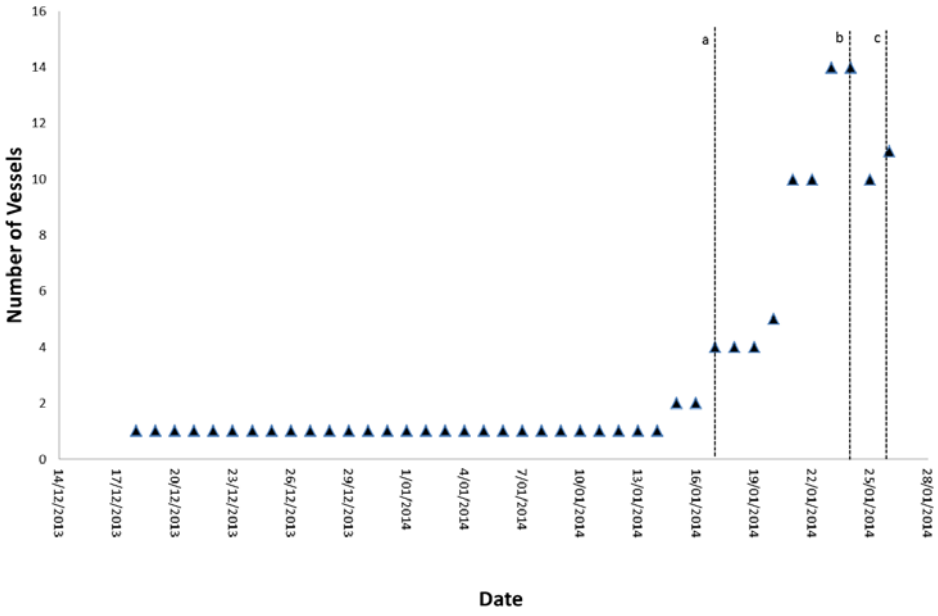


Figure 1: Number of vessels fishing in Subarea 88.2 in 2013/14; the vertical dotted lines indicate the closure dates in: (a) Subarea 88.1 (17 January), (b) SSRU 882H (24 January) and (c) SSRUs 882C–G (26 January).

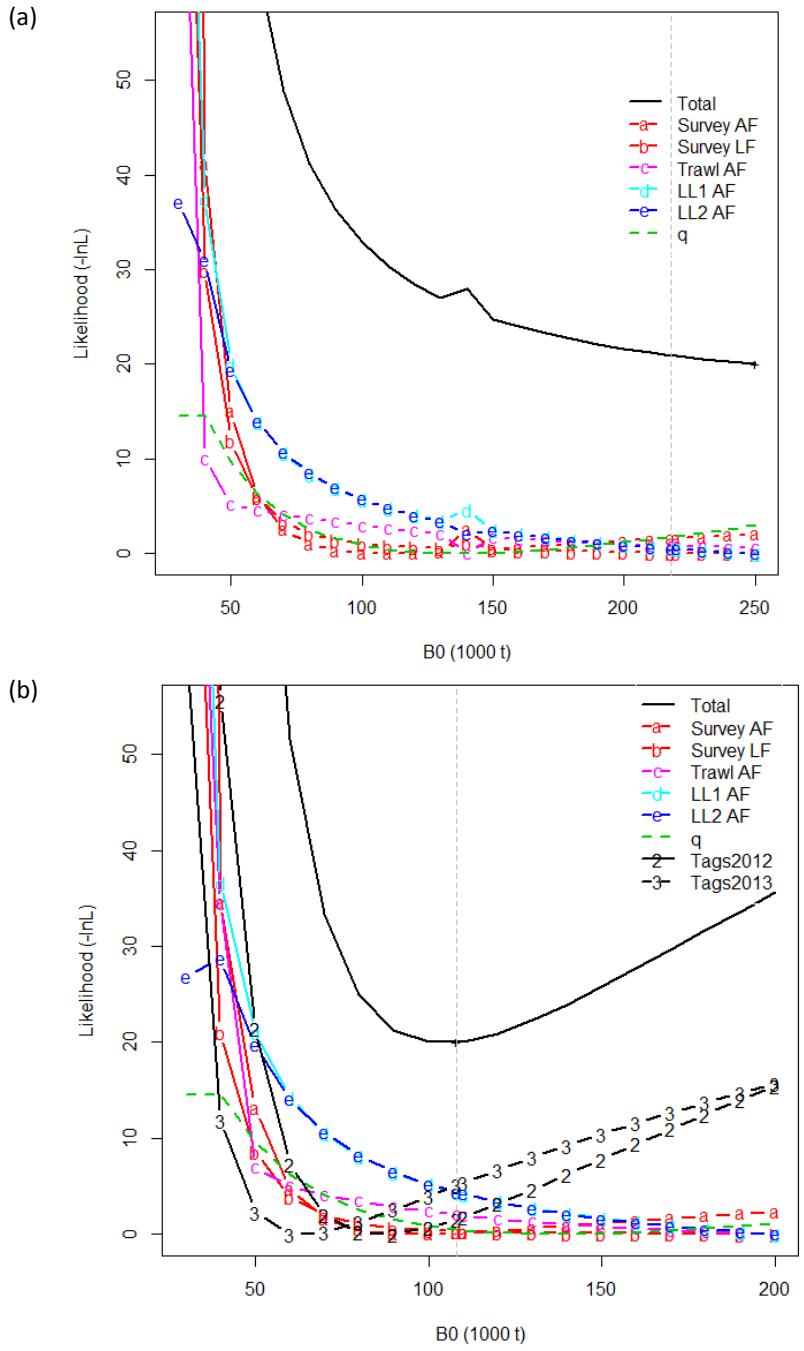


Figure 2: Likelihood profiles (–2 log-likelihood) across a range of B_0 values for (a) 'Model 13' (estimated year-class strength (YCS) 1986–2009) and (b) 'Model 14' (estimated YCS 1986–2009 and tag releases 2012 and 2013). Shown are the total objective function (Total) and contributions to the total objective function from survey abundance-at-age (Survey AF), abundance-at-length (Survey LF), trawl catch-at-age (Trawl AF), longline catch-at-age in depths shallower than 1 500 m (LL1 AF) and deeper than 1 500 m (LL2 AF), survey catchability q (q), tag releases in 2012 (Tags 2012) and tag releases in 2013 (Tags 2013). To create these profiles, B_0 values were fixed while the remaining parameters were estimated. Values for each dataset were rescaled to have a minimum of 0, while the total objective function was rescaled to 20. The dotted grey line indicates the MPD estimate.

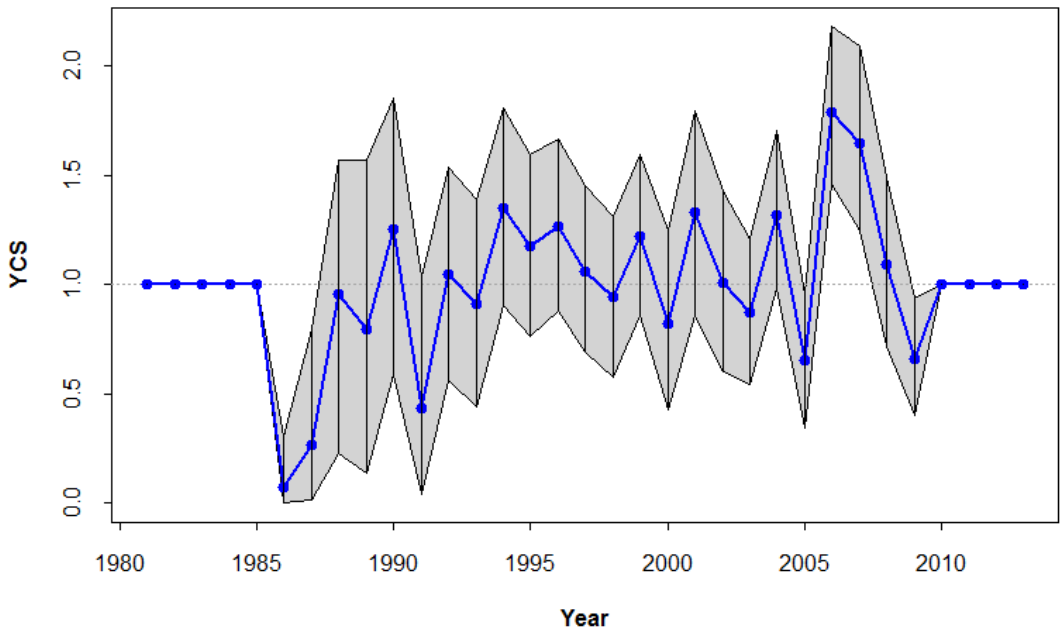


Figure 3: Year-class strength (YCS) estimates (median and 95% CI from MCMC sampling) for 'Model 14' (estimated YCS 1986–2009 and tag releases 2012 and 2013).

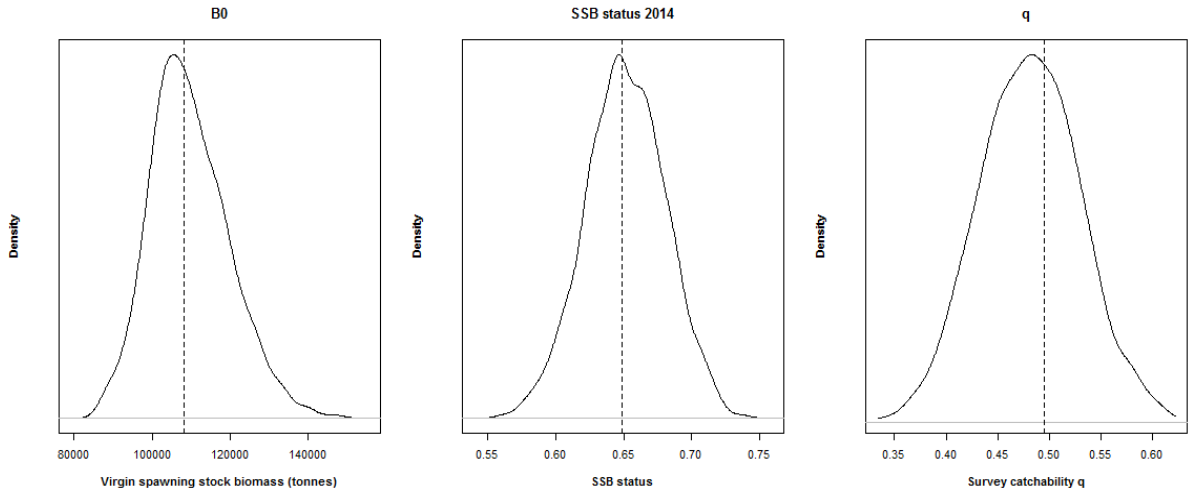


Figure 4: MCMC posterior distribution of B_0, SSB status in 2014 and survey catchability q for 'Model 14' (estimated year-class strength (YCS) 1986–2009 and tag releases 2012 and 2013). Vertical line is the MPD estimate.

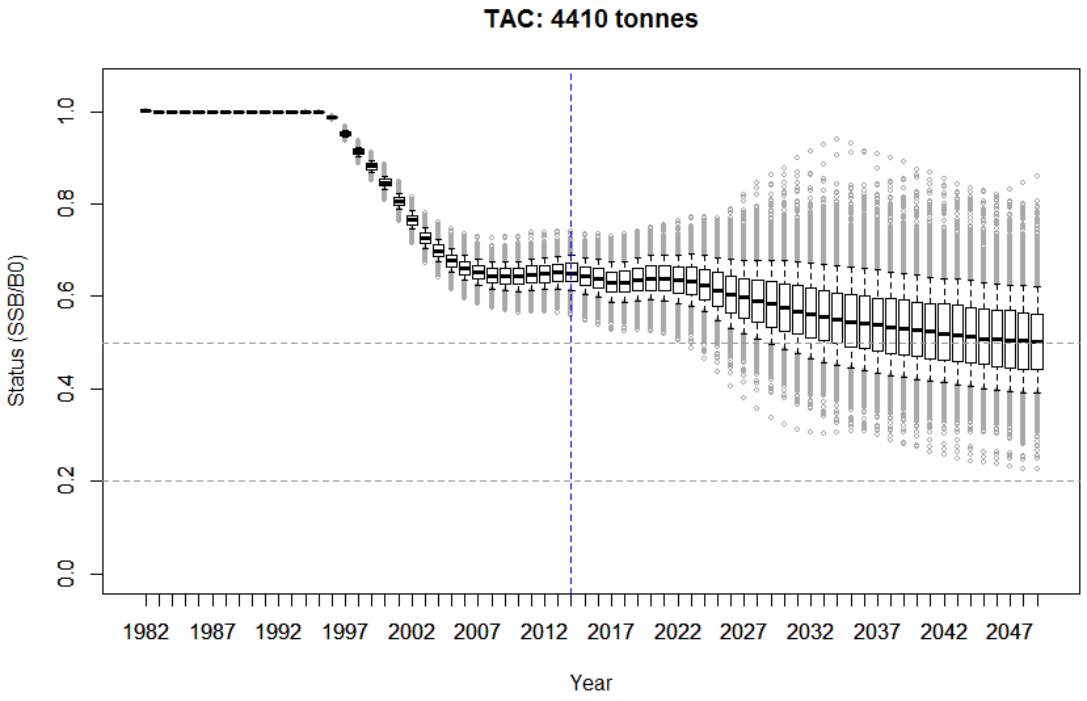


Figure 5: Projected SSB status relative to B_0 for 'Model 14' (estimated year-class strength (YCS) 1986–2009 and tag releases 2012 and 2013) using MCMC samples and random lognormal recruitment from 2011–2049 with annual constant catches. Boxplots represent the distribution of the estimates across 1 000 projection trials. Dotted lines show the 50% and 20% status levels used in the CCAMLR decision rules.

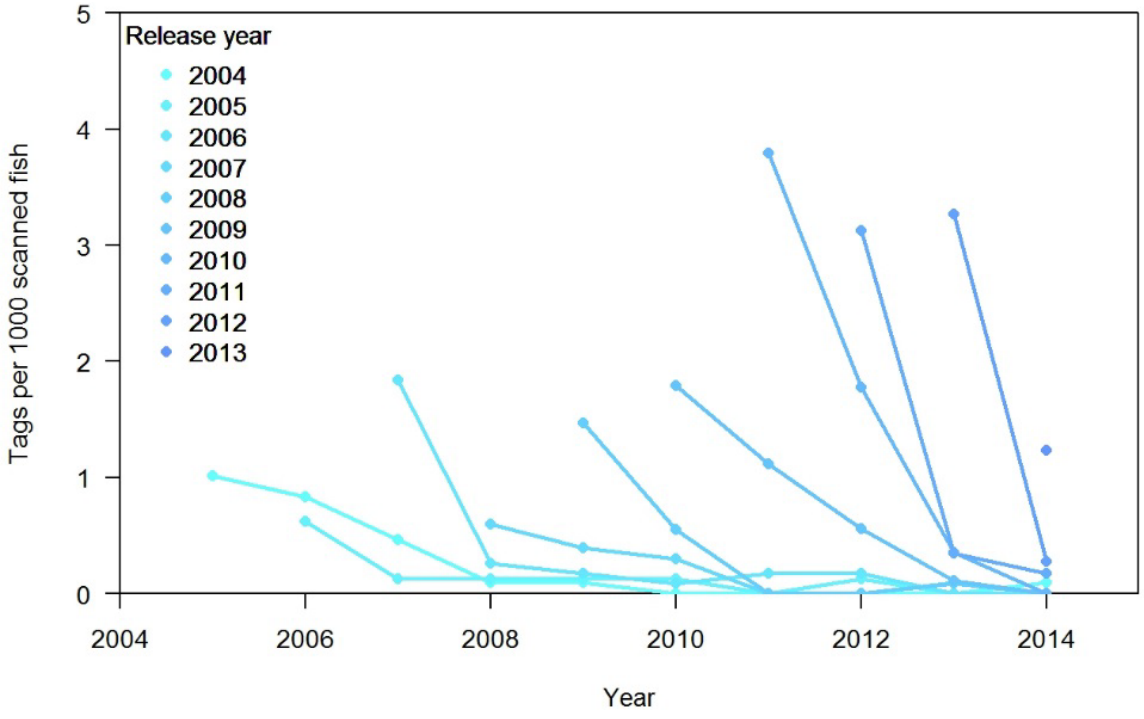


Figure 6: Observed tag-recapture rate for each tag-release cohort (by year, colour) over time in SSRU 882H.

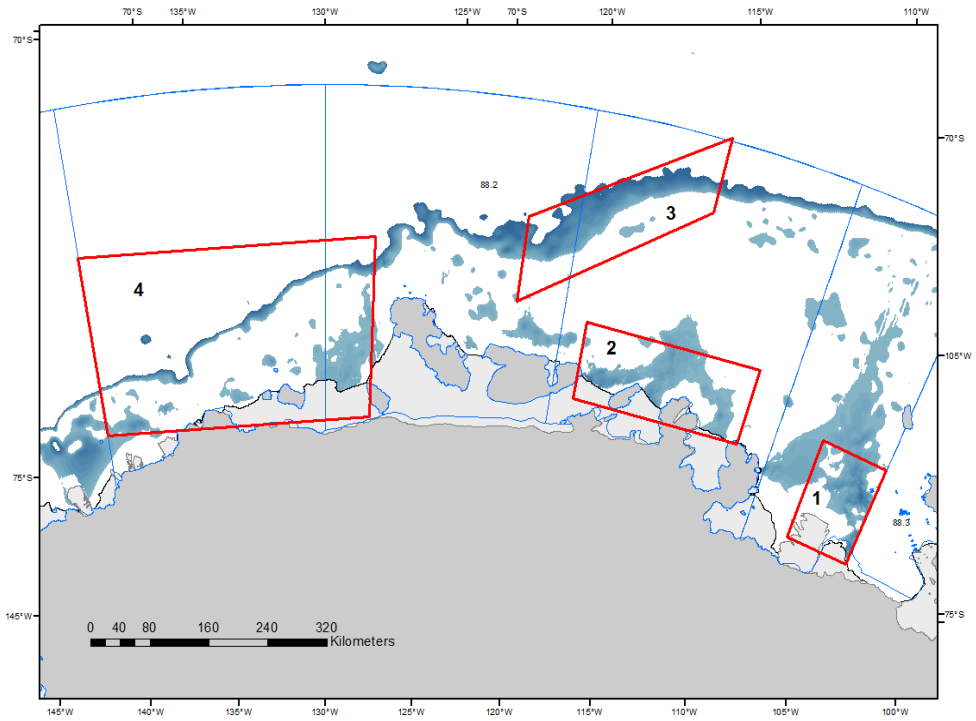
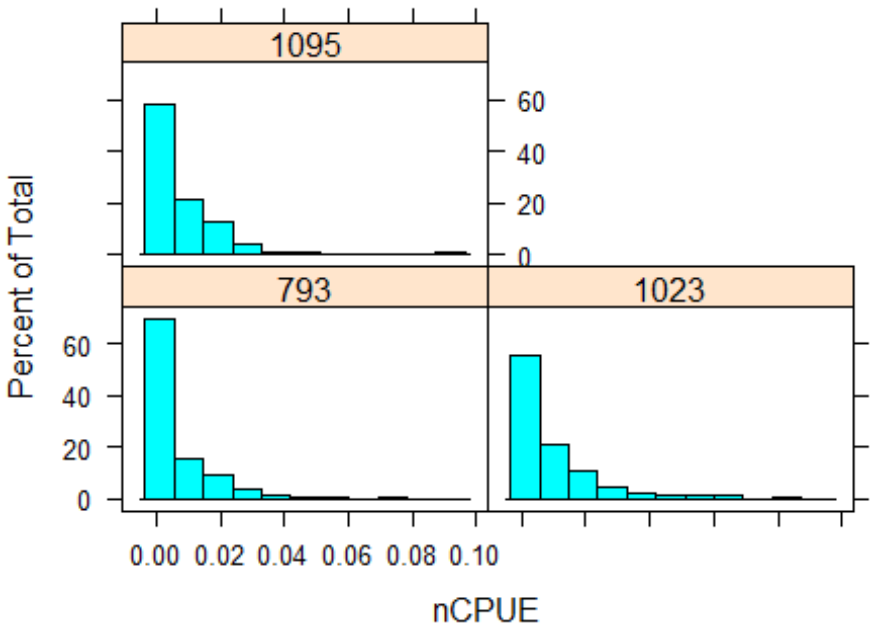


Figure 7: The main fishing grounds (1–4) fished in SSRUs 882C–G since 2006 (WG-FSA-14/59). The depth strata from 600 to 1 800 m are coloured in blue. Coordinates for these polygons are provided in Table 4.

(a)



(b)

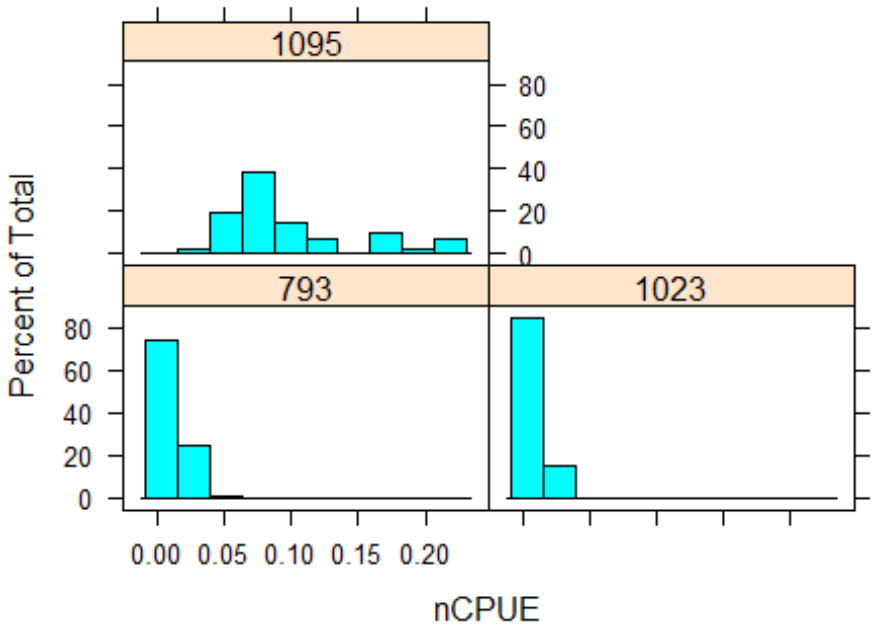


Figure 8: CPUE (numbers of fish per hook) for (a) by-catch and (b) *Dissostichus mawsoni* from the *Koryo Maru No. 11* (1 023) and *Shinsei Maru No. 3* (793) using trotlines in the southern SSRUs in Subarea 48.6 and *Yantar 35* (1 095) in Subarea 48.5 using autolines. These are the only vessels to have fished in those areas.

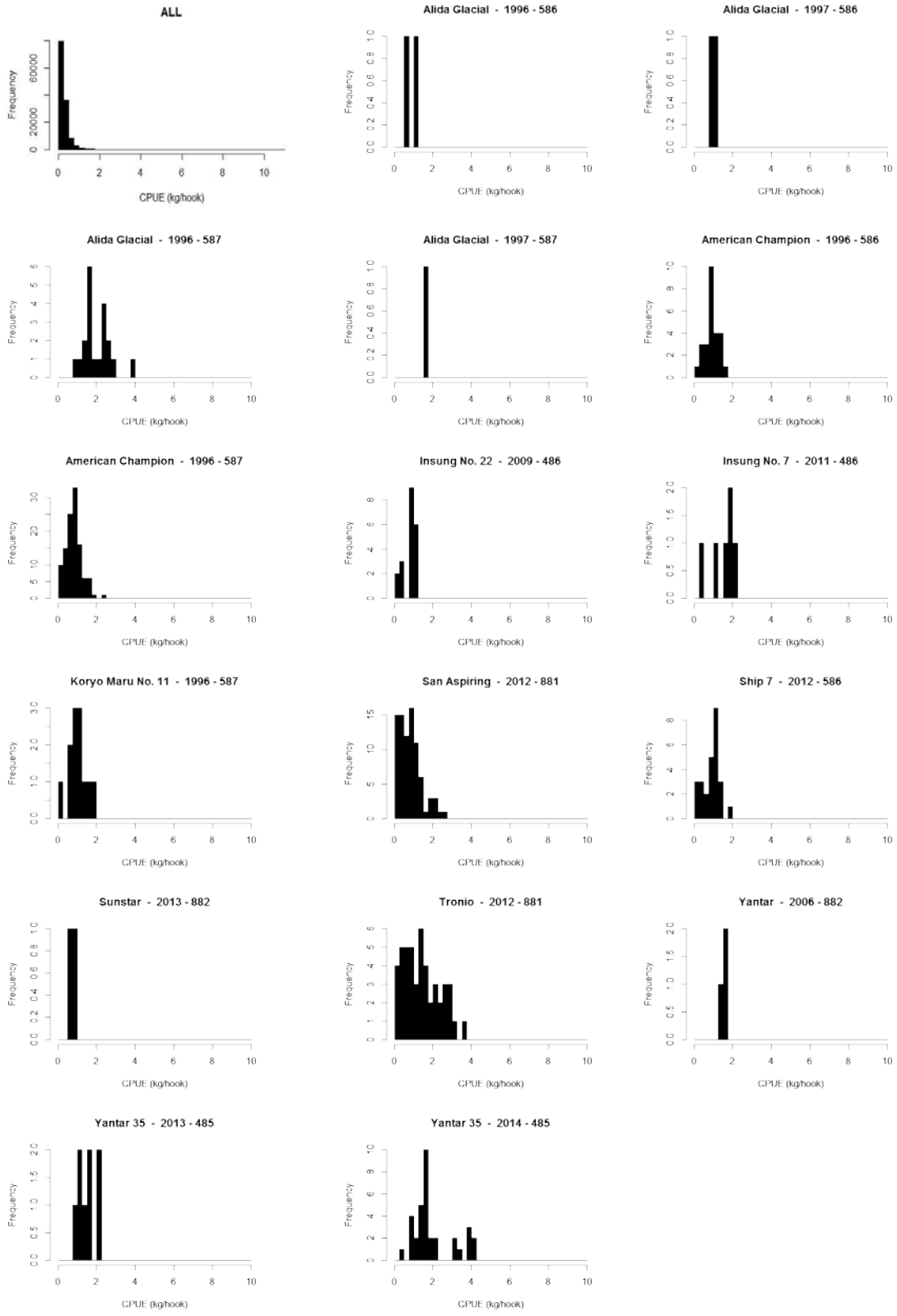


Figure 9: Distribution of CPUE values for sets for longline vessels from Table 6.

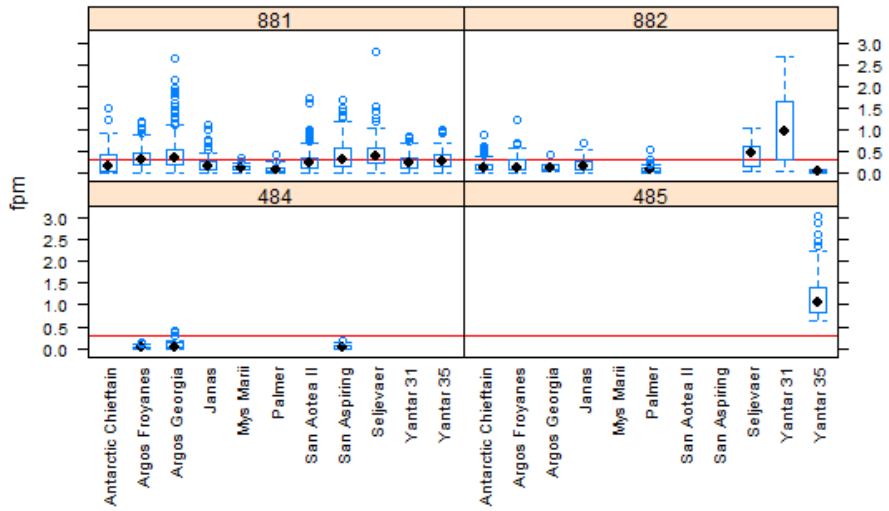


Figure 10: Box-whisker plots of the distribution of hauling rates, fish per minute (fpm), for individual autoline vessels fishing in management areas 88.1, 88.2, 48.4 and 48.5 (2012–2014). The horizontal red line indicates the overall mean for all vessels.

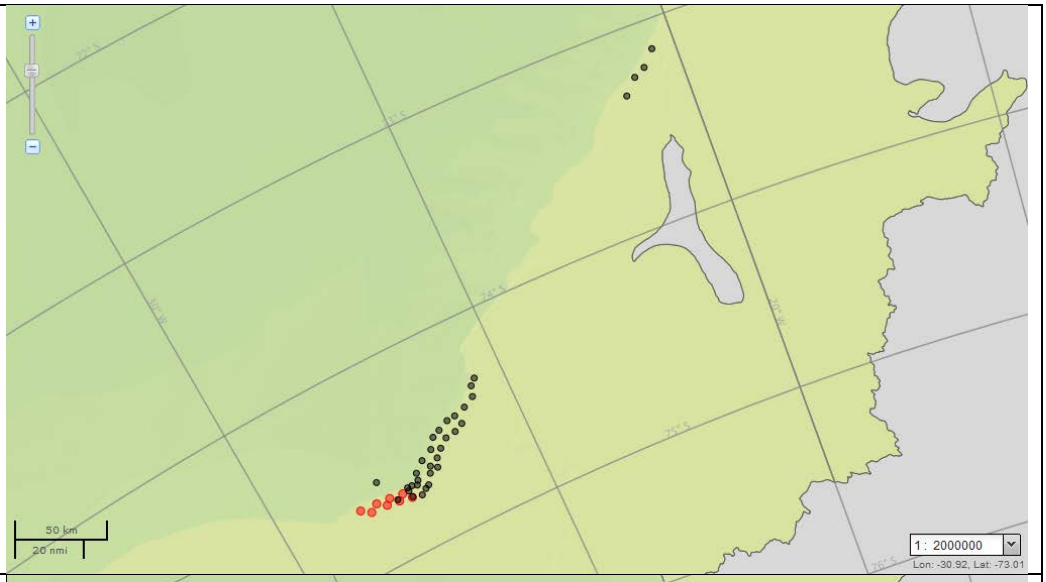
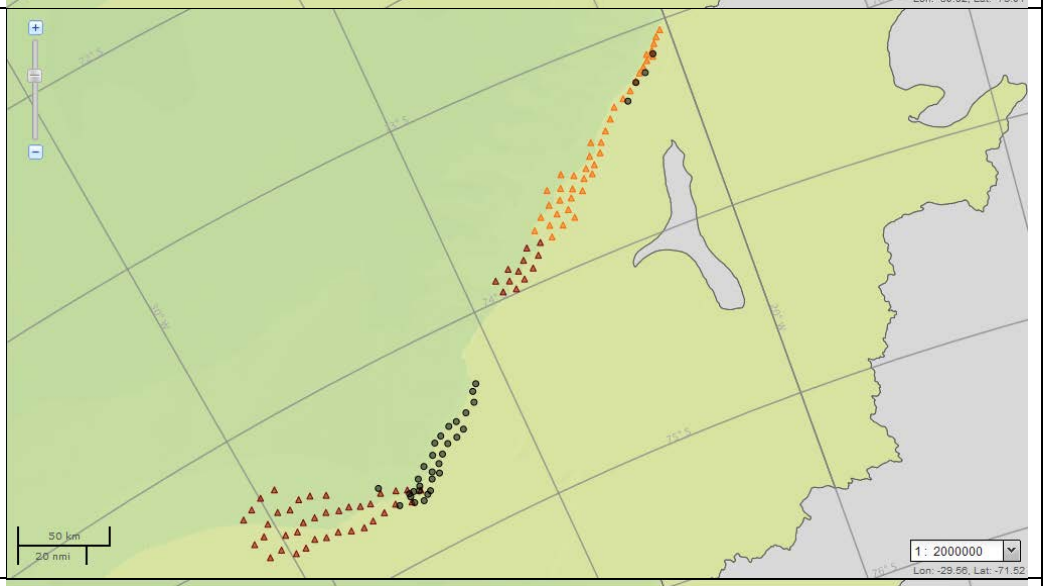
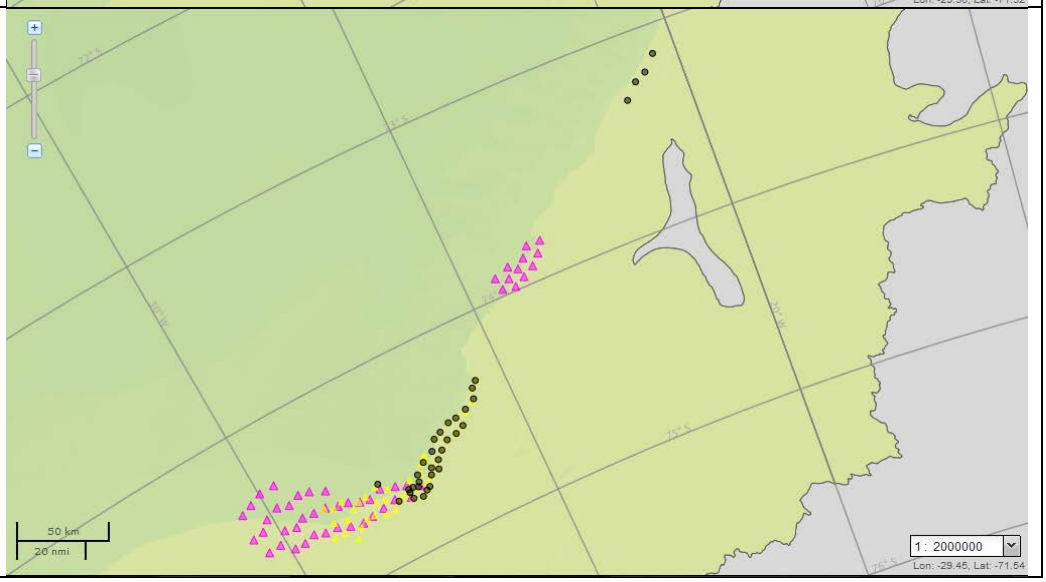
Location of catches in 2013 (red) and 2014 (black) in research fishing in Subarea 48.5.	
Proposed locations of research of hauls for 2014 (option 1 brown triangles, option 2 orange triangles) and location of catches in 2014 (black circles).	
Proposed locations of research of hauls for 2015: (option 1: magenta triangles, option 2: yellow triangles) and location of catches in 2014 (black circles).	

Figure 11: Proposed and actual locations of fishing activities in Subarea 48.5 in 2013, 2014 and 2015.

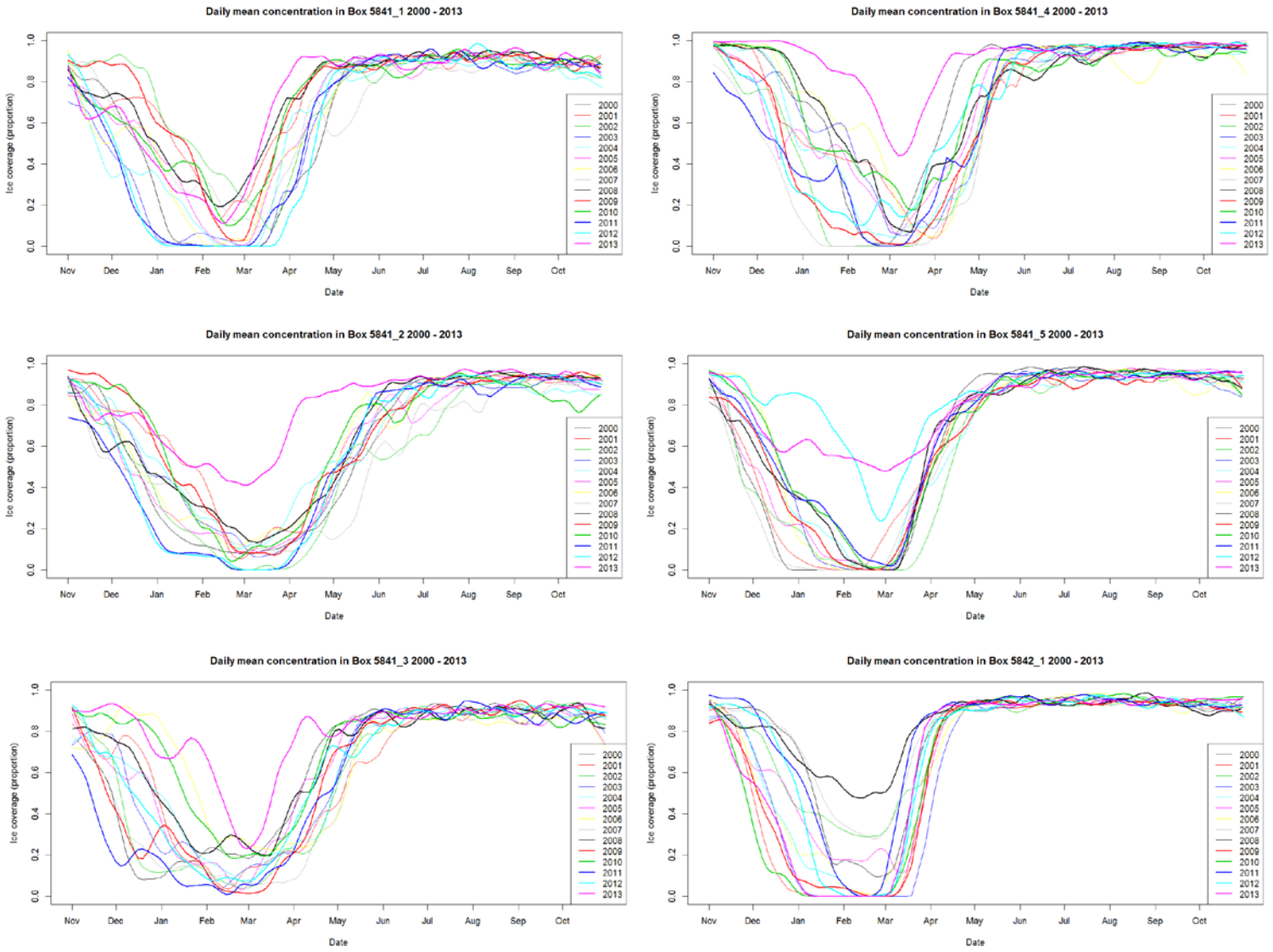


Figure 12: Mean daily sea-ice concentrations in research blocks in Divisions 58.4.1 and 58.4.2 (see paragraph 3.18).

Appendix A

List of Participants

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(Hobart, Australia, 6 to 17 October 2014)

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Jodi Gustafson
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Pailin Munyard

Appendix B

Agenda

Working Group on Fish Stock Assessment
(Hobart, Australia, 6 to 17 October 2014)

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 data

4. Established fisheries

    4.1 Review of preliminary assessments
        4.1.1 *Dissostichus eleginoides* Division 58.5.2
        4.1.2 *Dissostichus eleginoides* Division 58.5.1 and Subarea 58.6
        4.1.3 *Dissostichus eleginoides* and *D. mawsoni* Subarea 48.4
        4.1.4 *Champsocephalus gunnari* Divisions 58.5.1 and 58.5.2
        4.1.5 *Dissostichus* spp. Subarea 88.2

    4.2 Assessments and management advice

    4.3 Update Fishery Reports for established fisheries
        4.3.1 *Champsocephalus gunnari* Subarea 48.3
        4.3.2 *Champsocephalus gunnari* Division 58.5.2
        4.3.3 *Dissostichus eleginoides* Subarea 48.3
        4.3.4 *Dissostichus eleginoides* Division 58.5.2
        4.3.5 *Dissostichus eleginoides* Division 58.5.1
        4.3.6 *Dissostichus eleginoides* Subarea 58.6 (French EEZ)
        4.3.7 *Dissostichus eleginoides* Subarea 58.6 and 58.7 (South African EEZ)

5. Exploratory and other fisheries

    5.1 Exploratory fisheries
        5.1.1 Exploratory fisheries in 2013/14
        5.1.2 Exploratory fisheries notified for 2014/15

    5.2 Research to inform current or future assessments
        5.2.1 Subareas 48.2, 48.5 and 48.6
        5.2.2 Subarea 58.4
        5.2.3 Subareas 88.1 and 88.2

5.3 Update Fishery Reports for exploratory fisheries
5.3.1 *Dissostichus* spp. Subareas 88.1 and 88.2
5.3.2 *Dissostichus* spp. Subarea 48.4
5.3.3 *Dissostichus* spp. Subarea 48.6
5.3.4 *Dissostichus* spp. Division 58.4.1
5.3.5 *Dissostichus* spp. Division 58.4.2
5.3.6 *Dissostichus* spp. Division 58.4.3a
5.3.7 *Dissostichus* spp. Division 58.4.3b
5.3.8 *Dissostichus* spp. Division 58.4.4

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

6.1 Review of VMEs notified in 2013/14
6.2 Report on Bottom Fisheries and VMEs

7. Scheme of International Scientific Observation

8. Non-target catch in CCAMLR fisheries

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

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

10. Future work

10.1 Organisation of intersessional activities
10.2 Notification of Scientific Research

11. Other business

12. Advice to the Scientific Committee

13. Adoption of the report

14. Close of the meeting.

Appendix C

List of Documents

Working Group on Fish Stock Assessment
(Hobart, Australia, 6 to 17 October 2014)

WG-FSA-14/01 Rev. 2	Summary of scientific observer data collected in the CAMLR Convention Area during 2014 Secretariat
WG-FSA-14/02	Analytical data on determination of reproductive potential of Antarctic toothfish *D. mawsoni* in the Pacific (SSRUs 88.1, 88.2, 88.3), Indian Ocean (SSRUs 58.4.1 и 58.4.2) and Atlantic (SSRU 48.6, 48.5) Antarctic areas S.V. Piyanova and A.F. Petrov (Russia)
WG-FSA-14/03 Rev. 2	Progress report on the Weddell Sea Research Program Stage II A.F. Petrov, I.I. Gordeev, S.V. Pianova and E. F. Uryupova (Russia)
WG-FSA-14/04	Research plan for the exploratory longline fishery for *Dissostichus* spp. in 2014/15 in Division 58.4.4 Delegation of France
WG-FSA-14/05	Revised research plan for the exploratory longline fishery for *Dissostichus* spp. in 2014/15 in Division 58.4.3a Delegation of France
WG-FSA-14/06	Revised stock assessment of the Patagonian toothfish, *Dissostichus eleginoides*, in research block C of Division 58.4.4 (Ob and Lena Banks) using CASAL A. Rélot-Stirnemann (France)
WG-FSA-14/07	2006–2013 fish distribution and biomass in the Kerguelen EEZ (CCAMLR Division 58-5-1) for the bathymetric range 100–1 000 m G. Duhamel, M. Hautecœur and R. Sinegre (France)
WG-FSA-14/08	Revised plan of research program of the Ukraine in Subarea 48.2 in 2015 Delegation of Ukraine
WG-FSA-14/09	Plan of research program of the Russian Federation in Subarea 48.5 (Weddell Sea) in season 2014/2015 Delegation of the Russian Federation

WG-FSA-14/10	Comparison of two methods to assess fish losses due to depredation by killer whales and sperm whales on demersal longline N. Gasco, P. Tixier, G. Duhamel and C. Guinet (France)
WG-FSA-14/11	Stock assessment of mackerel icefish (*Champsocephalus gunnari*) in the vicinity of Kerguelen Islands (Division 58.5.1) after the 2013 POKER Biomass survey R. Sinegre and G. Duhamel (France)
WG-FSA-14/12	Review of skate (Rajiformes) by-catch in CCAMLR toothfish fisheries Secretariat
WG-FSA-14/13	Research program on resource potential and life cycle of *Dissostichus* species from the Subarea 88.2 A in 2014–2017 Delegation of the Russian Federation
WG-FSA-14/14 Rev. 1	Stock assessment and proposed TAC for Antarctic toothfish (TOA) in the Subarea 88.2 H in the season 2014–2015 S.M. Goncharov and A.F. Petrov (Russia)
WG-FSA-14/15	Comparative data on size–age composition and growth of Antarctic toothfish *Dissostichus mawsoni* in Ross Sea, Amundsen Sea and Weddell Sea A.F. Petrov, E.N. Kyznetsova, S.V. Piyanova and I.I. Gordeev (Russia)
WG-FSA-14/16	A review of by-catch in CCAMLR exploratory toothfish fisheries E. McClure, K. Reid (Secretariat)
WG-FSA-14/17	Revised research plan for the exploratory fisheries for *Dissostichus* spp. in Subarea 48.6 in 2014/15 Delegation of Japan
WG-FSA-14/18	Revised research plan for the exploratory fisheries for *Dissostichus* spp. in Division 58.4.1 in 2014/15 Delegation of Japan
WG-FSA-14/19	Revised research plan for the exploratory fisheries for *Dissostichus* spp. in Division 58.4.2 in 2014/15 Delegation of Japan
WG-FSA-14/20	Revised research plan for the exploratory fisheries for *Dissostichus* spp. in Division 58.4.3a in 2014/15 Delegation of Japan

WG-FSA-14/21	Revised research plan for toothfish in Division 58.4.4 b by *Shinsei maru No. 3* in 2014/15 Delegation of Japan
WG-FSA-14/22	Assessment models for Patagonian toothfish in research block 5843a_1 of Division 58.4.3a, Elan Bank K. Taki (Japan)
WG-FSA-14/23	Revised assessment models for Patagonian toothfish in research block C of Division 58.4.4, Ob and Lena Banks K. Taki (Japan)
WG-FSA-14/24	Reviewing the need for bottle test for specified longline gear configurations Secretariat
WG-FSA-14/25	Macrourus ID guide for observers for CCAMLR Subareas 48.3 and 48.4 J. McKenna, K.A. Ross and M. Belchier (United Kingdom)
WG-FSA-14/26	The demersal fish communities of the shelf and slope of South Georgia and Shag Rocks (CCAMLR Subarea 48.3) S. Gregory, M.A. Collins and M. Belchier (United Kingdom)
WG-FSA-14/27	The use of electronic monitoring camera system for the toothfish fishery in CCAMLR Subarea 48.3: a study case to help CCAMLR R.A. Benedet (United Kingdom)
WG-FSA-14/28	White-chinned petrel incidental mortality event in the Subarea 48.3 Patagonian toothfish fishery during the season extension period in the 2013/14 season M.A Collins, M. Soffker, C. Darby, K. Ross and P.N. Trathan (United Kingdom)
WG-FSA-14/29 Rev. 1	A preliminary CASAL population assessment of Patagonian toothfish in CCAMLR Subarea 48.4 based on data for the 2009–2014 fishing seasons V. Laptikhovsky, R. Scott, M. Söffker and C. Darby (United Kingdom)
WG-FSA-14/30 Rev. 1	A Petersen tag-recapture preliminary population assessment of Antarctic toothfish in CCAMLR Subarea 48.4 based on data for the 2009–2014 fishing seasons V. Laptikhovsky, R. Scott, M. Söffker, T. Earl and C. Darby (United Kingdom)

WG-FSA-14/31	A false positive in the CCAMLR tag overlap statistic arising from low catch volume and consequent limited sample size C. Darby (United Kingdom)
WG-FSA-14/32	Steepness for Antarctic toothfish (*Dissostichus mawsoni*) based on life history M. Mangel, J. Brodziak and G.M. Watters (USA)
WG-FSA-14/33	Maturity stages for skates (Rajiformes) J.R. Ellis, S.R. McCully Phillips and V. Laptivovsky (United Kingdom)
WG-FSA-14/34	An integrated stock assessment for the Heard Island and the McDonald Islands Patagonian toothfish (*Dissostichus eleginoides*) fishery (Division 58.5.2) P. Ziegler, D. Welsford, W. de la Mare and P. Burch (Australia)
WG-FSA-14/35	Results of the Spanish exploratory longline fishery for *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2 in the two previous seasons R. Sarralde, L.J. López-Abellán and S. Barreiro (Spain)
WG-FSA-14/36 Rev. 1	Updated and revised stock assessments of Patagonian toothfish (*Dissostichus eleginoides*) in the vicinity of Kerguelen Islands (Division 58.5.1) and Crozet Islands (Subarea 58.6) S. Romain and G. Duhamel (France)
WG-FSA-14/37	Revised research plan for the exploratory longline fishery for *Dissostichus* spp. in Subarea 48.6 in 2014/15 Delegation of the Republic of Korea
WG-FSA-14/38	Revised research plan for the exploratory longline fishery for *Dissostichus* spp. in Division 58.4.1 in 2014/15 Delegation of the Republic of Korea
WG-FSA-14/39	Revised research plan for the exploratory longline fishery for *Dissostichus* spp. in Division 58.4.2 in 2014/15 Delegation of the Republic of Korea
WG-FSA-14/40	Report on season extension trials in the Patagonian toothfish longline fishery in CCAMLR Statistical Division 58.5.2 T. Lamb (Australia)
WG-FSA-14/41	The 2014 annual random stratified trawl survey in the waters of Heard Island (Division 58.5.2) to estimate the abundance of *Dissostichus eleginoides* and *Champsocephalus gunnari* G.B. Nowara, T.D. Lamb and D.C. Welsford (Australia)

WG-FSA-14/42	Updated models of the habitat use of Patagonian toothfish (*Dissostichus eleginoides*) on the Kerguelen Plateau around Heard Island and the McDonald Islands (Division 58.5.2) C. Péron and D.C. Welsford (Australia)
WG-FSA-14/43	Development of the Patagonian toothfish (*Dissostichus eleginoides*) tagging program in Division 58.5.2, 1997–2014 D.C. Welsford, C. Péron, P.E. Ziegler and T.D. Lamb (Australia)
WG-FSA-14/44	A preliminary assessment of mackerel icefish (*Champsocephalus gunnari*) in Division 58.5.2, based on results from the 2014 random stratified trawl survey D.C. Welsford (Australia)
WG-FSA-14/45	An update of the ageing program for Patagonian toothfish (*Dissostichus eleginoides*) at the Australian Antarctic Division, including a summary of new data available for the Integrated Stock Assessment for the Heard Island and the McDonald Islands fishery (Division 58.5.2) B.M. Farmer, E.J. Woodcock and D.C. Welsford (Australia)
WG-FSA-14/46	Investigating the uncertainty of age determinations for Patagonian toothfish (*Dissostichus eleginoides*) and the implications for stock assessment P. Burch, P. Ziegler, W. de la Mare and D. Welsford (Australia)
WG-FSA-14/47 Rev. 1	Bycatch of skates (Rajiformes) and grenadiers (Macrouridae) in longline fisheries in Subarea 48.3 V. Laptikhovsky, M. Soeffker, M. Belchier, J. Roberts, C. Darby, J. Ellis and R. Scott (United Kingdom)
WG-FSA-14/48	Preliminary stock assessment of Rajiformes in statistical Subarea 48.3 M. Soeffker, V. Laptikhovsky, J. Ellis and C. Darby (United Kingdom)
WG-FSA-14/49	Nine years of tag-recapture in CCAMLR Statistical Subarea 48.3 – Part II: Spatial movement and analysis M. Soeffker, C. Darby and R.D. Scott (United Kingdom)
WG-FSA-14/50	Brief analysis of tag-recapture data in Statistical Subarea 48.4 M. Soeffker, C. Darby, M. Belchier and R. Scott (United Kingdom)

WG-FSA-14/51	Results of the third CCAMLR sponsored research survey to monitor abundance of subadult Antarctic toothfish in the southern Ross Sea, February 2014 and development of the time series S. Mormede, S.J. Parker, S.M. Hanchet, A. Dunn (New Zealand) and S. Gregory (United Kingdom)
WG-FSA-14/52	A characterisation of the toothfish fishery in Subareas 88.1 and 88.2 from 1997–98 to 2013–14 M. Stevenson, S. Hanchet, S. Mormede and A. Dunn (New Zealand)
WG-FSA-14/53	Comparison of age readings by two otolith preparation techniques and readers S.J. Parker (New Zealand), A.F. Petrov (Russia), C.P. Sutton (New Zealand) and E.N. Kuznetsova (Russia)
WG-FSA-14/54	Methodology for automated spatial sea ice summaries in the Southern Ocean S.J. Parker, S.D. Hoyle, J.M. Fenaughty and A. Kohout (New Zealand)
WG-FSA-14/55 Rev. 1	Quantifying the impacts of ice on demersal longlining; a case study in CCAMLR Subarea 88.1 J.M. Fenaughty and S.J. Parker (New Zealand)
WG-FSA-14/56	Investigating emigration in stock assessment models of Antarctic toothfish (*Dissostichus mawsoni*) in Subarea 88.2 SSRUs 88.2C–H S. Mormede, A. Dunn and S.M. Hanchet (New Zealand)
WG-FSA-14/57	Preliminary investigations into a two-area stock assessment model for Antarctic toothfish (*Dissostichus mawsoni*) in the Amundsen Sea Region S. Mormede, A. Dunn and S.M. Hanchet (New Zealand)
WG-FSA-14/58	Seamount-specific biomass estimates from SSRU 88.2H in the Amundsen Sea derived from mark-recapture data S.J. Parker and S. Mormede (New Zealand)
WG-FSA-14/59	Towards the development of an assessment of stock abundance for Subarea 88.2 SSRUs 88.2C–G S.M. Hanchet and S.J. Parker (New Zealand)
WG-FSA-14/60	Medium-term research plan for the Ross Sea toothfish fishery Delegations of New Zealand, Norway and the United Kingdom

WG-FSA-14/61	Proposal for a longline survey of toothfish in the northern Ross Sea region (SSRUs 88.2 A and B) Delegations of New Zealand, Norway and the United Kingdom
WG-FSA-14/62	Using acoustic echo counting to estimate grenadier abundance in the Ross Sea (SSRU88.1I) Y. Ladroit, R.L. O'Driscoll and S. Mormede (New Zealand)
WG-FSA-14/63	Discrimination of two species of grenadier (Gadiformes, Macrouridae), *Macrourus whitsoni* and *M. caml*, in the Ross Sea region of the Southern Ocean (CCAMLR Subareas 88.1 and 88.2) on the basis of otolith morphometrics M.H. Pinkerton, C. Ó Maolagáin, J. Forman and P. Marriott (New Zealand)
WG-FSA-14/64	Deployment and recovery of an archival tag on an Antarctic toothfish in the Ross Sea S.J. Parker, D.N. Webber and R. Arnold (New Zealand)
WG-FSA-14/65	Modelling the circumpolar distribution of Antarctic toothfish using correlative species distribution modelling methods L.M. Robinson and K. Reid (Secretariat)
WG-FSA-14/66	Has krill fishing the potential to adversely affect recruitment in Antarctic notothenioid fishes? K.-H. Kock (Germany) and C.D. Jones (USA)
WG-FSA-14/67	Updated progress report on the research fishery for *Dissostichus* spp. in Subarea 48.6 being jointly undertaken by Japan and South Africa: 2012/13 and 2013/14 R. Leslie (South Africa), K. Taki, T. Ichii (Japan) and S. Somhlaba (South Africa)
WG-FSA-14/68	Report on the CCAMLR marine debris monitoring program Secretariat
Other documents	
WG-FSA-14/P01	Composition of leucocytes in peripheral blood of Antarctic toothfish *Dissostichus mawsoni* (Nototheniidae) I.I. Gordeev, D.V. Mikryakov, L.V. Balabanova and V.R. Miktyakov *J. Ichthyol*., 54 (6) (2014): 422–425
WG-FSA-14/P02	New data on trematodes (Plathelminthes, Trematoda) of fishes in the Ross Sea (Antarctic) S.G. Sokolov and I.I. Gordeev *Invertebrate Zoology*, 10 (2) (2013): 255–267

WG-FSA-14/P03	Mitigating killer whale depredation on demersal longline fisheries by changing fishing practices P. Tixier, J. Vacquie Garcia, N. Gasco, G. Duhamel and C. Guinet *ICES J. Mar. Sci*. (accepted)
WG-FSA-14/P04	Habituation to an acoustic harassment device (AHD) by killer whales depredating demersal longlines P. Tixier, N. Gasco, G. Duhamel and C. Guinet *ICES J. Mar. Sci*. (accepted)
WG-FSA-14/P05	A perspective on steepness, reference points, and stock assessment M. Mangel, A.D. MacCall, J. Brodziak, E.J. Dick, R.E. Forrest, R. Pourzand and S. Ralston *Can. J. Fish. Aquat. Sci*., 70 (2013): 930–940
WG-FSA-14/P06	Demersal fishing interactions with marine benthos in the Australian EEZ of the Southern Ocean: An assessment of the vulnerability of benthic habitats to impact by demersal gears D.C. Welsford, G.P. Ewing, A.J. Constable, T. Hibberd and R. Kilpatrick (Eds). 2014. Final Report, FRDC Project 2006/042. Australian Antarctic Division and the Fisheries Research and Development Corporation. Kingston, Australia: 257 pp.
CCAMLR-XXXIII/03	Maturity stages for skates (Rajiformes) J. R. Ellis, S.R. McCully Phillips and V. Laptivovsky (United Kingdom)
CCAMLR-XXXIII/BG/01	Implementation of conservation measures in 2013/14: Fishing and related activities Secretariat
CCAMLR-XXXIII/BG/02	Fishery notifications 2014/15 summary Secretariat
CCAMLR-XXXIII/BG/14	The Price of Fish: A global trade analysis of Patagonian (*Dissostichus eleginoides*) and Antarctic toothfish (*Dissostichus mawsoni*) Secretariat
CCAMLR-XXXIII/BG/28 Rev. 1	Mapping trends in activity of illegal, unreported and unregulated (IUU) fishing in the CAMLR Convention Area Secretariat