Annex 7

Report of the Working Group
on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2012)

CONTENTS

* Appendices F to U are published only in electronic format (www.ccamlr.org/node/75667).

Appendix R*: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Division 58.4.2

Appendix S*: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Division 58.4.3a

Appendix T*: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Division 58.4.3b

Appendix U*: Fishery Report: Exploratory fishery for *Dissostichus* spp. in Divisions 58.4.4a and 58.4.4b

REPORT OF THE WORKING GROUP ON FISH STOCK ASSESSMENT

(Hobart, Australia, 8 to 19 October 2012)

OPENING OF THE MEETING

1.1 The meeting of WG-FSA was held in Hobart, Australia, from 8 to 19 October 2012. The Convener, Dr M. Belchier (UK), opened the meeting and welcomed participants (Appendix A).

ORGANISATION OF THE MEETING AND ADOPTION OF THE AGENDA

2.1 This year's agenda of WG-FSA focused on data-poor fisheries, depleted and recovering stocks, by-catch, biology and ecology, CCAMLR's Scheme of International Scientific Observation and VMEs (SC-CAMLR-XXX, Table 6). The agenda included a workshop on ageing of otoliths from *Dissostichus eleginoides* and *D. mawsoni* (SC-CAMLR-XXX, paragraph 3.139). The agenda of the meeting was discussed and adopted without change (Appendix B).

2.2 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.

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

- Subgroup on Assessments (coordinator: Dr D. Kinzey, USA)
- Subgroup on Research Plans in Data-poor Fisheries (coordinator: Dr B. Sharp, New Zealand)
- Subgroup on VMEs (coordinator: Dr C. Jones, USA, SC-CAMLR Chair)
- Subgroup on the Scientific Observer Program (coordinator: Dr J. Brown, UK)
- Subgroup on Non-target Catch in CCAMLR Fisheries (coordinator: Dr C. Darby, UK)
- Subgroup on Biology, Ecology and Fish-based Ecosystems (coordinator: Dr K.-H. Kock, Germany)
- Workshop on Techniques and Procedures for Ageing of Otoliths from *D. eleginoides* and *D. mawsoni* (coordinator: Dr D. Welsford, Australia).

2.4 In this report, paragraphs dealing with advice to the Scientific Committee and other working groups have been highlighted. These paragraphs are listed under Item 13. In addition, the information used in developing assessments and other aspects of the Working Group's

work is provided in the Report on Bottom Fisheries and VMEs (Appendix F) and the Fishery Reports (Appendices G to U). These reports will be published on the CCAMLR website (www.ccamlr.org – go to 'Publications', see 'Fishery Reports').

2.5 The report was prepared by Drs Brown, Darby, J. Ellis (UK), Mr N. Gasco (France), Drs O. Godø (Norway), S. Hanchet (New Zealand), Jones, Kinzey, Kock, S. Mormede (New Zealand), S. Parker (New Zealand), D. Ramm (Data Manager), K. Reid (Science Manager), Mr R. Sarralde (Spain), Mr R. Scott (UK), Dr Sharp, Mr C. Sutton (New Zealand), Drs K. Taki (Japan), Welsford, R. Wiff (Chile) and P. Ziegler (Australia).

REVIEW OF AVAILABLE DATA

3.1 The Working Group reviewed data submitted to the Secretariat from commercial fisheries and fishery-based research in 2011/12, including information relevant to stock assessments. This information is briefly described in this section and the data have been used throughout the report.

Data reporting

3.2 Since WG-FSA-11 the Secretariat has continued to develop procedures, databases and data forms based on the advice from the Scientific Committee and the Commission. This work has included, inter alia:

(i) updating fishery and scientific observer data forms and the tag-overlap statistic calculator prior to the start of the 2011/12 fishing season, and related revisions to the databases

(ii) processing fishery, observer, research and compliance data from all fisheries in the Convention Area in 2011/12 – these data have undergone limited and preliminary validation prior to the meeting, and further validation will be conducted in the forthcoming intersessional period

(iii) facilitating the deployment of research hauls in the exploratory fisheries in Subareas 48.6 and 58.4 (WG-SAM-12/06; Item 5)

(iv) updating fishery and observer information reported in the Fishery Reports (see Items 4 and 5) and the Report on Bottom Fisheries and VMEs (Item 6).

3.3 The Working Group recalled that daily catch and effort reporting in exploratory finfish fisheries was introduced to assist the Secretariat in monitoring fisheries during the seasons (CM 23-07). This reporting system has been operating alongside the five-day catch and effort system (CM 23-01) and there is considerable duplication in the reporting and processing of data (CCAMLR-XXXI/BG/06, Figure 1).

3.4 The Working Group agreed that five-day catch and effort reporting in exploratory finfish fisheries was no longer necessary, and it recommended that the requirement for five-day reporting (CM 23-01) be removed from these fisheries. The Working Group agreed that

all data required in the existing five-day, 10-day and monthly catch and effort reporting forms can be incorporated into a single data reporting form (see CCAMLR-XXXI/BG/06).

3.5 The Working Group endorsed WG-SAM's recommendation that fishing vessels undertaking research fishing under CMs 21-02 or 24-01 and carrying observers would use form C1 (trawl) or C2 (longline) throughout these activities to record catch and effort, and the scientific observers on board would use cruise reports and logbooks to record biological and tagging data (Annex 5, paragraph 3.6). Research vessels undertaking research under CM 24-01 would continue to use form C4 to record catch, effort and biological data.

3.6 The Working Group acknowledged the important role of fishing crews, scientific observers and Members in collecting CCAMLR data.

Activities in CCAMLR fisheries

3.7 The 2011/12 fishing season started on 1 December 2011 and will end on 30 November 2012, and fishing was still in progress in some areas at the time of the meeting. Members' fishing vessels operated in the fisheries targeting icefish (*Champsocephalus gunnari*), toothfish (*D. eleginoides* and/or *D. mawsoni*) and krill (*Euphausia superba*), and catches reported to September 2012 are summarised in Table 1. Detailed information is provided in the Fishery Reports (Appendices G to U).

3.8 The Secretariat monitored catch limits in all areas fished and used a forecast model to advise Members and vessels of the closure of areas and fisheries. In 2011/12, 10 fishing areas were closed by the Secretariat (CCAMLR-XXXI/BG/06, Table 2); these closures were triggered by catches of *Dissostichus* spp. approaching agreed catch limits.

3.9 The Working Group noted that catch limits were exceeded on three occasions in 2011/12, and the amount caught in excess of the limit (overrun) was <1 tonne in SSRU 5842E, 1 tonne in SSRU 5841E, and 123 tonnes in SSRUs 881B, C and G; the total catch limit for Subarea 88.1 was not exceeded. The overrun in SSRUs 881B, C and G occurred during a period of strong winds and dense sea-ice which hindered fishing activities and resulted in erratic daily fishing effort and catches. In addition, high catches on the day of the closure, and subsequent catches taken by two vessels which were unable to recover all of their lines (including lost lines) by the time of the closure contributed to the overrun (CCAMLR-XXXI/BG/06) (paragraph 5.18).

3.10 The Working Group noted that four vessels had conducted fishing under CM 41-01 in the exploratory fisheries for *Dissostichus* spp. in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a in 2011/12: *Hong Jin No. 701* (Republic of Korea), *Koryo Maru No. 11* (South Africa), *Saint André* (France) and *Shinsei Maru No. 3* (Japan). These vessels completed 267 research hauls in designated fine-scale rectangles and these activities were reviewed by WG-SAM (Annex 5, paragraphs 3.1 to 3.6). Research fishing was also conducted in the exploratory fishery in Division 58.4.3b under CM 41-07.

3.11 Members also conducted research fishing under CM 24-01 on *Dissostichus* spp. in Division 58.4.4b and Subareas 88.1 (SSRUs J and L), 88.2 (SSRU A) and 88.3 (WG-FSA-12/08).

Estimates of effort from IUU fishing

3.12 The Working Group reviewed estimates of IUU fishing activities in 2011/12 (WG-FSA-12/11 Rev. 1). Three IUU fishing vessels were sighted in Division 58.4.1 and Subarea 58.6: *Huiquan* (previously *Wutaishan Anhui 44*), *Huang He 22* (previously *Sima Qian Baru 22*) and *Baiyangdian*. Information available indicated that one of these vessels used gillnets, and one vessel used longlines. These vessels, and three other IUU-listed vessels, were also sighted in areas outside the Convention Area, and some of these vessels were observed during port visits.

3.13 Information available to the Secretariat indicated that some IUU fishing vessels in the Convention Area go undetected either because of limited surveillance or because the vessels are not sighted and reported by licensed vessels. Seven IUU fishing vessels appear to be consistently engaged in fishing activities (*Huang He 22*, *Huiquan*, *Kuko*, *Octopus I*, *Perlon*, *Ray* and *Shaanxi He 33*) and sighting information in 2010, 2011 and 2012 indicated that these vessels have operated in conjunction with at least one support vessel.

3.14 The Working Group noted that estimates of IUU catches are important in informing inputs into stock assessments in assessed fisheries and research requirements and stock status in data-poor exploratory fisheries. These estimates are also important in developing the Working Group's advice to the Scientific Committee and Commission on broader issues of IUU fishing that might impact on achieving the objectives of the Convention.

3.15 WG-FSA-12/11 Rev. 1 summarised the recommendations of the Joint Assessment Group (CCAMLR-XXX, paragraph 9.6; CCAMLR-XXIV, paragraphs 8.3 to 8.6) into data collection, estimation of uncertainty and risk analysis. The Working Group agreed that the information presented in WG-FSA-12/11 Rev. 1 indicated that, although the mechanism for data acquisition existed through CMs 10-02, 10-06 and 10-07, relatively little information is currently being provided.

3.16 In considering the estimation of uncertainty in IUU catch, the Working Group noted that the two components used to calculate catch were the catch rate of IUU fishing vessels and the number of days that IUU fishing vessels had fished at that catch rate. The Working Group agreed that it is important to consider uncertainty in both components and recognised that uncertainty in the number of days fished could only be evaluated with data on surveillance effort (rather than just sighting reports from that surveillance effort). In the absence of such effort data, it is not possible to determine whether a decrease in sighting reports reflects a decrease in IUU fishing effort or a decrease in surveillance effort.

3.17 The Working Group noted that it may be possible to undertake a spatial risk assessment, similar to that used by WG-IMAF for seabird–fishery interactions, using data on the distribution of fishable areas, the periods of the year when these areas are accessible to fishing and some measure of the presence of licensed vessels or surveillance effort. However, some concern was expressed that undertaking such an analysis would require careful evaluation, as the outcomes may be of potential utility to IUU fishers.

3.18 The Working Group also discussed alternative approaches to acquiring data on IUU fishing, such as deriving estimates of IUU catches from market-based information, and the possible use of genetic approaches to determine the provenance of fish.

3.19 The Working Group agreed that the information currently provided to the Secretariat is insufficient to provide sightings-based estimates of IUU catches. Furthermore, given the absence of data on surveillance effort with which to effort-correct the number of sightings and number of days fished, it is not possible to provide an estimate of uncertainty or to evaluate trends in IUU catches. The Working Group sought advice from the Scientific Committee and Commission on how the required data might be provided to the Secretariat.

Catches of *D. eleginoides* in waters adjacent to the Convention Area

3.20 Catches of *D. eleginoides* from fisheries outside the Convention Area and reported in the CDS in the calendar years 2011 and 2012 (to September) are summarised in Table 2; most of this catch came from Areas 41 (southwest Atlantic) and 87 (southeast Pacific).

3.21 The Working Group noted that some vessels fishing for *D. eleginoides* inside and outside the South African EEZ in Area 51, adjacent to the Convention Area, report fine-scale catch and effort data (Resolution 18/XXI) to the Secretariat.

ESTABLISHED FISHERIES

4.1 In addition to specific recommendations for each of the individual assessments, the Working Group made a number of general recommendations that should apply to all stock assessments. These include:

(i) for assessment methods that incorporate a composite likelihood (e.g. CASAL), a plot or table showing the contribution to the total likelihood of each likelihood component, as well as a plot of the likelihood profile for SSB_0, should be displayed

(ii) an evaluation of the spawning biomass estimated by the assessment model to be in a population but not vulnerable to the fisheries should be reported and its influence on management advice considered (e.g. through a sensitivity analysis using alternative selectivity)

(iii) work plans be developed to allow species-specific analyses and management advice for toothfish assessments and catch limits where both species co-occur, such as in Subareas 48.6 and 88.1, as opposed to combined species (*Dissostichus* spp.) catch limits

(iv) development of methods to incorporate the effect of depredation on stock assessments, including the impact on catch rates, and the quantity and size distribution of fish taken by depredation.

4.2 The Working Group reviewed preliminary assessments for *C. gunnari* in Division 58.5.2 and *D. eleginoides* in Division 58.5.1.

C. gunnari South Georgia (Subarea 48.3)

4.3 The Fishery Report for *C. gunnari* at South Georgia (Subarea 48.3) is contained in Appendix G.

4.4 In 2011/12, the catch limit for *C. gunnari* was 3 072 tonnes. Commercial fishing was conducted by two vessels and the total reported catch up to 24 September was 546 tonnes, although the fishery is still open and a third vessel entered the fishery in September 2012.

4.5 WG-FSA-12/37 reported on a groundfish survey conducted in January 2012 in Subarea 48.3. Twenty hauls were conducted around Shag Rocks, and three hauls northwest of South Georgia. The survey indicated mainly age 2+ and 3+ fish around Shag Rocks. Mainly 2+ fish were found in the northwest of South Georgia compared to 1+ and 2+ fish last year. This survey did not provide adequate spatial coverage to provide an assessment.

Management advice

4.6 The Working Group did not undertake an assessment of *C. gunnari* for Subarea 48.3 in 2012, and recalled its advice from 2011 that the catch limit for *C. gunnari* should be set at 2 933 tonnes in 2012/13 based on the outcome of the short-term projection undertaken in 2011.

C. gunnari Heard Island (Division 58.5.2)

4.7 The Fishery Report for *C. gunnari* at Heard Island (Division 58.5.2) is contained in Appendix H.

4.8 In 2011/12, the fishery was closed to commercial fishing operations and a catch limit of 30 tonnes of *C. gunnari* was set aside for research and by-catch (4.4 tonnes were taken in the survey, Appendix H).

4.9 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 2012 were described in WG-FSA-12/25. The Working Group noted the change in cohort structure of *C. gunnari*, first noted in 2011 with 4–5 year classes present simultaneously, had persisted in the 2012 survey, however, 2+ fish currently dominate the population.

4.10 The Working Group also noted that investigation of condition factors through time may provide some insight into the cause of the recent changes in cohort structure observed in surveys in Division 58.5.2.

4.11 The Working Group evaluated the preliminary assessment of *C. gunnari* in Division 58.5.2, based on survey results set out in WG-FSA-12/26. The short-term assessment was implemented in the GYM, using the one-sided bootstrap lower 95% confidence bound of total biomass of 3 987 tonnes from the 2012 survey and using the revised growth parameters described in WG-FSA-10/12.

4.12 The projection of fish of the 1+ to 3+ age classes from 2011/12 gives a projected yield of 679 tonnes in 2012/13 and 573 tonnes in 2013/14.

4.13 The Working Group noted that sensitivity tests included in WG-FSA-12/26 indicated that the approach of using the lower one-sided 95% percentile of the survey biomass is robust to uncertainty in estimates of natural mortality (*M*) and the von Bertalanffy growth parameter (*K*), resulting in lower catch limits when compared to scenarios using the median biomass estimate.

Management advice

4.14 The Working Group recommended that the catch limit for *C. gunnari* in Division 58.5.2 should be 679 tonnes for 2012/13 and 573 tonnes for 2013/14 based on the outcome of the short-term projection.

D. eleginoides South Georgia (Subarea 48.3)

4.15 The Fishery Report for *D. eleginoides* at South Georgia (Subarea 48.3) is contained in Appendix I. The catch limit for *D. eleginoides* in 2011/12 for Subarea 48.3 was 2 600 tonnes. The total reported catch was 1 844 tonnes.

Management advice

4.16 The Working Group did not undertake an assessment of this stock in 2012, and therefore recommended that its advice from 2011 be carried forward in its entirety for 2012/13.

D. eleginoides Heard Island (Division 58.5.2)

4.17 The Fishery Report for *D. eleginoides* at Heard Island (Division 58.5.2) is contained in Appendix J.

4.18 In 2011/12, the catch limit of *D. eleginoides* was 2 730 tonnes. The catch of *D. eleginoides* reported for this division by the end of September 2012 was 1 935 tonnes.

Management advice

4.19 The Working Group did not undertake an assessment of this stock in 2012, therefore it recommended that its advice from 2011 be carried forward in its entirety for 2012/13.

D. eleginoides Kerguelen Island (Division 58.5.1)

4.20 The Fishery Report for *D. eleginoides* at Kerguelen Island (Division 58.5.1) is contained in Appendix K.

4.21 In 2011/12, the catch limit of *D. eleginoides* set by France in its EEZ in Division 58.5.1 was 5 100 tonnes (season 1 September to 31 August), allocated to seven longliners. The catch for the current CCAMLR season reported to October 2012 was 2 957 tonnes.

4.22 An integrated assessment using CASAL was presented in WG-FSA-12/09 and the Working Group discussed several issues regarding model fits to catch rate, tagging and length-frequency data in the base-case model. Biomass estimates from the POKER surveys were substantially underestimated (by about half of the observed values), the model-estimated length frequencies for the POKER surveys were bimodal compared to the unimodal observations, the CPUE estimates did not fit well the initial high observations of the time series when high levels of IUU fishing were reported, and tag-recaptures from all release years tended to be overestimated in the first year of liberty.

4.23 A series of sensitivity runs were conducted during the meeting to explore the effects of different data sources and assumptions on model outputs (Table 3). Three scenarios were run with YCS fixed to 1, excluding CPUE data for the model fit, and assuming twice the observed levels of IUU catches in each year. This resulted in estimates of B_0 ranging from 215 835 to 244 460 tonnes compared to 218 078 tonnes in the base case; *SSB* status ranged from 0.62 to 0.67 compared to 0.72 in the base case.

4.24 The Working Group recommended that the following issues be investigated to provide a more robust assessment:

(i) explore simpler models with fewer fisheries based on similarity of data

(ii) use recapture data from tagged fish at liberty for five years or less

(iii) age fish from POKER surveys and fisheries catches and include them in the model as they become available

(iv) explore IUU fishing effects on unfished biomass estimate

(v) compare results from a configuration with YCS fixed at 1, and exclude CPUE data to the base case.

Management advice

4.25 The Working Group agreed that until a more robust stock assessment is undertaken, the model described in WG-FSA-12/09 could be used to provide management advice for the 2012/13 season. The Working Group agreed that the current catch limit of 5 100 tonnes could be used as management advice for 2012/13.

4.26 At the time of adoption, Mr Gasco noted that the assessment subgroup had agreed that the catch limit of 5 100 tonnes satisfies the CCAMLR decision rules as presented in WG-FSA-12/09.

4.27 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 32-13, remain in force.

D. eleginoides Crozet Islands (Subarea 58.6)

4.28 The Fishery Report for *D. eleginoides* in Subarea 58.6 (French EEZ) is contained in Appendix L.

4.29 In 2011/12, the catch of *D. eleginoides* reported in Subarea 58.6 to October 2012 was 480 tonnes.

Management advice

4.30 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 32-11, remain in force in 2012/13.

D. eleginoides Prince Edward and Marion Islands (Subareas 58.6 and 58.7)

4.31 The Fishery Report for *D. eleginoides* in Subareas 58.6 and 58.7 (South African EEZ) is contained in Appendix M.

Management advice

4.32 No new information was available on the state of fish stocks in the South African EEZ at the Prince Edward Islands and the Working Group was unable to provide management advice for this fishery.

EXPLORATORY AND OTHER FISHERIES

Exploratory fisheries in 2011/12

5.1 Seven exploratory longline fisheries for *Dissostichus* spp. operated in 2011/12 and the season's catches from these fisheries are summarised in Table 4 (see Subareas 48.6, 88.1 and 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b). Detailed information is provided in the Fishery Reports (Appendices G to U). No new fishery was conducted in 2011/12.

5.2 All vessels fishing in these 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; these requirements also apply to the fishery for *Dissostichus* spp. in Subarea 48.4 (CM 41-03). In 2011/12, all vessels met the required tagging rates (Table 4), and all but one vessel achieved, or exceeded, the required tag-overlap statistic (Table 5). A total of 7 609 *Dissostichus* spp. were tagged and released (Table 6), and 278 tagged fish were recovered (Table 7).

5.3 Vessels engaged in exploratory fisheries in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a are also required to undertake research hauls (CM 41-01). Research fishing in these fisheries in 2011/12 was reviewed by WG-SAM (paragraph 3.10).

5.4 The Working Group reviewed information on hook loss in longline fisheries (WG-FSA-12/65). All longline fishing vessels are required to report the number of hooks attached to sections of longlines which are lost or abandoned during the course of fishing (refer 'number of hooks lost that were attached to lost sections of the longline' in the C2 data form). These data are required to develop methods to estimate unaccounted fishing mortality arising from lost sections of longlines (SC-CAMLR-XXX, Annex 7, paragraphs 4.35 and 4.36).

5.5 The Working Group noted that approximately 60% of the vessels operating in the exploratory longline fisheries in 2010/11 and 2011/12 had reported hooks lost attached to sections of lines. In some cases vessels did not report these data in the C2 data, although information from scientific observers indicated that hooks attached to sections of longline were lost. Based on available data, an estimated 313 000 to 318 000 hooks were lost attached to sections of lines in each of the last two seasons in these fisheries (WG-FSA-12/65).

5.6 The Working Group reiterated the need for all vessels operating in longline fisheries in the Convention Area to report the number of lost hooks that are attached to sections of lines (SC-CAMLR-XXX, Annex 7, paragraph 4.36). It urged the Scientific Committee and Commission to consider an appropriate mechanism to achieve a greater level of engagement with the requirements to complete the C2 data reporting form.

5.7 The Working Group recalled that an increased spatial overlap in fishing effort between seasons had the potential to increase the success of tag-recapture experiments. A process to constrain fishing effort in a number of fine-scale rectangles to achieve this spatial overlap was implemented in 2011/12 (SC-CAMLR-XXX, Annex 7, paragraph 6.76). The subsequent deployment of research hauls in data-poor exploratory fisheries in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a was reviewed by WG-SAM (paragraph 3.10). WG-SAM had agreed that it would be useful for WG-FSA to have available maps of these deployments that include depth, catches, mark–recapture information and a distance scale (Annex 5, paragraphs 3.1 to 3.4).

5.8 The Working Group reviewed the Secretariat's development of mapping and visualisation tools to facilitate the review of data from data-poor exploratory fisheries (WG-FSA-12/62). A visualisation and initial analysis of fishing effort and tag-recapture data indicated that the relative rate of tag recaptures was higher in the northern SSRUs of Subarea 48.6 and in Division 58.4.3a compared to the southern SSRUs of Subarea 48.6 and in Divisions 58.4.1 and 58.4.2.

5.9 The Working Group reviewed the fishery characterisation for the exploratory fisheries for *Dissostichus* spp. in Subareas 88.1 and 88.2 (WG-FSA-12/42). Most of the catch in Subarea 88.1 in 2011/12 was taken from SSRU 881K (i.e. on the slope). About 70% of the catch in the north was taken from SSRU 881C, and about 85% of the catch on the shelf was taken from SSRU 881J. As in the past, most of the catch in Subarea 88.2 was taken from SSRU 882H in the north. There is no evidence of truncation of the overall length-frequency distribution in any of the SSRUs, but there has been a marked reduction in median fish length in SSRUs 881H and I over the last two to three years. This appears to be at least partly a result of vessels carrying out more fishing in shallower parts of the slope, but could also reflect fishing on different parts of the slope, or a pulse of strong year classes. However, the Working Group recognised the limitations of length-frequency distribution data from commercial fishing and cautioned against over-interpretation.

5.10 The Working Group reviewed an analysis in WG-FSA-12/07, prepared by the Secretariat and the Republic of Korea, of the anomalously high CPUEs reported by two Korean-flagged vessels (*Insung No. 2* and *Insung No. 7*) fishing in the exploratory fisheries (CCAMLR-XXX, paragraph 11.3(i) and Annex 6, paragraph 2.30). The joint analysis provided an overview of the data and a commentary on the fishing operations of the vessels. The distribution of CPUE values from these vessels showed distinct differences to the other vessels that participated in longline fisheries in Subarea 48.6 and Divisions 58.4.1 and 58.4.2. The analysis also indicated that the only other vessel that displayed a similar pattern of CPUE was the *Insung No. 22* when fishing in Subarea 48.6.

5.11 The Working Group agreed that it was not possible to explain the anomalous characteristics of the CPUE data from the three Korean vessels at this time, and that such data collected on these vessels should not be used in scientific analyses for CCAMLR. The Working Group agreed that all data, including tagging data, collected on these vessels in the years with anomalous CPUE data should be flagged as not suitable for analysis. The Working Group recommended that all data collected on the *Insung No. 22* in 2009, *Insung No. 2* in 2010 and *Insung No. 7* in 2011 should be flagged accordingly.

5.12 The Working Group welcomed the undertaking from the Republic of Korea and the Secretariat to provide an analysis of all data collected on these vessels for consideration at the next meeting of WG-SAM, noting that data-quality flags could be reviewed on the basis of this analysis.

5.13 The Working Group reviewed the fishery characterisation for the exploratory fishery for *Dissostichus* spp. in Subarea 48.6 (WG-FSA-12/38). Most of the catch of *D. mawsoni* was taken in SSRUs 486E and G, while *D. eleginoides* was mostly caught in SSRUs 486A and G. The mean length of individuals of both species is larger in females, and individuals of *D. mawsoni* are caught in deeper water and have a larger mean length than *D. eleginoides*. There is no evidence of truncation in the overall length-frequency distribution of both species, although some evidence of a reduction in the mean fish length has been observed in the past three fishing seasons.

5.14 The Working Group recalled the operational difficulties encountered at the start of the tagging program in the exploratory fisheries in Subareas 48.6 and 58.4. It requested that further consideration be given to the inclusion of the early tag-recapture data in these time series.

5.15 The Working Group agreed that the regular updates on the characterisations of the fisheries in Subareas 88.1 and 88.2 (paragraph 5.9) provide essential information for the development and review of assessments and management of these fisheries. The recent development of the characterisation of the fishery in Subarea 48.6 (WG-SAM-12/33; WG-FSA-12/38; paragraph 5.13), led by Dr Wiff (first recipient of a CCAMLR Scholarship), had contributed to a better understanding of the fishery and stock in that subarea. The Working Group also noted that similar characterisations are being developed by Mr J.C. Quiroz (Chile) and his colleagues for the exploratory fisheries in Divisions 58.4.3a and 58.4.3b and the closed fisheries in Divisions 58.4.4a and 58.4.4b. The Working Group encouraged the development of characterisations for other fisheries (e.g. the exploratory fisheries in Divisions 58.4.1 and 58.4.2).

Exploratory fisheries notified for 2012/13

5.16 Ten Members submitted notifications for a total of 26 vessels for exploratory fisheries for *Dissostichus* spp. in Subareas 48.6, 88.1, 88.2 and Divisions 58.4.1, 58.4.2, 58.4.3a and 58.4.3b in 2012/13 (Table 8, CCAMLR-XXXI/12 Rev. 1 and XXXI/18 to XXXI/27). There were no notifications submitted for new fisheries.

5.17 The Working Group expressed concern at the number of vessels which had been notified in Subarea 88.2 (23 vessels). A total of 16 vessels were permitted to fish in that subarea in 2011/12, and a maximum of 19 vessels were permitted to fish in 2008/09 (Table 5; Appendix N). The Working Group agreed that a large number of vessels fishing in an area with a small catch limit would increase the risk of an overrun.

5.18 The Working Group requested that the Scientific Committee and Commission review fishing capacity in exploratory fisheries with small catch limits relative to the number of vessels that may fish in the coming season.

5.19 The Working Group noted that there have been occasional catch overruns in a number of SSRUs in the Convention Area over several years in both exploratory and assessed fisheries. It recommended that the Scientific Committee consider how catch overruns within SSRUs should be accounted for with respect to the management of these areas within season and in the forthcoming season.

5.20 During the course of the meeting, three Members advised the Secretariat of replacement vessels for the exploratory fisheries in Subareas 88.1 and 88.2 in 2012/13:

(i) *Jung Woo No. 3* (Korean-flagged) has been replaced by *Kostar*
(ii) *Chio Maru No. 3* (Russian-flagged) has been replaced by *Ugulan*
(iii) *Professor Frolov* (Ukrainian-flagged) has been replaced by *Poseydon I*.

5.21 The Working Group requested advice from the Scientific Committee on how the introduction of vessels with limited or no experience in the conduct of potential research fishing in exploratory, data-poor or closed fisheries, either as replacement vessels or newly notified vessels, may compromise the evaluation and implementation of research plans agreed during the meeting.

5.22 The notifications for exploratory fisheries in Divisions 58.4.1, 58.4.2 and 58.4.3a and Subarea 48.6 also required a research plan (CM 21-02, paragraph 6). These plans were submitted to WG-SAM which requested that the plans be revised and submitted to WG-FSA for evaluation (Annex 5, paragraphs 3.1 to 3.28 and Table 6). The revised research plans were reviewed under Item 5.3.

5.23 The Working Group did not undertake an assessment of *Dissostichus* spp. in Subareas 88.1 and 88.2 in 2012 and therefore recommended that its advice from 2011 be carried forward in its entirety for the 2012/13 fishing season.

5.24 All exploratory bottom fisheries notified for 2012/13 required a preliminary assessment of the potential for proposed bottom fishing activities to have significant adverse impacts on VMEs (CM 22-06, paragraphs 2, 3 and 7). These preliminary assessments were reviewed under Item 6.2.

Other *Dissostichus* spp. fisheries

Dissostichus spp. South Sandwich Islands (Subarea 48.4)

5.25 The Fishery Report for *Dissostichus* spp. South Sandwich Islands (Subarea 48.4) is contained in Appendix O.

5.26 In 2011/12, the catch limits of the fishery for *Dissostichus* spp. in Subarea 48.4 were 48 tonnes for *D. eleginoides* in the north and 33 tonnes for *Dissostichus* spp. (*D. eleginoides* and *D. mawsoni* combined) in the south. The reported catch of *Dissostichus* spp. in Subarea 48.4 North and 48.4 South was 44 tonnes and 33 tonnes respectively.

5.27 The Working Group reviewed the preliminary assessments of *Dissostichus* spp. in Subarea 48.4 (WG-FSA-12/36). A CASAL age-based assessment is used for *D. eleginoides* in the northern area of Subarea 48.4, and Petersen biomass estimates were conducted separately for *D. eleginoides* and *D. mawsoni* in the southern area.

5.28 For the stock assessment of *D. eleginoides* in the northern area, a comparative length-based assessment yielded very similar estimates of spawning biomass, harvest rate and recruitment to those of the age-based assessment.

5.29 Compared to the assessment last year (SC-CAMLR-XXX, Annex 7), additional size-at-age and catch-at-age information have been included in the assessment in an attempt to reduce the dependency of the model on a relatively small amount of age-based data. The Working Group recommended that further work be conducted to obtain additional age-based information for earlier years of the fishery.

5.30 The assessment continues to identify a single, very large recruitment event in the early 1990s that has a strong influence on the age structure of the population in subsequent years. The Working Group discussed the apparent dependence of the fishery on only one or two cohorts and the problems associated with this in projecting future yields. The merits and disadvantages of parametric and non-parametric bootstrapping procedures were discussed. The Working Group recommended that this issue should be further investigated for the next assessment of this stock.

5.31 The Working Group noted that information on ageing error is not currently available for Subarea 48.4. Sensitivity analyses could be conducted using indicative ageing error estimates available for *D. eleginoides* in Division 58.5.2 to provide a sensitivity estimate of the assessment to possible levels of mis-ageing.

5.32 The Working Group recalled its recommendations of previous years for separate, species-specific assessments to be conducted for the entire management area instead of species-combined assessments for separate areas. The Working Group noted that this should be achievable with the information presently available.

Management advice

5.33 The Working Group recommended the following limits for toothfish and by-catch in Subarea 48.4:

(i) Subarea 48.4 North –

(a) a catch limit of 63 tonnes for *D. eleginoides*

(b) the continued prohibition of the targetting of *D. mawsoni*. Any *D. mawsoni* that are retained must be counted against the catch limit of *Dissostichus* spp. in the southern area

(c) maintenance of catch limits for by-catch species, with a limit for macrourids of 10 tonnes (16% of the catch limit for *D. eleginoides*) and a limit for rajids of 3 tonnes (5% of the catch limit for *D. eleginoides*).

(ii) Subarea 48.4 South –

(a) a catch limit of 52 tonnes for *Dissostichus* spp. (*D. eleginoides* and *D. mawsoni* combined)

(b) maintenance of a move-on rule for by-catch species, with a minimum macrourid trigger of 150 kg and 16% of the catch of *Dissostichus* spp. per line, and a trigger for rajids set at 5% of the catch of *Dissostichus* spp. per line.

Research to inform current or future assessments

5.34 The Working Group evaluated research and proposals to undertake research intended to lead to stock assessments of *Dissostichus* spp. within regions of the following subareas and divisions:

- Subarea 48.5
- Subarea 48.6
- Division 58.4.1
- Division 58.4.2

- Division 58.4.3a
- Division 58.4.3b
- Division 58.4.4.

5.35 The Working Group evaluated aspects of research fishing designs, assumptions, proposed tagging approaches and catch rates, and likelihood of achieving objectives, taking into consideration previous research endeavours, progress made, or new/refined approaches in these areas. In addition, the Working Group discussed general matters relevant to all research plans.

5.36 The Working Group endorsed the research fishing proposal evaluation process recommended by WG-SAM using the criteria laid out in Annex 5, Table 6 and CM 24-01, Format 2. The Working Group also considered the specific advice provided by WG-SAM on the individual research proposals, as well as vessel suitability, to complete the proposed research. Results of the WG-FSA evaluation using Table 6 of WG-SAM for all research proposals are provided in Tables 9 to 13.

Exploratory fisheries

Subarea 48.6

5.37 Information on this fishery is summarised in Appendix P.

5.38 The Working Group evaluated preliminary species-specific age-structured assessments for *D. mawsoni* and *D. eleginoides* in Subarea 48.6 north of 60°S (SSRUs 486A and G) and for *D. mawsoni* in Subarea 48.6 south of 60°S (SSRUs 486B, C, D and E) (WG-FSA-12/31). The assessment framework was implemented in AD model builder.

5.39 The Working Group noted that the assessment framework was developed in direct response to the recommendation from WG-SAM-12 and is still in an early stage of development. The model framework was not presented to WG-FSA-12 as a formal assessment of *Dissostichus*. It is presented (i) as the basis for a biomass estimate in support of the research plan submitted by South Africa for Subarea 48.6 (WG-FSA-12/30), and (ii) to illustrate the modelling framework that South Africa intends to develop over the next few years for analysis of the data collected during the proposed research in order to provide a robust assessment of the resources in Subarea 48.6.

5.40 Recalling the advice of WG-FSA-07 on evaluating new methods (SC-CAMLR-XXVI, Annex 5, paragraph 4.27), the Working Group suggested that such an evaluation should include, inter alia, the analysis of simulated (theoretical) data for a number of fish stock scenarios and a description on how uncertainty is treated by the model. Furthermore, the Working Group provided the following guidance for further development of the model framework:

(i) the length structure of the tagged fish should be incorporated and the tag-recapture likelihood modified to use size of tagged fish

(ii) calculations of tag availability, scanning probabilities, and double tag loss implemented in this model follow the single-tag approximation. Methods to implement a full double-tag model should be investigated. It is noted that further work on these topics may benefit CASAL assessments as well

(iii) likelihood profiles, cryptic spawning biomass, the contribution of each component to the total likelihood, and similar model evaluation methods should be displayed (paragraph 4.1)

(iv) age data for this subarea are not available. Within the model, von Bertalanffy growth parameters for *D. mawsoni* were estimated in preference to assuming growth parameters from other regions. It would be preferable to obtain age data for this subarea and incorporate those into the likelihood

(v) additional work on estimated species proportions in the IUU fishery should be undertaken.

5.41 The Working Group noted that an assessment implemented in CASAL is also planned for Subarea 48.6 in 2014 and this would provide an opportunity to compare the results from different assessment models for the same fishery to evaluate parameter uncertainty due to model structure.

5.42 The Working Group recommended that an evaluation of the model framework in WG-FSA-12/31 be provided to WG-SAM and that CCAMLR decision rules be used in estimating yields for this fishery.

5.43 Proposals for research fishing in Subarea 48.6 were submitted by South Africa (WG-FSA-12/30) and Japan (WG-FSA-12/60 Rev. 1). Both proposals were revisions of papers submitted to WG-SAM-12 (WG-SAM-12/12 Rev. 1 and 12/09 respectively).

5.44 WG-FSA-12/60 Rev. 1 provided a research proposal that included, inter alia, plots of tag releases by fine-scale rectangle, and proposed that research blocks should focus on those rectangles with the highest numbers of tags available for recapture, extended also to include adjacent rectangles that are extensions of continuous bathymetric features. It was recommended in this proposal to eliminate the 3 n mile limit requirement between research sets. A Petersen estimate of biomass was presented for the northern SSRUs of Subarea 48.6.

5.45 The proposal in WG-FSA-12/30 aimed to divide the SSRUs in the northern part of Subarea 48.6 into seven research areas and the southern SSRUs into four research areas, based on historical fishing activities and tag releases. It proposed that vessels select areas prior to each fishing season, prioritising the areas with the highest number of tag releases, but taking ice conditions into account, and conduct the first 10 sets as research lines 3 n miles apart, targeting fine-scale rectangles with the highest number of tag releases.

5.46 The Working Group noted that WG-FSA-12/30 included no commitment to do ageing for the otoliths collected in this research. The Working Group noted that ageing data was a high priority for input into stock assessments, and encouraged collaboration between Members to age otoliths in different data-poor fisheries.

5.47 WG-FSA-12/30 also proposed modifying the tagging rates within fine-scale rectangles based on the density of tagged fish within the fine-scale rectangle. Although the Working Group felt that adaptively changing the tagging rate had some merit, it recommended retaining a consistent tagging rate of five tags per tonne throughout the subarea.

5.48 The Working Group recommended that research fishing be undertaken in the northern and southern research blocks previously described in WG-FSA-12/60 Rev. 1 and agreed that all sets should be considered as research sets, until time is such that a robust stock assessment has been undertaken.

5.49 The Working Group noted with concern that there has been only a single recapture of a tagged fish in the southern SSRUs in Subarea 48.6, and emphasised that recaptures are critical if a tag-based method of assessment continues to be pursued for these SSRUs. Alternate explanations were proposed that may explain the lack of recaptures in the south, including poor tagging size-overlap statistics in earlier years, poor spatial overlap between fishing years (WG-FSA-12/31, Appendix A, Figure 6), movement of tagged fish out of the fished area, and/or very low exploitation rates resulting in a low probability of recapturing tagged fish (WG-FSA-12/60 Rev. 1, Table 9).

5.50 The Working Group noted that suitable fishing areas of southern Subarea 48.6 SSRUs B, C and F are often covered by sea-ice. It was noted the research blocks identified in SSRUs D and E in WG-FSA-12/60 Rev. 1 are more likely to be ice-free and that more tags have been released in these two SSRUs, and thus there is a higher likelihood of recapturing tagged fish in these blocks.

5.51 The Working Group therefore recommended research fishing in the southern Subarea 48.6 should be restricted to the research blocks in SSRUs D and E identified in WG-FSA-12/60 Rev. 1. Expanding research fishing to other southern SSRUs should only occur after there are sufficient tag returns to inform a robust tag-based index of abundance in SSRUs D and E.

5.52 The Working Group agreed that the research blocks identified in Figure 94 of WG-FSA-12/60 Rev. 1 could be used as a basis for research fishing in both the northern and southern area SSRUs of Subarea 48.6.

5.53 Dr T. Ichii (Japan) indicated that, when the research blocks are covered with sea-ice, the alternative survey in the neighbouring ice-free area is valuable to clarify the life-history of toothfish. The Working Group referred this issue to the Scientific Committee for advice.

5.54 With respect to total allowable catch limits for the northern and southern Subarea 48.6, the Working Group recommended that it would be desirable to set species-specific catch limits (*D. eleginoides* and *D. mawsoni*) given the mixed species composition in parts of the northern region. Should a catch limit of one species be met, additional fish of that species could be tagged and released, or the vessel could move to another area where the likelihood of catching the species is decreased.

5.55 The Working Group noted the results of the preliminary age-structured assessment model described in WG-FSA-12/31 and the preliminary estimate of biomass based on the

Petersen estimate set out in WG-FSA-12/60 Rev. 1. It was noted that the two methods gave very different answers, were based on different assumptions, and more work was needed to better understand the disparity between the two estimates.

5.56 The Working Group agreed that the estimates as set out in Table 9 of WG-FSA-12/60 Rev. 1 could be used as interim advice for catch limits associated with research fishing in Subarea 48.6, and that the catches can be apportioned to the four areas described in Subarea 48.6. The Working Group noted that the proposed overall levels of catch limit in Subarea 48.6 (200 tonnes in the northern SSRUs, and 200 tonnes in the southern SSRUs) were consistent with the preliminary assessment set out in WG-FSA-12/31.

Divisions 58.4.1 and 58.4.2 – East Antarctica

5.57 Information on this fishery is summarised in Appendixes Q and R.

5.58 Proposals for research fishing in Divisions 58.4.1 and 58.4.2 were submitted by Japan (WG-FSA-12/60 Rev. 1), the Republic of Korea (WG-FSA-12/39) and Spain (WG-FSA-12/69). The Working Group evaluated WG-FSA-12/69 independently from the other proposals, as the research was fundamentally different relative to the other proposals.

5.59 The Working Group noted that South Africa had submitted a paper to WG-SAM (WG-SAM-12/21) with the intention of conducting research fishing in Division 58.4.2. However, this paper was not revised on the basis of advice from WG-SAM, and not resubmitted to WG-FSA. The Working Group was not in the position to comment on the merits of this research plan.

5.60 WG-FSA-12/60 Rev. 1 presented a revised research plan (a revision of WG-SAM-12/09) for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 in Divisions 58.4.1 and 58.4.2. The proposal presented catch, effort and biological information from previous fishing trials in these divisions, and proposed continued research be carried out in five specific areas within three SSRUs in Division 58.4.1 (SSRUs C, E and G) and one SSRU in Division 58.4.2 (SSRU E).

5.61 The Working Group noted the proposal provided estimates of *D. mawsoni* standing stock based on a Petersen estimate (WG-FSA-11/31 Rev. 2) in SSRUs 5841C and G, and an overall estimate of stock biomass across the division. The Working Group noted that there is considerable uncertainty regarding the total number of tags currently available for recapture in these areas and the corresponding estimates of biomass, but that WG-FSA-12/60 Rev. 1 adopted the following conservative assumptions:

(i) weighting the year-specific Petersen biomass estimates inversely proportional to the CV, so that years with higher numbers of recaptures have higher weight in the final biomass estimate

(ii) assuming a higher tagging mortality (0.2) than is commonly applied in assessed fisheries.

5.62 Dr Welsford noted that the local biomass estimates provided in WG-FSA-12/60 Rev. 1 are still likely to be biased upwards as tags from vessels with poor tag-overlap statistics in the past are included.

5.63 In areas with insufficient tag recaptures to inform Petersen estimates, including SSRU E, the proposal uses CPUE × seabed area to derive preliminary estimates of biomass. The Working Group noted that estimates based on CPUE are inherently uncertain, but that the proposal applies the following assumptions:

(i) exploitation rates in WG-FSA-12/60 Rev. 1, Table 9, are based on proposed catches as a proportion of estimated local biomass within the research blocks, not total biomass estimates for the whole SSRU

(ii) exploitation rates for Divisions 58.4.1 and 58.4.2 are sufficiently low that they are likely to remain within appropriate limits even when applying a precautionary discount factor (e.g. 0.3 as in SC-CAMLR-XXX, Annex 5, paragraph 2.40iv) in the estimation of local biomass.

5.64 The Working Group noted the proposed timetable of research and analysis which includes a stock analysis using GLM and GAM to be established in 2012/13, a method of analysis for otolith in 2013/14, a CASAL catch-at-age model applied in 2014/15, and a full stock assessment completed in 2015/16–2016/17. The Working Group noted that the authors of the proposal had produced a preliminary stock assessment in SSRU 5844C using similar methods, and that the proposed timeline was reasonable.

5.65 The Working Group noted that there were several assumptions in the proposal that had not previously been evaluated, such as number of tags available for recapture, tagging mortality/loss rates and associated uncertainties, and that caution should be used when interpreting results and the feasibility of the timetable. Because the assumptions used were generally precautionary, the estimated exploitation rates and corresponding estimates of future tag recaptures per year shown in WG-FSA-12/60 Rev. 1, Table 9, are quite low, indicating that if the biomass estimates are accurate, then proposed catch limits are sufficiently conservative, but may be too low to lead to an assessment in the proposed time frame within these SSRUs.

5.66 Some Members were concerned that Japan had committed itself to a very large number of areas, and whether conducting research to deliver stock assessments across such a large number of areas was feasible. The Working Group recommended that Table 9 in WG-FSA-12/60 Rev. 1 could be used to set catch limits for the coming season. The Working Group recalled that the current catch limits in Division 58.4.1 were based on the analysis presented in Agnew et al. (2009). While it was recognised that it may take some time to get to an assessment based on a tag-recapture method with these catch limits, the Working Group agreed that it would be in a better position to evaluate the estimates of expected number of recaptures set out in WG-FSA-12/60 Rev. 1, Table 9, after the first year of the research fishing has been undertaken.

5.67 WG-FSA-12/39 (Republic of Korea) provided a research plan for *Dissostichus* spp. in SSRUs 5841C, E and G for 2012/13 which was a revision of WG-SAM-12/10 Rev. 1. The Working Group noted that there was some ambiguity with regard to the proposed analytical methods by which the objectives of the research would be achieved; proposed methods

included, inter alia, estimating the stock status by assessing/comparing estimates of biomass derived from mark–recapture experiments, VPA analysis based on the length or/and age composition, and local depletions.

5.68 The Working Group noted that VPA analysis is based on an assumption of exact catch-at-age with consequent underestimation of associated uncertainty and that the technique does not generally use tagging data. The Working Group recommended that, of the proposed methods, tag-based integrated assessments had the highest likelihood of estimating sustainable yield that would be consistent with the objectives of Article II.

5.69 The Working Group noted that the proposed research design was constrained to areas where tags had previously been released. The Working Group noted that the estimates of biomass in SSRUs C and G in WG-FSA-12/39 were very different to those set out in WG-FSA-12/60 Rev. 1 for the same SSRUs, and emphasised that this required further attention.

5.70 The Working Group also questioned the level of experience the vessel had working in the CAMLR Convention Area, and that it would be valuable to get more information on both experience in the area and experience with respect to tagging toothfish. Dr I. Yeon (Republic of Korea) indicated that the captain of the vessel has had experience fishing in the Antarctic for toothfish.

5.71 The Working Group noted that the proposals in WG-FSA-12/60 Rev. 1 and 12/39 both included commitments to do toothfish ageing. The Working Group recommended that a commitment to ageing the toothfish in the research fishery should be made for all data-poor areas and be initiated in the short term and following the recommendations in Item 10.

5.72 With respect to catch limits proposed in both WG-FSA-12/39 and 12/60 Rev. 1, the Working Group agreed that the research-block-specific limits set out in WG-FSA-12/60 Rev. 1, Table 9, were appropriate to achieve the objectives of these proposals. It further agreed that this will be revisited next year depending on the level of recaptures in the coming season.

5.73 WG-FSA-12/69 provided a research plan for *Dissostichus* spp. to be undertaken by Spain in Divisions 58.4.1 and 58.4.2. This was an update and revision to the proposal submitted at WG-SAM (WG-SAM-12/13). The objective of the research is to estimate the local abundance of toothfish using depletion experiments and tag-recapture experiments in the same locations, enabling a comparison of the two methods. The Working Group noted that WG-FSA-12/69 addressed the specific requests of WG-SAM.

5.74 The Working Group recalled the depletion model described in Agnew et al. (2009) in this region. It was recognised that this analysis had been conducted using commercial C2 data, with no experimental design implemented. The Working Group agreed that controlled depletion experiments are expected to be of higher value than the opportunistic use of commercial data to look for evidence of local depletion, such that the results described in Agnew et al. (2009) were of little value with respect to evaluating the potential success of the research proposed in WG-FSA-12/69. The Working Group emphasised that depletion-type experiments cannot be expected to achieve their objectives in a multi-vessel Olympic fishery.

5.75 The Working Group agreed that there was great potential value in conducting a simultaneous depletion and tagging experiment, and the combined use of these techniques could provide a very useful understanding of the localised stocks of toothfish. However, some Members felt that there would be advantages in undertaking a trial experiment in another area.

5.76 With respect to the timetable for achieving the objectives of the research, the Working Group agreed that a depletion experiment, if successful, could provide enough information to estimate standing stock biomass for the local area in one season. The tagging component of this research, if treated similarly to other experiments in the Convention Area, would likely take 2–3 years (e.g. Subarea 48.4 North) before results would be useful. However, taken together, the research could be used to address other uncertainties in these divisions, such as localised movements or potential of recapture at different temporal/spatial scales.

5.77 WG-FSA-12/69 indicated that the depletion experiment will commence when the vessel locates an area with a threshold CPUE >0.3 kg/hook, and end when it declines to 0.2 kg/hook. The Working Group agreed that it was important to differentiate a detectable decline in CPUE from variability in CPUE, which can be due to many factors.

5.78 The Working Group recommended that a program, or routine, be prepared to determine when a decline in CPUE is statistically significant and that a clear decision rule be developed to determine a basis to start and stop the depletion experiment.

5.79 The Working Group recognised that, even in the absence of a statistically significant depletion, a large number of tags would be released in the single area. As such, there would remain value in returning to the locations where tags had been released.

5.80 The Working Group recommended that the experiment should not rely on one set to determine when to start, but on clusters of three to five sets. To that end, setting short lines would be worthwhile, with a standardised constrained soak time. The Working Group also recommended that clusters of three lines separated by 10 n miles may be appropriate to search for a concentration of fish appropriate to initiate the experiment.

5.81 In terms of a catch limit for this research, the Working Group recommended that, in the absence of further information, the catch limits should be set at a limit of 50 tonnes in each proposed SSRU. Catch rates and levels taken during the experiment will be reviewed by WG-FSA in 2013 to determine the appropriateness of continuing the research with these limits.

5.82 The Working Group noted that there are currently two registered VMEs in SSRU 5841H, and agreed that there needs to be an appropriate buffer zone around these VMEs. The Working Group recommended that during the searching phase, before the initiation of the depletion experiment, fishing should not occur within 10 n miles from the centre point of the two registered VMEs (Appendix F).

Division 58.4.3a (Elan Bank)

5.83 Information on this fishery is summarised in Appendix S.

5.84 During the meetings, a preliminary stock assessment using CASAL was initiated for Elan Bank (Division 58.4.3a). The data included in the model were catch-weighted length frequencies, catches including estimated IUU catches, tag-release and tag-recaptures. The Working Group agreed that this assessment model was in a preliminary state but could be further developed to provide management advice. The Working Group suggested that proposals for future research fishing on Elan Bank should be based on the estimates of stock size, status and potential yield using further development of this model.

5.85 Proposals for research fishing in Division 58.4.3a (Elan Bank) were submitted by France (WG-FSA-12/29) and Japan (WG-FSA-12/60 Rev. 1).

5.86 The Working Group noted that South Africa had submitted a paper to WG-SAM (WG-SAM-12/21) with the intention of conducting research fishing in Division 58.4.3a. However, this paper was not revised on the basis of advice from WG-SAM, and not resubmitted to WG-FSA. The Working Group was not in the position to comment on the merits of this research.

5.87 WG-FSA-12/29 presented a research fishing plan to be conducted in the forthcoming season using 82 longlines, with 28 research hauls. This proposal was a revision and update of WG-SAM-12/14. The revised plan provides a preliminary estimate of biomass using Division 58.5.1 as a reference area, and incorporates both legal and available IUU catches in the analyses.

5.88 The Working Group considered that the use of small-scale rectangles in this area may not necessarily be required. However, it was agreed that, as with all other research proposals that will rely on tagging, effort should focus in the regions where tags are already in the water.

5.89 The Working Group recommended that the fishing be constrained to the area where the tags were previously released, and that sets and tagging should be more evenly distributed across the entire Division 58.4.3a bank.

5.90 The Working Group agreed that there is currently enough information, due to the recapture of tagged fish, to undertake a preliminary stock assessment of *D. eleginoides* in this division. With respect to a future age-based assessment, the Working Group agreed that the ageing process is important, and noted that there are currently no plans by France to age otoliths collected from Division 58.4.3a. It was recommended that France take steps to ensure that otoliths from this research fishery are aged.

5.91 The Working Group noted that the proposal included a commitment to monitor depredation levels by killer whales, but no commitment to take necessary measures to avoid the impact of depredation on the research. The Working Group recommended that vessels undertaking research in areas where depredation is a risk should propose strategies to avoid or mitigate depredation, e.g. stopping hauling and moving to other locations, and the use of holding tanks to retain tagged fish until predators are no longer present.

5.92 The Working Group questioned the source of the estimate of biomass obtained by the CPUE × seabed area method in WG-FSA-12/29, as it was considerably higher than the corresponding estimates in WG-FSA-12/60 Rev. 1 obtained for the same area using both this method and the Petersen estimator. The Working Group noted that the CPUE and reference biomass estimate in WG-FSA-12/29 used data from Division 58.5.1, which may be

inappropriate for application in research proposals of this kind due to the way in which fishing effort locations are assigned in the French EEZ fishery. The Working Group further noted that all estimates based on CPUE × seabed area should be viewed with caution, and that the Petersen estimate in WG-FSA-12/60 Rev. 1 should be considered more reliable if the assumptions regarding available tags are appropriate.

5.93 The Working Group undertook a preliminary stock assessment using CASAL which provided a framework for length-based and tag-based assessments, but was unable to provide additional management advice based on this analysis, other than that the biomass in this region is likely to be <4 000 tonnes. The Working Group suggested that proposals for future research in Division 58.4.3a could base estimates of precautionary catch using further progression of this model.

5.94 Based on last year's catch levels and number of tag returns (nine tags), the Working Group recommend using the research catch as set out in WG-FSA-12/60 Rev. 1, Table 9, which indicated a total catch of 32 tonnes.

Division 58.4.3b (BANZARE Bank)

5.95 Information on this fishery is summarised in Appendix T.

5.96 WG-FSA-12/56 presented a research proposal by Japan for continued research on BANZARE Bank (Division 58.4.3b). This paper was a revision of WG-SAM-12/15 Rev. 1, and focused on the continuation of research surveys undertaken by Japan since 2006/07.

5.97 The Working Group noted that the survey design adopted last year by the Scientific Committee was not followed due to operational difficulties by the vessel. Mr N. Miyagawa (Japan) indicated that operational difficulties included very rough weather, snow and fuel running short. The fishing master felt the vessel may have been in danger and thus the survey was not completed.

5.98 The Working Group recalled SC-CAMLR-XXX, paragraphs 9.34 to 9.36, where it was agreed that further advice on population status and trends, and the potential for a future fishery in the area, could not be provided until such time as available data on the current status of the stock on BANZARE Bank, historical fishing data, the results of past surveys and current research, and estimates of past and ongoing IUU removals have been fully analysed and reviewed. In the absence of such a review, the Working Group was not able to provide additional advice on the research plan or to revise management advice.

Closed fisheries

Subarea 48.5 – Weddell Sea

5.99 WG-FSA-12/12 proposed a plan of research by Russia to conduct fishing research in Subarea 48.5 in 2012/13. This proposal is a revision of WG-SAM-12/04. Subarea 48.5 is currently closed to fishing, and there has been no commercial fishing for *Dissostichus* spp. in

this subarea. The Working Group noted that the proposal set out a 3–5 year research plan with three different options with respect to regions of Subarea 48.5 where research fishing is to be undertaken.

5.100 Dr A. Petrov (Russia) informed the Working Group that this research would be undertaken for a minimum of three years, and if conditions are favourable, research could potentially proceed in all three proposed areas in a single season. In particular, he noted that in the eastern region, satellite-based sea-ice distribution charts provided in WG-FSA-12/12 indicated that some areas are consistently ice-free from January to March.

5.101 The Working Group recommended that of the three survey areas proposed, option 2 (WG-FSA-12/12, Figure 6) likely had the highest probability to achieve the objective of the research, given the recent sea-ice charts provided.

5.102 The Working Group recommended a catch limit of 50 tonnes in the eastern research block (option 2), as this was unlikely to be met in the proposed 40 sets, as the estimated catch rate was based on commercial CPUE from SSRU 881H.

5.103 Further, the Working Group recommended that the survey design be modified such that it was based on a more grid-like, or cluster-based, survey design so that adjacent sets in a cluster would span a range of depths, as this would provide considerably more information about relative fish abundance as a function of depth and would increase the likelihood of tag recaptures in the survey area.

5.104 It was recognised that the first component of this research could lead to indicative estimates of CPUE for the surveyed region, and potentially an initial estimate of biomass, but that a rigorous stock assessment involved considerably more information, such as gear selectivity, productivity, information on age and growth etc. The Working Group noted that the research proposal in WG-FSA-12/12 planned to provide a CPUE-based biomass estimate after three years of research fishing.

5.105 Several members of the Working Group were concerned that the heavy sea-ice in the Weddell Sea, and uncertainty in ice conditions (often changing on a daily basis), could impede efforts to return to the same research areas in subsequent seasons in order to recapture tags, thereby seriously compromising the ability to achieve the research objectives.

5.106 Some Members were concerned about vessel safety in the Weddell Sea given heavy sea-ice conditions. Although it was recognised that this was not a science question, the Working Group agreed that this should be taken into consideration by the Scientific Committee and Commission during deliberation of this research proposal.

5.107 Dr Petrov made the following statement to WG-FSA:

> ‘While Russia respects the Working Group’s opinion, Russia has its own view regarding its planned research in Subarea 48.5. Unfortunately, our view was not heard during the discussion within the Working Group. Russia’s scientific research plan fully meets the requirements of CM 21-02, paragraph 6(iii), and the requirements of the Scientific Committee (SC-CAMLR-XXX, Annex 5, paragraph 2.35). Russia will follow the advice of the Working Group to focus its research on option 2 (WG-FSA-12/12, Figure 6) with a catch limit of 50 tonnes. However, Russia would like to

emphasise that during discussion at the Working Group no objections other than ice-condition uncertainty were made regarding two other options (1 and 3) and all three options fully meet the requirements of CM 21-02 and CM 24-01 as reflected in Table 9 of the WG-FSA report. In this regard, Russia wishes to have its proposition better considered that if in the forthcoming 2012/13 season the areas in options 1 and 3 become free of sea ice, its intention in that proposal was to conduct research in these areas, with a catch limit 60.6 tonnes for option 1 (based on 50 longline stations × 6.0 km × 0.202 tonnes), and 111.84 tonnes for option 3 (based on a combined catch limit 'Eastern zone' + 'Western zone'). These catch limits are calculated based on advice contained in SC-CAMLR-XXX, Annex 5, Table 2.'

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

5.108 Information on this fishery is summarised in Appendix U.

5.109 The Working Group considered a preliminary CASAL stock assessment for *D. eleginoides* in SSRU 5844C (WG-FSA-12/59) and noted that IUU catches from the mid-1990s have not been incorporated into the model. The Working Group recommended sensitivity runs of the model using levels of IUU in SSRU C, ranging from zero to assuming that all observed IUU fishing in the division was from SSRU C.

5.110 The Working Group discussed whether model estimates of YCS, which showed an increasing trend between 1998 and 2005, might represent an actual increase in recruitment due to density dependence following release from IUU fishing and recommended sensitivity runs with YCS fixed at 1.

5.111 The Working Group considered that some estimates of age-at-length (Figure 1 of WG-FSA-12/59) were implausible and recommended that methods for age determination need to be better calibrated and validated (paragraph 5.119).

5.112 In the model fits, the combined penalties and priors appear to have a large effect in the likelihood profile for SSB_0. The Working Group recommended an evaluation of the effects of separated penalties and priors and exploration of alternative prior assumptions. In addition, the MPD and MCMC values estimated by the model were dissimilar, indicating either that the MCMCs had not converged or that there was some other structural problem.

5.113 The Working Group agreed that this assessment model was in a preliminary state but could be further developed to provide management advice in the future.

5.114 WG-FSA-12/58 Rev. 1 presented a research plan in Divisions 58.4.4a and 58.4.4b, and was a revision of WG-SAM-12/17. The paper proposed to continue the mark–recapture experiment previously undertaken in 2010/11 and 2011/12. While research in previous years was focused in SSRUs B and C, the updated paper proposed to discontinue the research in SSRU B and focus future research in SSRUs C and D. The rationale for moving the research fishing was based on high and annually increasing levels of depredation by killer whales in SSRU B over the past three seasons.

5.115 The Working Group agreed that it was likely that depredation was having a detrimental effect on the achievement of the research objectives by decreasing the potential

for retrieving tags and creating considerable uncertainty in the estimation of total removals. On this basis, the Working Group recommended that research fishing in SSRU B should be discontinued.

5.116 The Working Group also recommended that this and future research plans should implement strategies to avoid or mitigate depredation by killer whales early, before whales become habituated to fishing vessels and depredation increases to high levels.

5.117 The Working Group agreed that estimates of unaccounted mortality arising from killer whale depredation should be taken into consideration in future assessments, noting the method of Moir-Clark and Agnew (2010).

5.118 The Working Group noted that, consistent with recommendations of WG-SAM (Annex 5, paragraph 4.15), in SSRU C a preliminary stock assessment using CASAL had been presented to WG-FSA this year (WG-FSA-12/59) and that the proposed research program can be expected to contribute to an improved assessment in subsequent years.

5.119 The Working Group noted questions about the age–length key utilised in the SSRU C assessment and agreed that checking and supplementing the age data is a priority and that ageing from Ob and Lena Banks would also assist with understanding recruitment variability. Dr Taki informed the Working Group that within these divisions it is planned to expand the ageing program that led to the original age–length data used in the assessment.

5.120 The Working Group recommended that proposed research design and development of the CASAL-based assessment in SSRU C continue.

5.121 The Working Group noted that the research design has been shown to contribute data to the development of a preliminary assessment for SSRU C, and that the vessel and research proponents have a good track record of contributing useful science arising from their research results to WG-FSA, and of utilising these results to progress towards stock assessments in this division.

5.122 Some Members also noted that the potential to recapture tags that have moved between SSRUs would provide additional information about fish movements and stock structure. Some Members felt that, on this basis, the same research design implemented successfully in SSRU C should be extended to SSRU D.

5.123 Dr Welsford also noted that the research proposal for Division 58.4.4 was originally proposed in 2008 with the expectation that after three years a stock assessment would be produced. This expectation was not met. He further noted that it was important to remain focused on refining the assessment for SSRU C following the recommendations above, as this would provide a firm basis for evaluating the likelihood that the research design described in WG-FSA-12/58 Rev. 1 would also be successful in other SSRUs.

5.124 Other Members felt that the research should remain focused only in SSRU C until a full assessment is completed, in addition to noting the failure of the research to progress an assessment in SSRU B due to rapidly increasing killer whale depredation.

5.125 The Working Group noted that SSRU D was the only SSRU in which killer whale depredation has not been recorded during past research in this division.

5.126 The Working Group agreed that, if the research is extended into SSRU D, then the research design proposed in WG-FSA-12/58 Rev. 1 is appropriate, but that the continuation of research in SSRU C is the highest priority. The Working Group recommended that, if research occurs in both SSRUs, then in the coming year all planned research sets in SSRU C should be completed before research in SSRU D is initiated.

5.127 The Working Group noted that a catch limit of 70 tonnes was adopted for this division for 2011/12, but that only 28.3 tonnes were caught during the survey of SSRUs B and C. It further noted that, given the research design and expected catches, the catch limit is unlikely to be reached. The Working Group agreed that the catch limit should be set higher than anticipated catches to reduce the likelihood that the survey design has to be abandoned before completion in the event that catches are higher than anticipated, but that the catch limit should be appropriately precautionary given available information, including the fact that the fishery for this stock was closed in 2002 based on the conclusion that it was depleted.

5.128 It was noted that updated Petersen biomass estimates in WG-FSA-12/58 Rev. 1 estimated a biomass of 1 725 tonnes in SSRUs B and C. Therefore, the 70 tonne catch limit proposed in WG-FSA-12/58 Rev. 1 implies a local exploitation rate of 4.1%.

5.129 The Working Group noted that the application of these estimates to SSRUs C and D, instead of SSRUs B and C, requires assumptions about the relative abundance of fish between these two SSRUs. It noted that CPUEs in SSRU D from past research fishing by the *Shinsei Maru No. 3* were higher than in SSRU B in 2012, implying that the actual exploitation rate within SSRUs C and D may be lower than 4.1%. It further noted that the local biomass estimate is for only two of the four SSRUs, such that the overall exploitation rate of toothfish populations across the division as a whole will be lower than the local estimate.

5.130 Some Members recommended that the existing catch limit of 70 tonnes be retained consistent with advice in 2011/12 (SC-CAMLR-XXX, Annex 7, paragraphs 5.22 and 5.23), which included consideration of precautionary assumptions about historical depletion rates using the method of WG-FSA-10/42.

5.131 Other Members felt that the catch limit should be reduced to 50 tonnes (estimated local exploitation rate 2.9%) on the basis that lower exploitation rates are more appropriate if research was to proceed in SSRU D, given uncertainties in the current biomass and status of the stock in Division 58.4.4. They also noted that 50 tonnes was a closer reflection of the expected catches for the proposed survey design, and therefore was unlikely to restrict the survey in SSRU D if it proceeds in 2012/13.

5.132 The Working Group recommended that the Scientific Committee consider a catch limit in the range of 50 to 70 tonnes for this research in 2012/13, and that the catch limit be revisited in 2013/14 on the basis of new information from this research.

Generic issues applicable across all research proposals

5.133 The Working Group requested guidance from the Scientific Committee regarding maximum acceptable exploitation rates for research in data-poor or closed fisheries in order to guide both the design and evaluation of research proposals. Estimated local exploitation rates in research proposals agreed by the Working Group (WG-FSA-12/60 Rev. 1, Table 9) range

from 0.3% to 5.1%. It was further noted that an exploitation rate near 0% could also be an option, whereby all fish caught during the course of a research survey could be tagged and released.

5.134 The Working Group noted the conclusions of WG-FSA-12/18 that poor data arising from low tagging size overlap may be expected to produce biased biomass estimates, especially in the early years of research programs with low numbers of recaptures, i.e. as is expected for all new research proposals. The Working Group recommended that vessels undertaking research should seek to achieve the highest possible tag overlap rather than merely achieving the minimum required overlap of 60%. The Working Group further noted that a tag overlap that over-catches large fish will deviate from 100% the same as a tag overlap that over-catches small fish, and that evaluation of tag-overlap statistics should distinguish between these two situations.

5.135 The Working Group noted that, where spatially constrained research designs proposed by Members under CM 21-01 are approved, the requirements of CM 41-01, Annex B, as applied in 2011/12, under which the Secretariat-designated fishable fine-scale rectangles where fishing may occur, are no longer relevant. Both conservation measures seek to achieve the same outcome by focusing fishing effort in areas where tags are available for recapture, but via a different mechanism. The Working Group noted that the fine-scale rectangle approach under CM 41-01, Annex B, is still useful where particular research designs have not been designated in advance, and requested that the Scientific Committee consider whether either or both approach(es) are preferred in future.

5.136 The Working Group noted that sea-ice may interfere with research designs that require vessels to return to the same area in consecutive years, and recommended that future research proposals include information to enable WG-FSA to evaluate typical or historical ice conditions that may affect research feasibility.

5.137 The Working Group recommended that coordination between multiple vessels undertaking research fishing in the same area should be encouraged, and that there is scientific value in designing this coordination such that multiple vessels undertake research fishing in highly spatially overlapping areas. This will provide a maximum amount of information, allowing for comparisons between gear selectivity, catch rates, catch composition, tag recaptures, and other factors that are indicative of vessel performance and/or that will elucidate how research fishing can be optimised. It was agreed that:

(i) this type of coordinated research could substantially decrease the time necessary to collect information that would lead to a robust stock assessment

(ii) Olympic-style fishing would compromise effective research implementation

(iii) the scientific merit of the research will be substantially improved if there is a balance of catch and effort between the vessels fishing in the same spatially constrained area.

5.138 The Working Group recalled the CCAMLR-2000 Survey, which was a multi-national, multi-vessel, coordinated effort that yielded sufficient information to successfully allow a

stock assessment of krill in Area 48. Following a multi-national, multi-vessel, collaborative effort for finfish research could also prove very valuable toward gathering information to conduct a stock assessment in relatively short order.

5.139 The Working Group recalled the advice of the Scientific Committee (SC-CAMLR-XXX, paragraph 3.123) that the failure to achieve stock assessments in data-poor fisheries may be a consequence of research implementation rather than research design and noted that the track record of the individual vessels carrying out the research was relevant in the evaluation of research proposals. Relevant considerations include:

(i) past compliance with CCAMLR conservation measures (vessel dependent)
(ii) past tagging performance (vessel dependent)
(iii) fulfilment of prior commitments to conduct research (Member dependent)
(iv) subsequent delivery of analyses of the resulting data in ways that are likely to produce stock assessments (Member dependent).

5.140 The Working Group noted that only one vessel, the FV *Koryo Maru No. 11* (South Africa), did not meet the target tag-overlap statistic of 60% in 2011/12 in Division 58.4.2 (Table 5). For future research, the Working Group agreed that the value achieved in the tag-overlap statistic in previous years should be taken into consideration. The Working Group referred this matter to SCIC for further consideration.

5.141 The Working Group noted that the methods provided in WG-FSA-12/44, which evaluated the relative tagging performance in terms of tag detection and tag mortality between individual vessels, could also be used to evaluate vessel performance in future years.

5.142 The Working Group agreed that analysis of research implementation and vessel performance is important for a robust evaluation of research proposals to succeed, and that this analysis should include all vessels involved in the research fishery. It agreed that there was neither the time nor appropriate resources to undertake these evaluations during the course of the meeting.

5.143 The Working Group recommended that a framework for analysis of research implementation, vessel performance and associated quantitative metrics be developed, preferentially in collaboration with SCIC (as several aspects of these sorts of evaluations are coupled with compliance). The development of this framework could take place during the intersessional period and potentially be implemented at the next meeting of WG-FSA.

Results of research in exploratory fisheries

5.144 The Working Group considered WG-FSA-12/13 describing the results of two years of research fishing by Russia in Subarea 88.3. The authors presented a summary of the catches and biological data collected during the surveys, noting that ice conditions were much worse in 2012 and fishing was restricted to SSRU C. The authors presented catch estimates for SSRUs 883B, C and D based on the comparative CPUE method recommended by WG-SAM (SC-CAMLR-XXX, Annex 5, paragraph 2.40ii) for research plans and used an exploitation rate of 10% to calculate a yield of 343 tonnes. Dr Petrov recommended the Working Group consider this preliminary assessment of toothfish in Subarea 88.3.

5.145 The Working Group noted that, although this method is approved for use in providing indicative estimates of abundance for proposed research surveys, it is not considered sufficiently reliable for deriving catch limits for an exploratory fishery using the CCAMLR decision rules. The Working Group also noted some methodological problems with the estimates provided, including the absence of a discount factor (SC-CAMLR-XXX, Annex 5, paragraph 2.40iv) and the use of an exploitation rate of 10% to estimate yield.

5.146 The Working Group recalled that the original proposal was for three years of research (SC-CAMLR-XXIX, paragraphs 9.17 to 9.20), which would have allowed for at least two years of tag recaptures. Dr Petrov explained that Russia was unable to complete the third research survey because no vessels with the same fishing gear and experience were available for the 2012/13 season.

5.147 Dr Petrov noted that, based on the result of WG-FSA-12/13, Russia recommended that SSRUs 883B and C be opened as an exploratory fishery with a catch limit of 343 tonnes. He noted that these data represent the best available information for this subarea. He requested that this recommendation be considered by the Scientific Committee.

5.148 Dr Welsford did not consider that it was appropriate to open an exploratory fishery in SSRUs 883B and C, given the lack of a stock assessment for these areas.

5.149 The Working Group considered WG-FSA-12/15, describing the results of two years of research fishing by Russia in SSRU 882A. The authors presented catch estimates for SSRU 882A based on the CPUE method recommended by WG-SAM (SC-CAMLR-XXX, Annex 5, paragraph 2.40ii) for research plans which equalled 286 tonnes. Dr Petrov recommended the Working Group consider this preliminary assessment of toothfish in SSRU 882A.

5.150 The Working Group noted that this method is not considered sufficiently reliable for deriving catch limits for an exploratory fishery in accordance with the CCAMLR decision rules, and that there were again methodological issues with the lack of a discount factor and the exploitation rate used to estimate yield. No tags were recovered from previous releases from this SSRU or the adjacent SSRUs in Subarea 88.1. The Working Group also noted that SSRU 882A is currently assessed as part of the Ross Sea assessment (SC-CAMLR-XXX, Annex 7, Appendix R) and that results of research carried out in SSRU 882A would be most appropriately included within the Ross Sea assessment.

5.151 Dr Petrov noted that, based on the result of WG-FSA-12/15, Russia recommended that SSRU 882A be opened as an exploratory fishery with a catch limit of 286 tonnes. He noted that these data represent the best available information for this SSRU and that the area should be opened for rational use. He also noted that, if this area were opened, then this would relieve some of the pressure in SSRUs 881H, I and K. He requested that this recommendation be considered by the Scientific Committee.

5.152 The Working Group discussed how SSRU 882A could potentially be opened and managed as part of the Ross Sea fishery. In particular, how catch limits from the Ross Sea assessment could be applied to this SSRU, and whether additional research should be undertaken, given the paucity of information from this region. There is also uncertainty as to the stock affiliation and movements between SSRU 882A and the adjacent SSRUs 881K

and L. Collection of data on movements could also be valuable for informing movement hypotheses identified by Hanchet et al., 2008 and WG-FSA-12/P02, and to inform the spatial models (WG-FSA-12/44).

5.153 The Working Group reviewed WG-FSA-12/41 presenting the results of the first pre-recruit survey of Antarctic toothfish in the southern Ross Sea by New Zealand. It noted that the authors had included the additional analyses requested by WG-SAM (Annex 5, paragraph 4.23).

5.154 The Working Group noted that the design of the proposed 2012/13 survey had been supported by WG-SAM, including the assignment of 15 sets to the Glomar Challenger trough to the northeast of the three core strata (Annex 5, paragraph 4.22). However, it also recommended that some stations continue to be surveyed in the shallower (400–500 m) strata, in case the depth distribution of fish changed between years. The Working Group agreed that this would be best accomplished by moving five stations from the core strata into the 400–500 m depth strata (stratum D12 in WG-FSA-12/41).

5.155 The Working Group noted that it was intended to try including the results of the 2012 and proposed 2013 surveys as input to the 2013 stock assessment (using CASAL) for the Ross Sea fishery. The results of the work will provide additional proportion-at-age data of toothfish not fully recruited to the fishery and a time series of abundance index for these age classes. With two surveys, there should be sufficient data to try estimating YCS in the stock assessment model as a sensitivity analysis. The Working Group also noted that, independent of its contribution to the model, the pre-recruit survey may enable detection of a change in recruitment earlier than would be reliably detected using data from the commercial fishery alone.

5.156 The Working Group reviewed WG-FSA-12/56, describing the results of research by Japan in Division 58.4.3b. It noted that, due to operational difficulties and poor weather, only 22 of the planned 48 research hauls were completed in 2012 and no tagged fish were recaptured. The Working Group agreed that the survey had provided useful new information on the comparison of CPUE between the trotline and Spanish systems and on the suitability of fish for tagging between the two methods.

5.157 The Working Group reviewed WG-FSA-12/57, describing the results of research by Japan in Division 58.4.4. It noted that the authors had included details of the measures used to avoid killer whale depredation as requested by WG-SAM (Annex 5, paragraph 4.12). Despite these measures, killer whale depredation in SSRU 5844B may still have compromised the success of research in this area. The Working Group agreed that there has been a low incidence of killer whales in SSRU 5844C, and that research carried out in this area has been more successful.

5.158 The Working Group noted that in Division 58.4.4 killer whales were generally more frequently seen and were in higher numbers in SSRUs A and B than in SSRUs C and D. The Working Group noted that a standardised CPUE analysis showed that catch rates were 40% lower when killer whales were present when the lines were being hauled, and recommended that future analyses should include gear type (e.g. trotline or Spanish line) in the analysis. Tag recaptures from this research had provided the data necessary to develop a preliminary stock assessment for *D. eleginoides* in SSRU 5844C (WG-FSA-12/59).

Research methods

5.159 WG-FSA-12/18 presented a simulation study to examine the influence of a low tag-overlap statistic (matching the length distribution of tagged fish with the length distribution of captured fish), the numbers of tagged fish, depletion history, the scan rate (catch), and the number of years of tag releases and recoveries, on the accuracy and precision of estimates of SSB_0 and $SSB_{current}$ from an integrated assessment model using CASAL. Variable tag size overlap levels resulted in a changing pattern of expected tag recoveries through time, as tagged fish grew and were selected more or less frequently by the fishery.

5.160 Low tag overlap was the most influential factor, acting to generate conflict in the fits to different data sources and generating an overestimation bias in this example. This effect degraded with longer data time series, and was not greatly influenced by the number of tags deployed or the scan rate. Because the mechanism of influence within a model is complex and depends on the actual assumptions and model configuration, the Working Group recommended that it would be important to examine the potential for further bias in each situation. For example, bias of the Ob and Lena assessment (WG-FSA-12/58 Rev. 1) was simulated, and was underestimating biomass by 16%.

5.161 The Working Group agreed that a tag-overlap statistic of at least 60% was supported by the study (WG-FSA-12/18), and encouraged vessels to maximise their overlap statistic, especially in the context of new fisheries or research proposals where initial models are likely to rely on low numbers of recaptures.

5.162 The Working Group suggested that, because consistent trends in recruitment estimates emerged in the simulations, it would be useful to examine the influence of fixing recruitment for this analysis. Further work is needed to understand the mechanism of why the degree of tag overlap influences assessment model performance. The conclusions of this paper will be incorporated into the research design recommendations for research plans in exploratory fisheries.

5.163 WG-FSA-12/44 and 12/45 described the further development of SPM in the Ross Sea region. The SPM presented in WG-FSA-12/44 is illustrative only, but is already generating realistic spatial distribution patterns and fits with observed fishery data. The Working Group noted that the primary purpose of developing SPM is to test the potential bias of single-area population models under assumptions implicit with various ontogenetic migration patterns. Estimating this potential bias was investigated in WG-FSA-12/45. Initial results suggested a small negative bias in the single-area model relative to the spatial model. The Working Group encouraged further development.

5.164 WG-FSA-12/47 Rev. 1 used a case-control study which controls for the confounding effect of factors such as time and location for tagging and size of fish tagged to develop relative indices of tagging mortality and the detection rate of recaptured fish for individual vessels.

5.165 The Working Group noted that this was a powerful and useful analytical approach and recommended it be used to develop a data-quality selection algorithm to select trips for use in the Ross Sea assessments. The actual selection criteria remain to be developed for discussion at WG-SAM-13.

5.166 One of the components of a successful tagging program is to be sure that the fishing method provides adequate numbers of fish suitable for tagging across the entire size range of fish captured. New data collection forms introduced in 2012 were designed to allow an evaluation of the suitability of fish captured for tagging. WG-FSA-12/49 summarised the data collected to date and recommended some changes to the data collected. The paper also used paired trotline–Spanish line experimental gear to estimate relative differences in length selectivity between the two gear configurations used. Those results suggested that the trotline catch rates were higher for medium-sized *D. eleginoides*, but about the same for very small and very large fish.

Tagging training

5.167 As indicated in WG-FSA-12/47 Rev. 1, the Working Group recognised that the significant differences in relative tagging mortality and relative recapture rates between vessels suggest that improvement of performance in both tagging deployment and tagging recovery is needed on some vessels.

5.168 Following advice from WG-SAM (Annex 5, paragraphs 2.1 to 2.31) an intersessional ad hoc tagging group further developed a toothfish and skate tagging protocol checklist. This checklist is intended to be a reference for fish tagging and a tagging training module for all involved (observers and crew) in tagging and recapturing toothfish or skates, as presented in WG-SAM-12/31.

5.169 A nine-step tagging checklist was developed, covering fish handling to tagged fish release (Appendix D). Currently, the checklist is in text form, but the Working Group recommended that the checklist should be transformed into a diagrammatic version that contains minimal text and uses graphics (drawn or photographic) to convey the essential information.

5.170 The Working Group noted that using new technologies to minimise recording errors should be investigated. Developing data recording methods and error trapping at data entry could improve recovered tag linking and potentially reduce the time fish are out of the water during the tagging procedure.

5.171 The Working Group agreed with the recommendations of WG-SAM (Annex 5, paragraph 2.26) that weighing fish to be tagged was not necessary.

5.172 The Working Group noted that the condition of tissue surrounding the tag attachment site is typically documented with photographs for recaptured fish. However, collecting these data places demands on observer time and the benefits of collecting these data have not been evaluated. The Working Group recommended that data derived from tag site photographs be evaluated intersessionally with a view to providing recommendations on the value of continuing to collect these data routinely.

5.173 The Working Group recommended that the ‘fish condition and hooking injury form’ for use in exploratory fisheries be modified to assess fish using the tagging suitability categories, detailed in Appendix D. These higher-resolution categories would be much more useful in the analysis of gear configuration and fishing operational effects on the suitability of fish for tagging.

5.174 The Working Group recommended that the L11 tag deployment form only record the fate of the tagged fish if the tag deployment was observed to fail. In that case, the reason for the failure should be noted (e.g. fish attacked by predator, and the type of predator identified) from a dropdown list in the form.

5.175 The Working Group recommended that the text-based tagging checklist be implemented in the upcoming season, and that a diagram-based version be developed and implemented intersessionally. The Working Group also recommended further development of the tagging training module to incorporate video and photographs for review by WG-FSA-13.

5.176 The Working Group noted the use of holding tanks on some vessels during the tagging procedure and encouraged Members to provide details of these, including, when used, effectiveness, size and materials of tank.

5.177 The Working Group noted concerns about potential increased loss of T-bar style tags from skates in comparison to dart tags. Pole tagging using dart tags while fish were in the water has been trialled, but tag-shedding and post-tagging mortality rates were likely to be high. Tagging fish brought on board with dart tags has also been carried out by some Members with more success. Noting that using two different tag types and applicators would incur extra cost and some potential for confusion, the Working Group encouraged comparative work from existing skate recaptures to examine tag-shedding rates of T-bar tags if possible.

5.178 Notwithstanding the advice of WG-SAM that implementation of an incentive system may be difficult (Annex 5, paragraph 2.22), the Working Group noted that some incentive program designs may be feasible and serve to improve the performance of tag deployment and tag recoveries. The Working Group considered that a program that included the key principles below could be successful:

- The incentive scheme should be a lottery to permit a substantive prize.
- The lottery should be comprised of verified tags returned to CCAMLR any time after the fishing season the tag was deployed.
- The lottery winner should be the vessel that recovered the tag (as opposed to an individual), with a corresponding prize to the vessel releasing the tagged fish. This recognises the entire vessel crew as a team (as all do not handle fish), and creates an incentive for vessel operators to encourage good tagging and tag-recovery performance.
- The prize should be funded by fishing Members only, for example, a levy on purchased tags or on the notification application fee for fishing in exploratory fisheries. A single prize could be awarded annually.

5.179 The Working Group requested that the Secretariat produce a tagging poster for display on vessels to encourage checking for tag recaptures, including details of the tag lottery.

5.180 The Working Group recommended that a tag recovery lottery system with the characteristics noted above be considered for development intersessionally if adopted.

5.181 The Working Group noted that the tagging training module developed by the intersessional correspondence group is currently configured as an MS PowerPoint, describing the purpose and importance of the tagging program, plus the details of tag-deployment and tag-recapture protocols. Several Members have provided photographs and videos that could be used as training materials for those tagging toothfish and skates. The Working Group noted a list of desired photographs and videos of particular tagging operations to better describe the proper tagging process and to be used in the training module, including examples of:

(i) fish landing and handling techniques for each gear type
(ii) evaluation of suitability to tag
(iii) configuration and use of holding tanks
(iv) tagging station layout
(v) tag application
(vi) fish release
(vii) data recording
(viii) tagging of toothfish and skates
(ix) tag-recovery operations
(x) toothfish and skate biological sampling (otoliths, gonad weights, tag site photos, tag documentation).

5.182 The Working Group noted it is important that examples are received from a variety of vessels and vessel configurations so that the training module is directly applicable to all operations. It requested that photos and videos could be submitted intersessionally through the CCAMLR tagging program coordinator by 1 July 2013 to be incorporated into the tagging training module and presented to WG-FSA-13. Photo and video credits will be listed in the training module.

5.183 The Working Group recommended that, to improve the performance of the tagging program, all persons tagging toothfish and skates in CCAMLR longline fisheries should be trained to do so. Training resources will be enhanced through the use of the tagging training module, and once implemented, could be used by vessel crews and observer programs.

5.184 To be able to target the appropriate audience for training, the Working Group recommended that the person or people tagging or recovering tagged fish are identified as crew (C), observer (O) or mix of observer and crew (M) in the L11 tag deployment and L12 tag recovery forms.

Assessment and management advice for depleted and recovering stocks

Subarea 48.1 – *C. gunnari* and *N. rossii*

5.185 WG-FSA-12/10 summarised the results of a random stratified trawl survey undertaken on the shelf of the South Shetland Islands (Subarea 48.1). The Working Group recalled that *C. gunnari* and *Notothenia rossii* were heavily exploited in this subarea in the late 1970s and 1980s, and the fishery was closed in 1990/91 due to a collapse of these stocks. Thus, the recovery of these species from depletion is of considerable interest to CCAMLR.

5.186 It was noted that *C. gunnari* were regularly encountered across much of the western and northern shelves of Elephant Island (WG-FSA-12/10, Figure 2F). The estimate of total

standing stock biomass for *C. gunnari* (WG-FSA-12/10, Table 3A) for the total surveyed area was 25 038 tonnes, primarily composed of age 3+ fish. The Working Group noted that the survey indicated the first substantial signal of recovery for this stock, and the highest level of biomass observed since the fishery was closed and the stock monitored on a semi-annual basis by the USA and Germany (1996 to 2012).

5.187 The Working Group recommended that this fishery remain closed until such time that another survey(s) be undertaken to confirm the recovery of these populations and an assessment be undertaken.

C. gunnari Kerguelen Islands (Division 58.5.1)

5.188 There is currently no Fishery Report for this species in Division 58.5.1.

5.189 The Working Group reviewed a preliminary stock assessment of *C. gunnari* in the vicinity of the Kerguelen Islands (Division 58.5.1) based on the 2010 POKER biomass survey (WG-FSA-12/16 Rev. 1). The assessment used the same procedure to that used for this species in Division 58.5.2.

5.190 The Working Group agreed that it may be possible to compare dynamics between icefish populations in Divisions 58.5.1 and 58.5.2 based on recent survey results (e.g. correlations in trawl surveys). Recruitment between two areas may indicate that the different populations are responding to environmental changes at the scale of the Kerguelen Plateau (e.g. Sokolov and Rintoul, 2009).

Management advice

5.191 The Working Group agreed that the approach outlined in WG-FSA-12/16 Rev. 1 was a valid methodology to use for assessing icefish in this division and encouraged progress toward a new assessment based on the 2013 POKER survey.

BOTTOM FISHING ACTIVITIES AND VULNERABLE MARINE ECOSYSTEMS

6.1 WG-FSA-12/27 compared the rates at which VME by-catch is observed on autoline sets versus Spanish gear longline sets in the Ross Sea region fishery, and models the relative probability of detecting VME taxa using these gear types as a function of depth. While the authors noted that biased reporting between vessels would change the outcome of the calculations, they concluded that autolines have a higher impact on VME taxa relative to Spanish longlines.

6.2 The Working Group noted that the analysis compares VME taxa by-catch at the surface between different gear types, and that this may not be related to the level of impact occurring to VME taxa on the bottom. Some Members noted that model calculations are

likely to be sensitive to the way in which the model treats observations of zero by-catch, and that alternate methods may be more appropriate. On this basis, the Working Group did not support the conclusions regarding relative levels of impact between gear types.

6.3 The Working Group agreed that further work to evaluate VME impacts by longlines would likely require direct observations of gear behaviour in contact with the seafloor, for example, using cameras (WG-FSA-08/58 and WG-EMM-10/33), as differences among fishing gears, especially with depth, can influence the ability to map VME taxa distributions with longline gears. Dr Brown informed the Working Group that camera work of this kind on different gear types was currently in progress in Subarea 48.3. The Working Group encouraged Members to continue with this work and to submit the results for further consideration within CCAMLR. The Working Group encouraged progressing this work, including incorporating additional factors (e.g. hauling time, hauling speed, or weather conditions) and considering a case-control approach described in WG-FSA-12/47 Rev. 1 to control for spatial heterogeneity.

6.4 WG-FSA-12/69 proposed research fishing using a depletion experiment design in SSRU 5841H (paragraph 5.73), in which two VMEs were registered under CM 22-06 based on information from direct observation using underwater video (WG-EMM-08/38). The Working Group discussed the particular research design of the fishing experiment in WG-FSA-12/69 and recommended that during the 'searching' phase prior to initiation of the depletion experiment, fishing should not occur within 10 n miles of the registered VME locations. This requirement will ensure that in the course of the depletion experiment fishing will not occur within 5 n miles of the registered VMEs.

6.5 The Working Group noted that under the requirements of CM 21-02, fishing in data-poor areas will occur in the context of approved research designs, but that, where existing conservation measures, such as CMs 22-06 and 22-07, have the potential to impact that research (for example research using tethered cameras to investigate longline impacts on known VMEs), it is unclear whether there exists a mechanism to exempt fishing under CM 21-02 from these requirements, as currently exists for research under CM 24-01. The Working Group agreed that resolution of these questions would require guidance from the Scientific Committee and/or Commission.

Review of VMEs notified in 2011/12

6.6 The Working Group noted that in 2011/12, 38 VME risk areas were triggered under CM 22-07 (CCAMLR-XXXI/BG/06) and six new VMEs were recommended by WG-EMM for inclusion in the VME registry under CM 22-06 (Annex 6, paragraphs 3.82 to 3.93).

Review of preliminary assessments of the impact of bottom fishing

6.7 The Working Group recalled the advice of WG-FSA-11 (SC-CAMLR-XXX, Annex 7, paragraphs 7.11 to 7.13) and agreed that in future the Secretariat should review preliminary VME impact assessments included in Members' notifications to participate in new and

exploratory fisheries, in consultation with Members where required, to update Tables 1 and 2 in the Report on Bottom Fisheries and VMEs (SC-CAMLR-XXX, Annex 7, Appendix D) and report the results for consideration by WG-FSA.

6.8 The Working Group noted that all notifying Members provided the required information to inform VME impact estimates in their research notifications this year, but that not all of this information was easily located and in a format that facilitated easy integration into Appendix F.

6.9 The Working Group conducted a review of the preliminary assessments of bottom fishing activities provided by Members notifying to fish in exploratory fisheries. The review consisted of summarising the information required for Table 2 of Appendix F, and producing spatial summaries of historical fishing effort using the cumulative impact assessment framework incorporated into the plotImpact software (WG-FSA-12/55).

6.10 The Working Group noted that the historical spatial summaries of footprint and percentage impact provide the best summary of estimated impacts to date, and that the proposed fishing effort in each subarea or area/subarea/division (ASD) is dependent on catch limits in each area, accessibility due to sea-ice, and decisions made during fishing operations throughout the season. Therefore, accurate predictions of the spatial distribution of proposed fishing effort cannot be made within each subarea or ASD, or even among ASDs. Furthermore, the Working Group noted that the rate at which the cumulative impact is growing in each ASD is small relative to the estimated cumulative impact and can be evaluated by examining the historical fishing footprint and impact estimates provided in Appendix F.

6.11 The Working Group recommended that the potential for bottom fisheries to cause significant adverse impacts to VMEs could be evaluated with available fishing data, and does not require information on proposed effort for the upcoming season. The Working Group recommended that, if this approach to assessing the potential for bottom fishing to have significant adverse impacts on VMEs as required in CM 22-06 is adopted, then the preliminary assessments submitted via CM 22-06, Annex A, would no longer be required and Annex A could be removed.

6.12 As new information becomes available to inform gear-specific footprint and impact estimates for trotlines, Spanish lines, pots and trawls, e.g. using tethered cameras as in paragraph 6.3, then the gear-specific input parameters used in the impact assessment framework and associated spatial impact summary software (paragraph 6.13) can be updated.

Report on Bottom Fisheries and VMEs

6.13 WG-FSA-12/55 described an update of the plotImpact software adopted by the Scientific Committee in 2011 to produce combined cumulative VME impact assessments and impact maps using Secretariat databases (SC-CAMLR-XXX, paragraph 5.4). The updated software has been developed into an R library with improved functionality. The Working Group welcomed these developments.

SCHEME OF INTERNATIONAL SCIENTIFIC OBSERVATION

7.1 In accordance with CCAMLR's Scheme of International Scientific Observation, scientific observers were deployed on all vessels in all finfish fisheries in the Convention Area in 2011/12. Information collected by scientific observers was summarised in WG-FSA-12/66 Rev. 2 and 12/70 Rev. 2.

7.2 The Working Group noted that training resources, such as guides for maturity staging and species identification, were used by various Members' technical coordinators to train observers and urged those Members to provide these to the Secretariat to be available on the CCAMLR website for general use.

7.3 Recognising that data collected by observers is an important source of information used by the Scientific Committee to assess the status of resources in the CCAMLR region, the Working Group thanked the observers and technical coordinators for the sterling work that they continue to undertake and for the body of data that they have provided over the years.

7.4 The Working Group recommended that an external review is undertaken of the CCAMLR Scheme of International Scientific Observation to promote the ongoing improvement of the program and the quality of its data collection.

7.5 This external review of the CCAMLR Scheme of International Scientific Observation would involve consultation with the CCAMLR Secretariat, Member State technical coordinators, observers, the fishing industry and data clients such as scientists participating in CCAMLR working groups. The outcomes and recommendations resulting from this review would be available for consideration by the Scientific Committee (or a subgroup designated by the Scientific Committee). The proposed aims for the external review are:

1. Describe the current situation

   Provide an overview of the existing observer scheme, including its objectives, organisational structure, observer training requirements, observer deployment, data collection processes and management and quality assurance processes.

2. Identify present challenges

   Evaluate performance of the Scheme of International Scientific Observation relative to defined goals and objectives. These will include the original objectives as well as current science priorities of CCAMLR. Has the scheme met these objectives in an effective manner?

3. Describe potential solutions and improvements

   Can positive changes be made to existing procedures to better meet stated objectives of the scheme? This evaluation should identify instances where objectives are currently not being met and circumstances where changes could improve delivery of objectives.

7.6 The Working Group proposed that the review panel would be composed of the following persons:

(i) an internationally recognised person with experience in the coordination of an international observer program such as NAFO or NMFS. It also recommended that this external expert shall be internationally recognised in their field, but shall have no previous involvement or direct experience with CCAMLR

(ii) an expert from a CCAMLR Member State with experience of operating within the Scheme of International Scientific Observation

(iii) the Chair of the Scientific Committee

(iv) a proficient CCAMLR observer with wide experience in the different CCAMLR target fisheries.

7.7 The Working Group proposed that the review panel would be appointed by the Executive Secretary in consultation with the Chair of the Scientific Committee. The panel members shall be independent and participate in their personal capacity, not as a Member representative.

7.8 The Secretariat calculated the approximate cost of the review as A$25 000 to cover the meeting of the review panel at the Secretariat and the costs of the invited external expert and possibly the other panel members.

FISH BY-CATCH

Submitted papers

8.1 Nine papers on fish by-catch were presented to WG-FSA covering identification, associations and abundance within the krill fishery in Area 48, and the directed toothfish and icefish fisheries in Areas 48, 58 and 88.

8.2 WG-EMM-12/28 presented the results of a method used to explore variables influencing finfish by-catch in the krill fishery of Area 48. The majority of fish caught were either small juveniles or larvae, dominated by Myctophidae (lanternfish) and Channichthyidae (icefish) with lower levels of Nototheniidae present. Time of day, krill catch, sea-surface temperature, bottom depth, fishing depth and season were all significantly associated with the presence of finfish by-catch in krill catches by the observed vessel. The Working Group noted that another likely covariate that will determine the catch rate of finfish juveniles is distance from the shore.

8.3 WG-EMM-12/29 presented a methodology that could be used to estimate the total finfish by-catch of the Area 48 krill fishery and quantify the impact of by-catch on the finfish stocks. Estimates of total unrealised spawning biomass of the by-catch (i.e. the spawning biomass that the small fish caught in the krill fishery would have contributed to the population) suggested that finfish by-catch by the vessel was unlikely to have impacted the

finfish stock biomass in Area 48. The Working Group noted that uncertainties regarding mortality rates of early life-history stages would influence the levels of impact estimated in this study.

8.4 The Working Group noted that the two studies provide a useful methodology to the monitoring of the potential impact of krill fishing removals of by-catch species on the finfish stocks and that in order to conduct an extended analysis that can be applied to the total fishery, similar data on catch rates and explanatory variables would be required for other krill fishing techniques. Consequently, the training of observers on krill vessels should be extended to include identification of juvenile finfish, at least to the family level. The CCAMLR Secretariat was requested to develop an identification guide with the help of scientists from Member States that can be added to the CCAMLR website in order to facilitate the extension to the data collected by CCAMLR observers (Annex 6).

8.5 WG-FSA-12/24 reviewed the by-catch of *Channichthys rhinoceratus* and *Lepidonotothen squamifrons* in fisheries at Heard Island and McDonald Islands (Division 58.5.2); both species are widespread over the plateau in waters of <1 000 m. *Channichthys rhinoceratus* and *L. squamifrons* are among the most common by-catch species caught in the toothfish and mackerel icefish trawl fisheries at Heard Island and McDonald Islands (Division 58.5.2). These species are rarely taken in the longline fishery. The annual take of these species is well below the precautionary by-catch limits set by CCAMLR, move-on rules apply, and a substantial part of their distribution occurs within the HIMI Marine Reserve, and therefore current by-catch levels are likely to be low risk. The Working Group noted that potentially the catch rates could be compared to swept-area biomass estimates from the survey in order to provide estimates of the exploitation rate for use in the provision of future management advice. The Working Group noted that a mark–recapture experiment for *L. squamifrons* could be useful for comparing biomass estimates with other methods.

8.6 WG-FSA-12/35 presented a study comparing molecular and morphological identification of *Macrourus* species caught as by-catch in the toothfish longline fisheries in CCAMLR Subareas 48.3 and 48.4. The Working Group noted that changes in species identification which result in splitting of species will require modifications to the CCAMLR database and introduce complexity, in that historic data will comprise more than one species, where splitting of catches was not possible (paragraph 9.23).

8.7 WG-FSA-12/42 presented a characterisation of the by-catch in Subareas 88.1 and 88.2 from 1997/98 to 2011/12. For each by-catch group, the main species were identified and the location and depth distribution of catches and catch rates illustrated.

8.8 WG-FSA-12/50 characterised the by-catch of *Muraenolepis* spp., which are caught in low numbers with bottom longline and trawl gears throughout the CAMLR Convention Area. The paper was discussed under Item 9.

8.9 WG-FSA-12/51 examined demersal fish population densities in the Ross Sea region using comparisons between video and trawl survey methods. *Macrourus* spp. were approximately eight times less abundant by number in the demersal trawl than the video data, but because of different selectivities, derived biomass estimates were similar. The Working Group agreed that video and trawl methods could provide complementary information that could be used together to provide data for assessments of demersal fish populations.

8.10 WG-FSA-12/P11 explored whether acoustic methods can be used to monitor grenadier (Macrouridae) abundance in the Ross Sea region. Grenadiers are the main by-catch species in exploratory longline fisheries for toothfish. Ongoing monitoring tools are needed to assess the stock status of grenadiers and to ensure ecological relationships are maintained. Acoustic data collected during New Zealand's International Polar Year Census of Marine Life survey of the Ross Sea in 2008 provided evidence that single acoustic targets close to the bottom over the Ross Sea slope are grenadiers. There was a positive correlation between acoustic backscatter and trawl and longline catches of grenadiers. Key uncertainties of the acoustic method were mark identification away from the bottom, and technical issues with low signal-to-noise ratio at depths greater than 1 000 m and the acoustic dead zone close to the bottom.

Skate tagging

8.11 The Working Group noted that the skate tag returns from the Year-of-the-Skate (2009/10 and 2010/11) had currently not been examined in detail. Table 14 presents the number of skate recorded each year by CCAMLR division, Table 15 the number of skate tagged, Table 16 the percentage tagging rate and Table 17 the number of recaptures in each year.

8.12 Tagging has occurred almost exclusively in Subareas 48.3, 48.4 and 88.1 and Division 58.5.2, despite regular catches of substantial numbers of skate in Subareas 58.4 and 58.6. The Year-of-the-Skate increased the numbers of areas in which tagging had regularly occurred but the overall numbers released in the new areas remained low.

8.13 Tag returns from the additional areas not covered by the Year-of-the-Skate program have subsequently been low. For example, only a single tag has been returned from Subarea 58.6. Returns from Subareas 48.3, 48.4 and 88.1, which had approximately double the number of tags released during 2009 and 2010, have not yet shown an increase that might be expected from the increased tagging effort. However, the Working Group noted that an evaluation of scanning rates would be required to confirm whether the recapture rates had changed. Australia provided data on returns from Division 58.5.2 which showed that they have increased, however, it is yet to be determined if these increased returns result from activities during the Year-of-the-Skate.

8.14 A significant factor in the release and subsequent recapture of tags is the strategy used by vessels to avoid areas with higher concentrations of skates in order to comply with the by-catch mitigation measures as set out in CM 33-03, to minimise lost fishing time in releasing and/or tagging skates, and in order to increase the potential for catching toothfish – a hook occupied by a skate is not available to a toothfish.

8.15 The Working Group recalled that WG-FSA-08/55 discussed analysis of the skate tagging at Heard Island and McDonald Islands (Division 58.5.2). The recapture rate was <1% in eight years (46 recaptures) and the longest time at liberty was six years. The average distance between release and recapture points was 4.8 n miles, the furthest distance was 40 n miles and the shortest 0.2 n miles, with only 3 recaptures >10 n miles from their release point.

8.16 The Working Group considered that evaluations of the potential for assessment in areas with a history of tag releases would be useful, but recognised that such an assessment would not only be problematic in terms of the spatial overlap of the fishery with previously tagged fish, and also in terms of the species composition of the skate complex and their distributions and size compositions.

8.17 Despite the potential problems with development of stock assessments, the Working Group considered that the tagging data will provide useful data on growth rates, distribution and movement rates as the time series of recaptures develops.

8.18 As a start to the process, the Working Group requested that the CCAMLR Secretariat prepare a review of the skate and ray by-catch and tagging program, including:

(i) Catch data –

(a) table of skate retained, discarded, released, tagged, total hauled by subarea/division and year from C2 data

(b) table of skate retained, discarded, released, tagged, total hauled by subarea/division and year from observer data (need % observed and then pro-rated by observation tally period)

(c) plot of location of catches/catch rates by subarea/division and year from C2 data.

(ii) Tag data –

(a) table of skate releases and recaptures by year (including number of single/double-tagged fish) and number of tags linked

(b) movement of tagged skate within Subareas 48.3, 48.4 and 88.1

(c) changes in growth of tagged skate as a function of length with time at liberty within Subareas 48.3 and 88.1

(d) plots showing location of tag releases and tag recaptures for Subareas 48.3 and 88.1 and subsequent fishing effort.

(iii) Biological data –

(a) table of biological data collected by subarea/division

(b) scaled length-frequency distributions of skates by subarea/division and year (for areas where there are sufficient data for individual species)

(c) table of fate of released skate by condition by subarea/division and year.

Skate by-catch in Division 58.4.3a

8.19 WG-FSA-12/29 outlined a research plan for *Dissostichus* spp. in 2012/13 in Division 58.4.3a fishing twice a year from 2013 to 2015 (paragraph 5.87).

8.20 The Working Group noted that there was an unusually high by-catch of skate in Division 58.4.3a in 2011/12 (WG-FSA-12/29); a total catch of 33 tonnes of skate was reported, just below that of the target species toothfish (34 tonnes). The fishing was conducted by the vessel fishing in the same area as that proposed in the proposed research plan covering the period from 2013 to 2015.

8.21 Data submitted by the vessel indicated that all of the skate were considered dead and consequently processed rather than being released when alive, as would have been required by CM 33-03, paragraph 4.

8.22 The Working Group examined catch rates by other vessels that have fished within Division 58.4.3a. The majority of vessels fishing in the area have substantially lower catch rates of skate, only one of which had similar catch rates to those detailed in WG-FSA-12/29 in 2005 prior to the requirement to release skates in CM 33-03, paragraph 4, which was introduced in 2007.

8.23 Given that the average soak time was 29 hours and that the vessel returned toothfish that were considered in sufficiently good condition to meet the vessel's tagging objectives, the Working Group could find no reason for the abnormally high rate of skate mortality.

8.24 The high skate by-catch mortality rate resulting from fishing by this vessel within Division 58.4.3a introduces a complication in determining its suitability to conduct research fishing twice a year in the subarea without further consideration of substantial by-catch of skate and potential impact on the skate stock in the subarea.

8.25 The Working Group noted that, if the research proposal outlined in WG-FSA-12/29 is to proceed, then the restrictions outlined in CM 33-03 are unlikely to be sufficient to prevent a substantial by-catch of skate by the *Saint André* during 2013 to 2015. The Working Group recommended that the Scientific Committee consider a specific skate by-catch mitigation measure (e.g. a revised skate catch limit or move-on rule) that would be appropriate to this vessel during the research fishing in Division 58.4.3a.

8.26 The Working Group recommended that the high skate by-catch and mortality rates from the *Saint André* fishing in Division 58.4.3a be drawn to the attention of SCIC.

Seabirds and marine mammals

8.27 The Working Group recalled the outcomes of discussions at WG-IMAF last year (SC-CAMLR-XXX, Annex 8, paragraphs 10.1 to 10.8) that, while the number of seabirds being killed in CCAMLR fisheries had reduced, there remained a need for a routine review of incidental mortality and of the implementation of conservation measures associated with mitigation. Accordingly, the Secretariat presented WG-FSA-12/66 Rev. 2 and 12/70 Rev. 2 that provided this review.

8.28 During 2011/12 (WG-FSA-12/66 Rev. 2) there were two seabird mortalities in Subarea 48.3 (one black-browed albatross and one southern giant petrel). In the French EEZs, 16 seabird mortalities were observed (all white-chinned petrels) in Subarea 58.6 and 38 (34 white-chinned and four grey petrels) in Division 58.5.1. In addition, a single Cape petrel was recorded dead in the krill fishery in Subarea 48.1. There were two marine mammal mortalities recorded in longline fisheries in 2012, one sperm whale entangled in the main line in Subarea 48.3 and one southern elephant seal hooked/entangled and drowned in Division 58.5.2. There were no recorded mortalities of birds or mammals in finfish trawl fisheries.

8.29 WG-FSA-12/28 Rev. 1 provided an update on the French plan of action to reduce seabird by-catch in the French EEZs in Subarea 58.6 and Division 58.5.1. The Working Group welcomed the update and noted that, while from 2008 to 2012 there had been an 80% decrease in total seabird mortality, the rate of decrease over the past three years was 27%. Compared to last year, there had been a continued reduction in seabird mortality in Division 58.5.1 but an increase in Subarea 58.6.

8.30 The Working Group noted that the level of seabird by-catch had stabilised (WG-FSA-12/28 Rev. 1, Figures 2 and 3) in recent years and that the seabird by-catch should be zero. It recommended that France continue to take additional steps to mitigate seabird by-catch.

8.31 Mr Gasco informed the Working Group that French authorities had identified two vessels responsible for the majority of the by-catch in Subarea 58.6 and restrictions would be placed on the operation of these vessels in order to further reduce seabird by-catch. The Working Group welcomed the proposal for targeted action to further reduce seabird by-catch in the French EEZs.

8.32 The analysis in WG-FSA-12/28 Rev. 1 showed the difference between the annual extrapolated estimate of seabird mortality when presented in CCAMLR seasons (1 December to 30 November) and French seasons (1 September to 31 August). The Working Group suggested that, if the rate of by-catch was estimated on a monthly basis for extrapolation, this would resolve the discrepancies between reporting periods that cover different parts of the year, and that presenting these data at monthly intervals would assist in interpreting time series of seabird catches.

Marine debris

8.33 WG-FSA-12/64 provided a review of marine debris surveys in the Convention Area which have been reported to the Secretariat as part of the CCAMLR marine debris monitoring program. As in previous years, monitoring sites were located in Subareas 48.1, 48.2, 48.3 and 58.7. Results indicate that there has been no trend (either up or down) in the amount of debris in beach surveys, in nests of seabirds and in the incidence of marine mammal entanglements in the last decade.

8.34 The Working Group encouraged those Members currently engaged in the collection of marine debris data to review any potential covariates, including both fishing and non-fishing shipping traffic, that might provide insights into the pattern of occurrence of marine debris,

with research programs in areas where there was currently no marine debris monitoring, but where there was an active fishery (e.g. the Ross Sea), to undertake such monitoring.

BIOLOGY, ECOLOGY AND INTERACTIONS IN FISH-BASED ECOSYSTEMS

9.1 Thirty-six papers on biology and ecology were provided and discussed by the subgroup. The papers covered:

(i) biological parameters for target and by-catch species, including those data that can be used in stock assessment

(ii) ecological and ecosystem studies

(iii) taxonomic studies that have implications for observer programs and/or biodiversity studies.

9.2 Given the number of papers submitted and the time available for discussion, it was not possible to consider all papers in plenary. All papers are summarised in Appendix E. The discussion in the Working Group relating to selected papers are provided below (by region where applicable).

9.3 The characterisation of population structure and distribution patterns of both target and by-catch species is an important component of fisheries management. With the advent of spatial population and ecosystem models, the factors influencing population distribution are increasingly important. Biological investigations utilising various methods such as larval dispersal simulations, catch distributions, adult movement simulations, genetics, tagging, age composition, parasite species composition, and otolith microchemistry have all been recently applied to a number of target and by-catch species throughout the Convention Area. In most cases, these studies are indicative and provide hypotheses for further testing, but have not provided definitive answers to this complex problem. For most species, detailed knowledge of the biology, distribution and habitat preferences of different life-history stages is needed to develop more realistic models, for example parameterising the spatial population models presented in WG-FSA-12/44. The Working Group welcomed these studies and encouraged Members to continue conducting studies to inform the characterisation of population structure. It was noted that such studies could benefit from collaborative initiatives.

9.4 The collection of data from target and by-catch species from CCAMLR fisheries have provided a unique dataset with which to examine the biology and ecology of these species. The Working Group encouraged Members to consider not only the broader scientific interest, but also to consider the implications of these studies for CCAMLR's ecosystem-based approach to fisheries management.

9.5 Members were encouraged to outline their plans for upcoming research to facilitate collaborative studies and to allow the Biology and Ecology Subgroup to develop more targeted discussions on work of relevance to future meetings of WG-FSA.

Pan-Antarctic studies

9.6 Detailed information on various aspects of the biology and ecology of *D. mawsoni* from Russian literature was provided in WG-FSA-12/14 and the Working Group considered that this information would complement the *D. mawsoni* species profile (WG-FSA-10/24) and encouraged relevant material from the extensive Russian literature on *D. mawsoni* be added to the species profile.

9.7 The Working Group noted that the genetic population study of *D. mawsoni* given in WG-FSA-12/21 indicated a homogeneous circumpolar population that contradicts previous genetic findings. However, the small sample size and methods applied meant that the findings were not comparable to previous genetic studies. The Working Group encouraged the authors to submit this paper for peer review in order that the methods used can be fully evaluated. Homogeneity of the *D. mawsoni* population was also suggested by its parasite fauna (WG-FSA-12/P09) but more detailed information on the abundance and prevalence of parasites, and the location and timing of sampling, was needed. The Working Group noted that although genetic and parasite data may be useful tools to give information on stock structure, other methods (e.g. spatial patterns in life-history parameters, microsatellite data, movements from tagging data) should also be examined to give a coherent view of stock structure.

9.8 The Working Group recognised that some interesting information regarding *Pleuragramma antarcticum* was indicated in WG-FSA-12/23 but it was not possible to comment further, as only an abstract and some figures were presented at this time, and it looked forward to receiving a concise account of the full results in the future.

9.9 WG-FSA-12/50 provided an overview of the biology of Muraenolepidae from by-catch in the longline fishery. The Working Group agreed that the taxonomy of this genus is complicated and requires further study. Members are encouraged to collaborate with ongoing initiatives by collecting samples and biological information of *Muraenolepis* spp. from various locations in the Southern Ocean and making these available to the Working Group.

9.10 The Working Group discussed the suggestion of *Muraenolepis* spp. having a semelparous reproductive strategy and noted that most fish with such a strategy are from freshwater and from very different taxa (e.g. Osmeridae and Salmonidae). Further work was encouraged to confirm this reproductive strategy, as it is possible that germinal cells (oogonia) are localised within the ovary in this taxon.

Ross Sea

Biological parameters for commercial and by-catch species

9.11 Age-at-sexual maturity of *D. mawsoni* receives regular updated data. Several papers described maturity stages from macroscopic changes analysis in gonadosomatic index and histological assessments of gonads of females and males. Reproductive studies of other species (e.g. *Macrourus* spp., *Muraenolepis* spp. and two liparid species) were also conducted recently.

9.12 A multi-disciplinary approach, incorporating otolith chemistry, age data and numerical Lagrangian particle simulations, indicated a single self-recruiting population of *D. mawsoni* in the southeast Pacific basin and the Ross Sea, with a life history structured by the large-scale circulation (WG-FSA-12/P02). It was one of the first papers viewing the population structure of *D. mawsoni* on a circumpolar scale. The Working Group encouraged the authors to continue their work.

9.13 The Working Group agreed that the most robust estimate of the spawning ogives for *D. mawsoni* in the Ross Sea were the $L_{50\%}/A_{50\%}$ values of females 135 cm/16.9 years, and males 109 cm/12 years, presented in WG-FSA-12/40, and that these should be evaluated for use in the upcoming assessment for Subareas 88.1 and 88.2. The Working Group also encouraged collection of reproductive data from the winter spawning period to distinguish fish which may abort maturation and fish that may develop later in the spawning season.

9.14 The Working Group noted that many biological studies of toothfish were conducted using fishery-collected samples, with various conclusions about the size and age of spawning in the Ross Sea and elsewhere. These studies are often limited by sample size, spatial and/or temporal distribution of samples, or assumptions of reproductive development. The Working Group encouraged an overall review and synthesis of these studies to provide robust and consistent inputs for use in stock assessment.

Ecological and ecosystem studies

9.15 WG-FSA-12/P04 provided an updated analysis of a McMurdo Sound vertical longline survey for *D. mawsoni*, which started in 1972, for which recent changes in the CPUE were attributed to the effects of the longline fishery in the Ross Sea. The Working Group recalled an earlier paper which had been submitted by the authors on this subject (WG-EMM-08/21) and the consideration of the paper at the time (SC-CAMLR-XXVII, Annex 4, paragraphs 6.21 to 6.26). The Working Group agreed that many of the inconsistencies of the earlier paper had been addressed, and thanked the authors for submitting the associated data to the CCAMLR Secretariat. However, it noted that the dataset was still lacking some basic details, such as the depth of the fishing sites each year. Depth appears to have varied across the time series and would be an important part of a CPUE standardisation, as it has been shown to be strongly related to toothfish abundance (WG-FSA-10/24 and 12/41).

9.16 The Working Group agreed that the apparent decline in toothfish CPUE at McMurdo Sound since 2001 was not consistent with analyses based on the data collected by the fishery elsewhere in the Ross Sea region. Unstandardised CPUE from the fishery, in terms of catch per hook or catch per set, have been relatively stable since the start of the fishery (WG-FSA-12/42), whilst the 2011 stock assessment indicated that spawning stock biomass had declined to 80% B_0. Furthermore, the standardised catch rates from a research longline survey of pre-recruit toothfish (70–110 cm TL) in the southern Ross Sea in 2012 were similar to those made by the same vessel fishing in the area earlier in the fishery, between 1999 and 2003 (WG-FSA-12/41; Figure 1). Fish condition in the southern Ross Sea was similar to that observed in McMurdo Sound (Figure 2).

9.17 The Working Group agreed that, given the relative spatial scale of the Ross Sea fishery and the location of McMurdo Sound (Figure 3), the changes reported in WG-FSA-12/P04

may reflect local ecosystem changes arising from the extreme hydrological conditions caused by the breaking-off and grounding of two large icebergs between 2000 and 2005 (Robinson and Williams, 2012). These icebergs had a profound effect on the hydrology and primary productivity in the McMurdo Sound region during this period and caused a 50–70% reduction in phytoplankton in 2000/01 and 90% in 2002/03. Extensive ice build-up also occurred in the inner Sound from 1998 onwards with an increasing thickness of a band of multi-year fast-ice extending around the edge of the Sound until 2010. The resulting lower abundance of food in the area could have led to the reduced abundance of toothfish and poor condition, as noted in WG-FSA-12/P04. The Working Group also considered that the potential changes in the mean number of killer whales per pod during the past decade (presented in WG-FSA-12/P03) were consistent with these local-scale changes.

9.18 The Working Group agreed that the time series in McMurdo Sound could be a useful tool to monitor local toothfish abundance and ecology within McMurdo Sound and recommended it be continued. However, it also emphasised the importance of the standardisation of the survey with respect to hook and bait type, time of sampling, fishing depth and fishing location, among other factors. The Working Group also noted that, given the spatial scale of the Ross Sea and the location of McMurdo Sound (Figure 3), a local sampling effort would not be expected to provide an index of the status of the stock centred well over 500 km away.

9.19 Recent data on the diet of *D. mawsoni* in the Ross Sea were provided (WG-FSA-12/06 and 12/52). Trophic level was related to fatty acids and stable isotopes (WG-FSA-12/61). The Working Group noted that quantified dietary data are needed to better understand trophic interactions and for use in trophic and ecosystem models.

9.20 A balanced ecosystem model (WG-EMM-12/53) for the Ross Sea, using 35 trophic groups, indicated that eight groups (phytoplankton, mesozooplankton, *P. antarcticum*, small demersal fish, *E. superba*, cephalopods, crystal krill (*E. crystallorophias*) and pelagic fish) would be informative for examining ecosystem changes.

Taxonomic studies

9.21 As by-catch species collections and investigations grow, questions arising from observed variations in biological characteristics suggest the presence of cryptic (morphologically similar but genetically distinct) species within several families of Antarctic fish, especially the families Rajidae, Macrouridae, Muraenolepididae, Liparidae and Zoarcidae (see WG-FSA-12/53).

9.22 Recent molecular studies have confirmed the presence of a fourth species of *Macrourus* in the Southern Ocean (WG-FSA-12/54 Rev. 1). The new species, *M. caml* has now been formally described by McMillan et al. (2012). These documents list the characteristics that can be used for correct identification of the species (see Appendix E). The Working Group recommended that updated identification guides be provided to observers throughout the Convention Area to aid in documenting catch of this new species.

9.23 The Working Group noted that historical *M. whitsoni* catch data would have included the newly described species (*M. caml*). The Working Group agreed that a new species code

should be developed for *M. caml* and another species code should be used for historical data for *M. whitsoni* catches for use in regions where there is spatial overlap in the range of the two species.

9.24 The Working Group noted that there are currently several ongoing studies aimed at revising the taxonomy of the genus *Muraenolepis* and encouraged cooperation among Members to collect specimens from various subareas to inform future studies.

Scotia Sea

Biological parameters for commercial and by-catch species

9.25 Several documents provided biological information for a range of species in the Scotia Sea, including toothfish (*D. mawsoni* and *D. eleginoides*) (WG-FSA-12/37 and 12/38); *L. squamifrons* (WG-FSA-12/34); South Georgia icefish (*Pseudochaenichthys georgianus*) (WG-FSA-12/68 Rev. 1), with site-specific data also provided for a range of species in WG-FSA-12/10 and 12/P06.

Ecological and ecosystem studies

9.26 WG-FSA-12/P01 provided information on trends in relative catch rates for two previously overexploited demersal notothenid species sampled by trammel net over a 28-year period. The Working Group noted that the low sampling effort and site-specific nature of the survey means that it may not necessarily be informative for understanding the stock status of the species considered over the geographic range of the stock.

9.27 Changes in abundance of the marbled *N. rossii* sampled by trawl surveys since 1998 in Subarea 48.1 were presented in WG-FSA-12/19. An increase in catches of *N. rossii* around Elephant Island over this period was observed, although the aggregating nature of this species means that trawl surveys have a high number of hauls with zero/low catches, and a few sites with high catch rates (>5 tonnes per 30 mins). This variability can result in uncertain biomass estimates. Indeed, this survey was not originally designed to monitor this species. The Working Group noted that further analyses could be undertaken on catch rates, and that modification to existing survey design would compromise the time series, and a species-specific survey may be required. The Working Group recommended a further survey to be undertaken using an improved survey design.

9.28 Current catch rates for *Gobionotothen gibberifrons* (WG-FSA-12/20) during surveys are substantially lower than at the start of the time series (1998). This time series indicated low recruitment since 2000, even though fisheries on this species ceased in the early 1980s and were prohibited after 1989/90. The Working Group considered that the current status of this species remains unclear and our knowledge of what environmental factors influence recruitment for Antarctic demersal fishes remains poor.

9.29 Article II.3(c) of the Convention aims to prevent changes that are not potentially reversible over two or three decades. Given that targeted fisheries for *N. rossii* and *C. gunnari* were prohibited over two decades ago, studies on these populations may now inform on the

appropriateness of this time frame for their recoveries. The Working Group noted that improved studies on the age composition of these populations would be valuable in assessing population age structure as an indicator of stock recovery.

9.30 The relationships between fish populations and their occurrence in the diet of Antarctic shags at the South Shetland Islands was presented in WG-FSA-12/05. The Working Group considered that, while such data may provide useful insights into changes in local fish populations, the relationships with wider stock/population trends remain unclear.

9.31 The Working Group agreed that analyses of long-term data on fish populations should also include analyses of other relevant species and environmental indices to better understand changes in populations, especially rates of recovery in the context of broader ecosystem dynamics.

9.32 WG-FSA-12/33 summarised data from ichthyoplankton surveys in Cumberland Bay, South Georgia (2002–2008), which informs on the spawning periods of various species, and highlights the important role of bays for these early life-history stages. The Working Group encouraged further studies on ichthyoplankton and post-larval stages in the region (WG-FSA-12/04 and 12/33), as these can provide valuable ecological information for ecosystem management and ecosystem models.

9.33 WG-FSA-12/P10 presented results of modelled simulations of egg/larval dispersal to examine the potential influence of oceanographic and life-history variability on the dispersal and retention of *C. gunnari* (a demersal egg-layer) and *N. rossii* (a pelagic spawner). The Working Group considered that such models can give a broad regional-scale approach to understanding issues of potential connectivity. However, the spatial resolution of models may not fully address some coastal oceanographic features, and a poor understanding of larval behaviour means such models may be less accurate on finer spatial scales.

Taxonomic studies

9.34 The taxonomic issues relating to *Macrourus* spp. were discussed in WG-FSA-12/35, showing similar spatial distributions in relation to oceanography as noted in the Ross Sea (WG-FSA-12/54 Rev. 1). This study also reported that the sub-Antarctic species *M. holotrachys* was indistinguishable genetically from the North Atlantic *M. berglax*. The Working Group considered that further taxonomic revision of this genus is required.

AGEING WORKSHOP FOR *D. ELEGINOIDES* AND *D. MAWSONI*

10.1 Recalling the Workshop on Estimating Age in Patagonian Toothfish held in 2001 (SC-CAMLR-XX, Annex 5, Appendix H), it was agreed to focus primarily on *D. mawsoni*, and that the objectives of the 2012 Workshop would be to provide advice on the following topics:

(i) otolith collection protocols
(ii) otolith preparation protocols
(iii) definition of otolith structures

(iv) quality assurance and quality control
(v) validation
(vi) data management.

Otolith collection protocols

10.2 It was noted that two methods of collecting otoliths for ageing are currently used in CCAMLR fisheries:

(i) random sampling: all otoliths are collected from a random selection of toothfish during sampling of the catch by observers

(ii) length-stratified random sampling: otoliths are collected from a random selection of fish during sampling of the catch by observers, with observers ceasing collection for length bins once 5 to 10 otoliths per length bin have been collected.

10.3 It was noted that length-stratified sampling was likely to be more efficient at collecting otoliths from the extremes of the length distribution of the catch, while avoiding collecting large amounts of otoliths from more common size classes. It was agreed that both methods were likely to provide sufficient otoliths that were representative of the age classes of fish in the catch to generate age–length keys and estimate catch-at-age. It was further agreed that a description of the sampling and subsampling that is used to select otoliths for processing and ageing should be presented with any ageing dataset.

Otolith preparation protocols

10.4 Mr Sutton presented WG-FSA-12/43 Rev. 1. It was noted that since 2010 the National Institute of Water and Atmospheric Research Ltd (NIWA) laboratory has developed a reference collection of 240 *D. mawsoni* otoliths, prepared using the 'bake-and-embed' method. Mr Sutton noted that 60 of the sister otoliths of the reference collection had also been thin-sectioned and similar results had been obtained for both methods. Mr Sutton noted that the inner zones of *D. mawsoni* otoliths are the most difficult to interpret, and so measurements based on the annuli widths for juvenile *D. mawsoni* collected in the South Shetland Islands are used to infer the position of the first three annuli. The 4th to 8th annuli can also be unclear, but in older fish annuli narrow, and opaque and translucent zones become easier to distinguish.

10.5 The Working Group noted that a Russian ageing program currently uses the 'break-and-burn' method, as presented in WG-SAM-12/18. Dr Petrov noted that over 6 000 *D. mawsoni* otoliths had been processed and aged from Subarea 88.1 and Divisions 58.4.1 and 58.4.2 and that this had been part of the input data into stock assessments using the TISVPA model presented in WG-FSA-06/50 and 09/14.

10.6 The Working Group noted that the sections shown in WG-SAM-12/18 were similar in appearance to those produced by the bake-and-embed method used by New Zealand. However, it noted that a comparison between the two ageing methods has not been performed

and, therefore, it was unable to provide advice on whether the two methods are likely to produce similar results when used for mass ageing. To facilitate this comparison, Dr Petrov provided a sample of otoliths prepared using the break-and-burn method. Mr Sutton undertook to perform a 'blind' read of the sample to determine if he could replicate the results of the Russian study during the workshop, and also prepare the sister otoliths provided by Dr Petrov using the bake-and-embed method and report the results to WG-FSA at its next meeting.

10.7 The Working Group recalled the advice from the Workshop on Estimating Age in Patagonian Toothfish, which had concluded that, when followed consistently, both thin-sections and bake-and-embed protocols were likely to enable similar levels of structural detail to be observed in *D. mawsoni* otoliths. It therefore agreed that, for CCAMLR Members wishing to commence ageing programs, the choice of which method to use could be determined by available laboratory equipment and expertise, and the ability to produce consistent results. It also agreed that the ageing manual presented in WG-FSA-12/43, and the ageing manual describing preparation of thin sections of *D. eleginoides* at the Australian Antarctic Division (Nowara et al., 2009) be hosted on the CCAMLR website to assist with Members seeking to develop their own ageing programs.

Definition of otolith structures

10.8 The Working Group noted that the Workshop on Estimating Age in Patagonian Toothfish (SC-CAMLR-XX, Annex 5, Appendix H) had provided detailed advice on the definition of otolith structures. It agreed that the internal and external structures of *D. mawsoni* otoliths were similar to those of *D. eleginoides* otoliths, and therefore the definitions developed at the 2001 Workshop could also be used for *D. mawsoni*.

Quality assurance and quality control

10.9 It was noted that data on readability of individual sections was routinely collected in some ageing programs. It was agreed that, while the assessment of readability may be subjective, it provided a useful ancillary dataset which could be used to assess ageing error rates (e.g. Candy et al., 2012) and for evaluating different processing methods, and therefore should be routinely collected by mass ageing programs.

10.10 It was noted that in mass ageing of fish from Subarea 88.1 and Division 58.5.2, reference collections are used for training and are regularly re-read by experienced readers, and age bias plots (Campana, 2001) are used to ensure consistency across readers and batches. For example, at NIWA, a batch of new otoliths is not read until a reader achieves a CV of 10% when compared to previous readings of the reference collection by an experienced reader.

10.11 It was agreed that development of a reference collection was of critical importance in producing consistent ages for mass ageing used in stock assessment. It was therefore agreed that any laboratory conducting ageing should develop a reference collection that contains otoliths covering:

(i) the full range of sizes encountered across the sampled area
(ii) males and females
(iii) a range of readabilities.

10.12 It was agreed that, to cover the range of age classes likely to be encountered in *Dissostichus* spp., the reference collections should contain more than 100 otoliths. It was noted that there is also a benefit for ageing laboratories to develop a smaller training collection, including otoliths of high readability and images with annuli marked, to assist with familiarising novice readers with the structural features of otoliths, prior to reading the reference collection. It was agreed that electronic images of reference collections for *D. mawsoni* in Subarea 88.1 and for *D. eleginoides* in Division 58.5.2 be made available on the CCAMLR website. The Working Group also encouraged Members to develop reference and training collections for other toothfish populations in the Convention Area.

10.13 It was further agreed that during mass ageing, readers should regularly read and re-read a reference collection. Within- and between-reader ages should then be compared using age-bias plots to ensure that ages are consistent and that there is no significant drift between batches, and this information should be routinely reported alongside ageing datasets used in assessments. The Working Group also encouraged exchange of digital images of reference collections between research groups to enable intercalibration of ageing protocols.

10.14 Dr L. Pshenichnov (Ukraine) noted that Ukrainian scientists had commenced ageing *Dissostichus* otoliths collected from the Indian Ocean sector. More than 200 otoliths had been aged, and it was noted that Ukraine had access to otoliths collected by the Soviet fleet from the Kerguelen Plateau, Ob and Lena Banks and around South Georgia back to the 1980s. The Working Group welcomed the information provided by Dr Pshenichnov and encouraged the Ukrainian research to be reported to WG-FSA, including a description of the protocols used to prepare the otoliths, how annuli were interpreted and age bias plots for repeat readings of a subset of the otoliths prepared to date.

Validation

10.15 It was recalled that a validated ageing protocol has three requirements:

(i) clear incremental structures are visible in the otolith throughout the lifespan of the fish

(ii) ability to identify the first annulus marking the end of the first year of life

(iii) confirmation that annuli are formed on a yearly basis after the first annulus.

10.16 The Working Group agreed that several studies in different populations of *D. eleginoides*, and for *D. mawsoni* in the Ross Sea, have confirmed that all three requirements are likely to be met for these species. It was noted that work conducted on small

juvenile *D. mawsoni* had proposed alternative interpretations of the inner structure around the primordium which may lead to an underestimate of age of one year using the ageing protocol currently used by NIWA (Horn et al., 2003; La Mesa, 2007). It was also noted that ageing error was likely to be of a similar magnitude to the difference between the alternative interpretations. It was requested that Members prioritise the collection and analysis of otoliths from small juvenile *D. mawsoni* to assist with verifying the location and appearance of the first annulus in this species.

10.17 The further development of validation studies for *D. mawsoni*, such as the use of fluorescent calcium markers, was encouraged by the Working Group. It was recalled that similar age validation studies had been conducted in Subarea 48.3 (WG-FSA-03/80) and Division 58.5.2 (WG-FSA-05/60) for *D. eleginoides*.

Data handling

10.18 It was agreed that the analysis and application of ageing datasets would be enhanced by developing a database in the Secretariat. It was agreed that to be included in such a database, a dataset should include:

(i) species

(ii) unique identifier for each individual animal that can be linked to capture location and time and biological information (length and sex)

(iii) structure aged (e.g. otoliths in fish, thorns in skates)

(iv) reader name

(v) preparation method

(vi) is the data derived from a reference collection or production batch?

(vii) unique identifier for each reading instance

(viii) readability

(ix) the age estimate/annulus count

(x) any other comments regarding how the age estimate was derived.

10.19 It was requested that the Secretariat develop a database structure that could store the recommended data fields, and that once developed, Members submit ageing datasets to the Secretariat.

FUTURE WORK

11.1 The Working Group agreed that its meeting in 2013 would focus on stock assessments and the review and development of research plans. Further detailed consideration of biology and ecology and bottom fishing activities and VMEs would be given in 2014.

11.2 The Working Group agreed to the following future work:

(i) Research plans –

(a) development of measures of vessel performance and capacity to undertake specified research activities (paragraph 5.143).

(ii) Assessments –

(a) development and revision of annual and biennial assessments in 2013

(b) evaluation of the consequence of reopening SSRU 882A to fishing and implications for stock assessment and the allocation of catch limits in the Ross Sea (paragraph 5.152)

(c) development of background documentation on the data and approaches used in assessments (paragraph 12.4).

(iii) Biology and ecology –

(a) Secretariat review of skate biology and dynamics based on data collected during the Year-of-the-Skate and other years (paragraph 8.18)

(b) development of focus topics for the meeting in 2014 (see also paragraph 11.6).

(iv) Tagging training –

(a) development of the tagging training module (paragraph 5.181).

(v) WG-SAM –

(a) development of research plans in data-poor fisheries and closed areas

(b) development of methods to determine appropriate rates of exploitation for research fishing in data-poor and closed fisheries (paragraph 5.133)

(c) development of spatially explicit population models (paragraph 5.163)

(d) review of methods and preliminary results from assessments in 2013

(e) preparation of a scoping paper (led by Dr Candy) on the implementation of the CCAMLR decision rules in stock assessments and related consequences for management advice.

(vi) Review of the Scheme of International Scientific Observation (paragraph 7.4).

(vii) Development of a CCAMLR database for ageing data (paragraph 10.18).

11.3 The Working Group recommended that the Scientific Committee give further consideration to the development of generic, Member-independent research plans based on

best science and survey design, and which facilitate long-term, multi-nation, multi-vessel participation. A workshop on this topic in 2013 may assist develop this work.

11.4 The Working Group noted that the successful conduct of multi-year research fishing in exploratory fisheries may require further consideration of the way such fisheries are categorised and notified annually under CM 21-02.

11.5 The Working Group agreed that it had been difficult during this meeting to give full consideration to all papers submitted under Item 9 (Biology, ecology and interactions in fish-based ecosystems). This was due to the broad range of topics covered by these papers, the large number of papers submitted and the limited time available during the meeting.

11.6 The Working Group also noted that the focus topic at this meeting (Item 10) had been successful in bringing together detailed and specific knowledge on the ageing of otoliths. The Working Group encouraged further development of focus topics and thematic sessions.

11.7 The Working Group encouraged participants to prepare future contributions to working groups in close consultation with representatives of the Scientific Committee. These representatives are well placed to provide background on CCAMLR matters and guidance on the development of papers and reporting of findings to the working groups.

OTHER BUSINESS

12.1 The Working Group noted that some analyses reported at its meeting had used data-grooming techniques to remove data which contained errors or were of poor quality. The Working Group encouraged participants to provide detailed accounts in their papers of any data-grooming technique used and a description of CCAMLR data which may have been excluded from the analyses. This would allow the Working Group and others to replicate such analyses.

12.2 The Working Group also encouraged participants to report any CCAMLR data-error or data-quality issue to the Secretariat so that the Secretariat may take appropriate steps to address these errors or associated issues. The Working Group agreed that a reporting form should be distributed with each data extract to assist data users in reporting such matters.

12.3 The Working Group discussed the use of routine procedures for data backup and snapshots, and noted that such procedures are implemented in the Secretariat. The Secretariat also maintains a comprehensive audit trail for amendments made to CCAMLR data.

12.4 The Working Group also discussed the development and maintenance of background documentation on data extractions, grooming and preliminary steps leading to stock assessments. Such information would supplement the information in the Fishery Reports.

12.5 The Working Group reminded participants that CASAL files (estimation.csl, output.csl, population.csl, and MCMC output if available) should accompany the assessment papers submitted to the meetings. The Convener was encouraged to issue a reminder at the time of circulating the agenda for the 2013 meeting.

ADVICE TO THE SCIENTIFIC COMMITTEE AND ITS WORKING GROUPS

13.1 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.

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

(i) Data reporting –

- (a) daily and five-day catch and effort reporting (paragraph 3.4)
- (b) data reporting during research fishing (paragraph 3.5)
- (c) reporting of number of hooks lost attached to sections of longlines (paragraph 5.6).

(ii) Estimates of IUU fishing –

- (a) submission of data on surveillance effort and other information necessary to develop estimates of IUU fishing (paragraph 3.19).

(iii) Established fisheries –

- (a) *C. gunnari* in Subarea 48.3 (paragraph 4.6)
- (b) *C. gunnari* in Division 58.5.2 (paragraph 4.14)
- (c) *D. eleginoides* in Subarea 48.3 (paragraph 4.16)
- (d) *D. eleginoides* in Division 58.5.1 (paragraphs 4.25 and 4.27)
- (e) *D. eleginoides* in Division 58.5.2 (paragraph 4.19)
- (f) *D. eleginoides* at Crozet Islands (paragraph 4.30)
- (g) *D. eleginoides* at Prince Edward and Marion Islands (paragraph 4.32).

(iv) Exploratory and other fisheries –

- (a) exclusion of vessel-specific data from future analyses (paragraph 5.11)
- (b) fishing capacity in fisheries with small catch limits (paragraphs 5.18 and 5.19)
- (c) notification of vessels with limited experience in research fishing (paragraph 5.21)
- (d) review by WG-SAM of modelling approaches (paragraph 5.42)
- (e) tagging training (paragraphs 5.171, 5.173, 5.174 and 5.180)
- (f) review by SCIC of tagging performance (paragraph 5.140)
- (g) generic issues related to research proposals (paragraphs 5.133, 5.135, 5.137 and 5.143)
- (h) *C. gunnari* and *N. rossii* in Subarea 48.1 (paragraph 5.187)
- (i) *C. gunnari* in Division 58.5.1 (paragraph 5.191)
- (j) *Dissostichus* spp. in Subarea 48.4 (paragraph 5.33)
- (k) *Dissostichus* spp. in Subarea 48.6 (paragraphs 5.48, 5.51 to 5.53 and 5.56)
- (l) *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2 (paragraph 5.72)
- (m) *Dissostichus* spp. in Divisions 58.4.3a and 58.4.3b (paragraphs 5.94 and 5.98)
- (n) *Dissostichus* spp. in Subareas 88.1 and 88.2 (paragraph 5.23)

(o) research fishing in Subarea 48.5 (paragraphs 5.101 to 5.103)
(p) research fishing in Divisions 58.4.4a and 58.4.4b (paragraphs 5.113, 5.115, 5.117, 5.120, 5.126 and 5.132).

(v) Bottom fishing activities and VMEs –

(a) preliminary assessments under CM 22-06 (paragraph 6.11).

(vi) Scheme of International Scientific Observation –

(a) external review (paragraphs 7.4 to 7.6).

(vii) Non-target catch –

(a) review of rajid by-catch and tagging program (paragraph 8.18)
(b) rajid by-catch in Division 58.4.3a (paragraphs 8.25 and 8.26).

(viii) Other matters –

(a) future work (paragraphs 11.1, 11.3, 11.4 and 11.7).

ADOPTION OF THE REPORT

14.1 The report of the meeting was adopted.

CLOSE OF MEETING

15.1 In closing the meeting, Dr Belchier thanked all participants, including subgroup coordinators, rapporteurs and the Secretariat for their contributions and collaborations in the work of WG-FSA.

15.2 Dr Belchier, on behalf of the Working Group, also thanked Dr Kock for his life-time scientific contribution and great dedication to the work of WG-FSA and the Scientific Committee. Dr Kock has been involved with CCAMLR since its beginning and has convened WG-FSA and chaired the Scientific Committee. Dr Kock's contribution has been inspirational and the Working Group wished him well in his retirement.

15.3 Dr Sharp, on behalf of the Working Group, thanked Dr Belchier for leading the Working Group during his first year as convener, and during a period of major scientific developments.

REFERENCES

Agnew, D.J., C. Edwards, R. Hillary, R. Mitchell and L.J. López Abellán. 2009. Status of the coastal stocks of *Dissostichus* spp. in East Antarctica (Divisions 58.4.1 and 58.4.2). *CCAMLR Science*, 16: 71–100.

Campana, S.E. 2001. Accuracy, precision and quality control in age determination, including a review of the use and abuse of age validation methods. *J. Fish Biol.*, 59: 197–242.

Candy, S.G., G.B. Nowara, D.C. Welsford and J.P. McKinlay. 2012. Estimating an ageing error matrix for Patagonian toothfish (*Dissostichus eleginoides*) otoliths using between-reader integer errors, readability scores, and continuation ratio models. *Fish. Res.*, 115–116: 14–23.

Hanchet, S.M., G.J. Rickard, J.M. Fenaughty, A. Dunn and M.J. Williams. 2008. A hypothetical life cycle for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region. *CCAMLR Science*, 15: 35–53.

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

La Mesa, M. 2007. The utility of otolith microstructure in determining the timing and position of the first annulus in juvenile Antarctic toothfish (*Dissostichus mawsoni*) from the South Shetland Islands. *Polar Biol.*, 30: 1219–1226.

McMillan, P., T. Iwamoto, A. Stewart and P.J. Smith. 2012. A new species of grenadier, genus *Macrourus* (Teleostei, Gadiformes, Macrouridae) from the southern hemisphere and a revision of the genus. *Zootaxa*, 3165: 1–24.

Moir Clark, J. and D.J. Agnew. 2010. Estimating the impact of depredation by killer whales and sperm whales on longline fishing for toothfish (*Dissostichus eleginoides*) around South Georgia. *CCAMLR Science*, 17: 163–178.

Nowara, G., J. Verdouw and J. Hutchins. 2009. Otolith preparation and ageing of Patagonian toothfish, *Dissostichus eleginoides*, at the Australian Antarctic Division. In: Welsford, D.C., G.B. Nowara, S.G. Candy, J.P. McKinlay, J. Verdouw and J. Hutchins (Eds). *Evaluating Gear and Season Specific Age-length Keys to Improve the Precision of Stock Assessments for Patagonian Toothfish at Heard Island and McDonald Islands*. Final Report, FRDC project 2008/046.

Robinson, N.J. and M.J.M. Williams. 2012. Iceberg-induced changes to polynya operation and regional oceanography in the southern Ross Sea, Antarctica, from in situ observations. *Ant. Sci*., 24 (5): 514–526.

Sokolov, S. and S.R. Rintoul. 2009. The circumpolar structure and distribution of the Antarctic Circumpolar Current fronts. Part 2: Variability and relationship to sea surface height. *J. Geophys. Res. – Oceans*, 114: C11, doi: 10.1029/2008JC005248.

Table 1: Total reported catches (tonnes) of target species in fisheries in the Convention Area in 2011/12. CM: conservation measure; research and by-catch limits in bracket. (Source: catch and effort reports to 24 September 2012 unless otherwise indicated.)

Target species	Region	CM	Catch (tonnes) of target species		Reported catch (%limit)
			Limit	Reported	
Champsocephalus gunnari	48.3	42-01	3 072	546	18
	58.5.2	42-02	0 (30)	4	-
Total				550	
Dissostichus eleginoides	48.3	41-02	2 600	1 844	71
	48.4 North	41-03	48	43	90
	58.5.1 French EEZ[a]	ns	ns	2 810	-
	58.5.2	41-08	2 730	1 935	71
	58.6 French EEZ[a]	ns	ns	450	-
	58 South African EEZ[b]	ns	ns	60	-
Dissostichus spp.	48.4 South	41-03	33	33	100
	48.6	41-04	400	381	95
	58.4.1	41-11	210	157	75
	58.4.2	41-05	70	53	76
	58.4.3a	41-06	86	34	40
	58.4.3b	41-07	0 (40)	9	-
	58.4.4a, 58.4.4b	24-01	0 (70)	28	-
	88.1	41-09	3 282	3 175	97
	88.2	41-10	530	414	78
	88.3	24-01	-	4	-
Total				11 430	
Euphausia superba	48.1, 48.2, 48.3, 48.4	51-01	620 000	157 119	25
	58.4.1	51-02	440 000	No fishing	-
	58.4.2	51-03	452 000	No fishing	-
Total				157 119	

[a] Reported in fine-scale data to August 2012
[b] Inside the Convention Area
ns Not specified by CCAMLR

Table 2: Estimated catch (tonnes) of *Dissostichus eleginoides* reported in the CDS for fisheries operating outside the Convention Area in the calendar years 2010, 2011 and 2012 (to 17 September 2012).

Ocean sector	Region	Catch (tonnes)		
		2010	2011	2012
Southwest Atlantic	41.2.3	448	408	108
	41.3	299	172	29
	41.3.1	1 819	2 538	1 355
	41.3.2	3 967	4 820	3 194
	41.3.3	-	79	-
Southeast Atlantic	47	27	-	-
	47.4	51	196	66
Western Indian	51	238	670	217
Southwest Pacific	81	276	412	85
Southeast Pacific	87	5 316	4 265	3 757
Total			13 560	8 811

Table 3: Values of B_0 (tonnes), *SSB* (tonnes), *SSB* status (ratio), and ratio of model estimates of POKER survey biomass to the observed biomass for four scenarios of the Kerguelen model for Division 58.5.1, including the base case (Scenario 1). In Scenario 2, year-class strength (YCS) was fixed to 1, Scenario 3 excluded CPUE data and Scenario 4 assumed twice the observed levels of IUU catches in each year.

Scenario	1. Base case	2. YCS fixed to 1	3. Without CPUE	4. IUU catches × 2
B_0	218 078	215 835	244 460	223 179
SSB	156 916	132 750	158 582	150 441
SSB status	0.72	0.62	0.65	0.67
POKER 1	0.55	0.57	0.57	0.55
POKER 2	0.51	0.84	0.87	0.51

Table 4: Number of individuals of *Dissostichus* spp. tagged and released and the tagging rate (fish per tonne of green weight caught) reported by vessels operating in 2011/12 in fisheries for *Dissostichus* spp. which have tagging requirements outlined in the conservation measures. The required tagging rate (required rate) for *Dissostichus* spp. is listed for each subarea and division, and does not include any additional requirements when conducting research fishing in closed SSRUs. The number of *D. eleginoides* tagged is indicated in parentheses. (Source: observer data and catch and effort reports.)

Subarea/division (required rate)	Flag State	Vessel name	TOT tagged and released		
			Number of fish		Tagging rate
48.4 (5)	New Zealand	*San Aspiring*	246	(218)	6.5
	UK	*Argos Georgia*	204	(85)	5.2
48.6 (5)	Japan	*Shinsei Maru No. 3*	1239	(14)	5.1
	South Africa	*Koryo Maru No. 11*	708	(57)	5.2
58.4.1 (5)	Korea	*Hong Jin No. 701*	812	(0)	5.2
58.4.2 (5)	Korea	*Hong Jin No. 701*	203	(0)	5.0
	South Africa	*Koryo Maru No. 11*	66	(3)	5.2
58.4.3a (5)	France	*Saint André*	235	(235)	6.9
58.4.3b (5)	Japan	*Shinsei Maru No. 3*	51	(30)	5.7
88.1 (1)	Korea	*Hong Jin No. 701*	109	(3)	1.3
		Hong Jin No. 707	462	(0)	1.0
		Jung Woo No. 2	186	(0)	1.2
		Jung Woo No. 3	236	(0)	1.2
	New Zealand	*Antarctic Chieftain*	128	(1)	1.2
		Janas	168	(0)	1.3
		San Aotea II	304	(15)	3.8**
		San Aspiring	528	(1)	1.1
	Norway	*Seljevaer*	178	(0)	1.0
	Russia	*Chio Maru No. 3*	203	(2)	1.0
		Sparta	2	(2)	1.6
		Yantar 31	362	(0)	1.2
	Spain	*Tronio*	546	(0)	1.0
	UK	*Argos Froyanes*	38	(0)	1.3
		Argos Georgia	301	(1)	1.1
88.2 (1)	Korea	*Hong Jin No. 707*	38	(0)	1.5
	New Zealand	*Antarctic Chieftain*	59	(0)	1.0
		Janas	99	(0)	1.0
	Russia	*Chio Maru No. 3*	101	(0)	10.3*
		Sparta	36	(0)	1.1
	UK	*Argos Froyanes*	210	(0)	1.0

* Tagging rate includes research fishing in SSRU A.
** Tagging rate includes research fishing in SSRUs J and L.

Table 5: Time series of the tag-overlap statistic (CM 41-01) for (a) *Dissostichus mawsoni* and (b) *D. eleginoides* tagged by vessels actively fishing in the exploratory fisheries in 2011/12. The statistic was implemented in 2010/11, and comparative values were calculated for previous seasons. Values were not calculated for total catches of less than 2 tonnes (*) and length data were aggregated by 10 cm length intervals.

(a) *Dissostichus mawsoni*

Flag State	Vessel name	Subarea/ division	2007	2008	2009	2010	2011	2012
Japan	*Shinsei Maru No. 3*	48.6	33	31	65	68	95	85
		58.4.1				57		
		58.4.2			36			
		58.4.3a			*			
		58.4.3b	29	49	36	55	85	86
		58.4.4b		*				
Korea	*Hong Jin No. 701*	48.6					84	
		58.4.1					70	89
		58.4.2						78
		88.1						72
	Hong Jin No. 707	88.1		18	25	50	64	71
		88.2			36		73	62
	Jung Woo No. 2	48.6	12					
		58.4.2	29					
		88.1	29	25	19	26	93	91
	Jung Woo No. 3	88.1			21	42	88	86
		88.2				15	84	
New Zealand	*Antarctic Chieftain*	88.1			57	61	96	89
		88.2			61		92	96
	Janas	88.1	69	80	43	79	85	81
		88.2			73		81	83
	San Aotea II	88.1	52	69	77	79	88	88
	San Aspiring	88.1	76	74	81	88	90	92
		88.2					77	
Norway	*Seljevaer*	88.1						79
Russia	*Chio Maru No. 3*	88.1					78	75
		88.2					55	69
	Sparta	88.1					63	*
		88.1					79	62
	Yantar 31	88.1						90
South Africa	*Koryo Maru No. 11*	48.6					50	70
		58.4.2						48
Spain	*Tronio*	58.4.1	31	21			52	
		58.4.3b	65					
		88.1		22	19	69	69	69
		88.2			17	49		
UK	*Argos Froyanes*	88.1		46	43	53	75	61
		88.2		31	55	54	75	65
	Argos Georgia	88.1	55	65		47	69	89
		88.2			56	100	50	

(continued)

Table 5 (continued)

(b) *Dissostichus eleginoides*

Flag State	Vessel name	Subarea/ division	2007	2008	2009	2010	2011	2012
France	*Saint André*	58.4.3a						79
Japan	*Shinsei Maru No. 3*	48.6	34	44	26	42	*	*
		58.4.1				43		
		58.4.2			*			
		58.4.3a	100		45		86	
		58.4.3b	36	36	21	*	81	69
		58.4.4a		51		100		
		58.4.4b		59		100	95	82
Korea	*Hong Jin No. 701*	48.6					76	
		58.4.1						*
	Hong Jin No. 707	88.1			21		*	
	Jung Woo No. 2	48.6	43					
		58.4.2	*					
		88.1	56	43				*
	Jung Woo No. 3	88.1						*
New Zealand	*Antarctic Chieftain*	88.1					*	*
		88.2						*
	Janas	88.1	*	*	*		*	*
	San Aotea II	88.1	*	*	*	*	*	71
	San Aspiring	88.1	*	*	*	*	*	*
Russia	*Chio Maru No. 3*	88.1					*	*
	Sparta	88.1						*
South Africa	*Koryo Maru No. 11*	48.6					80	70
		58.4.2						*
Spain	*Tronio*	58.4.1	*	*			*	
		58.4.3a	*					
		88.1		75	*		*	
UK	*Argos Froyanes*	88.1			*			
	Argos Georgia	88.1	*	*				*

Table 6: Number of *Dissostichus* spp. tagged and released in exploratory longline fisheries. (Source: scientific observer data.)

Subarea/ division	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
48.6				4	62	171	129		941	1 213	1 308	1 948	5 776
58.4.1					462	469	1 507	1 134	1 127	627	747	812	6 885
58.4.2					342	136	248	673	277	291	408	269	2 644
58.4.3a					199	104	9	41	113		14	235	715
58.4.3b					231	175	289	417	356	60	62	51	1 641
88.1	326	960	1 068	2 250	3 209	2 972	3 608	2 574	2 943	3 066	3 073	3 751	29 800
88.2		12	94	433	355	444	278	389	603	325	667	543	4 143
Total	326	972	1 162	2 687	4 860	4 471	6 068	5 228	6 360	5 582	6 279	7 609	51 604

Table 7: Number of tagged *Dissostichus* spp. recaptured in exploratory longline fisheries. (Source: scientific observer data.)

Subarea/ division	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total
48.6						3	2		2	10	2	34	53
58.4.1							4	6	8	4	5		27
58.4.2									1	1			2
58.4.3a						6		2	2			9	19
58.4.3b					1	6	1	1	1	1			11
88.1	1	4	13	32	59	71	206	216	103	250	218	147	1 320
88.2				18	17	28	33	36	56	44	60	88	380
Total	1	4	13	50	77	114	246	261	173	310	285	278	1 812

Table 8: Summary of Members' notifications for exploratory fisheries for *Dissostichus* spp. in 2012/13.

Member and vessel	Subarea/division where fishing has been notified						
	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	88.1	88.2
France							
Saint André				✓			
Japan							
Shinsei Maru No. 3	✓	✓	✓	✓	✓	✓	
Korea							
Hong Jin No. 701						✓	✓
Hong Jin No. 707						✓	✓
Insung No. 3		✓				✓	✓
Insung No. 5						✓	✓
Kostar						✓	✓
Sunstar						✓	✓
New Zealand							
Antarctic Chieftain						✓	✓
Janas						✓	✓
San Aotea II						✓	✓
San Aspiring						✓	✓
Norway							
Seljevaer						✓	✓
Russia							
Ugulan						✓	✓
Palmer						✓	✓
Sarbay						✓	✓
Sparta						✓	✓
Yantar-31						✓	✓
Yantar-35						✓	✓
South Africa							
Koryo Maru No. 11	✓		✓	✓			
Spain							
Tronio		✓	✓			✓	✓
Ukraine							
Koreiz						✓	✓
Poseydon I						✓	✓
Simeiz						✓	✓
UK							
Argos Froyanes						✓	✓
Argos Georgia						✓	✓
Total Members	2	3	3	3	1	8	7
Total vessels	2	3	3	3	1	24	23

Table 9: Subarea 48.5 – Preliminary research proposal evaluation criteria as agreed by the focus topic on data-poor fisheries as defined at WG-SAM-11 (paragraph references are included in the criteria) and as set out in CM 24-01 Format 2.

Subarea 48.5			
CM 24-01 Format 2 Evaluation Criteria		WG-FSA-12/12 – Russia 'Eastern area' (option 2)	WG-FSA-12/12 – Russia option 1 and 'Eastern' plus 'Western area' (option 3)
1. Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)		Y	Y
2. Is there a detailed survey/data collection plan? (paragraph 2.25)		Y	Y
3. Does the research adequately address these three requirements for an estimate of stock status? (paragraphs 2.27 to 2.29)		Y	Y
	(i) index of abundance	Y	Y
	(ii) stock hypothesis/life history	Y	Y
	(iii) biological parameters	Y	Y
4. Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)			
	(i) tag overlap	Y	Y
	(ii) spatial overlap	Y	[see note 1]
	(iii) temporal overlap	Y	Y
	(iv) fish viability	Y	Y
	(v) post-release depredation	n/a	n/a
5. Is the initial design for data-poor area complete? (paragraph 2.40)			
	(i) appropriate spatially restricted area	Y	[see note 1]
	(ii) preliminary plausible estimate of *B*	n/a	n/a
	(iii) total catch and tag rates to achieve a target CV	n/a	n/a
	(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	Y	Y
6. Is there a detailed description of proposed data analysis to achieve objectives of 1?		Y	Y
7. Is there future planned research leading to an assessment along with a corresponding time frame?		Y	Y

Note 1: Some Members felt that tag-based research in these areas was unlikely to be operationally feasible, due to the likelihood that ice conditions would prevent the research vessel from consistently accessing the same location. Other Members agreed that option 2 should be highest priority but that research should also proceed in the other identified areas subject to favourable ice conditions (paragraph 5.107).

Table 10: Subarea 48.6 – Preliminary research proposal evaluation criteria as agreed by the focus topic on data-poor fisheries as defined at WG-SAM-11 (paragraph references are included in the criteria) and as set out in CM 24-01 Format 2.

Subarea 48.6		
CM 24-01 Format 2 Evaluation Criteria	WG-FSA-12/60 Rev. 1 – Japan	WG-FSA-12/30 – South Africa
1. Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	Y	Y [note 4]
2. Is there a detailed survey/data collection plan? (paragraph 2.25)	Y	Y
3. Does the research adequately address these three requirements for an estimate of stock status? (paragraphs 2.27 to 2.29)	Y	Y
(i) index of abundance	Y	Y [note 4]
(ii) stock hypothesis/life history	Y	Y
(iii) biological parameters	Y* [note 1]	N [note 1]
4. Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)		
(i) tag overlap	Y	[note 2]
(ii) spatial overlap	Y	[note 3]
(iii) temporal overlap	Y	Y
(iv) fish viability	Y	Y
(v) post-release depredation	n/a	n/a
5. Is the initial design for data-poor area complete? (paragraph 2.40)		
(i) appropriate spatially restricted area	Y	[note 3]
(ii) preliminary plausible estimate of *B*	Y	Y [note 4]
(iii) total catch and tag rates to achieve a target CV	Y	N
(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	Y	[note 4]
6. Is there a detailed description of proposed data analysis to achieve objectives of 1?	Y	Y [note 4]
7. Is there future planned research leading to an assessment along with a corresponding time frame?	Y	Y [note 4]

Note 1: WG-FSA-12/60 Rev. 1 included a commitment to undertake otolith ageing, and requests assistance from other Members. WG-FSA-12/30 does not commit to undertake ageing. The Working Group encouraged both proponents to collaborate with other Members to develop appropriate otolith ageing methods and to age toothfish otoliths collected in this area.

Note 2: In the 2011 fishing season the *Koryo Maru No. 11* had a tag-overlap statistic of 48%, lower than the required 60%, in Division 58.4.2, but achieved a 70% overlap in Subarea 48.6. The overall tag-overlap statistic for the whole season was 70%.

Note 3: WG-FSA-12/30 identified spatial research blocks, but the Working Group felt that they were insufficiently constrained, and instead recommended the research blocks identified in WG-FSA-12/60 Rev. 1.

Note 4: WG-FSA-12/30 referenced the preliminary stock assessment framework presented in WG-FSA-12/31 to illustrate the model development that has been initiated in order to analyse the data that will be collected during the research. The Working Group noted that the assessment framework must be submitted to WG-SAM.

Table 11: Divisions 58.4.1 and 58.4.2 – Preliminary research proposal evaluation criteria as agreed by the focus topic on data-poor fisheries as defined at WG-SAM-11 (paragraph references are included in the criteria) and as set out in CM 24-01 Format 2.

Divisions 58.4.1 and 58.4.2			
CM 24-01 Format 2 Evaluation Criteria	WG-FSA-12/60 Rev. 1 – Japan	WG-FSA-12/39 – Korea	WG-FSA-12/69 – Spain
1. Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	Y	[note 1]	[note 4]
2. Is there a detailed survey/data collection plan? (paragraph 2.25)	Y	Y	N
3. Does the research adequately address these three requirements for an estimate of stock status? (paragraphs 2.27 to 2.29)			
(i) index of abundance	Y	[note 1]	Y
(ii) stock hypothesis/life history	Y	Y	N
(iii) biological parameters	Y	Y	Y
4. Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)			
(i) tag overlap	Y	Y	Y
(ii) spatial overlap	Y	Y [note 2]	Y
(iii) temporal overlap	Y	Y	Y
(iv) fish viability	Y	Y	
(v) post-release depredation	n/a	n/a	n/a
5. Is the initial design for data-poor area complete? (paragraph 2.40)			
(i) appropriate spatially restricted area	Y	Y [note 2]	Y
(ii) preliminary plausible estimate of *B*	Y	[note 3]	N/A
(iii) total catch and tag rates to achieve a target CV	Y	Y	N/A
(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	Y	[note 3]	Y
6. Is there a detailed description of proposed data analysis to achieve objectives of 1?	Y	[note 1]	[note 4]
7. Is there future planned research leading to an assessment along with a corresponding time frame?	Y	[note 1]	[note 4]

Note 1: WG-FSA-12/39 lists a variety of research and analytical activities and a reporting schedule within which results will be reviewed by CCAMLR, but is unclear with respect to what actual methods will be employed to generate indices of abundance and how the research will be used to produce a stock assessment (paragraph 5.67).

Note 2: WG-FSA-12/39 proposed set locations at which fishing would take place in the vicinity of previously released tags, but the Working Group instead recommended the research blocks identified in WG-FSA-12/60 Rev. 1.

Note 3: WG-FSA-12/39 estimated biomass in SSRUs C and G by simple Petersen estimator, but did not discount the number of tags available for recapture based on assumed tag mortality or natural mortality; the resulting estimates of *B* were judged by the Working Group to be implausibly high. The Working Group instead recommended the biomass estimation method and catch limits proposed in WG-FSA-12/60 Rev. 1.

Note 4: The Working Group noted that the depletion experiment proposed in WG-FSA-12/69 is substantially different from the tag-based methods in other proposals, and that some of the assessment criteria in this table do not apply to this method. However, the Working Group noted that, to inform a comparison with tag-based methods where experimental locations are revisited in subsequent years, and to develop areal biomass estimates from local point-based estimates, further elaboration of proposed methods would be useful.

Table 12: Division 58.4.3a – Preliminary research proposal evaluation criteria as agreed by the focus topic on data-poor fisheries as defined at WG-SAM-11 (paragraph references are included in the criteria) and as set out in CM 24-01 Format 2.

Division 58.4.3a		
CM 24-01 Format 2 Evaluation Criteria	WG-FSA-12/60 Rev. 1– Japan	WG-FSA-12/29 – France
1. Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	Y	N
2. Is there a detailed survey/data collection plan? (paragraph 2.25)	Y	Y [note 1]
3. Does the research adequately address these three requirements for an estimate of stock status? (paragraphs 2.27 to 2.29)		
(i) index of abundance	Y	Y
(ii) stock hypothesis/life history	Y	
(iii) biological parameters	Y	[note 1]
4. Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)		
(i) tag overlap	Y	Y
(ii) spatial overlap	Y	Y [note 2]
(iii) temporal overlap	Y [note 3]	Y
(iv) fish viability	Y	Y
(v) post-release depredation	n/a	n/a
5. Is the initial design for data-poor area complete? (paragraph 2.40)		
(i) appropriate spatially restricted area	Y	[note 2]
(ii) preliminary plausible estimate of *B*	Y	Y [note 4]
(iii) total catch and tag rates to achieve a target CV	Y	N [note 5]
(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	Y	[note 4]
6. Is there a detailed description of proposed data analysis to achieve objectives of 1?	Y	Y
7. Is there future planned research leading to an assessment along with a corresponding time frame?	Y	Y

Note 1: WG-FSA-12/29 did not include a commitment to undertake otolith ageing. The Working Group encouraged proponents to collaborate with other Members to develop appropriate otolith ageing methods and to age toothfish otoliths collected in this area.

Note 2: WG-FSA-12/29 proposed a constrained spatial design but the Working Group recommended the research block identified in paper WG-FSA-12/60 Rev. 1.

Note 3: WG-FSA-12/60 Rev. 1 did not identify a season in which the research would take place but committed to undertake the research in a consistent season each year, to be determined subject to subsequent decisions about research to be undertaken in other areas.

Note 4: WG-FSA-12/29 provided a preliminary biomass estimate based on CPUE and seabed area, but the Working Group recommended use of the Petersen-based estimate in WG-FSA-12/60 Rev. 1.

Note 5: WG-FSA-12/29 reproduced CV estimation figures from WG-SAM-11 but did not apply the formula to generate figures with reference to the particular estimation in Division 58.4.3a.

Table 13: Divisions 58.4.4a and 58.4.4b – Preliminary research proposal evaluation criteria as agreed by the focus topic on data-poor fisheries as defined at WG-SAM-11 (paragraph references are included in the criteria) and as set out in CM 24-01 Format 2.

Divisions 58.4.4a and 58.4.4b	
CM 24-01 Format 2 Evaluation Criteria	WG-FSA-12/58 Rev. 1 – Japan
1. Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	Y
2. Is there a detailed survey/data collection plan? (paragraph 2.25)	Y
3. Does the research adequately address these three requirements for an estimate of stock status? (paragraphs 2.27 to 2.29)	
(i) index of abundance	Y
(ii) stock hypothesis/life history	Y
(iii) biological parameters	Y [note 1]
4. Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)	
(i) tag overlap	Y
(ii) spatial overlap	Y
(iii) temporal overlap	Y
(iv) fish viability	Y
(v) post-release depredation	Y [note 2]
5. Is the initial design for data-poor area complete? (paragraph 2.40)	
(i) appropriate spatially restricted area	Y [note 3]
(ii) preliminary plausible estimate of *B*	Y
(iii) total catch and tag rates to achieve a target CV	Y
(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	Y [note 4]
6. Is there a detailed description of proposed data analysis to achieve objectives of 1?	Y
7. Is there future planned research leading to an assessment along with a corresponding time frame?	Y

Note 1: Otolith ageing has been undertaken in this area, but the Working Group recommended that the ageing results be checked and updated in collaboration with other Members where appropriate.

Note 2: Changes to the research design were agreed to avoid depredation in SSRU B.

Note 3: The spatial design of the research for both SSRUs was agreed by the Working Group, but there was no consensus about whether the research should proceed in SSRU D.

Note 4: Biomass estimates and catch limits were calculated in WG-FSA-12/58 using approved methods, but the Working Group did not agree on a recommended catch limit for this research.

Table 14: Total number of rajids hauled in longline fisheries.

Season	Subarea/division														
	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4a	58.4.4b	58.5.2	58.6	58.7	88.1	88.2	88.3
2004	4 696		0		7		31			8 351	15 204	0	8 137	133	
2005	1 145	0	5	10	537	7 133	1 752			16 781	22 755		15 381	5	
2006	21 991	4 363	0	6	17	2 347	858			6 556	27 382	0	15 444	947	
2007	9 784	6 800	3	13	61	8	2 107			8 723	23 685	0	12 087	16	
2008	21 155	9 000	0	11	74	332	518	1	5	8 028	24 005	0	7 621	0	
2009	26 686	10 075	1	1	0	643	506			10 028	36 444	20	7 998	279	
2010	16 724	6 620	0	0	7		48	1	144	8 801	25 084	9	7 788	0	
2011	13 437	4 785	0	0	0	13	11		88	6 679	14 720	62	5 853	185	
2012	13 731	5 704	2	0	0	9 320	12		8	6 668	18 674	149	2 363	28	8

Table 15: Total number of observed tagged rajidae.

Season	Subarea/division														
	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4a	58.4.4b	58.5.2	58.6	58.7	88.1	88.2	88.3
2004										276					
2005										179			615		
2006	388									843			457		
2007	442	100								1 132			691		
2008	885	112								1 115			1 301		
2009	1 596	254	6			34	5			1 480			1 972	102	
2010	1 594	238			7		8		19	1 402	48	11	2 273		
2011	761	219								1 202			10	1	
2012	856	199								293					2

Table 16: Percentage of rajids tagged.

Season	Subarea/division														
	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4a	58.4.4b	58.5.2	58.6	58.7	88.1	88.2	88.3
2004										3					
2005										1			4		
2006	2									13			3		
2007	5	1								13			6		
2008	4	1								14			17		
2009	6	3	*			5	1			15			25	37	
2010	10	4			*		17		13	16	0.2	*	29		
2011	6	5								18			0	1	
2012	6	3								4					25

* Reported number tagged > total number reported in C2 data.

Table 17: Percentage of rajids recaptured.

Season	Subarea/division														
	48.3	48.4	48.6	58.4.1	58.4.2	58.4.3a	58.4.3b	58.4.4a	58.4.4b	58.5.2	58.6	58.7	88.1	88.2	88.3
2004										8			6		
2005										2			10		
2006	1									4					
2007	8									16			21		
2008	29									9			36		
2009	31									9			23		
2010	43	3								19	1		30		
2011	43									18			31		
2012	44	1								2			5		

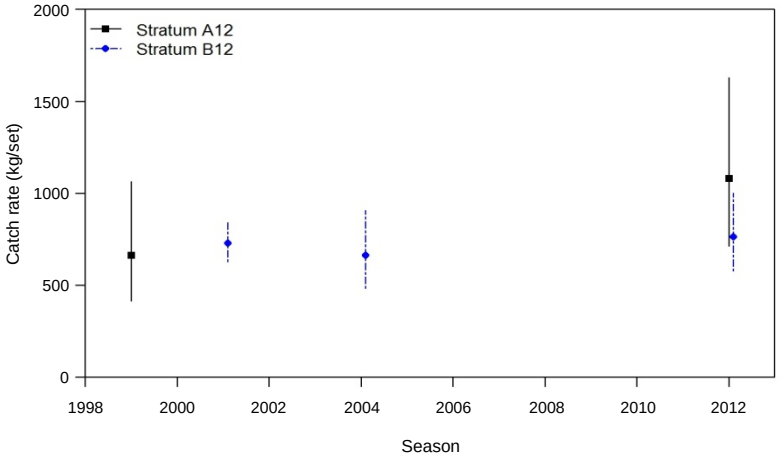

Figure 1: Standardised CPUE indices for New Zealand vessels in strata A12 (southern part of SSRU 881J) and B12 (southern part of SSRU 881L) (WG-FSA-12/41) (see Figure 3) in 1999, 2001, 2004 and 2012. The standardised catch rate refers to 5 662 hooks per set.

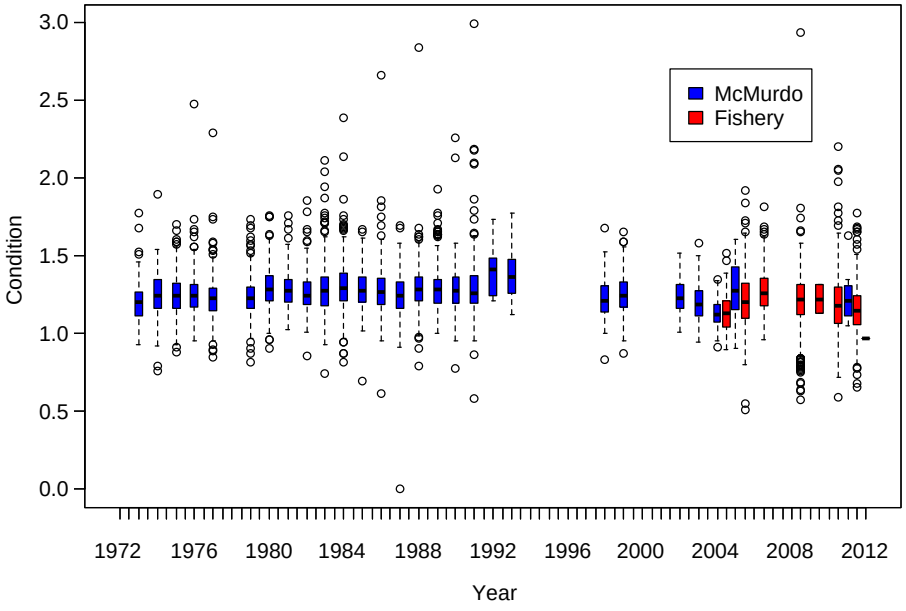

Figure 2: Fish condition for fish sampled in McMurdo Sound (blue) and the commercial toothfish fishery in SSRUs 881J and L, south of 75°S (red). The boxes are centred on the median and show the interquartile range, error bars 1.5 times the interquartile range, and circles indicate values outside that range.

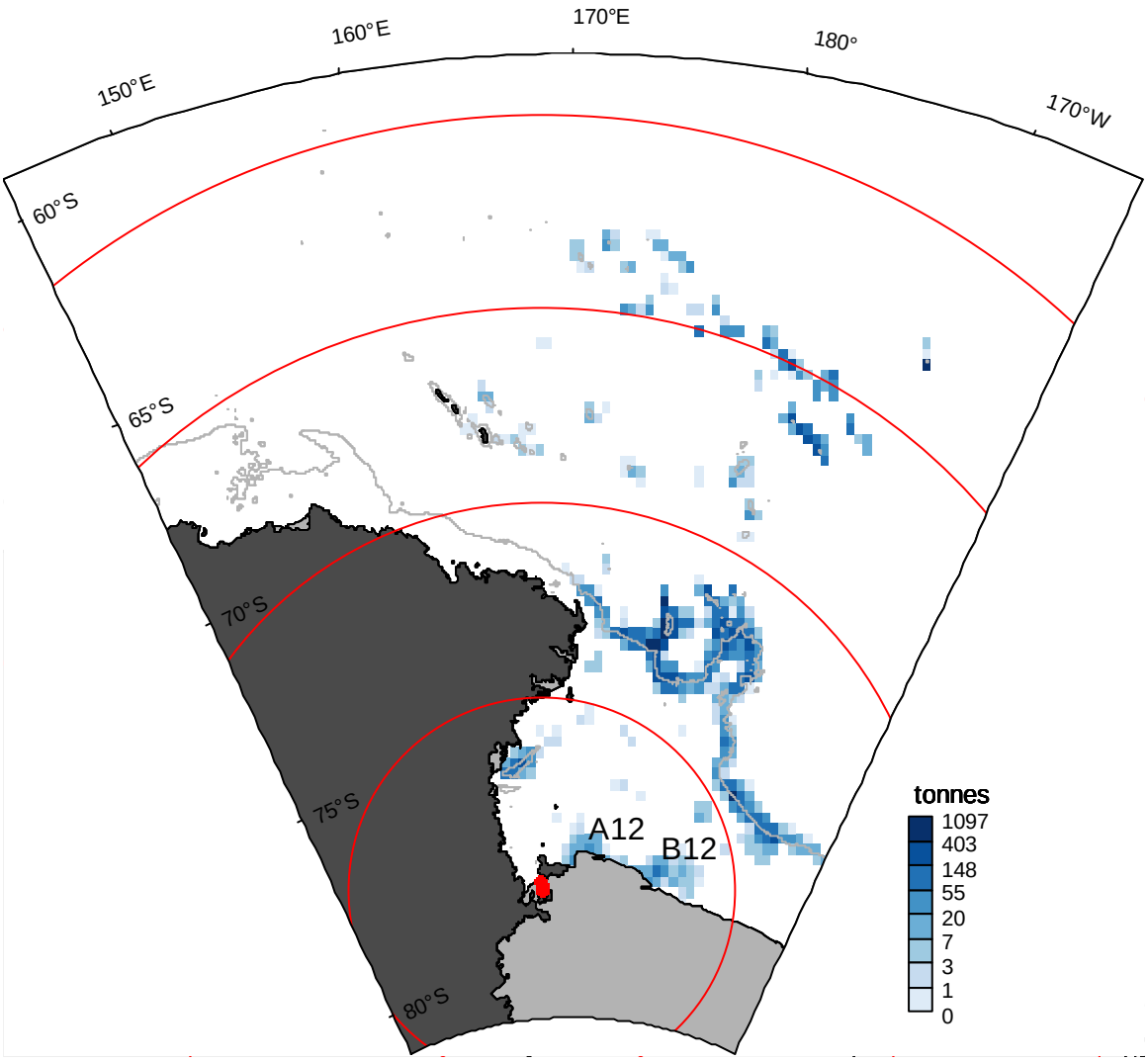

Figure 3: Distribution of total cumulative catch of Antarctic toothfish in the Ross Sea from 1997 to 2012 in relation to the sampling sites in McMurdo Sound (red dots). Red lines indicate 500 km concentric circles from McMurdo Sound. Grey line indicates the 1 000 m depth contour. Strata A12 and B12 (as in Figure 1) are indicated.

Appendix A

LIST OF PARTICIPANTS

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(Hobart, Australia, 8 to 19 October 2012)

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Appendix B

AGENDA

Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2012)

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
   4.2 Assessments and management advice
   4.3 Update Fishery Reports for established fisheries

5. Exploratory and other fisheries

   5.1 Exploratory fisheries in 2011/12

   5.2 Exploratory fisheries notified for 2012/13

   5.3 Research to inform current or future assessments
      5.3.1 Research plans
      5.3.2 Results of research in exploratory fisheries
      5.3.3 Research methods (including tagging)

   5.4 Update Fishery Reports for exploratory fisheries

   5.5 Assessment and management advice for depleted and recovering stocks

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

   6.1 Review of VMEs notified in 2011/12
   6.2 Review of preliminary assessments of the impact of bottom fishing
   6.3 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

    9.1 Ross Sea region
    9.2 Scotia Sea region
    9.3 Other regions

10. Ageing workshop for *D. eleginoides* and *D. mawsoni*

11. Future work

12. Other business

13. Advice to the Scientific Committee

14. Adoption of the report

15. Close of the meeting.

Appendix C

LIST OF DOCUMENTS

Working Group on Fish Stock Assessment
(Hobart, Australia, 8 to 19 October 2012)

WG-FSA-12/01	Provisional Agenda and Provisional Annotated Agenda for the 2012 Meeting of the Working Group on Fish Stock Assessment (WG-FSA)
WG-FSA-12/02	List of participants
WG-FSA-12/03	List of documents
WG-FSA-12/04	Microincrement analysis in otoliths of *Notothenia rossii* fingerlings from the South Shetland Islands to estimate early life history timings and to validate annulus formation E. Barrera-Oro (Argentina) and M. La Mesa (Italy)
WG-FSA-12/05	Linking fish and shags population trends R. Casaux and E. Barrera-Oro (Argentina)
WG-FSA-12/06	The Antarctic toothfish *Dissostichus mawsoni* (Nototeniidae) nutrition in the Ross Sea during the fishing season 2011/12 Yu.V. Korzun and N.A. Misar (Ukraine)
WG-FSA-12/07	Analysis of anomalous CPUE data from data-poor exploratory fisheries Secretariat and Delegation of the Republic of Korea
WG-FSA-12/08	Scientific research notifications (Conservation Measure 24-01) Secretariat
WG-FSA-12/09	A updated population status model for the Patagonian toothfish, *Dissostichus eleginoides*, at Kerguelen Islands (Division 58.5.1) using CASAL A. Rélot-Stirnemann (France)
WG-FSA-12/10	The composition, abundance and reproductive characteristics of the demersal fish fauna in the Elephant Island–South Shetland Islands region and at the tip of the Antarctic Peninsula (CCAMLR Subarea 48.1) in March–early April 2012 K.-H. Kock (Germany) and C.D. Jones (USA)

WG-FSA-12/11 Rev. 1	IUU Fishing in 2011/12 and development of methods to estimate IUU catches Secretariat
WG-FSA-12/12	Plan of research program of the Russian Federation in Subarea 48.5 (Weddell Sea) in season 2012/13 A.F. Petrov, V.A. Tatarnikov and I.I. Gordeev (Russia)
WG-FSA-12/13	Results of Phase I and II of the research program for toothfish fishery in Subarea 88.3 during the 2010/11–2011/12 seasons A.F. Petrov, V.A. Tatarnikov, K.V. Shust and I.I. Gordeev (Russia) (this is a revision of WG-SAM-12/05)
WG-FSA-12/14	*Dissostichus mawsoni* distribution and biology A.F. Petrov (Russia)
WG-FSA-12/15	Report of the 1st and the 2nd stage of research fishing conducted by Russian Federation in SSRU 882A in 2010–2012 E.F. Kulish and I.I. Gordeev (Russia) (this is a revision of WG-SAM-12/08)
WG-FSA-12/16 Rev. 1	Stock assessment of mackerel icefish (*Champsocephalus gunnari*) in the vicinity of Kerguelen Islands (Division 58.5.1) after the 2010 POKER Biomass survey R. Sinegre and G. Duhamel (France)
WG-FSA-12/17	Some aspects of size composition dynamics of Antarctic toothfish (*Dissostichus mawsoni*) from the Ross Sea (Statistical Subarea 88.1) A.K. Zaytsev (Ukraine)
WG-FSA-12/18	Influence of the quality and quantity of data from a multi-year tagging program on bias and precision of biomass estimates from an integrated stock assessment – update P.E. Ziegler (Australia)
WG-FSA-12/19	Has *Notothenia rossii* around Elephant Island and the lower South Shetland Islands (Subarea 48.1) recovered from exploitation some 30 years ago? K.-H. Kock (Germany) and C.D. Jones (USA)
WG-FSA-12/20	The recent decline in recruitment of *Gobionotothen gibberifrons* in the South Shetland Islands (CCAMLR Subarea 48.1) K.-H. Kock (Germany) and C.D. Jones (USA)

WG-FSA-12/21	Characteristics of population-genetic structure of Antarctic toothfish (*Dissostichus mawsoni*) from near-continental seas of Pacific, Indian and Atlantic sectors of the Antarctica N.S. Mugue, A.F. Petrov, D.A. Zelenina, I.I. Gordeev and A.A. Sergeev (Russia)
WG-FSA-12/22	Design of the used on Russian vessels *Sparta* and *Chio Maru No. 3* bottom trot-line for toothfish fishing I.G. Istomin, V.V. Akishin, V.A. Tatarnikov and I.I. Gordeev (Russia)
WG-FSA-12/23	Population structure and connectivity of an important pelagic forage fish in the antarctic ecosystem, *Pleuragramma antarcticum*, in relation to large scale circulation J.W. Ferguson (USA)
WG-FSA-12/24	Analysis of the by-catch of *Channichthys rhinoceratus* and *Lepidonotothen squamifrons* from the fisheries at Heard Island and the McDonald Islands (Division 58.5.2) G.B. Nowara, D.C. Welsford, S.G. Candy and T.D. Lamb (Australia)
WG-FSA-12/25	The annual random stratified trawl survey to estimate the abundance of *Dissostichus eleginoides* and *Champsocephalus gunnari* in the Heard Island region (Division 58.5.2) for 2012 G.B. Nowara and T. Lamb (Australia)
WG-FSA-12/26	A preliminary assessment of mackerel icefish (*Champsocephalus gunnari*) in Division 58.5.2, based on recent survey results D.C. Welsford (Australia)
WG-FSA-12/27	The relative impacts of autolines and Spanish longlines on vulnerable marine ecosystems T. Gerrodette and G. Watters (USA)
WG-FSA-12/28 Rev. 1	Assessment of the Action Plan aimed at reducing incidental catch of seabirds in the French EEZ included in the CCAMLR Division 58.5.1 and Subarea 58.6 C. Marteau and J. Ringelstein (France)
WG-FSA-12/29	Research plan for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 in Division 58.4.3a A. Rélot-Stirnemann (France) (this is a revision of WG-SAM-12/14)

WG-FSA-12/30	Finfish research proposals for Subarea 48.6 by *Koryo Maru 11* for 2012/13 C. Heiniken and R. Ball (South Africa) (this is a revision of WG-SAM-12/12)
WG-FSA-12/31	Preliminary analysis of toothfish catch, CPUE, size structure and mark-recapture data from SSRUs 486A and 486G, with comments on the sustainability of different harvest levels E. Thomson and M. Bergh (South Africa)
WG-FSA-12/32	Comparative analysis of the results of determination of reproductive ability of Antarctic toothfish in the Subarea 88.3 S.V. Piyanova, A.F. Petrov and A.V. Presnyakov (Russia)
WG-FSA-12/33	An analysis of temporal variability in abundance, diversity and growth rates in the coastal ichthyoplankton assemblage of South Georgia (sub-Antarctic) M. Belchier and J. Lawson (United Kingdom)
WG-FSA-12/34	Distribution and biology of grey notothen (*Lepidonotothen squamifrons*) around South Georgia and Shag Rocks (Southern Ocean) CCAMLR Subarea 48.3. S. Gregory, J. Brown and M. Belchier (United Kingdom)
WG-FSA-12/35	Molecular and morphological identification of *Macrourus* species caught as by-catch in the toothfish longline fisheries in CCAMLR Subareas 48.3 and 48.4. E. Fitzcharles, K. Brigden, S. Gregory, M. Belchier and J. Brown (United Kingdom)
WG-FSA-12/36	Population assessment of Patagonian toothfish in Subarea 48.4 R. Scott (United Kingdom)
WG-FSA-12/37	Results from the reduced groundfish survey conducted in CCAMLR Subarea 48.3 in January 2012 J. Brown, S. Gregory, A. Stanworth, V. Carretero, G. Baker and M. Belchier (United Kingdom)
WG-FSA-12/38	A characterisation of the toothfish fishery in Subarea 48.6 from 2003/04 to 2011/12 R. Wiff (Chile), M. Belchier (United Kingdom), J.C. Quiroz and J. Arata (Chile)
WG-FSA-12/39	Research plan for the exploratory longline fishery for *Dissostichus* spp. in SSRUs C, E and G in Division 58.4.1 in 2012/13 Delegation of the Republic of Korea (this is a revision of WG-SAM-12/10 Rev. 1)

WG-FSA-12/40	Indexing maturation of Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region S. Parker and P. Marriott (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-12/41	Results of a CCAMLR-sponsored research survey to monitor abundance of pre-recruit Antarctic toothfish in the southern Ross Sea, February 2012 S.M. Hanchet, S. Mormede, S. Parker, A. Dunn (New Zealand) and H.-S. Jo (Republic of Korea) (*CCAMLR Science*, submitted)
WG-FSA-12/42	A characterisation of the toothfish fishery in Subareas 88.1 and 88.2 from 1997/98 to 2011/12 M.L. Stevenson, S.M. Hanchet, S. Mormede and A. Dunn (New Zealand)
WG-FSA-12/43	Manual for age determination of Antarctic toothfish, *Dissostichus mawsoni* V2 C.P. Sutton, P.L. Horn and S.J. Parker (New Zealand)
WG-FSA-12/44	Further development of coarse- and medium-scale spatially explicit population dynamics operating models for Antarctic toothfish in the Ross Sea region S. Mormede, A. Dunn, S. Parker and S. Hanchet (New Zealand)
WG-FSA-12/45	Using outputs from spatial population models of Antarctic toothfish in the Ross Sea region to investigate potential biases in the single population model S. Mormede and A. Dunn (New Zealand)
WG-FSA-12/46	Spatial Population Model User Manual, SPM v1.1-2012-09-06 (rev. 4806) A. Dunn, S. Rasmussen and S. Mormede (New Zealand)
WG-FSA-12/47 Rev. 1	Quantifying vessel performance in the CCAMLR tagging program: spatially and temporally controlled measures of relative mortality and tag-detection rates S. Mormede and A. Dunn (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-12/48	Models of larvae dispersion of Antarctic toothfish (*Dissostichus mawsoni*) A. Dunn, G.J. Rickard, S.M. Hanchet and S.J. Parker (New Zealand)

WG-FSA-12/49	Summary of toothfish tagging suitability data from paired Spanish line – trotline sets S. Parker and D. Fu (New Zealand)
WG-FSA-12/50	Characterisation of Muraenolepis species by-catch in the CCAMLR Convention Area S. Parker, P. McMillan and P. Marriott (New Zealand)
WG-FSA-12/51	Demersal fish communities in the Ross Sea region of Antarctica: comparisons between video and trawl survey methods D.A. Bowden, S.M. Hanchet and P.M. Marriott (New Zealand)
WG-FSA-12/52	Diet of Antarctic toothfish (*Dissostichus mawsoni*) from the Ross Sea region, Antarctica D.W. Stevens, M.R. Dunn, M.H. Pinkerton and J.S. Forman (New Zealand)
WG-FSA-12/53	Testing for genetic differentiation between two size classes of the starry skate (*Amblyraja georgiana*) P. Ritchie and A. Fleming (New Zealand)
WG-FSA-12/54 Rev. 1	Distribution, morphology, growth, reproduction, diet and trophic position of two species of grenadier (*Macrourus whitsoni* and *M. caml*) in the Ross Sea region of the Southern Ocean (CCAMLR Subareas 88.1 and 88.2) M.H. Pinkerton, P. McMillan, J. Forman, P. Marriott, P. Horn, S. Bury and J. Brown (New Zealand) (*CCAMLR Science*, submitted)
WG-FSA-12/55	plotImpact v2.0-2012 D.N. Webber (New Zealand)
WG-FSA-12/56	Survey results on abundance and biology of toothfish in Division 58.4.3b by *Shinsei Maru No. 3* during 2006/07–2011/12 and proposal of the consecutive survey in 2012/13 K. Taki, T. Iwami, M. Kiyota and T. Ichii (Japan)
WG-FSA-12/57	Revised reports on abundance and biological information on toothfish in Divisions 58.4.4 a and 58.4.4b by *Shinsei Maru No. 3* in 2011/12 K. Taki, T. Iwami, M. Kiyota and T. Ichii (Japan)
WG-FSA-12/58 Rev. 1	Revised research plan for toothfish in Divisions 58.4.4 a and 58.4.4b by *Shinsei Maru No. 3* in 2012/13 Delegation of Japan

WG-FSA-12/59	Towards the development of a stock assessment for Patagonian toothfish in Division 58.4.4, SSRU C on Ob and Lena Banks K. Taki (Japan)
WG-FSA-12/60 Rev. 1	Revised research plan for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a Delegation of Japan (this is a revision of WG-SAM-12/09)
WG-FSA-12/61	Fatty acid analysis to infer diet of Antarctic toothfish caught in February 2012 in the southern Ross Sea I. Yeon, H.-S. Jo, C. Lim (Republic of Korea), S.M. Hanchet (New Zealand), D.-W. Lee and C.-K. Kang (Republic of Korea) (*CCAMLR Science*, submitted)
WG-FSA-12/62	An analysis of fishing location and tag recaptures in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a in 2012 Secretariat
WG-FSA-12/63	The CCAMLR Scheme of International Scientific Observation – a scoping paper on the operations and sampling requirements of the scheme Secretariat
WG-FSA-12/64	Review of activities in monitoring marine debris in the CAMLR Convention Area Secretariat
WG-FSA-12/65	Hook loss in CCAMLR exploratory fisheries Secretariat
WG-FSA-12/66 Rev. 2	Summary of scientific observations in the CAMLR Convention Area for 2011/12 Secretariat
WG-FSA-12/67	Foraging zones of the two sibling species of giant petrels in the Indian Ocean throughout the annual cycle: implication for their conservation L. Thiers, K. Delord, C. Barbraud (France), R.A. Phillips (United Kingdom) and H. Weimerskirch (France)
WG-FSA-12/68 Rev. 1	Migrations of Antarctic fish *Pseudochaenichthys georgianus* Norman, 1939 in the Scotia Sea R. Traczyk (Poland)

WG-FSA-12/69	Revised research plan for the Spanish exploratory longline fishery for *Dissostichus* spp. in Divisions 58.4.1 and 58.4.2: Fundamentals and procedures R. Sarralde, L.J. López Abellán and S. Barreiro (Spain) (this is a revision of WG-SAM-12/13)
WG-FSA-12/70 Rev. 2	Summary of scientific observations related to Conservation Measures 24-02 (2008), 25-02 (2009) and 26-01 (2009) Secretariat

Other documents

WG-FSA-12/P01	Slow recovery of previously depleted demersal fish at the South Shetland Islands, 1983–2010 E.R. Marschoff, E.R. Barrera-Oro, N.S. Alescio and D.G. Ainley (*Fish. Res.*, 125–126 (2012): 206–213)
WG-FSA-12/P02	Does large-scale ocean circulation structure life history connectivity in Antarctic toothfish (*Dissostichus mawsoni*)? J. Ashford, M. Dinniman, C. Brooks, A. Andrews, E. Hofmann, G. Cailliet, C. Jones and N. Ramanna (*Can. J. Fish. Aquat. Sci*., in press)
WG-FSA-12/P03	Trophic interactions and population trends of killer whales (*Orcinus orca*) in the southern Ross Sea D.G. Ainley and G. Ballard (*Aquatic Mammals*, 38 (2) (2012): 153–160, doi: 10.1578/AM.38.2.2012.153)
WG-FSA-12/P04	Decadal trends in abundance, size and condition of Antarctic toothfish in McMurdo Sound, Antarctica, 1972–2011 D.G Ainley, N. Nur, J.T Eastman, G. Ballard, C.L Parkinson, C.W Evans and A.L. DeVries (*Fish and Fisheries* (2012), doi: 10.1111/j.1467-2979.2012.00474.x)
WG-FSA-12/P05	Unnatural selection of Antarctic toothfish in the Ross Sea, Antarctica D.G. Ainley, C.M. Brooks, J.T. Eastman and M. Massaro In: Huettmann, F. (Ed.). 2012. *Protection of the Three Poles*, Chapter 3. Springer Verlag, doi: 10.1007/978-4-431-54006-9_3)

WG-FSA-12/P06	The fish fauna of the Argentine Islands region (Antarctica; 12 UAE 2007–2008) and morphometrical changeability of *Notothenia coriiceps* (Richardson, 1844) V.N. Trokhymets, V.A. Tymofyeyev and J.S. Perechrest (*Ukraininan Antarctic Journal*, 9 (2010))
WG-FSA-12/P07	Robust characterisation of the age structure, growth and recruitment of toothfish in the Macquarie Island and Heard Island and McDonald Islands fisheries D.C. Welsford, S.G. Candy, J.J. Verdouw and J.J. Hutchins (*AFMA Project 2009/839*, Final Report (2012))
WG-FSA-12/P08	The spawning dynamics of Patagonian toothfish in the Australian EEZ at Heard Island and the McDonald Islands and their importance to spawning activity across the Kerguelen Plateau D.C. Welsford, J. McIvor, S.G. Candy and G.B. Nowara (*FRDC Tactical Research Fund Project 2010/064*, Final report (2012))
WG-FSA-12/P09	Modern data on parasitofauna of *Dissostichus mawsoni* and by-catch species from logline fishing in Antarctica I.I. Gordeev and S.G. Sokolov (*Proceedings of the 5th Russian conference with international participation on theoretical and marine parasitology, 23–27 April 2012, Kaliningrad* (2012): 63–64)
WG-FSA-12/P10	Physical and behavioural influences on larval fish retention: contrasting patterns in two Antarctic fishes E.F. Young, J. Rock, M.P. Meredith, M. Belchier, E.J. Murphy and G.R. Carvalho (*Mar. Ecol. Progr. Ser.*, in press. doi: 10.3354/meps09908. The abstract is available on www.int-res.com/prepress/m09908.html)
WG-FSA-12/P11	Can acoustic methods be used to monitor grenadier (Macrouridae) abundance in the Ross Sea region? R.L. O'Driscoll, S.M. Hanchet and B.S. Miller (*J. Ichthyol.*, 52 (10) (2012): 1–9)

Appendix D

TAGGING PROTOCOL CHECKLIST

TAG DEPLOYMENT

1. Use proper handling procedures, minimise time out of water.
2. Ideally use at least two people, more for large fish, transport fish using a carrier.
3. Carefully and quickly remove the hook.
4. Assess suitability categories. Do not tag if any condition or injury listed below is present.

Assessment category	Do not tag
Hook injuries	Hook injury outside the mouth area (outside the lips, jaw, or cheek), or in the back of the mouth
Gills	Gills pink or white
Bleeding	Any visible bleeding from gills, or excessive bleeding elsewhere
Body	Visible damage to fish body with open wounds
Organs	Visible damage to eye or penetration of body cavity, including by crustaceans (amphipods/lice)
Scales	Abrasions or single area of recent scale loss equal to, or exceeding, the area equivalent to the fish tail

5. Double-tag fish using sequential tag numbers if possible.
6. Confirm tag is anchored with a gentle tug.
7. Record set, date and time, species, total length (cm) for toothfish, pelvic length (cm) for skates, and both tag numbers (all leading characters, tag colour and type), and tagger identifier.
8. Double-check both tag numbers.
9. Release fish headfirst into water, unless predators present.

TAG RECOVERY

1. Record set number, tag numbers (all leading characters, tag colour and type), date and time, sex, total length (cm) for toothfish, pelvic length (cm) for skates, total weight (kg), gonad stage, and gonad weight for toothfish (grams) and tag finder identifier code.
2. Photograph attached tag with readable tag numbers using template, multiple photos if needed.
3. Record tag numbers, set number, fish serial number and length on otolith envelope.
4. Collect tags, both otoliths (for toothfish) and place all in otolith envelope.

Appendix E

SUMMARY OF BIOLOGICAL STUDIES

PAN-ANTARCTIC STUDIES

1. A detailed description of *Dissostichus mawsoni* biology is given in WG-FSA-12/14, including information on life cycle, distribution, age and growth, reproduction and diet.

2. WG-FSA-12/21 examined results of genetic data collected from *D. mawsoni* in Subareas 48.6, 88.1 and 88.3 and Divisions 58.4.1 and 58.4.2 for determining population structure. Frequencies of SNP alleles in the study areas were similar, indicating no genetic isolation but a homogeneous population of *D. mawsoni* circumpolar around the Antarctic continental seas. This contradicts the findings of Kuhn and Gaffney, 2008, who identified population differentiation in the Ross Sea.

3. WG-FSA-12/23 used microchemistry of otoliths to show four separate populations (Ross Sea, the southern Antarctic Peninsula in Marguerite Bay and off Charcot Island, off Joinville Island, and around the South Orkney Islands) of Antarctic silverfish (*Pleuragramma antarcticum*) (which is a main prey item of many marine predators). These results suggested that silverfish are not transported by the Antarctic Circumpolar Current, shelf processes on the West Antarctic Peninsula, or along the Weddell Front.

4. WG-FSA-12/32 discussed the reproductive biology of *D. mawsoni* in Subarea 88.3 in the Bellingshausen Sea. There were very few mature fish and no pre-spawning fish found (n = 361). Absolute fecundity was 0.11–0.47 million eggs (n = 3).

5. Data on distribution (spatial and depth), reproduction and growth of *Muraenolepis* spp., a by-catch species in the longline fishery (although caught in low numbers) were presented in WG-FSA-12/50. A lack of understanding of this genus remains and further taxonomic work is required to identify all species. *Muraenolepis* spp. has a circumpolar distribution and is mainly found at depths of 800 to 1 000 m and catches are dominated by females, although there is no sexual dimorphism in length–weight data. In the Ross Sea it is probable that *Muraenolepis* spp. spawn in early winter and are a semelparous species with $L_{50\%}$ 40 cm (7.8 cm) for females. Further research is needed on this species, especially on smaller individuals.

6. WG-FSA-12/P09 described the parasite fauna of *D. mawsoni* and by-catch species *Macrourus whitsoni*, *Chionobathyscus dewitti*, *M. microps* and *Bathyraja meridionalis* in Subareas 48.6, 58.4 and 88.1. *Dissostichus mawsoni* had a similar parasitofauna in other near-shore continental seas of Antarctica, which could be a sign of homogeneity.

ROSS SEA

Biological parameters for commercial and by-catch species

7. Several papers concerning reproduction of *D. mawsoni* and other by-catch species in the Ross Sea were submitted in 2011 and 2012. WG-FSA-11/04 summarised macroscopic maturity stage and gonadosomatic index (GSI) data of Antarctic toothfish from SSRUs of the northern, slope and shelf areas, and noted that some females showed gonad development at less than 85 cm, and resulted in $L_{50\%}$ maturity estimates of 99–102 cm for females and 102–105 cm for males. The paper also suggested a protracted spawning season because some individuals show gonad development as early as December.

8. WG-FSA-11/27 presented a histologically based review of female and male *D. mawsoni* in the Ross Sea using samples from Russian vessels. Their analyses indicated that two vitellogenic size classes of oocytes are found in maturing females. Absolute fecundity estimates therefore should separate the two cell stages to estimate the numbers of eggs to be released in the upcoming spawning season. Oocyte development indicates that spawning occurs after March–April. In a related study, WG-FSA-12/32 described the reproductive status of toothfish sampled in the Bellingshausen Sea (Subarea 88.3). The fish sampled in late summer showed similar reproductive development to those sampled in the Amundsen and Ross Sea slope areas, with large fish of both sexes showing gonad development.

9. WG-FSA-12/40 provided updated Ross Sea slope spawning ogives for *D. mawsoni* males and females based on histological assessment, estimating $L_{50\%}/A_{50\%}$ values of females 135 cm/16.9 years, and males 109 cm/12 years. Analysis of GSI of histologically assessed fish suggested that a summer month GSI value greater than 1% can be used to index development for spawning in the upcoming season. Histological analysis also suggested that almost all fish in the northern area of the Ross Sea had spawned in the previous season and were preparing to spawn in the upcoming season. On the slope, of the samples of fish that had spawned in the previous season, 80% were preparing to spawn in the upcoming season. This suggests either spawning occurs on the slope or migration from the north to the slope occurs during early spring. Collections from closer to, or during, the winter spawning season would be instructive to determine the proportion of fish which may skip spawning, and to identify the timing of movements from the Ross Sea slope area to the north using changes in condition.

10. WG-FSA-11/18 presented oocyte size distributions from several species of Antarctic fishes caught as fishery by-catch. It noted the presence of multiple distinct modes of developing oocytes in summer spawners. A similar feature of the presence of a large size range of oocytes in the maturing class was present for winter spawners. The authors interpreted these developmental characteristics as indicators that spawning likely occurs in several batches as an adaptation to unpredictable environmental conditions in high latitudes.

Ecological and ecosystem studies

11. Three papers described temporal changes, or the potential for temporal changes, in upper trophic level ecosystem dynamics in McMurdo Sound in the southwestern Ross Sea.

12. WG-FSA-12/P03 reported that the mean number of animals per sighting of fish-eating type C killer whales (distinguished from mammal-eating Type B killer whales by pod size and animal size) has decreased off Cape Crozier, Ross Island, during the past decade. The authors speculate that the change in sightings of the type C killer whales is a decrease in residence time in response to the decline in toothfish observed in McMurdo Sound, observed over a similar period.

13. WG-FSA-12/P04 described the toothfish longline fishing data series, spanning 1972–2011 and catch per unit effort declines beginning in 1997–2001. Analysis of fish length and condition suggests changes in sea-ice conditions were associated with a trend of increasing fish length with the index of September–October ice extent, and a trend of decreasing fish condition with minimum ice area. During the time series, fish condition increased until 1992, and has since decreased to a level similar to the start of the series. The change in CPUE was not associated with any of the factors analysed.

14. WG-FSA-12/P05 presented a review of the trophic ecology of the Ross Sea region and of fishery management experiences in other regions to express concern over the potential for longevity overfishing, in which a fishery selecting the largest fish can cause size and age truncation in the population. The authors suggested that, if age and size truncation is significant, the ecological role of toothfish as predator and prey, as well as their reproductive capacity, could be altered.

15. Two papers discussed the ontogenetic distribution of *D. mawsoni* in the Ross Sea in relation to large-scale oceanography. WG-FSA-12/48 presented an updated Lagrangian particle tracking simulation to characterise the potential passive dispersal pathways of Antarctic toothfish larvae originating from specific locations within the Ross Sea. Results show that larvae from some potential spawning sites are retained within the Ross Sea gyre, while larvae from other sites may be dispersed outside the Ross Sea region. Circumpolar simulations using likely spawning locations throughout the Southern Ocean show the dispersal paths for passive drogues. Further simulations require information on vertical distribution and any directed swimming of larvae or juveniles.

16. WG-FSA-12/P02 described a multidisciplinary approach to understanding adult Antarctic toothfish movement patterns within the Ross Sea. Otolith microchemistry, age composition, tag-recapture data, and passive particle movement simulations of sub-adults on the Ross Sea shelf all support the life history and stock structure hypotheses of Hanchet et al. (2008), which entailed a general alignment of ontogenetic movement with the Ross Sea gyre. Juvenile fish recruit from the eastern Ross Sea and SSRUs 882A and B shelf regions then grow and migrate to northern area hills and seamounts for spawning. The paper also supported different stock origin of toothfish in the Ross Sea compared with toothfish from the Antarctic Peninsula using otolith microchemistry.

17. Korzun and Misar (WG-FSA-12/06) reported on the stomach contents of specimens (n = 2 623) caught during 2011/12 (SSRUs 881B, C, H, J, K). A total of 29 prey taxa were recorded, with the main prey species including grenadiers (e.g. *Macrourus* spp.), channichthyids (mainly *C. dewitti*), nototheniids and squids (e.g. glacial squid (*Psychroteuthis glacialis*)). Although primarily piscivorous, crustaceans (e.g. *Notocrangon antarcticus*) were observed occasionally. No instances of cannibalism were reported. Information on sizes of prey was also provided.

18. Stevens et al. (WG-FSA-12/52) examined 1 022 toothfish caught in Subarea 88.1 during 2003, 2005 and 2010. The diets of sub-adults and adults were broadly similar, with a variety of demersal fish, cephalopods and benthic invertebrates consumed, although sub-adult toothfish predated on a greater variety of smaller prey (e.g. *Trematomus* spp., *Bathydraco* spp. and crustaceans such as *Nematocarcinus*). Overall, *Macrourus* spp. was the most important prey taxa, with icefish (e.g. *C. dewitti*), eel cods (probably *M. evseenkoi*) and *P. glacialis* also consumed. On oceanic seamounts, toothfish fed substantially on *Macrourus* spp., the morid cod *Antimora rostrata* and occasional meso- and epipelagic fish.

19. Yeon et al. (WG-FSA-12/61) analysed the fatty acids (FA) and stable isotopes ($\delta^{15}N$) of *D. mawsoni* and a range of other species (mostly fish, but samples of octopus and shrimps were also analysed) to better understand the trophic structure of the Ross Sea. There were similarities in the FA compositions in the muscle tissue of *D. mawsoni* and *P. antarcticum*, *Pogonophryne barsukovi*, *Dacodraco hunteri* and *T. loennbergii*, suggesting a trophic link between toothfish and these fish species. The mean $\delta^{15}N$ values of *D. mawsoni* were higher than those of *P. antarcticum*, *P. barsukovi* and *T. loennbergii*, confirming the higher trophic position of toothfish.

20. Pinkerton and Bradford-Grieve (WG-EMM-12/53) used a balanced ecosystem model to explore biomass and flow of organic matter by trophic level, mixed trophic impacts and to evaluate ecosystem-level characteristics of the Ross Sea shelf and slope. The model used 35 trophic groups, averaged over a typical year. The system was characterised by a high biomass of mesozooplankton and benthic invertebrates. The biomass of top predators (trophic levels >4.5) was only 0.5% of the total living biomass in the Ross Sea (excluding bacteria). The six groups with the highest 'indices of ecological importance' in the food web were phytoplankton, mesozooplankton, *P. antarcticum*, small demersal fishes, Antarctic krill (*Euphausia superba*) and cephalopods. Crystal krill (*E. crystallorophias*) and pelagic fishes were also likely to be important in the food web. It was suggested that these eight groups could be priorities for further monitoring of ecosystem change in the region. Antarctic toothfish was found to have a moderate index of ecological importance for the wider ecosystem, although it would have a greater impact on 'medium-sized' demersal fish.

Taxonomic studies

21. Ritchie and Fleming (WG-FSA-12/53) undertook a genetic study of samples of *Amblyraja georgiana* collected across the Ross Sea, as an earlier study had reported different size classes, which could have been due to the presence of cryptic species. However, the results of this study indicated that samples were not reproductively isolated. In contrast, some subtle differences in the DNA sequences of *B. eatonii* samples were observed.

22. Recent studies have indicated that a fourth species of *Macrourus* occurred in the southern Ocean. Pinkerton et al. (WG-FSA-12/54 Rev. 1) provided recent species-specific information on the distribution, morphology, growth, reproduction, diet and trophic position for the newly described *M. caml* and the sympatric *M. whitsoni* (these species were previously confounded in biological studies). The geographic distributions of the two species were similar, although *M. caml* may be proportionally more common in waters less than ca. 1 000 m deep. Biological differences are summarised in Table 1.

Table 1: Reported differences in various aspects of the biology of *Macrourus caml* and *M. whitsoni* in the Ross Sea. Adapted from Pinkerton et al. (WG-FSA-12/54 Rev. 1).

Species:	*M. caml*	*M. whitsoni*
Sample size	636 (74%)	227 (26%)
No. of rays in left pelvic fin	Usually (ca. 95%) with 8 fin rays (range 7–9)	Usually (ca. 97%) with 9 fin rays (range 8–10)
Teeth in lower jaw	Usually (98%) with 2 rows of teeth (range 1–3). Teeth small and close	Usually (99%) with 1 row of teeth (range 1–2). Teeth large and spaced
Teeth in upper jaw	Outer row not enlarged	Outer row enlarged
Body colour	Medium/dark brown or blackish	Pale to medium brown
Length of intestine	Intestines relatively long, wide and flaccid	Intestines relatively short, narrow and robust
Total length (L_T) range observed	34.5–84 cm (observed to 89 cm in a previous study)	34.5–65.1 cm (observed to 66 cm in a previous study)
Median length (L_T)	52 cm (male); 55 cm (female)	45.5 cm (male); 51.8 cm (female)
Relationship between pre-anal length (L_{PA}) and total length (L_T)	$L_{PA} = 0.534 + 0.333\ L_T$ $L_T = 4.51 + 2.67\ L_{PA}$ (Combined, $r^2 = 0.89$, N = 632) $L_{PA} = 1.78 + 0.302\ L_T$ $L_T = 1.91 + 2.87\ L_{PA}$ (Males, $r^2 = 0.87$, N = 252) $L_{PA} = 0.653 + 0.336\ L_T$ $L_T = 3.11 + 2.71\ L_{PA}$ (Females, $r^2 = 0.91$, N = 380)	$L_{PA} = –0.536 + 0.355\ L_T$ $L_T = 7.37 + 2.48\ L_{PA}$ (Combined, $r^2 = 0.88$, N = 226)
Length–weight relationship	$W = 0.002203\ L_T$ ^3.218 (Combined; $r^2 = 0.91$, N = 634) $W = 0.08779\ L_{PA}$ ^3.136 (Combined; $r^2 = 0.91$, N = 634)	$W = 0.001754\ L_T$ ^3.232 (Combined; $r^2 = 0.93$, N = 234) $W = 0.09334\ L_{PA}$ ^3.047 (Combined; $r^2 = 0.92$, N = 234)
Observed age range	13–38 years	6–27 years
Estimated von Bertalanffy growth parameters (due to a lack of small fish in samples, t_0 assumed to be –0.1.)	L_{inf} = 59.9 (male), 62.9 (female) K = 0.091 (male), 0.101 (female)	L_{inf} = 50.1 (male), 57.2 (female) K = 0.175 (male), 0.146 (female)
Estimated length at 50% sexual maturity (females only)	46 cm L_T; 16 cm L_{PA}; 13.2 yrs	52 cm L_T; 18 cm L_{PA}; 16 yrs
Estimated tropic level	4.4	4.1–4.2

SCOTIA SEA REGION

Biological parameters for commercial and by-catch species

23. Additional information on the biology of some fish species were also provided in accounts summarising current data for toothfish (*D. mawsoni* and *D. eleginoides*) in Subarea 48.6 (WG-FSA-12/38) and from a reduced groundfish survey around South Georgia and Shag Rocks (Subarea 48.3) (WG-FSA-12/37).

24. Gregory et al. (WG-FSA-12/34) summarised available groundfish survey data (1986–2012) on the distribution and biology of grey rockcod (*Lepidonotothen squamifrons*) around South Georgia and Shag Rocks. The distribution was patchy, with large aggregations

in specific 'hotspots' east of Shag Rocks and southwest of South Georgia. This patchy distribution resulted in uncertain biomass estimates. Greatest catch rates were in waters 250–350 m deep. Length-frequency data showed a progression of recognisable cohorts and increasing size over time, possibly indicating some recovery of the stock or progression of a strong cohort over the time period. Mean length at 50% maturity for males and females (37–38 cm) was similar to that described for the population in the Indian Ocean basin. Analyses of stomach contents indicated a diet dominated by salps/tunicates, euphausiids and amphipods, with ontogenetic and bathymetric differences in the diet.

25. Traczyk (WG-FSA-12/68 Rev. 1) examined the geographic and bathymetric distribution of South Georgia icefish (*Pseudochaenichthys georgianus*) in the area of Scotia Arc islands and on the shelf of South Georgia Island. Results from biological investigations for the species (including age and growth, length at maturity etc.) were summarised.

Ecological and ecosystem studies

26. Kock and Jones (WG-FSA-12/19) discussed the current status of marbled rockcod *Notothenia rossii*. A feature of *N. rossii* catches in surveys is that large numbers may be caught in certain areas, with low catch rates elsewhere. This has implications for survey design and data analysis. The factors that influence where large aggregations of *N. rossii* occur are poorly understood, but may include topographic features, hydrographic conditions and/or the locations of dense concentrations of krill. Although recent surveys have reported occasional large catches of *N. rossii*, following a period of historic low catch rates, the aggregating nature of the species hampers accurate estimates of biomass. Further studies to examine the potential benefits of adapting survey design (e.g. by stratifying trawl surveys in areas of consistent high density; examining the merits of acoustic sampling in areas of high abundance) to better evaluate current biomass are required. Additionally, alternative methods of data analysis for skewed survey data could be explored, such as the delta-lognormal GLM approach described by Lo et al. (1992) and Stefansson (1996).

27. Kock and Jones (WG-FSA-12/20) discussed the status of humped rockcod (*Gobionotothen gibberifrons*) around Elephant Island and the South Shetland Islands. Although commercial fisheries in the area ceased in 1990, analyses of survey data (1998 to 2012) indicated a decline in estimated biomass between 1998 and the most recent surveys (2007 and 2012). The length distributions indicated a reduction in the numbers of juvenile fish (20–30 cm length), with the proportion of juveniles <10% in 2012. Reasons for this apparent decline in recruitment are unclear, but it could be related to changing environmental conditions and subsequent changes in the structure of planktonic assemblages.

28. Belchier and Lawson (WG-FSA-12/33) summarised data from ichthyoplankton surveys in Cumberland Bay, South Georgia (2002–2008). Data were collected for 22 species from nine families. Maximum larval densities were observed in late August and September. Larval identification using morphological features agreed closely with genetic identification for most taxa, although the use of morphological features resulted in some misidentifications between the nototheniids *L. nudifrons* and *T. hansoni* (data for these taxa were subsequently pooled for data analyses). The two other dominant taxa were *Krefftichthys anderssoni* (Myctophidae) and *C. gunnari* (Channichthyidae). Multiple larval cohorts were evident for *C. gunnari*, suggesting a protracted spawning season. Larval growth estimates were provided

for five species, and the timings of peak abundance given for the main species. Multivariate analyses revealed significant seasonal and interannual differences in the larval fish assemblage.

29. Barrera-Oro and La Mesa (WG-FSA-12/04) used otolith microstructure analyses to provide information on the fingerlings of *N. rossii*. Samples of pelagic 'blue' phase (n = 7) and demersal 'brown' phase (n = 26) fingerlings were collected from Potter Cove (South Shetland Islands). Counting the daily rings back from the date of capture indicated that there were two main periods of larval hatching, one in late summer (February/March) and another in winter (July/August). Larval settlement was estimated to occur about 8 months from hatching. Age/length frequency distributions of fish sampled in spring 2010 showed the presence of two cohorts (biological ages 0+ and 1+) that hatched in summer and winter. Growth rates were estimated at 0.26–0.31 mm/day. This study provided new information on the hatching periods of the species and helped validate annulus formation. Further research on the spawning stages of fish sampled offshore in early summer and on fingerling stages sampled inshore in the winter is needed to confirm the findings and to clarify other uncertainties relative to early life history of the species.

30. Young et al. (WG-FSA-12/P10) contrasted patterns of larval fish dispersal for mackerel icefish (*C. gunnari*) (a demersal egg-layer) and marbled rockcod (*N. rossii*) (a pelagic spawner). Such issues play an important role in the maintenance of adult stocks and connectivity of populations etc. Simulations (using a particle tracking model with biological relevant behaviours in conjunction with an ocean circulation model) was used to examine the potential influence of oceanographic and life-history variability on the dispersal and retention of the two species. Mean retention of *N. rossii* larvae was predicted to be 5.3%, considerably lower than that of *C. gunnari* (31.3%), due to the longer planktonic phase of the former. Dispersal/retention of *C. gunnari* was strongly influenced by location of the spawning site, with the greatest contribution to overall retention from spawning sites on the southwest South Georgia shelf. A consistent feature in *C. gunnari* was the lack of larval exchange between South Georgia and Shag Rocks (despite being separated by only 240 km).

31. Kock and Jones (WG-FSA-12/10) provided a detailed account of a recent demersal trawl survey (70 hauls) in the region of Elephant Island–South Shetland Islands and the tip of the Antarctic Peninsula. Fifty-four fish species were caught, with the dominant species including various nototheniids (*G. gibberifrons*, *L. larseni*, *N. coriiceps* and *N. rossii*), and *C. gunnari*, *C. aceratus* and *Chionodraco rastrospinosus* (Channichthyidae). A range of data (e.g. catch weights, length frequency, length–weight relationships and reproductive biology) were provided.

32. Trokhymets et al. (WG-FSA-12/P06) provided recent information on the ichthyofauna of the Argentine Islands region (2007–2008), including information on the meristic and morphometric characters of black rockcod (*N. coriiceps*) from two areas (Meek–Penola Channel and west coast of Grotto Island).

33. Casaux and Barrera-Oro (WG-FSA-12/05) examined the numbers of breeding pairs of Antarctic shag (*Phalacrocorax bransfieldensis*) at Harmony Point and Duthoit Point (Nelson Island, South Shetland Islands), which declined during the 1990s. The potential effects of historical fishing on two prey species (*N. rossii* and *G. gibberifrons*) on shag populations were discussed.

34. Marschoff et al. (WG-FSA-12/P01) summarised the current status of some fish species. Industrial fishing off the South Shetland Islands in the late 1970s and early 1980s had depleted several fish stocks. Changes in size and abundance of *N. rossii* and *G. gibberifrons* (exploited species) and *N. coriiceps* (unexploited) were examined over the period 1983–2010. Catch rates of *N. coriiceps* increased at the start of the time series, and although indicating a decline over the time series, have been relatively stable in recent years. The abundance of *N. rossii* (relative to *N. coriiceps*) declined from 1983 to 1991, and has subsequently increased. Changes in mean length are suggestive of recruitment pulses. Relative abundance of *G. gibberifrons* also declined at the start of the time series, but has remained low. The increase in mean length over the time series suggests that there has been little recruitment. Factors involved, which may include fishing impacts (e.g. by-catch in krill fisheries), ecosystem interactions, depensation and environmental influences, were discussed.

Taxonomic studies

35. Fitzcharles et al. (WG-FSA-12/35) discussed taxonomic issues regarding *Macrourus* spp. (Macrouridae) from South Georgia and the South Sandwich Islands. The identification by scientific observers and fisheries biologists was compared with subsequent genetic identification, and results generally confirmed the correct identification based on morphological characters. There were, however, some noteworthy findings. Firstly, there was some confusion between the juveniles of *M. carinatus* and *M. holotrachys*. Secondly, four species of *Macrourus* were identified genetically in the Southern Ocean, thus corroborating an earlier study that reported another species (*Macrourus* sp. nov.) occurring in the CAMLR Convention Area, with latitudinal gradients in their distributions observed at the South Sandwich Islands. Thirdly, the sub-Antarctic species *M. holotrachys* was indistinguishable genetically from the north Atlantic *M. berglax*. This new macrourid has recently been formally described as *M. caml* (McMillan et al., 2012).

REFERENCES

Hanchet, S.M., G.J. Rickard, J.M. Fenaughty, A. Dunn and M.J. Williams. 2008. A hypothetical life cycle for Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region. *CCAMLR Science*, 15: 35–53.

Kuhn, K.L. and P.M. Gaffney. 2008. Population subdivision in the Antarctic toothfish (*Dissostichus mawsoni*) revealed by mitochondrial and nuclear single nucleotide polymorphisms (SNPs). *Ant. Sci.*, 20 (4): 327–338.

Lo, N.C., L.D. Jacobson and J.L. Squire. 1992. Indices of relative abundance for fish spotter data based on delta-lognormal models. *Can. J. Fish. Aquat. Sci.*, 49: 2515–2526.

McMillan, P., T. Iwamoto, A. Stewart and P.J. Smith. 2012. A new species of grenadier, genus *Macrourus* (Teleostei, Gadiformes, Macrouridae) from the southern hemisphere and a revision of the genus. *Zootaxa*, 3165: 1–24.

Stefansson, G. 1996. Analysis of groundfish survey abundance data: combining the GLM and delta approaches. *ICES J. Mar. Sci.*, 53: 577–588.

Appendices F to U are only available electronically at:
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