**Report of the Working Group on
Statistics, Assessments and Modelling**
(Punta Arenas, Chile, 30 June to 4 July 2014)

Contents

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Opening of the meeting

1.1   The 2014 meeting of WG-SAM was held at the Laboratorio Berguño, Chilean Antarctic Institute (Instituto Antártico Chileno – INACH), Punta Arenas, Chile, from 30 June to 4 July 2014. The meeting was convened by Dr S. Hanchet (New Zealand) and local arrangements were coordinated by Dr J. Arata (Chile) with support from INACH.

1.2   Dr Hanchet welcomed participants (Appendix A) and outlined the large workload that had been directed to WG-SAM and recalled that the role of the Working Group was to advise on quantitative and related issues relevant to the work of the Scientific Committee and its other working groups.

Adoption of the agenda and organisation of the meeting

1.3   The agenda was adopted (Appendix B).

1.4   Documents submitted to the meeting are listed in Appendix C and the Working Group thanked all the authors of papers for their valuable contributions to the work presented to the meeting.

1.5   In this report, paragraphs that provide advice to the Scientific Committee and its other working groups have been highlighted. A list of these paragraphs is provided in Item 6.

1.6   The report was prepared by Drs M. Belchier (UK; WG-FSA Convener), C. Darby (UK), C. Jones (USA; Chair of the Scientific Committee), S. Mormede and S. Parker (New Zealand), D. Ramm and K. Reid (Secretariat), Mr R. Scott (UK), Drs B. Sharp (New Zealand), D. Welsford and P. Ziegler (Australia).

A review of progress towards updated integrated assessments of toothfish

Subarea 48.3

2.1   WG-SAM-14/35 described analyses of nine years of data derived from tagged and recaptured toothfish in Subarea 48.3, including movement, growth, tag shedding and maturation rates. The Working Group noted that comparable tag characterisations would be useful for all fisheries, and summary data, including numbers of fish tagged, released and recaptured, tag-overlap statistics, tag shedding, post-tagging mortality estimates and spatial distribution of tags would be useful to include in the Fishery Reports. The Working Group requested that the Secretariat examine the potential for providing such summaries for consideration at WG-FSA-14. It also welcomed the plan by UK scientists to conduct further

analysis of reproductive biology and the spatial dynamics of toothfish in Subarea 48.3. The Working Group noted that the mean tag overlap statistic for length frequencies had increased through time, from around 65% between 2004 and 2006 to around 85% between 2010 and 2013.

Division 58.5.2

2.2   WG-SAM-14/23 Rev. 1 described progress towards an updated assessment for toothfish in Division 58.5.2, including ageing otoliths collected from recent surveys and commercial fishing, re-estimation of the growth function taking account of selectivity, and proposed revised weightings of the survey time series. The authors noted that CASAL version 2.30-2012-03-21 rev 4648 will be used to conduct the revised assessment.

2.3   The Working Group noted that currently the assessment assumes the trawl survey has a $q = 1$. It recommended that tests of the sensitivity of the assessment to q be conducted, as well as estimating q within the assessment. It noted that the survey estimate of biomass on the main trawl ground could be compared to biomass estimates calculated from the tag recaptures in the surveys to create a prior for q.

2.4   The Working Group recommended that ageing toothfish from the most recent surveys should be a priority, to enable improved estimates of year-class strength (YCS) and ageing of samples from the commercial longline fishery, to enable better estimation of fishery selectivity and growth of male and female fish above twenty years old. It also recommended sensitivity testing of the age set for the plus group based on the distribution of ages observed in the fishery and investigation of the trends in survey length frequency.

2.5   The Working Group agreed that tag releases and recaptures from the longline fishery could be used to provide an index of abundance for adult toothfish. The Working Group noted that, because toothfish movements and spatial patterns of fishing effort can generate bias in tag-based biomass estimates, actual fishing effort patterns and apparent fish movements in this area should be considered in any such application of tag data to the assessment.

2.6   Dr Ziegler presented a map illustrating the historical concentration of tag releases in a small number of spatially restricted trawl grounds and the patchy distribution of longline effort around the slope through time in Division 58.5.2. The Working Group noted that methods to account for this bias were currently being investigated, including developing movement and fleet dynamics models to reduce any bias that would be introduced by including these data in their entirety in an integrated assessment. It also noted that tag-based abundance estimates could be calculated external to CASAL using subsets of data that better meet model assumptions and that such analyses may provide a useful context in interpreting the revised assessment.

Subarea 88.2

2.7   The Working Group noted work to progress an assessment of toothfish in Subarea 88.2, including: consideration of stock structure (WG-SAM-14/26), otolith microchemistry analyses (WG-SAM-14/33), a spatial description of the fishery and biomass

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estimation on individual seamounts and the use of tag data to estimate abundance (WG-SAM-14/08 and 14/27), a proposed CASAL assessment (WG-SAM-14/29) and options for improving the amount and quality of information for the SSRUs 882C–G portion of the subarea (WG-SAM-14/28).

2.8   WG-SAM-14/26 presented a stock structure hypothesis in Subareas 88.1, 88.2 and 88.3 comprising two spawning components with some potential mixing between the two in the juvenile stage. The Working Group noted the preliminary results of otolith microchemistry analyses (WG-SAM-14/33) which indicated that adult fish in SSRUs 881C and 882H may have occupied different habitats as juveniles. The Working Group considered that, whilst there was some evidence that identified separate population units in Subareas 88.1 and 88.2, there was insufficient evidence to conclude that there is a clear stock separation between the two areas. The Working Group agreed that the most precautionary approach would be to consider toothfish in Subareas 88.1 and 88.2 as separate management units as is currently assumed in the existing management approach and that additional research would be useful to further test or develop the hypothesis.

2.9   The Working Group noted the additional information that can be obtained from the use of satellite tags and considered that a multinational collaborative program would be a useful approach.

2.10   During the meeting, analysis of decay rates of tag recaptures showed an ability to monitor the decline of cohorts of tags over a period of three to four years. Furthermore, the decay rates had steeper gradients in the most recent years, indicating increasing exploitation rates over time and potential localised depletion consistent with the results of WG-SAM-14/27. The Working Group recommended that revised estimates of abundance, including seamount-specific estimates, be calculated using tag-recapture information for one, two and three years at liberty using both the Petersen and Chapman methods and that this matter be referred to WG-FSA for further consideration. The Working Group further considered that updated stock assessments in this area should evaluate the use of tagging data up to three years at liberty as well as the estimation of emigration rates.

2.11   The Working Group recalled the previous analyses of Agnew et al. (2006) and Welsford and Ziegler (2013) and noted the potential for bias in abundance estimates derived from spatially clumped tag-release and -recapture data. The analysis in WG-SAM-14/27 suggested that actual fishing effort in SSRU 882H is spread across all fishable habitat and that fishing patterns are relatively consistent between years, indicating that the effects of spatial bias are likely to be low. Dr Constable informed the Working Group of preliminary analyses to investigate the potential bias in total population estimates derived from localised tag recaptures around seamounts. The Working Group considered this to be a useful and important analysis and recommended this be submitted for consideration by WG-FSA.

2.12   The Working Group recalled the advice of the Scientific Committee in 2013 (SC-CAMLR-XXXII, paragraphs 3.165 to 3.167) that to date the majority of tags had been recaptured from the northern area and that fishing in the south had been conducted on an intermittent basis and not in spatially consistent locations. The Working Group considered a number of options for the estimation of toothfish biomass in Subarea 88.2, including integrated assessments using CASAL and biomass estimates based on tag recaptures for both the northern and southern areas.

2.13   The Working Group identified the following options that should be presented to WG-FSA for further consideration:

(i)   a CASAL-based assessment for SSRU 882H

(ii)   a CASAL-based assessment for the whole of Subarea 88.2 that excludes tag-recapture data for the southern area

(iii)   tag-based abundance estimates calculated using recaptures of tagged fish up to three years at liberty.

2.14   The Working Group considered that in SSRUs 882C–G obtaining tag-based estimates of abundance should be a priority. The Working Group agreed that options for the spatial management of fishing effort within SSRUs 882C–G should be presented to WG-FSA in order to better facilitate abundance estimation from the tagging program.

2.15   The Working Group discussed what percentage value should be used as an appropriate exploitation level when determining catch limits from estimates of total stock abundance. The Working Group recalled the previous work of Welsford (2011) and de la Mare et al. (1998) and noted that a value of 4% is currently used within research blocks in data-poor fisheries. The Working Group noted that the 4% value had been determined from analyses on Patagonian toothfish (*Dissostichus eleginoides*) and recommended that a revised analysis for Antarctic toothfish (*D. mawsoni*) should be conducted for consideration by WG-FSA.

2.16   The Working Group noted that any proposal to change the method by which exploitation rates are determined must have a strong scientific foundation and identified the following options by which an appropriate value might be determined:

(i)   use of the GYM to estimate an appropriate gamma value

(ii)   a fishing-mortality-based strategy informed by catch curves and tag-cohort analyses

(iii)   an approach similar to that currently used for icefish.

2.17   The Working Group noted that in the context of determining appropriate catch limits, it is important to distinguish between estimates of local biomass obtained from within research blocks and estimates of abundance of the whole stock derived from analytical assessments to which the CCAMLR harvest control rules are applied.

Division 58.4.4

2.18   Two CASAL assessments were presented for toothfish in Division 58.4.4.

2.19   WG-SAM-14/15 presented a revised assessment for *D. eleginoides* in research block C of Division 58.4.4 that explored the potential for the inclusion of additional information in the assessment model, including catch-at-length and age information, the use of annual age–length keys (ALKs) and revised maturity estimates. The maximum of the posterior density (MPD) results of several comparative assessments using the revised data showed generally

consistent estimates of initial and current biomass and fairly good fits to age composition and tag data. However, some large differences were evident between the MPD estimates and median values of the Markov Chain Monte Carlo (MCMC) analyses.

2.20   The Working Group noted the highly structured nature of fishing under the research plan and considered that good progress was being made towards the development of an assessment for this area. The Working Group further noted that although there was general consistency in the MPD results of the assessments, they were all characterised by high uncertainty and that MCMC analyses continue to show poor convergence.

2.21   Dr K. Taki (Japan) noted the high incidence of IUU fishing in this area and the Working Group recommended that an analysis of IUU fishing scenarios would be useful for further consideration by WG-FSA.

2.22   WG-SAM-14/18 presented further developments of a CASAL assessment for toothfish in Division 58.4.4 that explored a number of potential IUU fishing scenarios and compared the results of those assessments to estimates of abundance derived from Petersen tag-based approaches. The Working Group noted that estimates of IUU fishing based on sightings data have not been calculated for the recent period. The Working Group encouraged further analyses to estimate levels of IUU fishing, including within the CASAL framework.

2.23   The Working Group commended the progress made by France (WG-SAM-14/18) and Japan (WG-SAM-14/15) towards the development of the assessment but noted some differences in the input data between the two sets of input files and recommended that closer collaboration on the calculation of these data would lead to more consistent results between the two approaches. The Working Group made a number of recommendations regarding the standardisation of input data, including the use of consistent estimates of natural mortality, maturity and growth and alternative priors for initial biomass estimates. The Working Group noted that age data are available and could be included in the assessment.

2.24   The Working Group recommended that further development of the assessment in Division 58.4.4 should consider the following:

(i)   estimation of YCS

(ii)   data weighting

(iii)   estimation of IUU catches using fixed selection patterns (possibly based on expert knowledge of likely selection patterns)

(iv)   use of CCAMLR harvest control rules to calculate future yield options.

2.25   The research programs for Division 58.4.4 are further discussed in paragraphs 4.13 to 4.15 and comments on the difficulties encountered when undertaking multiple research programs in the same area are given in paragraphs 3.4 and 3.5.

A review of stock assessment methodologies used
in CCAMLR's integrated toothfish assessments

Software version controls

2.26   WG-SAM-14/32 presented a protocol for version control of stock assessment software within CCAMLR, with the specific example of the CASAL program. It was proposed that the latest version approved by CCAMLR of any stock assessment software submitted to CCAMLR should be used by default to conduct assessments, unless a newer update or development version was regarded as necessary, in which case it was considered the responsibility of the software user to demonstrate that the latest development version performed as expected.

2.27   The Working Group considered the process of software validation, version control and usage within CCAMLR, noting that this was a CCAMLR responsibility and that processes for new software had previously been agreed by WG-SAM in 2007 (SC-CAMLR-XXVI, Annex 7, paragraph 6.3) and has been reiterated on a number of occasions (e.g. SC-CAMLR-XXVIII, Annex 6, paragraph 5.11). In the past it was considered that the introduction of new software for review requires:

(i)   the method, procedure or approach be submitted to WG-SAM with sufficient information to enable replication of the model. This includes, but is not limited to, the software package or code and the input data

(ii)   the method, procedure or approach be tested against previously documented and appropriate scenarios, simulated data or other ecological models

(iii)   the realism and suitability of the method, procedure or approach be reviewed by the relevant working group (WG-EMM, WG-FSA or WG-IMAF).

2.28   The Working Group considered a process for version control and agreed that a CCAMLR e-group[1] (led by Dr Darby) be established to further develop and recommend a protocol that will include a process for validating and approving software updates and present a paper to WG-FSA-14.

2.29   The Working Group further recommended that CASAL version 2.30-2012-03-21 rev 4648 be considered the current approved CCAMLR version until a process is agreed for validating and approving updated software. This version was provided at the meeting and is to be posted on the CCAMLR website. The use of newer versions of CASAL would need to be reviewed by WG-SAM and would require documentation and sufficient justification.

2.30   The Working Group noted that the R library associated with version 2.30-2012-03-21 rev 4648 of CASAL is compatible with R 2.x versions only and this should be noted on the CCAMLR website, and should be considered by the e-group (paragraph 2.28).

External review

2.31   WG-SAM-14/16 presented the ICES Benchmark Protocol, which is a review process for evaluating the data and analyses that form the basis of ICES management advice for a

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

stock. A full stock review is conducted every three to five years for each stock in turn and protocols for the assessment data and model structure specified. Assessments are conducted following the benchmark-agreed protocol with the only update being the addition of new data each year. ICES benchmark meetings review the stock structure, fishery characteristics, biological and assessment data, stock assessment and projection methodology. The review includes experts from outside of the ICES community and stakeholders to broaden knowledge and enhance credibility. The paper noted that ICES science was strongly independent of the political process and majority decisions were the norm. It also noted that introducing benchmarking of CCAMLR assessments would be expected to provide greater transparency, quality control and stability to WG-FSA and the Scientific Committee management advice and to improve communication between scientists, the industry, stakeholders and administrators. The ICES stock annexes, equivalent to CCAMLR Fishery Reports, and the ICES advisory sheets were also presented to WG-SAM for illustration.

2.32 The Working Group recalled that the Scientific Committee had agreed that independent expert reviews of CCAMLR stock assessments would be valuable and should be facilitated (SC-CAMLR-XXXII, paragraph 3.66). The Working Group agreed that external reviewers would assist in making CCAMLR stock assessment reviews more transparent and robust and that their contributions to assessment review meetings, or even as contributors to WG-SAM during assessment years, could be valuable, although this would have obvious budget implications.

2.33 Recalling Scientific Committee agreement (SC-CAMLR-XXXII, paragraph 3.66), the Working Group recommended a process by which a detailed review of a selected stock assessment could be conducted in the year prior to an assessment year. Independent reviewers would be appointed by the Scientific Committee and the chair of that panel be appointed to manage the meeting and the provision of a report of the review. The review could be conducted in the country of the Member conducting the assessment and would be open to other Members. The review would be facilitated by the Secretariat and would likely require a week to complete. The independent reviewers would present a report of their evaluation of the assessment to WG-SAM and to the Scientific Committee. The Working Group considered that identifying one assessment per assessment cycle would be an appropriate workload detailed in a multiyear work plan.

Seabed area calculations

2.34 The Working Group noted that seabed areas had been recalculated by the Secretariat for subareas, SSRUs and research blocks and that these are now available in the *Statistical Bulletin*.

Tag selection

2.35 The Working Group recalled that decisions about how to use tagging data of varying quality in a stock assessment are critical in tag-based stock assessments. The Scientific Committee agreed in 2012 that the approach described in Mormede and Dunn (2013) using pairwise tagging performance metrics indicative of tag-detection rates, should be further developed for use in stock assessments (SC-CAMLR-XXXI, paragraph 3.167). The method

described in WG-SAM-14/30 calculates relative indices of effective tagging mortality and effective tag detection for each vessel and weights the contribution of each vessel's tagging data in the assessment based on each index independently, thus allowing all of the tagging data to be used.

2.36   The Working Group agreed that the revised method provided an appropriate approach to weighting tag data for stock assessments.

2.37   The Working Group agreed that the method should be used in the Ross Sea stock assessment and could also be considered for use in all other areas where tagging data are used in stock assessments.

2.38   Dr A. Petrov (Russia) made the following statement:

'Some Members have stated doubt about the necessity of the use of the presented method for the stock assessment of SSRUs 882C–H in 2014, because of a small representativeness of the data. I suggest to continue work on the presented method on more statistical material.'

2.39   WG-SAM-14/31 presented an updated spatial population model (SPM) for the Ross Sea region. Changes resulted in better fits to maturity, age composition, tagging information and in the estimated residence times in the northern area. The model can now be run at a fine scale (population distributed among 446 cells) and is intended to be used to test different hypotheses of fish distribution patterns within the Ross Sea and as a management strategy evaluation tool, for example, calculating the potential for stock assessment bias due to spatial changes in the toothfish tagging program, or the estimation of local exploitation rates. Further, spatial population models are useful research planning tools and can be used to identify critical information gaps.

Priority assessment methodology issues

2.40   The Working Group discussed a framework by which high-priority assessment methodology issues could be progressed within CCAMLR. Several longstanding issues were discussed and placed into a priority list for future work. The Working Group recommended that over the next few years, the most important issues to progress in order of priority were:

(i)   The development of standard diagnostic tools for integrated stock assessments. These include data characterisation and summary diagnostics prior to conducting an assessment, diagnostics associated with assessing model performance and convergence and diagnostics associated with MCMC interpretation. This would also include the estimation and characterisation of cryptic biomass.

(ii)   Developing recommended data weighting and screening procedures.

(iii)   Refinement of a standardised process for local biomass estimation and the subsequent development of advice on catch limits considering precautionary exploitation rates in data-poor fisheries, consistent with previous advice (SC-CAMLR-XXXII, paragraphs 3.170, 3.171 and 3.183).

(iv) Analysis and management strategy evaluation of CCAMLR harvest decision rules.

(v) Comparison of MCMC and covariance resampling methods.

(vi) Methods to determine the influence of spatial patterns of tag releases and fishing effort on estimates of stock dynamics determined from tag-based analyses, e.g. on seamounts (paragraph 2.12).

2.41   The Working Group considered that the highest priority was the development of standard diagnostic tools for integrated assessments. To progress this item, the Working Group recommended that papers describing common diagnostic information needs that are common to all integrated stock assessments in CCAMLR be identified and submitted to WG-FSA. In addition, papers are requested that review integrated stock assessments used in other regions and identify useful diagnostic methods that could be used within CCAMLR to also be submitted to WG-FSA-14. The Working Group requested WG-FSA review and integrate these results to identify an agreed set of diagnostic procedures that could be further developed into an R library and made available through the Secretariat via a software repository. The Working Group considered that development of a CCAMLR e-group led by Dr Ziegler would be a useful way to progress this issue in the short term.

2.42   The Working Group recalled the work by Ziegler (2013) which showed that a low tag-overlap statistic can introduce bias into tag-based assessments. The Working Group recommended that methods to account for potential bias in assessments resulting from low tag overlap, e.g. inverse weighting of cohorts of tags, be investigated. It also recommended that a spatial overlap statistic be developed to reflect the fact that fish movement and fleet dynamics may result in changes to the number of tags that are available for recapture.

Developments in integrated stock assessment methodologies for krill

2.43   WG-SAM-14/20 described an integrated stock assessment model for krill that combines an age-structured cohort model with survey observations. This is a single-area population model that uses survey data collected by Germany (RMT8 net sampling), the USA (IKMT net samples and hydroacoustic transects) and Peru (IKMT sampling) that is organised into different temporal aggregations (annual, seasonal or monthly).

2.44   The Working Group noted the substantive progress in developing an integrated assessment for krill since the last paper (WG-EMM-12/27) that represented four areas and attempted to estimate movement between them. A single-area model approach was adopted since the four areas were close together and estimating movement proved to be difficult due to paucity of data.

2.45   The Working Group discussed the krill population biomass estimated by the different model scenarios. Estimating population biomass was sensitive to the level of survey aggregation that was used in different scenarios. Biomass was estimated, together with natural mortality and other parameters, such as steepness of the stock-recruitment relationship, without a scaling factor or bounds. High estimates of natural mortality equal to, or greater than, 1 resulted in good model fits to the data, but also led to high ratios of total biomass compared to spawning stock biomass (i.e. large numbers of young krill). The Working Group

suggested that age- or length-specific natural mortality may be explored. The structure of the model meant that the area over which the biomass was estimated was unconstrained; the biomass estimates could represent not only the survey area itself, but also a wider, yet unknown, area outside of this. The overall biomass estimates were in the range of the estimates from the CCAMLR-2000 Survey when scaled up to the entire Scotia Sea, although estimates based on different temporal aggregations of the data varied widely. The Working Group encouraged evaluating and including environmental correlates with biomass in the model to allow for future projection of biomass.

2.46   Dr Petrov made the following statement:

> 'Total abundance of krill-dependent predators is currently not known, which means that the total krill consumption by predators cannot be determined at present. Influence of predators on krill stock cannot be estimated also. At the same time, available data show that annual krill consumption by predators will be significantly higher than the annual catch. Therefore, integrated models may be insufficient for adequate modelling of the population dynamic of krill in Subarea 48.1. According to the work of Steve Nicol to be presented at the ARK workshop in Punta Arenas, Chile, the total krill consumption by predators is 48 million tonnes, and the total catch is approximately 200 000 tonnes, i.e. catch equals 0.4% of the total krill consumption by predators.'

Evaluation of research plans from Members notifying to fish in new and exploratory fisheries in Subareas 48.6 and 58.4

General

3.1   The Working Group commended the high standard of the research plans, which has improved substantially over the last few years. It acknowledged the improvement in the research proposals, the analysis and presentation of the results and the effort of Members to start ageing otoliths. The Working Group followed the established process to review the design and methodology in research proposals and noted that WG-FSA would review the catch limits. This process is described in SC-CAMLR-XXXII, paragraphs 3.170, 3.171 and 3.183.

3.2   The Working Group noted that the reviews of progress in developing assessments based on research proposals did not include all the data available, as some data from the current season were not available at the time of the analysis. The Working Group recommended that the table generated at WG-FSA-13 (SC-CAMLR-XXXII, Table 3) for assessing research proposals be used as a template to be updated by the Secretariat in advance of WG-SAM and WG-FSA each year. It further recommended that three columns be added with data from the most recent season: actual catch to date, expected tags recovered given that catch, and actual tags recovered.

3.3   The Working Group recommended that available data in the CCAMLR database could be used by the Secretariat to start developing circumpolar habitat modelling of toothfish. It further noted that an in-depth review of all research should be undertaken at the end of the initial three years and would be useful to evaluate how Members had addressed their planned objectives. However, it also noted that in many areas the approved research plans have not yet been implemented.

3.4   The Working Group noted that in most cases two or more Members were carrying out research fishing under CMs 21-02 or 24-01 in the same parts of the Convention Area. The Working Group discussed approaches for harmonising this research, including operational aspects of the fishing by vessels, data analysis and otolith age determination, as well as the development of stock assessments.

3.5   The Working Group recognised that there were practical difficulties in collaboration and coordination and encouraged the Scientific Committee to consider mechanisms that could be put in place to help Members to work together more effectively to deliver multi-Member research proposals to meet the needs of CCAMLR.

Subarea 48.6

3.6   The Working Group considered WG-SAM-14/01, 14/10, 14/11 and 14/21.

3.7   WG-SAM-14/10 reported on research fishing undertaken by Japan and South Africa in Subarea 48.6 in 2012/13 and the first two months of the 2013/14 season. The Working Group noted that to date there have been 31 recaptures of tagged fish, although nearly half of these have been within season. The Working Group suggested that the high level of within-season tag recapture was a result of spatial aggregation of fishing within the subarea. With these numbers of returns it was thought likely that the development of an integrated stock assessment in this subarea could be achieved as soon as 2015.

3.8   The Working Group noted that the use of higher-resolution bathymetry for maps of fishing locations would assist with the visualisation of fishing patterns and could help in refining the spatial extent of research blocks. The Working Group encouraged the gathering of bathymetric data from fishing vessels to develop more accurate depth data. It was noted that bathymetry data for the whole CCAMLR region is available via the CCAMLR-GIS and high-resolution data could be added.

3.9   Members undertaking research noted evidence of increasing IUU fishing activity in Subarea 48.6. The Working Group expressed concern about the potential for high levels of unreported fish mortality through IUU fishing, which increases the uncertainty associated with assessments.

3.10   The Working Group thanked Japan and South Africa for the progress made on their research within Subarea 48.6, which demonstrated how close and effective collaboration could lead to considerable progress towards the development of an assessment.

3.11   WG-SAM-14/01 presented a revised research plan for Subarea 48.6 for 2014/15 by Japan. A number of revisions to the existing research plan were noted by the Working Group, including:

(i)   a request for increased flexibility under adverse ice conditions
(ii)   an increase in catch limit from 50 to 100 tonnes in research block 486_3
(iii)   improvements to age-determination capacity by increasing access to reference sets.

3.12   The Working Group noted that estimated local exploitation rates associated with the proposed increased catch in research block 486_3 remain lower than 4%, consistent with the agreed process for assessing appropriate catch limits.

3.13   The Working Group considered two suggestions by Japan aimed at improving operational flexibility in circumstances when difficult sea-ice conditions made it impossible for the vessel to deploy fishing gear in the designated research blocks. Japan requested that:

 (i) if both the buffer zone and extended buffer zone are inaccessible in heavy sea-ice, a vessel shall notify the Secretariat, and may attempt to set research lines in the nearest fishable area reasonably close to the original research block. In such a case the catch will be counted against the catch limit for the original research block

 (ii) when a vessel attempting to survey cannot find the nearest fishable area, the whole catch limit in that research block for the fishing season be carried over to the following season. The carried-over catch limit will be effective for the following season only.

3.14   The Working Group recalled previous substantive discussion around previous requests to move beyond the designated research blocks when sea-ice was problematic (SC-CAMLR-XXXII, paragraphs 3.177 to 3.181). The Working Group recalled that the primary aim of the research blocks is to ensure that fishing effort is located in areas where there is a high likelihood of recapturing tags and spatial overlap of fishing effort between years is maximised. Fishing outside the research block was unlikely to lead to the recapture of tagged fish and, therefore, would provide limited information to assist with the development of stock assessments. The Working Group was unable to provide further advice on this operational issue and recommended that it was given further consideration by the Scientific Committee.

3.15   The Working Group discussed Japan's request to carry over catch limits for a year within research blocks when heavy sea-ice made fishing impossible. Some participants expressed concern that this approach was not precautionary and could potentially lead to high fishing mortality on specific cohorts. However, it was noted that it was desirable to ensure that sufficient tags were available for recapture to progress the development of stock assessments and this may be facilitated by carrying the catch limits over for one year.

3.16   It was recalled that simulations (SC-CAMLR-XXVI, Annex 7, paragraph 6.13) had shown that inadvertent doubling of catches in a single year was unlikely to have any long-term impact on toothfish stock abundance and it was long-term average catches that were considered most important. However, it was noted that these analyses were applied to a single assessed stock and their findings may not be valid for data-poor fisheries.

3.17   The Working Group recommended that natural mortality should be considered and discounted from the following year's catch limit within a research block if the catch is carried forward. The Working Group requested that the issue of catch carry-over be further considered by WG-FSA.

3.18   The Working Group discussed the allocation of catches between years in the context of multiyear research plans. It was noted that in order to obtain sufficient data on which to base a stock assessment in a shorter time period, it may be beneficial to have higher tagging

rates within the first year of a research program with lower catches, and then increased efforts to recapture tagged fish with increased catches in subsequent years. Such a strategy may help overcome difficulties in tagging programs when there is a need for operational flexibility in areas subject to heavy ice years.

3.19 Concern was expressed that high tagging rates per tonne of fish caught could lead to a reduction in data quality due to operational constraints on vessels. Whilst there was general agreement that increasing tag availability at the start of a research program was likely to expedite the development of a stock assessment, each particular research program should be assessed on an individual basis.

3.20 The Working Group recommended that WG-FSA consider methods by which the effect of the tagging rate on data quality might be evaluated and by which the tagging rate of fish could be increased without impacting upon data quality.

3.21 Dr Taki informed the Working Group that Japan had started to develop an Antarctic toothfish ageing program and had been working with the Secretariat to obtain reference sets of otoliths. Issues had arisen with the distribution and availability of these sets, which had the potential to constrain the development of the program.

3.22 The Working Group requested that Members develop reference collections of digital images of otoliths to provide a useful additional resource to assist in the development of Members' otoliths ageing programs (SC-CAMLR-XXXI, Annex 7, paragraphs 10.1 to 10.19). It noted that these reference collections could be available from the Secretariat.

3.23 Details of the third year of South Africa's planned research in Subarea 48.6 were provided in WG-SAM-14/11. The Working Group noted that the research plan was the same as that undertaken in 2013/14, with no increase in catch requested.

3.24 WG-SAM-14/21 outlined research planned by the Republic of Korea in Subarea 48.6 and discussion on the research plan is provided in paragraph 3.27.

Divisions 58.4.1 and 58.4.2

3.25 Japan, the Republic of Korea and Spain had all proposed research fishing in Divisions 58.4.1 and 58.4.2 in 2014/15 as reported in WG-SAM-14/02, 14/03, 14/09, 14/12 Rev. 1 and 14/21. Only Spain fished this season and encountered some difficulties in conducting research fishing due to sea-ice conditions and also reported encountering an IUU fishing vessel and gillnet gear.

3.26 The Working Group considered the research reports and plan by Japan in WG-SAM-14/02 and 14/03 and noted no fishing was able to be conducted in 2013/14. Japan requested operational flexibility in case of sea-ice conditions for all its proposals (paragraphs 3.13 to 3.15). The updated catch limits where data were available were similar to those agreed in 2012/13, and the proposal was to continue the research as agreed in 2013/14.

3.27 The Working Group considered the research plan developed by the Republic of Korea in WG-SAM-14/21, which presented an integrated research program, including age and length composition, diet, reproductive biology, food-web structure including plankton

sampling, the routine use of conductivity temperature depth probes (CTDs) on longlines and the use of pop-up satellite tags in Subarea 48.6 and Divisions 58.4.1 and 58.4.2. It also included the routine use of CTDs by Korean vessels fishing in Subareas 88.1 and 88.2. The Working Group noted that the plan was comprehensive but ambitious and recommended prioritisation of objectives might be necessary, particularly in light of the benefits of focusing effort and the variable accessibility of some areas. The Working Group also noted the initial results from an otolith ageing program and encouraged Korea to submit a paper to WG-FSA describing its program and the results.

3.28   Regarding the Spanish depletion experiment and ongoing research plan in WG-SAM-14/09 and 14/12 Rev. 1, the authors noted that the experimental catch of 42 tonnes had been exceeded once in one SSRU in the first two years of the experiment and this may jeopardise the experiment in areas with high fish densities. The Working Group requested that the CV of the de Lury estimates of local biomass be provided to WG-FSA to be used to consider appropriate catch levels in the experiment and the value of such experiments relative to other methods for estimating biomass for use in stock assessments. It also recommended the survey area be stratified in areas of high and low catch rates and biomass be calculated accordingly.

3.29   The Working Group noted that there is a need to identify the area to which the biomass estimate would be applied and recommended that this be considered by WG-FSA. It noted that one possible method might be to use areal attraction and effective area, which could be calculated using an approach similar to that used to assess lithodid crab densities in Subarea 48.3 (Collins et al., 2002).

3.30   The Working Group noted that tags had been recaptured and recommended Petersen estimates be calculated where suitable. It also noted that the biomass calculation extrapolated to the scale of entire SSRUs assumed all areas had a high catch rate as observed in the location of the depletion experiment, when actually some exploratory locations had catch rates too low to run a depletion experiment.

3.31   Spain proposed that the experiment be carried out for another four years, to revisit the areas already fished and to carry on prospecting as much as possible, increasing the catch limit from 42 to 50 tonnes, with an expectation of a stock assessment by the end of 2017/18. The Working Group recommended that a full review of all the results be considered by WG-SAM-15 before a decision is made to extend the survey.

Division 58.4.3a

3.32   The Working Group noted that France and Japan had proposed to continue research in this division in 2013/14. The *Saint André* caught a total of 16 tonnes of toothfish and recaptured 22 tags, but the *Shinsei Maru No. 3* had not yet carried out its research. The Working Group further noted that France and Japan proposed to continue research in this division in 2014/15, as described in WG-SAM-14/04 (Japan) and 14/17 (France). The Working Group noted that the proposal was a very good example of international collaboration and should be commended.

3.33   The Working Group noted with concern that the concentration of effort and the large number of tags recovered out of a small catch (22 recaptured for 16 tonnes catch when 11

were expected for a total catch of 32 tonnes) indicated a high risk of localised depletion and unsustainable exploitation in the west, with no other known areas of high catch-per-unit-effort (CPUE) across the bank.

3.34   The Working Group noted that there had been an error in translation in the French version of CM 33-03 that had led to the by-catch move-on rule being triggered at lower levels of by-catch than in the English version (see also paragraph 5.9). This caused the French-flagged vessel to move to areas of lower macrourid by-catch which in turn caused greater spatial aggregation of longline sets.

3.35   The Working Group expressed concern that within the French catch, high levels of skate by-catch were observed in the west and macrourid by-catch in the east, and questioned the viability of fishing in this region with a gear type that has high by-catch rates. However, the Working Group noted that 94% of skates were released alive this season. It noted that in the previous year, fishing with trotline gear had not experienced this problem. It also noted that this was an opportunity to compare gear types and recommended an analysis of the differences between the gear types be carried out to better understand tag-recapture and by-catch rates. The Working Group noted that only five sets were carried out in the eastern area, as it was limited by high macrourid by-catch.

3.36   The Working Group noted that although CPUE was used as a basis for the catch limit in the proposal in WG-SAM-14/04, 11 tags were recaptured last year and 22 so far this season. These tag-recapture rates indicate that local exploitation rates may be substantially higher than the agreed limit of 4% applied for other data-poor fishery research plans. It further noted that the CPUE-based biomass estimate was likely to be biased high, because catch data used in the calculation all derived from a single location at which catch rates were high, but these were extrapolated over the entire area, including to areas in which catch rates are known to be much lower. The Working Group noted that a CASAL stock assessment was in development for this region which will help to address these issues.

3.37   The Working Group recommended France and Japan consider how to refine the research consistent with the agreed framework for research plans in data-poor fisheries (SC-CAMLR-XXXII, Figure 10). The Working Group recommended that a research block should be defined around the location in the western Elan Bank in which tags have been released. Petersen biomass estimates should be used to define a catch limit inside the research block with an appropriate local exploitation rate (i.e. not greater than 4%). Outside the research block (i.e. in the prospecting phase), in order to ensure spread of the effort, the Working Group recommended that a grid survey, similar to that used in Division 58.4.4, be implemented following the conclusion of this year's program.

3.38   The Working Group noted the ongoing research undertaken by France to investigate skate condition and mortality rate and recommended that an analysis of skate by-catch be carried out and presented at WG-FSA, including species-specific spatial analyses and investigating alternative functional forms of the relationship between catch and depth.

Research proposals in other areas (closed areas, areas with zero catch limits, Subareas 88.1 and 88.2)

Subarea 48.2

4.1   The Working Group reviewed WG-SAM-14/13 and 14/22, which described a proposed research program by Ukraine to undertake a longline survey of toothfish in Subarea 48.2. The Working Group noted that the proposed survey design in 2014 remains largely unchanged from that initially proposed in 2013 (WG-SAM-13/15). The Working Group recalled that following WG-FSA in 2013 (during the meeting of the Scientific Committee and Commission), several participants of WG-FSA and the Secretariat had worked closely with Ukrainian scientists to modify the proposed research plan in accordance with working group advice (see SC-CAMLR-XXXII, Annex 4, paragraphs 3.14 to 3.21; SC-CAMLR-XXXII, Annex 6, paragraphs 6.70 to 6.79). Some Members noted that the 2014 proposal did not incorporate these modifications. The Working Group recommended that Ukrainian scientists consider incorporating these modifications prior to re-submission of this research plan for consideration by WG-FSA. Specific recommendations include:

(i)   improved stratification of the proposed survey stations by depth

(ii)   reduced distance between stations, for reasons of operational feasibility as well as to more accurately map patterns of toothfish distribution and abundance

(iii)   focusing the research on a smaller region of Subarea 48.2

(iv)   including some consideration of historical harvest and research activities in this area.

4.2   The Working Group recalled conservation measure (CM) 25-02, paragraph 5, in which daytime setting of longlines is prohibited in order to minimise risks of incidental seabird capture. The Working Group expressed concern that the proposed research would involve daytime setting during summer in a location with potentially vulnerable seabird populations, and using a gear type (Spanish line) known to pose considerable risk to seabirds. The Working Group recommended that the proposal be modified to minimise the risk of incidental seabird captures.

4.3   The Working Group noted that two of the proposed survey stations were located inside the South Orkney Islands MPA (CM 91-03) such that research within the MPA should be designed and considered in the context of the MPA research and monitoring plan, with consideration of potential effects of the proposed research activities on the objectives of the MPA in the location of the proposed survey stations. The Working Group recommended that these matters should be referred to WG-EMM.

4.4   The Working Group recalled the agreed framework for research plans in data-poor fisheries (SC-CAMLR-XXXII, paragraphs 3.170, 3.171 and 3.183 and Figure 1). It noted that the proposed research in Subarea 48.2 does not include a plan or likely schedule by which the research will progress to the biomass estimation phase leading to a stock assessment. The Working Group recommended that the proposal be modified so that it is consistent with the advice contained in the data-poor fisheries framework and diagram agreed last year (SC-CAMLR-XXXII, Figure 1).

4.5   The Working Group recalled the concerns of the Scientific Committee in 2013 regarding the effects of the low tag-overlap statistic achieved by the vessel listed in this proposal in the past (SC-CAMLR-XXXII, paragraphs 3.211 and Annex 6, paragraph 5.4) and encouraged the proponents to include in their proposal a commitment to achieving tag-overlap statistics substantially higher than the minimum level (i.e. 60%) required in exploratory fisheries.

Subarea 48.5

4.6   The Working Group reviewed a report on year 2 of an ongoing multiyear toothfish research program by Russia in the Weddell Sea in 2014 (WG-SAM-14/05) and considered a proposal to continue that research program in 2015 (WG-SAM-14/07). The Working Group noted that the objectives of this research are consistent with the framework for research in data-poor fisheries leading to stock assessments as agreed in 2013 and recommended that the research continue in 2014/15. The Working Group agreed that the proposed research design for options 1 and 2 was appropriate to achieve the objectives of the research, however, some Members expressed concern that ice conditions in the area of option 3 (i.e. western Weddell Sea) were sufficiently adverse that multiyear research to recover tagged fish in a consistent location may not be possible. The Working Group requested that Russia update the proposal for consideration by WG-FSA.

4.7   The Working Group thanked Russia for the thorough and detailed report of biological sampling and analyses and planned academic publications arising from this research. The Working Group noted interesting characteristics of toothfish diets in relation to by-catch reported in this area. Daggertooth (*Anotopterus pharao*) is unusual in toothfish diets because it is a pelagic fish, whereas blue antimora (*Antimora rostrata*) was notable by its absence in by-catch. The Working Group also noted that catch rates of by-catch species in this location were variable between years, and that by-catch rates were low compared with other toothfish fisheries elsewhere in the CCAMLR area. It encouraged Russian scientists to collaborate with other research in the area to better understand the potentially unique oceanographic and biological characteristics of this location.

4.8   The Working Group noted that the survey design that was implemented in 2013/14 was similar to what had been proposed last year under option 1, except that unfavourable ice conditions had blocked access to about 50% of the predefined research block in which tags were thought to be available for recapture (i.e. biomass estimation phase), and ice conditions also caused other sets outside the research block (i.e. prospecting phase) to be closer together than the originally planned 5 n miles separation distance. The Working Group recommended that the proponents report the level of catch that was taken from inside the research block in 2014 and calculate the number of expected tag recaptures associated with this level of catch, based on local biomass estimates and corresponding local exploitation rates. No tags were recaptured in 2014.

4.9   The Working Group further noted that the following changes may be consistent with the agreed framework for research plans in data-poor fisheries: (i) the research block in option 1 be redrawn to encompass the full extent of the area that had been surveyed in 2013/14 to take account of where tags are now thought to be available for recapture; (ii) the corresponding catch limit inside the research block be adjusted consistent with the decision

criteria for data-poor fisheries research plans (i.e. local exploitation rate not exceeding 4%); and (iii) the corresponding number of tag recaptures expected in 2014/15 be calculated based on updated estimates of local biomass. The Working Group recommended the proponents consider these points and forward the proposal to WG-FSA for further consideration. The Working Group agreed that returning to the research block in option 1 to recover tagged fish was the highest priority for this research.

4.10   The Working Group noted the proposed modification to the spatial design of the research under option 2 to include prospecting phase sets on two nearby seamounts and requested a map of the total area showing all the proposed research areas. The Working Group recommended that the revised proposal be considered by WG-FSA.

4.11   The Working Group agreed that participation by other Members in this research as part of a multi-Member, multi-vessel research program would provide valuable information regarding possible vessel effects and would facilitate more rapid development of a stock assessment (paragraphs 3.4 and 3.5).

4.12   The Working Group also requested that the Scientific Committee consider, consistent with the CCAMLR regulatory framework, whether fishing for *Dissostichus* spp. in Subarea 48.5 be considered an exploratory fishery under CM 21-02.

Division 58.4.4

4.13   WG-SAM-14/14 described a research plan for a longline survey of toothfish in Division 58.4.4 by Japan in 2014/15. WG-SAM-14/18 described a proposal from France to also undertake a research survey in Division 58.4.4. The Working Group endorsed the designs in the proposals and recommended that they be forwarded to WG-FSA for consideration. The Working Group agreed that it would be greatly beneficial for Japan and France to collaborate on this research.

4.14   The Working Group noted that in SSRU 5844D, research to date had not resulted in any tag recaptures, and consequently stock abundance had been estimated using the 'CPUE seabed area analogy' method. Some Members noted that, where CPUE-based estimates are derived from a single vessel, the order and timing of fishing relative to other vessels conducting research fishing could result in increased uncertainty in those CPUE-based estimates. However, the Working Group also noted that IUU fishing is known to occur in this area and may have the same effect.

4.15   Other Members recalled that in the example of research activities in Division 58.4.3a, tag-recapture rates had increased after France commenced research in the area and felt that the involvement of multiple vessels in the research programs where only one vessel has been operating, such as in Division 58.4.4, may accelerate the development of tag-based estimates of abundance. The Working Group noted that the increased tag-recapture rate associated with the French vessel's initiating research in Division 58.4.3a is likely to be because the vessel fished in a spatially constrained location. The Working Group agreed that tag-based estimates are likely to be more robust than those based solely on CPUE.

Ross Sea region – SSRUs 882A–B

4.16   The Working Group reviewed separate proposals for new research plans in SSRUs 882A–B (WG-SAM-14/06 and 14/34).

4.17   WG-SAM-14/06 presented a proposal by Russia for a multiyear research program on the slope of SSRU 882A. The Working Group recalled that in 2013 the Scientific Committee endorsed the importance of research in this area as a high priority to investigate toothfish distribution and movements and potential implications for stock structure and stock assessment (SC-CAMLR-XXXII, paragraph 3.76iv). The Working Group agreed that the research design proposed in WG-SAM-14/06 was appropriate to address these objectives and was a useful project to implement in the coming year. The Working Group requested that the proposal be forwarded to WG-FSA.

4.18   WG-SAM-14/34 presented a multiyear, multi-Member proposal by New Zealand, Norway and the UK for research in the north of SSRUs 882A–B. The Working Group recalled that in 2013 the Scientific Committee endorsed the importance of research in this area as a high priority to further parameterise the toothfish SPM and reduce potential bias in stock assessment (SC-CAMLR-XXXII, paragraph 3.76iv) and to better understand toothfish spawning dynamics (SC-CAMLR-IM-I, paragraphs 2.31(vii) and 2.32). The Working Group agreed that the research design proposed in WG-SAM-14/34 was appropriate to address these objectives and was a useful project to implement in the coming year.

4.19   In relation to the proposal in WG-SAM-14/34, the Working Group:

(i)   agreed that the proposed cluster design with a minimum inter-cluster separation distance and a maximum number of hooks per cluster was a useful design to deliver adequate spatial coverage of the survey in an area where fishable bathymetry has not yet been mapped

(ii)   questioned whether the option to set very long lines could diminish the statistical power of subsequent analyses (in instances where data is not aggregated into SPM cells)

(iii)   suggested that a shorter maximum line length within clusters be considered by the proponents

(iv)   suggested that the proponents consider adding limited sampling in adjacent areas of SSRU 881C (an area open to fishing within which commercial data is available) using the standardised survey gear to enable calibration between research catch rates in the survey area and adjacent commercial fishery data

(v)   requested that a revised proposal be submitted to WG-FSA

(vi)   discussed the proposed tagging rate of 3 fish per tonne and noted that because the primary research objective is to map fishable habitat and characterise the distribution, abundance and population characteristics of the toothfish population in new locations, tagging is a secondary priority, and returning to recapture tags in the same location in subsequent years may be of lesser priority than

continuing to map fishable habitats across all survey strata. However, releasing tagged fish in these areas can be expected to generate improved knowledge of toothfish movements and stock structure

(vii) noted that in this area where the average fish size is expected to be large, 3 fish per tonne implies tagging approximately every 10th fish. The maximum achievable tagging rate without compromising tagging performance (i.e. potentially resulting in increased tagging mortality and associated stock assessment bias, see also paragraph 3.18) is unknown, and may be variable in different contexts

(viii) recommended that an appropriate tagging rate should be considered by WG-FSA.

4.20   The Working Group noted that proposals set out in WG-SAM-14/06 and 14/34 would benefit from collaboration between New Zealand, Norway, Russia and the UK. The Working Group recommended that these Members work together to further harmonise the two proposals, to the extent possible, in advance of WG-FSA-14, and continue their collaboration in the implementation and analysis stages of both research plans. Specifically, the Working Group recommended that proponents consider working together to ensure: (i) gear standardisation between vessels; (ii) collection of a consistent suite of biological data and specimens for further analysis; (iii) collection of improved bathymetric data of the survey areas; and (iv) adequate spatial spread of fishing effort across the survey areas.

4.21   The Working Group noted that fish in SSRUs 882A–B are considered to be part of the Ross Sea region stock, for which a stock assessment and precautionary catch limits currently exist. Therefore, while some aspects of these research designs are similar to those prescribed under the framework for data-poor fisheries, the objectives of the research proposals described in WG-SAM-14/06 and 14/34 are different from those in data-poor areas.

4.22   The Working Group recalled previous advice that SSRU 882A could potentially be opened and managed as part of the Ross Sea fishery (SC-CAMLR-XXXI, paragraph 9.30) and that the boundaries of CM 41-09 should be revised so that catches in Subarea 88.1 and SSRUs 882A–B are managed under a single conservation measure commensurate with the Ross Sea fishery stock assessment (SC-CAMLR-XXXII, paragraph 3.160). On this basis, the Working Group requested that WG-FSA consider an appropriate mechanism to account for the catches required in these research plans.

4.23   The Working Group noted that new information collected under these research plans would be useful to parameterise the toothfish SPM in locations for which data are currently unavailable, thus improving current understanding of toothfish life cycle dynamics in the Ross Sea region with implications for improved stock assessment and management (WG-SAM-14/31).

Ross Sea region – toothfish sub-adult survey

4.24   The Working Group reviewed the results of the third year of a standardised survey for sub-adult toothfish on the southern Ross Sea shelf (WG-SAM-14/24) and a proposal by New

Zealand to continue that survey for a fourth year (WG-SAM-14/25). The Working Group agreed that the proposed survey design for 2015 was consistent with these objectives and recommended that the survey be implemented in accordance with this design.

4.25   The Working Group noted that peak cohorts in the plotted age frequencies from the first three years' surveys appear to shift by one year annually, suggesting that the survey is potentially able to track YCS and could provide information on recruitment variability. The Working Group discussed to what extent analysis of commercial fishery data could be adequate for the same purpose. The Working Group recalled that this analysis had been attempted when the sub-adult survey was first proposed, and at that time there was no interpretable signal apparent in the commercial fishery data, probably due to inconsistent spatio–temporal fishing patterns and/or variable gear selectivities between vessels. The Working Group agreed that repeating this analysis now, to enable comparison with the results obtained from the first three years of survey data, would be useful, and the results of this analysis will enable evaluation of the ongoing utility of this survey.

4.26   The Working Group noted that the purpose of the 'exploratory' (non-core) survey strata is to explore new areas in order to identify potential locations with high abundances of sub-adult toothfish, which may be considered as additional core survey strata in future. However, secondary research objectives may also be achieved incidentally by sampling toothfish in particular locations of interest. For example, the exploratory stratum in the extreme southwest Ross Sea in 2013 did not reveal high densities of sub-adult toothfish, but did reveal considerable numbers of larger toothfish in McMurdo Sound, an area in which toothfish population dynamics have been the subject of considerable interest. The Working Group agreed that, while monitoring larger toothfish is not the primary objective of the sub-adult survey, continued limited monitoring in this location may be of considerable value, especially in concert with new research and monitoring of potential toothfish predators in the same area (i.e. see WG-EMM-14/52).

4.27   The Working Group noted that one potential future exploratory stratum is located in the south of SSRU 882A, near the survey location proposed in WG-SAM-14/06. The Working Group noted that if it were possible to standardise gear deployments between vessels, vessels conducting research on the shelf and slope of SSRU 882A could productively contribute also to the sub-adult survey in the future.

Subareas 48.1 and 48.2

4.28   Dr Arata informed the Working Group that Chile intends to undertake a trawl survey for demersal finfish in Subareas 48.1 and 48.2 to monitor the recovery of fish stocks such as *Champsocephalus gunnari* and *Notothenia rossii* during 2014/15. The Working Group noted that this proposal had been reviewed by both WG-SAM and WG-FSA in 2013 (WG-SAM-13/14 and WG-FSA-13/10 respectively), and that due to logistical difficulties, the survey could not be undertaken in 2013/14, but would instead be conducted in 2014/15 using a different vessel. The Working Group recommended that the proposal to undertake the survey be updated and submitted for consideration by WG-FSA.

Other business

Fishery capacity

5.1   An analysis of capacity-related issues, using information derived from the CCAMLR C2 catch-and-effort data from the Ross Sea toothfish fishery was presented in WG-SAM-14/19. The analysis provided a series of metrics that CCAMLR could use to assess and monitor capacity and capacity utilisation.

5.2   The Working Group agreed that there was no evidence of overcapacity in the metrics presented but noted that no target capacity has been defined against which to assess fishery performance. The Secretariat was requested to provide annual reports of the metrics of capacity and capacity utilisation in order to monitor trends in capacity in exploratory toothfish fisheries. In addition, the Secretariat was also asked to include a measure of potential daily fishing capacity as a function of the catch limit for an area in order to identify situations where the catch limit could potentially be taken before any data are available with which to forecast the closure of that fishery (SC-CAMLR-XXXII, Annex 4, paragraphs 4.28 and 4.29).

5.3   The Working Group recognised that such simplified indices which summarise complex interactions need to be interpreted in the context of specific knowledge of the region and/or fishery in question and recommended that work to determine additional metrics of capacity be continued.

5.4   Dr Petrov made the following statement:

'The document (WG-SAM-14/19), submitted by the EU, does not include any proposals on toothfish fishery area expansion for research purposes and opening of fishing grounds closed for the time being.

Simulated conditions, in particular closed small-scale research units (SSRUs), are among the fundamental reasons of fleet concentration in the CCAMLR fishing grounds. Discussing the question of overcapacities in the CCAMLR zone, Russian scientists concur that all closed SSRUs should be opened, as we announced during the meetings of the Scientific Committee and Commission previously (SC-CAMLR-IM-I/03; SC-CAMLR-IM-I/04; SC-CAMLR-IM-I/05; SC-CAMLR-IM-I/06; WG-FSA-13/12; WG-FSA-13/13; SC-CAMLR-XXXII/06). After they recommend to analyse fishing conditions for studying a risk of overcapacity there.

We consider that the recommendations on overcapacity given by the EU are eligible when analysis of fishing capacities covering entire area without closed SSRUs is carried out. It is certain that new results will suspend a question of fishing capacities in the years.'

Fishery Reports

5.5   The Working Group recognised the important role of the Fishery Reports as a central source of reference material for scientists engaged in the work of the Scientific Committee. It agreed that a consistent format for the Fishery Reports that presented the key pieces of information for a fishery should include a general description and background information on the fishery, details of current management advice and details of the assessment or progress in

research designed to lead to an assessment. The Working Group also noted that, apart from the routine update of the tables and figures by the Secretariat, the bulk of the Fishery Report should remain largely unchanged between years. It also noted this would reduce the workload associated with the translation of the reports (CCAMLR-XXXII, Annex 7).

5.6   In considering the content and format of the Fishery Reports, the Working Group also agreed that an executive summary of each Fishery Report would be a useful addition to the more detailed presentation of the reports itself.

5.7   The presentation of the details of the assessment and/or progress in research could be used to produce a 'fishery data dashboard' on the CCAMLR website that provided agreed fishery indicators and a summary of the status, assessment and catch limits in place for each fishery.

Stock assessment course

5.8   The Working Group noted the suggestion from WG-FSA on the desirability of broadening the knowledge base of CCAMLR's approach to assessments and in particular in the use of CASAL software (SC-CAMLR-XXXII, Annex 6, paragraphs 11.1 and 11.2). The Working Group welcomed the offer from New Zealand to run a CASAL training course at the CCAMLR Secretariat immediately prior to WG-FSA-14. New Zealand scientists agreed to provide an SC CIRC outlining the content of the course and inviting participation from Members.

Translation of CM 33-03

5.9   Noting that discussion of the potential for triggering a closure in an SSRU as a result of macrourid by-catch in the decisions on fishing location in Division 58.4.3a, Mrs A. Relot (France) informed the Secretariat of an inconsistency in the different language versions of CM 33-03. Specifically, the English version of CM 33-03, paragraph 6, referred to 'each' of the two 10-day periods, whereas the French language version referred to 'one' of the 10-day periods. The Secretariat apologised for this mistranslation and confirmed that the French-language version had now been revised and was consistent with the English version (paragraph 3.34).

Advice to the Scientific Committee

6.1   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:

(i)   Integrated assessments of toothfish –

(a)   version control (paragraph 2.29)
(b)   external review (paragraph 2.33)
(c)   future work (paragraph 2.41).

(ii) Research plans for exploratory fisheries for toothfish in Subareas 48.6 and 58.4 –

    (a)   general (paragraphs 3.2, 3.3 and 3.5)
    (b)   Subarea 48.6 (paragraphs 3.14, 3.17, 3.20 and 3.22)
    (c)   Divisions 58.4.1 and 58.4.2 (paragraph 3.31).

(iii) Scientific research proposals for toothfish in other areas –

    (a)   Subarea 48.2 (paragraph 4.3)
    (b)   Subarea 48.5 (paragraph 4.12)
    (c)   Ross Sea region (paragraph 4.22).

(iv) Other matters –

    (a)   Fishery capacity (paragraph 5.2).

Adoption of the report and close of the meeting

7.1　　The report of the meeting of WG-SAM was adopted.

7.2　　In closing the meeting, Dr Hanchet thanked the participants for their contributions to the meeting and their work during the intersessional period, the subgroup coordinators for facilitating discussions, the rapporteurs for preparing the report and the Secretariat for its support. Dr Hanchet also thanked INACH for hosting the meeting and Dr Arata and colleagues for their kind hospitality and assistance during the meeting. Dr Hanchet's term as Convener of WG-SAM ended with this meeting.

7.3　　Dr Constable, on behalf of the Working Group, thanked Dr Hanchet for his outstanding role as convenor of WG-SAM. The Working Group was very thankful to Dr Hanchet for taking this role and for his significant contribution to the work of WG-SAM, the Scientific Committee and the Commission.

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(Punta Arenas, Chile, 30 June to 4 July 2014)

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Agenda

Working Group on Statistics, Assessments and Modelling
(Punta Arenas, Chile, 30 June to 4 July 2014)

1.   Introduction

      1.1   Opening of the meeting
      1.2   Adoption of the agenda and organisation of the meeting

2.   Methods for assessing stocks in established fisheries

      2.1   A review of progress towards updated integrated assessments of toothfish
      2.2   A review of stock assessment methodologies used in CCAMLR's integrated
             toothfish assessments
      2.3   A review of mechanisms by which CCAMLR decision rules are implemented
      2.4   Developments in integrated stock assessment methodologies for krill
      2.5   Other work

3.   Evaluation of research plans from Members notifying to fish in new and exploratory
      fisheries in Subareas 48.6 and 58.4

4.   Review of scientific research proposals for other areas (e.g. closed areas, areas with
      zero catch limits, Subareas 88.1 and 88.2)

5.   Other business

6.   Advice to the Scientific Committee

      6.1   WG-FSA
      6.2   General

7.   Adoption of report and close of meeting.

List of Documents

Working Group on Statistics, Assessments and Modelling
(Punta Arenas, Chile, 30 June to 4 July 2014)

WG-SAM-14/01   Research plan for the exploratory fisheries for *Dissostichus* spp. in
                    Subarea 48.6 in 2014/15
                    Delegation of Japan

WG-SAM-14/02   Research plan for the exploratory fisheries for *Dissostichus* spp. in
                    Division 58.4.1 in 2014/15
                    Delegation of Japan

WG-SAM-14/03   Research plan for the exploratory fisheries for *Dissostichus* spp. in
                    Division 58.4.2 in 2014/15
                    Delegation of Japan

WG-SAM-14/04   Research plan for the exploratory fisheries for *Dissostichus* spp. in
                    Division 58.4.3a in 2014/15
                    Delegation of Japan

WG-SAM-14/05   Progress report on the Weddell Sea Research Program Stage II
                    A.F. Petrov, I.I. Gordeev, S.V. Pianova and E.F. Uryupova
                    (Russia)

WG-SAM-14/06   Research program on resource potential and life cycle of
                    Dissostichus species from the Subarea 88.2 A in 2014–2017
                    Delegation of the Russian Federation

WG-SAM-14/07   Plan of research program of the Russian Federation in
                    Subarea 48.5 (Weddell Sea) in season 2014/2015
                    Delegation of the Russian Federation

WG-SAM-14/08   Stock assessment and proposed TAC for Antarctic toothfish
                    (TOA) in the Subarea 88.2 H in the season 2014–2015
                    S.M. Goncharov and A.F. Petrov (Russia)

WG-SAM-14/09   Continuation in the 2014/15 season of the research plan initiated
                    in 2012/13 for stocks of *Dissostichus* spp. in Divisions 58.4.1
                    and 58.4.2
                    Delegation of Spain

WG-SAM-14/10   Progress report on the research fishery for *Dissostichus* spp. in
                 Subarea 48.6 being jointly undertaken by Japan and South Africa:
                 2012/13 and 2013/14
                 R. Leslie (South Africa), K. Taki, T. Ichii (Japan) and
                 S. Somhlaba (South Africa)

WG-SAM-14/11   Revised South African work plan for 2014/15 for the joint
                 Japan/South Africa research on *Dissostichus* spp. in Subarea 48.6.
                 Delegation of South Africa

WG-SAM-14/12 Rev. 1   Results of the Spanish exploratory longline fishery for
                        Dissostichus spp. in Divisions 58.4.1 and 58.4.2 in the 2013/14
                        season
                        R. Sarralde, L.J. López-Abellán and S. Barreiro (Spain)

WG-SAM-14/13   Format for reporting finfish research proposals of the Ukraine in
                 Subarea 48.2 in 2015
                 Delegation of Ukraine

WG-SAM-14/14   Research plan for toothfish in Division 58.4.4b by *Shinsei maru
                 No. 3* in 2014/15
                 Delegation of Japan

WG-SAM-14/15   Revised assessment models for Patagonian toothfish in research
                 block C of Division 58.4.4, Ob & Lena Banks for the years
                 1989/1990 to 2012/13
                 K. Taki (Japan)

WG-SAM-14/16   The ICES Benchmark Protocol
                 C. Darby (United Kingdom)

WG-SAM-14/17   Research plan for the exploratory longline fishery for *Dissostichus*
                 spp. in 2014/15 in Division 58.4.3a
                 Delegation of France

WG-SAM-14/18   Proposal for a research plan for the exploratory longline fishery
                 for *Dissostichus* spp. in 2014/15 in Division 58.4.4
                 Delegation of France

WG-SAM-14/19   European Union – Measurement of capacity in CCAMLR
                 exploratory fisheries in Subareas 88.1 and 88.2
                 Delegation of the European Union

WG-SAM-14/20   Integrated models for Antarctic krill (*Euphausia superba*) using
                 survey data from 1981–2014 in Subarea 48.1
                 D. Kinzey, G.M. Watters and C.S. Reiss (USA)

WG-SAM-14/21   Research plan for the exploratory longline fishery for *Dissostichus*
                      spp. in Divisions 58.4.1, 58.4.2 and Subarea 48.6 in 2014/2015
                      (including CTD data in 88.1, 88.2)
                      Delegation of the Republic of Korea

WG-SAM-14/22   Plan of research program of the Ukraine in Subarea 48.2 in 2015
                      Delegation of Ukraine

WG-SAM-14/23 Rev. 1   Data and approach for the revised stock assessment for the Heard
                      Island and the McDonald Islands Patagonian toothfish
                      (*Dissostichus eleginoides*) fishery (Division 58.5.2)
                      P. Ziegler and D. Welsford (Australia)

WG-SAM-14/24   Preliminary results of the third CCAMLR sponsored research
                      survey to monitor abundance of subadult Antarctic toothfish in the
                      southern Ross Sea, February 2014
                      S. Mormede, S.J. Parker, S.M. Hanchet, A. Dunn (New Zealand)
                      and S. Gregory (United Kingdom)

WG-SAM-14/25   Proposal to continue the time series of CCAMLR-sponsored
                      research surveys to monitor abundance of subadult Antarctic
                      toothfish in the southern Ross Sea in 2015
                      S.M. Hanchet, S.J. Parker and S. Mormede (New Zealand)

WG-SAM-14/26   Stock structure of Antarctic toothfish in Statistical Area 88 and
                      implications for assessment and management
                      S.J. Parker, S.M. Hanchet and P.L. Horn (New Zealand)

WG-SAM-14/27   Analysis of seamount-specific catch and tagging data in the
                      Amundsen Sea, SSRU 88.2H
                      S.J. Parker (New Zealand)

WG-SAM-14/28   Towards the development of an assessment of stock abundance
                      for Subarea 88.2 SSRUs 88.2C–G – a discussion paper
                      S.M. Hanchet and S.J. Parker (New Zealand)

WG-SAM-14/29   Further investigations in the assessment of Antarctic toothfish
                      (*Dissostichus mawsoni*) in Subarea 88.2 SSRUs 88.2C–H for the
                      years 2002–03 to 2012–13
                      S. Mormede, A. Dunn and S.M. Hanchet (New Zealand)

WG-SAM-14/30   Calculating effective releases and recaptures for stock assessments
                      based on tag detection and tagging mortality indices
                      S. Mormede (New Zealand)

WG-SAM-14/31	An updated spatially explicit population dynamics operating model for Antarctic toothfish in the habitable depths of the Ross Sea region S. Mormede, A. Dunn, S. Parker and S. Hanchet (New Zealand)
WG-SAM-14/32	A proposed process for the management of model updates and software versions for stock assessment used within CCAMLR with the example of the CASAL software S. Mormede and A. Dunn (New Zealand)
WG-SAM-14/33	Preliminary examination of otolith microchemistry to determine stock structure in Antarctic toothfish (*Dissostichus mawsoni*) between SSRU 88.1C and 88.2H R. Tana, B.J. Hicks, C. Pilditch and S.M. Hanchet (New Zealand)
WG-SAM-14/34	Proposal for a longline survey of toothfish in the northern Ross Sea region (SSRUs 88.2 A and B) Delegations of New Zealand, Norway and the United Kingdom
WG-SAM-14/35	Nine years of tag-recapture in CCAMLR Statistical Subarea 48.3 – Part I: General data characterisation and analysis M. Soeffker, C. Darby and R.D. Scott (United Kingdom)