**Report of the Working Group
on Statistics, Assessments and Modelling**
(Santa Cruz de Tenerife, Spain, 25 to 29 June 2012)

CONTENTS

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INTRODUCTION

Opening of the meeting

1.1   The 2012 meeting of WG-SAM was held at the Centro Oceanográfico de Canarias (COC), Instituto Español de Oceanografía, Santa Cruz de Tenerife, Spain, from 25 to 29 June 2012. The meeting was convened by Dr S. Hanchet (New Zealand) and local arrangements were coordinated by Mr L. López Abellán (COC).

1.2   Dr Hanchet welcomed participants (Appendix A) and outlined the work schedule for the meeting. The Scientific Committee had identified three main areas of work for WG-SAM in 2012 (SC-CAMLR-XXX, paragraphs 15.3 and 15.4):

(i)   a focus topic on tagging which could include implementation of the tagging program, alternative tagging technologies, experiments to examine tagged fish mortality rates and tag detectability, tag-based stock assessment issues, review of tagging protocols, and development and provision of a training module for vessel operators

(ii)   evaluation of research plans from Members notifying to fish in exploratory fisheries in Subareas 48.6 and 58.4 in 2012/13

(iii)   review of research proposals for closed areas, areas with zero catch limits and other areas not included in (ii).

Adoption of the agenda and organisation of the meeting

1.3   The agenda was adopted without change (Appendix B). Item 2 was the focus topic which reviewed the CCAMLR tagging program (paragraph 1.2i).

1.4   Documents submitted to the meeting are listed in Appendix C. While the report has few references to the contributions of individuals and co-authors, the Working Group thanked all the authors 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 working groups have been highlighted. A list of these paragraphs is provided in Item 7.

1.6   The report was prepared by Dr M. Belchier (Convener WG-FSA), Mr C. Heinecken (South Africa), Drs C. Jones (Chair of the Scientific Committee), A. Petrov (Russia), D. Ramm (Data Manager), K. Reid (Science Manager), Mr R. Sarralde (Spain), Drs B. Sharp (New Zealand), K. Taki (Japan), D. Welsford (Australia) and P. Ziegler (Australia).

REVIEW OF THE CCAMLR TAGGING PROGRAM

Overview

2.1   Toothfish tagging programs have existed in CCAMLR fisheries since 1998, and have been used to estimate movement, growth and mortality rates and abundance. Tagging of toothfish from fishing vessels in new and exploratory fisheries started in 2000/01 and became mandatory in 2003/04. More than 50 000 toothfish have been tagged and released and 1 878 tagged individuals have been recaptured over this period. However, in the exploratory fisheries in Subareas 48.6 and 58.4 recapture rates have been much lower than expected given the number of tagged fish released in those fisheries. Hence, the Scientific Committee tasked WG-SAM with addressing the issues of design, implementation and analysis of tag-recapture research programs as a focus topic for its 2012 meeting.

2.2   WG-SAM-12/26 highlighted that CCAMLR tagging programs have many unique characteristics in comparison to other programs conducted in fisheries around the world. For example, CCAMLR is unique in:

- using tagged fish released and recaptured from commercial vessels as an index of absolute abundance in stock assessments

- having supply of standardised tags and tagging equipment and data management centralised within the Secretariat

- routinely double-tagging all fish, thereby allowing estimates of tag shedding and increasing the probability that tagged fish are detected when recaptured

- requiring tagging as a routine feature of data collection plans in research and exploratory fisheries

- having observer coverage on all fishing vessels.

The paper also made several recommendations for improving the performance of CCAMLR tagging programs.

2.3   The Working Group endorsed the following recommendations for improving the performance of CCAMLR tagging programs:

(i)   developing methods to minimise errors during data recording and data entry, e.g. the use of data checking algorithms and conditional formatting in the e-forms and cameras or voice recorders at sea

(ii)   reporting program-level diagnostics, such as the proportion of unmatched tags, and the number of missing data values for tagged fish

(iii)   conducting simulations to evaluate sensitivity to incomplete overlap in spatial distribution of tagged fish and recovery effort, and vessel-specific tag loss or post-tagging survival, and tag-detection rates

2.4   WG-SAM-12/23 described the different processes that may occur in a tag-recapture program (i) during the initial capture, tagging and release, (ii) when the fish is at liberty, and (iii) when a tagged fish is recaptured, that may affect the accuracy of an abundance estimator such as using the Lincoln-Petersen equation. It reviewed the existing measures that have been employed in CCAMLR tagging programs to mitigate bias (i.e. practical measures employed at sea to avoid bias) and remediate bias (i.e. modelling approaches to adjust for bias), and the priority issues that still remain to be addressed in CCAMLR tag-recapture experiments.

2.5   The Working Group noted that tag detection and scanning rates are likely to be high, due to the fact that every toothfish on all fishing vessels is handled several times between being brought on board, processed and frozen. However, the Working Group agreed that scanning and detection is unlikely to be 100% for all vessels or fisheries.

2.6   The Working Group noted that the tables in WG-SAM-12/23 provided a useful summary of factors to be considered in assessing the priority of issues that remain to be resolved when implementing tagging programs and producing abundance estimates from tag recaptures (Tables 1 to 4).

2.7   The Working Group agreed that several issues remain of high priority to be addressed in the use of tag-based abundance estimates. It therefore encouraged Members to conduct research on:

(i)   the development of spatially explicit models that account for the distribution of tag releases, recapture effort and toothfish movement while at liberty

(ii)   estimation of potential effects of decreased post-release survival of tagged fish in areas where depredation occurs (e.g. Division 58.4.4)

(iii)   estimation of fishery- and vessel-specific tag-shedding rates, including the effect of fish size

(iv)   estimation of fishery- and vessel-specific scanning and tag-detection rates

(v)   estimation of fishery- and vessel-specific post-release survival rates.

Design of programs

2.8   WG-SAM-12/25 proposed tagging fish at a constant number per number of fish caught as an alternative to the current requirement of tagging toothfish at a constant number of fish per tonne because of concerns that this may cause a disproportionate tagging rate in areas where catches are dominated by small fish or large fish.

2.9   In practice, when selecting fish for tagging, many vessels already use a 'tag every nth fish' approach and adjust n based on the size of fish being landed; this appears to be effective

in achieving both the required tagging rate and tag overlap. However, the Working Group suggested that Members developing research proposals consider the approach described in WG-SAM-12/25, particularly in areas where very small or very large fish dominate the catch where there is a risk that a tagging rate per tonne may not be optimal.

Implementation of programs

2.10   WG-SAM-12/31 reviewed current information provided by CCAMLR to participants in fisheries that include tagging programs for skates and toothfish. It included recommendations for improved tagging protocols and the development of training packages for distribution to observers and vessel crew to improve tagging operations at sea. An outline of a proposed training module for toothfish tagging, and videos of crew tagging on board a New Zealand vessel in the Ross Sea, were also presented.

2.11   The Working Group agreed that the skate and toothfish tagging information currently included in the *Scientific Observers Manual*, observer logbooks and C2 forms be reviewed and repackaged to more effectively target their intended audience, and be made available via the CCAMLR website and Secretariat.

2.12   The Working Group noted that CM 41-01 clearly specifies that the responsibility for undertaking tagging, tag recovery and correct reporting lies with the vessel and that the fishing vessel shall cooperate with the CCAMLR scientific observer in undertaking the tagging program.

2.13   The Working Group recalled the advice of the Scientific Committee that the lack of assessment in the data-poor fisheries in Subareas 48.6 and 58.4 may be a consequence of research implementation, rather than research design (SC-CAMLR-XXX, paragraph 3.123). The Working Group agreed that the information and training provided to participants in tagging programs is likely to influence their performance. Therefore, it recommended development of a tagging training package, including:

(i)   a description of the roles and responsibilities of designating and receiving Members, vessel crew, technical coordinators, and CCAMLR and national observers participating in tagging programs

(ii)   stepwise descriptions and diagrams of correct tagging procedures, including illustrations or photographs of tagging station layouts and tagging equipment

(iii)   instructions for identifying fish suitable for tagging, including videos and photos (see Table 5)

(iv)   a quick reference guide and checklist for use at the tagging stations on board vessels in a simple graphical format to minimise translation needs

(v)   videos and photographs of handling, measuring, tagging and releasing of toothfish on board fishing vessels

(vi)   description of the importance, and use by CCAMLR, of the results from toothfish and skate tagging programs.

2.14   The Working Group requested that those Members with experience in tagging programs work with the Secretariat to update current tagging protocols, collate material for the training package, and modify existing documentation as shown in Appendices 1 to 3 of WG-SAM-12/31, for consideration by WG-FSA-12. It also recommended that, when complete, the training package be translated into all languages used on board vessels operating in CCAMLR exploratory fisheries.

2.15   The Working Group agreed that the proposed criteria in WG-SAM-12/27 would be valuable for use in tagging programs in CCAMLR fisheries to identify fish that are suitable for tagging, and for collecting data in a standardised way on factors that influence suitability, such as the different gear types. The Working Group requested that Members provide diagrams or photographs to augment the table, and that the authors of WG-SAM-12/27 and the Secretariat provide a revised version of the table to WG-FSA for review with a view to using it in the coming fishing season.

2.16   The Working Group agreed that, in general, it was best to attempt to tag and return fish to the water immediately. However, the Working Group agreed that in areas where depredation of released fish was likely, or where toothfish are caught in batches by trawl, use of a holding tank with flow-through seawater was recommended. It also encouraged the use of holding tanks for experiments to determine the effects of handling and tagging post-release survival, similar to those conducted in Subarea 48.3 in the past (Agnew et al., 2006).

2.17   It was noted that, when tagging small toothfish caught in research trawls in Subarea 48.3, an enclosed chute was developed to release fish below the surface of the water to ensure fish escape seabird depredation.

2.18   The Working Group also noted that difference in ambient light levels at fishing depths and at the surface mean that toothfish captured during the day were vulnerable to eye damage, and recommended that minimising exposure of the fish to full sunlight during the tagging process would be desirable.

Analysis of results

2.19   Several papers discussed different aspects of data quality control and data analysis from tagging programs.

2.20   WG-SAM-12/32 detailed the development of a domestic Argentinian toothfish tagging program designed to collect information on growth and movement rates. Locations of recaptures are generally near the release location, however, several tagged fish have made large-scale movements and have been recaptured in the fisheries off Chile. Individuals who report tagged fish receive a wrist watch with the logo of the research program, proving an incentive to scan for tags. It was also noted that in areas where cachaloteras are used as mitigation against toothed whale depredation, fish are generally unsuitable for tagging due to abrasion injuries.

2.21   The Working Group thanked the authors for providing the paper, and encouraged other CCAMLR Members in the region to forward the details of any tags recaptured by their vessels to INIDEP.

2.22   The Working Group noted that reward schemes are part of the domestic toothfish tagging program in Argentina (WG-SAM-12/32) as well as the fishery in Subarea 48.3. However, estimates of the effect of introducing a reward system after a tagging program has been established are likely to be confounded with changes in abundance or many of the other processes noted in Tables 2 to 5. Furthermore, providing a reward for every tag, as tagging programs mature and tag-recapture numbers increase, may become prohibitively expensive. Therefore, the Working Group agreed that incentive systems to report tags may be difficult to implement generally across CCAMLR tagging programs.

2.23   WG-SAM-12/19 presented an analysis of Patagonian toothfish (*Dissostichus eleginoides*) movement rates in Subarea 48.3, and the Working Group encouraged further analyses of this kind as it has the potential to allow evaluation of potential biases in tag-based assessments, as well as inclusion of movement rates in spatial models. The Working Group noted that some of the directional aspects of movement detected in this study could be a function of the stratification used in the analysis and also encouraged an evaluation of the potential effects of season, and other factors such as length or maturity stage, on movement.

2.24   WG-SAM-12/22 provided an update on the tag-link status used to assess the level of confidence in the links made between tag releases and recaptures in the CCAMLR database. In response to the request from WG-FSA to develop threshold levels for use in assigning 'Status 2', where the tag numbers match but there are inconsistencies in the biological data (including length and weight), an analysis of within-year recaptures showed the variability of weight was much greater than for length for repeat measurements of individual fish.

2.25   The Working Group agreed that using weight change as a criteria may not be appropriate for link status characterisation and that the use of length should include both process and measurement error.

2.26   The Working Group recommended that, to reduce additional handling of fish, a weight measurement should no longer be a requirement when tagging fish.

2.27   WG-SAM-12/24 described a simulation study to evaluate the effects of the number of fish tagged, size of tagged fish, the duration of the tagging program and the type of auxiliary data available on bias and precision of an integrated assessment. The study used a modelling framework to simulate fish populations, fishing, data collection and stock assessments using CASAL.

2.28   The Working Group welcomed the development and application of this model framework, but noted the need for validation of the operating model used. It also recommended evaluating the effect of using different prior distributions for B_0 and year-class strength (uniform-log for B_0 and lognormal for year-class strength), since the use of uniform priors for these parameters in WG-SAM-12/24 could be the cause for some of the estimated biases observed in this study.

2.29   It was noted that the scenarios with a 60% tag size-overlap achieved assessments of similar bias and precision as those with a 100% tag size-overlap. The Working Group encouraged the investigation of the influence of the levels of tag size-overlap with the goal of determining the relationship between this parameter and bias and model performance.

2.30   WG-SAM-12/30 described a method to evaluate the relative tagging performance of a vessel or vessel trips with respect to the tag-detection rate of recaptured fish and the post-tagging survival of released fish. While controlling for the confounding effect of spatial and temporal variability of fishing effort associated with release and recapture events of tagged fish, the approach analysed tagging performance at the individual vessel level relative to all other fishing vessels in the fleet using a pair-wise case-control approach in which every haul by the 'case' vessel is paired with a corresponding control haul in the same time and location.

2.31   The Working Group noted that this method may be useful for evaluating tagging performance of vessels within CCAMLR tagging programs, and may provide an alternative means of selecting quality tagging data for inclusion in stock assessments. The Working Group encouraged further development of the method and sensitivity testing, including sensitivity analyses of the size of the reference area within which case hauls and control hauls are paired, and aggregating vessel data across different time periods to discern temporal trends. Using a simulated dataset would improve the understanding of the approach, e.g. in respect to the effects of rare events when scanning small numbers of fish. The Working Group also encouraged the authors to repeat the analysis at a wider geographical scale, including across other CCAMLR fishing areas.

EVALUATION OF RESEARCH PLANS FROM MEMBERS
NOTIFYING TO FISH IN EXPLORATORY FISHERIES

3.1   WG-SAM-12/06 summarised the 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. The Working Group recalled the changes in requirements of vessels conducting research fishing within these data-poor fisheries during 2011/12 with respect to fishing in designated fine-scale rectangles and corresponding research haul requirements.

3.2   With respect to the requirement to complete at least one research haul for every three commercial hauls after the first 10 research hauls, the Working Group noted that in all cases, except for one vessel, this requirement was met. However, on several occasions the requirement to conduct research hauls at a distance of ≥3 n miles apart was not met.

3.3   The Working Group agreed it would be useful to examine maps of these deployments that include depth, catches, mark-recapture information and a distance scale, and recommended that this information be made available for WG-FSA this year to make further progress on refining the 3 n mile requirement if the interim requirements of CM 41-01 are retained for 2012/13.

3.4   The Secretariat provided a demonstration of 3D mapping of fishing locations and bathymetry and advised that it could investigate a range of suitable mapping and visualisation tools to assist with the spatial analysis of effort distribution and present the results to WG-FSA. This offer was welcomed by the Working Group.

3.5   WG-SAM-12/07 described the two sets of requirements for reporting data from vessels undertaking research fishing: (i) that conducted under CM 24-01 (scientific research),

which requires data to be reported using data form C4; and (ii) that conducted under CM 41-01 (exploratory fisheries), which requires data to be reported using data form C2, as well as data collected by scientific observers using cruise reports and logbooks.

3.6 WG-SAM-12/07 proposed that fishing vessels undertaking research use form C2 throughout their research, with scientific observers continuing to use cruise reports and logbooks; any supplementary data requirements for research fishing would be reported on a separate form (i.e. form C4). The Working Group agreed that this proposal would simplify the process of data reporting from research fishing activities, and recommended that it be endorsed by the Scientific Committee. It was further agreed that reporting data from fishery-independent research trawl surveys under CM 24-01 would not be impacted by this change, but would continue to use the current survey data reporting system (i.e. form C4).

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

3.7 A requirement to submit research fishing plans in notifications for data-poor exploratory fisheries was adopted by the Commission at its 2011 meeting (CCAMLR-XXX, paragraph 12.9). WG-SAM was tasked to review these research plans to provide advice on whether they meet the requirements for CCAMLR-sponsored research as laid out in SC-CAMLR-XXX, Annex 5, paragraphs 2.25 and 2.26, and CM 21-02.

3.8 The Working Group reviewed research plans submitted by five Members wishing to conduct research fishing in data-poor exploratory *Dissostichus* spp. fisheries in Subareas 48.6 and 58.4:

- WG-SAM-12/09 by Japan for Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a

- WG-SAM-12/10 Rev. 1 by the Republic of Korea for Division 58.4.1

- WG-SAM-12/12 Rev. 1 by South Africa for Subarea 48.6 and Divisions 58.4.2 and 58.4.3a

- WG-SAM-12/13 by Spain for Divisions 58.4.1 and 58.4.2

- WG-SAM-12/14 by France for Division 58.4.3a.

3.9 In order to carry out an evaluation of the submitted research fishing plans against the criteria agreed by WG-SAM-11 (SC-CAMLR-XXX, Annex 5), the agreed format in CM 24-01, and noting the discussion of the Scientific Committee (SC-CAMLR-XXX, paragraphs 3.136 to 3.138, 9.5 and 9.6), the Working Group developed a preliminary evaluation table (Table 6) and evaluated each proposal following the criteria in that table.

3.10 The Working Group noted that the purpose of the preliminary evaluation was to provide feedback and advice on how plans could be modified and developed to ensure that they were best able to achieve CCAMLR's objectives (as outlined in SC-CAMLR-XXX, Annex 5, paragraph 2.25) and that modified plans would be resubmitted to WG-FSA for re-evaluation. During the course of the preliminary evaluation of research plans, the Working Group identified issues for which generic and specific advice could be provided.

3.11   The Working Group noted that no plan provided sufficient detail concerning how the proposed research would address CCAMLR's objectives (Table 6). The collection of data from a fishery survey was frequently cited as the main objective of the research with little consideration given to how the collection of such data would ultimately lead to the provision of a robust estimate of stock status (and precautionary catch limits) for *Dissostichus* spp. within a given area or time frame. The Working Group recommended that the ultimate objectives of any planned research should be stated explicitly within the research plan and consistent with the advice of SC-CAMLR-XXX, Annex 5, paragraphs 2.25 to 2.27.

3.12   The Working Group noted that the provision of detailed survey and data collection plans within the evaluated research plans (Table 6) was generally sufficiently detailed. However, the rationale for the collection of specific datasets was frequently not provided and the intended use of these data was unclear in many cases.

3.13   The Working Group assessed the consideration within research plans of the key requirements to achieve an estimate of stock status as outlined in Table 6 (3i to 3iii) namely:

(i)   an index of stock abundance
(ii)   a hypothesis of relationship of fish in the research area to the overall stock
(iii)   estimates of biological parameters relating to productivity (i.e. maturity, growth, recruitment and natural mortality).

3.14   The Working Group concluded that all research plans would benefit from the provision of a complete account of how an index of stock abundance would be derived. Whilst this was identified as an objective in many cases, the provision of more detail on the methods used, and an assessment of their appropriateness, is necessary to enable the evaluation of the likelihood the research plan could achieve CCAMLR objectives. For example, as most research involved tagging, plans should present comprehensive information on how abundance estimates from tagging will be derived, rather than use of CPUE data, in order to assist with the development of a more robust assessment.

3.15   Details of stock hypotheses were largely absent from the research plans. The Working Group recommended that more detail relating to the population structure and distribution for each 'stock' under consideration should be included. Information on the presence of different life-history stages in the research area, and their relationship with other populations of the target species, should also be added to research plans. If this information is unavailable, a review of the demographics of neighbouring populations could provide information that is indicative of the demographics of the stock, and a stock hypothesis could be developed from this.

3.16   The Working Group noted that research plans frequently state that a considerable amount of biological information would be collected. However, they rarely indicated how this information would be processed and analysed and how the information would ultimately contribute to a stock assessment, nor do they indicate how the existing data would be enhanced by further data collection.

3.17   The Working Group recommended that details are provided on the rationale underlying the collection of specific datasets. In addition, greater detail should be provided on how and when age determination to assess growth or age structure would be conducted. The

Working Group agreed that research fishing plans should be more explicit about the rationale behind the collection of additional biological data. Information on the purpose and use of datasets of sex, maturity and diet should be clear.

3.18   The Working Group noted that the degree of detail in the information on tagging performance (Table 6) varied considerably between research plans. Greater detail on how high tagging performance will be achieved with respect to the identified tagging metrics should be provided in all proposals.

3.19   The Working Group noted that some proposals provided no indication as to whether the research fishing was intended to be a multi-year effort. As most proposals were tag-recapture experiments intended to provide data for use in an assessment, it is important that research proponents commit to research fishing to be conducted over the course of several years to ensure the opportunity to recapture tags. The Working Group agreed that this information is required in the proposal for the evaluation process.

3.20   The Working Group recommended that WG-FSA follow the research fishing proposal evaluation process that was undertaken by the Working Group using the criteria laid out in Table 6 and CM 24-01, Format 2.

3.21   Noting that more than one Member had submitted research plans for some subareas and divisions, the Working Group discussed the potential for the coordination of research plans between Members to better achieve the objectives of research fishing. A coordination of research plans was likely to provide more extensive temporal and spatial coverage of research planned for data-poor exploratory fisheries in Subareas 48.6 and 58.4, and could prevent unnecessary duplication of research effort. It was also highlighted that the development of full stock assessments for a subarea or division was a major task that could be made easier by the coordination of research effort and assessment expertise and resources between Members.

3.22   Since it is now a requirement that research plans be submitted to the Secretariat by 1 June in advance of, and for consideration by, WG-SAM, there would be an opportunity for Members to discuss and coordinate research prior to the resubmission of the research plans to WG-FSA after preliminary evaluation at WG-SAM.

3.23   The Working Group recommended that an intersessional correspondence group be established to facilitate the coordination of research effort and plans between Members. Dr Belchier, in his capacity as Convener of WG-FSA, indicated that he would be willing to act in this role with the assistance of the Secretariat. The Secretariat recommended that, in line with other correspondence groups, a dedicated area of the website be established to facilitate the exchange of information between Members.

3.24   WG-SAM-12/09 provided a research fishing proposal for Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a. The Working Group noted a considerable amount of information was provided in this paper which provided a useful context to assist with the appraisal. In addition to the generic points advised in paragraphs 3.11 to 3.24, a number of other issues were raised by the Working Group:

    (i)   The Working Group discussed the impact of operational constraints, such as ice, which could prevent access to designated fine-scale rectangles. This issue was raised in WG-SAM-12/09 and a method described for spatial allocation of effort

for the 2012/13 research effort, should the designated fine-scale rectangles be inaccessible. A number of alternative methods to reallocate effort were discussed and it was agreed that there was still a requirement for the research fishery to be spatially constrained, and that the focus should be on areas where tags were already released. The Working Group recommended that this issue be further discussed at WG-FSA, recalling that fine-scale rectangles were an interim measure pending the development of satisfactory research plans in 2012/13.

(ii)   The Working Group recommended that where CPUE × seabed area comparisons are used to provide an initial estimate of plausible biomass within the proposed research area, care should be taken to ensure that the reference area from an assessed stock used in the comparison contains the same toothfish species as occur in the research area (SC-CAMLR-XXX, Annex 5, paragraph 2.40ii).

3.25   WG-SAM-12/10 Rev. 1 provided a research fishing proposal for Division 58.4.1. In addition to the generic comments in paragraphs 3.11 to 3.24, the Working Group also advised that only fish that had been hooked by a single hook (see Table 5) from the trotline gear should be selected for tag and release in order to maximise the potential for recapture.

3.26   WG-SAM-12/12 Rev. 1 provided research fishing proposals for Subarea 48.6 and Divisions 58.4.2 and 58.4.3a. The Working Group agreed that additional information on hook injuries sustained by fish and an assessment of fish 'vitality' presented at the Working Group was very useful and should be submitted to WG-FSA.

3.27   Mr Heinecken indicated that he had found the appraisal process to evaluate a research proposal against the metrics indicated in Table 6 to be extremely useful and that it would greatly assist with the development of research fishing plans that were better suited to meet CCAMLR's objectives.

3.28   WG-SAM-12/13 presented a research fishing proposal for Divisions 58.4.1 and 58.4.2. This proposal was intended primarily as a multi-year depletion experiment to be carried out sequentially in different SSRUs in subsequent years, and included three SSRUs in Division 58.4.1 that are currently closed to fishing. The Working Group noted that the proposed depletion experiment requires systematic fishing in small areas for a considerable period of time to estimate correlation between CPUE and catch to estimate abundance.

(i)   The Working Group recalled that there had been other depletion analysis studies for toothfish fisheries in the Convention Area undertaken in the past, but that these had failed to achieve their objective of leading to an assessment. However, it was also noted that the previous experiments used data from various fishing vessels engaged in commercial fishing operations, and not a controlled experiment (e.g. WG-FSA-94/24).

(ii)   The Working Group noted that it would be useful to combine the depletion experiment with tagging that would be undertaken during the research, as this would increase the power of the experiment to estimate local abundance. It also noted that revisiting the same location to recapture tags in the year(s) subsequent to the depletion experiment would be useful, as this would enable comparison of local abundance estimates generated by two different methods.

(iii) The Working Group agreed that there may be some fish that move into, or out of, the study area, and that this may affect the experiment. In addition, it requested that previous depletion experiments (both CCAMLR and international) be reviewed and that consideration of the power to detect a depletion which would result in an estimate of local biomass be presented to WG-FSA.

3.29 The proposal in WG-SAM-12/14 to conduct research fishing in Division 58.4.3a did not contain a detailed description of a research plan to indicate how the collected data would develop an estimate of abundance. There was no detailed survey design, no maps of the distribution of catch or tagging effort and, therefore, it was not possible for the Working Group to evaluate the potential for the research to lead to an estimate of abundance or to an assessment. The Working Group encouraged resubmission of a revised proposal to WG-FSA, taking into account Table 6 and the advice provided in paragraphs 3.11 to 3.24.

REVIEW OF SCIENTIFIC RESEARCH PROPOSALS FOR
OTHER AREAS (E.G. CLOSED AREAS, AREAS WITH
ZERO CATCH LIMITS, SUBAREAS 88.1 AND 88.2)

4.1 The Working Group reviewed reports from previous research fishing and considered scientific research proposals for new research fishing in closed areas, areas with zero catch limits and areas with stock assessments under CM 24-01. Proposals were evaluated for new or ongoing research fishing in Subareas 48.5 and 88.1 and Divisions 58.4.3b and 58.4.4. The Working Group also reviewed reports for research fishing already completed in Subareas 88.1, 88.2 and 88.3 and Divisions 58.4.3b and 58.4.4 in 2011/12.

4.2 The Working Group noted that, in general, the quality of new research fishing proposals submitted under CM 24-01 was improved from previous years, and thanked the proponents for their work. Evaluation of new proposals for research fishing in closed or zero-catch limit data-poor areas (i.e. WG-SAM-12/04, 12/11, 12/15 Rev. 1, 12/16 and 12/17), consistent with the advice of the focus topic on data-poor fisheries at WG-SAM-11 (SC-CAMLR-XXX, Annex 5), is summarised in Table 7. Evaluation of research proposals in areas with assessments (WG-SAM-12/28 and 12/29) proceeded separately.

Weddell Sea (Subarea 48.5)

4.3 The Working Group discussed WG-SAM-12/04 and 12/11, describing a proposal to conduct a five-year research fishing program to achieve an estimate of stock status for Antarctic toothfish (*D. mawsoni*) in Subarea 48.5. The Working Group agreed that the proposal was generally consistent with the advice of the focus topic on data-poor fisheries at WG-SAM-11 (Table 7). The Working Group noted that the success of a tag-based research program relies on the ability of the research vessel to revisit previously fished locations to recapture tags, and that it may not be possible to conduct multi-year research in the proposed locations due to difficult and variable ice conditions in the area, particularly in the western portion of Subarea 48.5. Working Group participants reported that areas in the western Weddell Sea that appear ice-free in WG-SAM-12/04, Figures 2 and 4, are known to have been

inaccessible to an ice-breaking research vessel during the same month in 2012. The proposed set locations in the eastern portion of Subarea 48.5 are likely to be more accessible, but potentially still subject to difficult or variable ice conditions.

4.4   The Working Group recommended that the authors resubmit WG-SAM-12/04 to WG-FSA, and provide additional details of the planned analytical methods identified in the annual research program leading to an assessment of stock status, including 'areal methods' (in years 2 and 3) and CASAL models (in years 4 and 5) mentioned in the paper. The Working Group also requested additional details regarding planned analyses of data from biological sampling (e.g. otoliths and gonads) to inform estimation of biological parameters affecting stock productivity. Additional analyses of ice conditions, and operations potentially affecting research feasibility, would also be important for the evaluation of this proposal.

BANZARE Bank (Division 58.4.3b)

4.5   The Working Group discussed WG-SAM-12/15 Rev. 1, describing the results of research by Japan in Division 58.4.3b in 2012 and a proposal to continue that research in 2013. 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 noted that, despite several years of research fishing in this location, there was still insufficient information (tag returns) to enable progress towards an estimate of stock status. This may be due to the combined effects of inconsistent spatial research design, variable research seasonality and/or low catches resulting in lower than anticipated numbers of fish being scanned.

4.6   The Working Group recommended that the authors resubmit this paper to WG-FSA and include additional information about what analyses are planned to lead to an assessment of stock status and on what time frame these analyses will occur. The Working Group also recommended additional details be provided regarding planned analyses of biological sampling (e.g. otoliths and gonads) to inform estimation of biological parameters affecting stock productivity. To estimate the likely time required to collect this information, the Working Group recommended that in addition to the analysis of required tagging and catch rates to achieve a target CV, the proponents also estimate the number of tag recaptures that would be expected each year as a function of scanning rate (catch).

4.7   The Working Group recalled the advice of the Scientific Committee in 2011 (SC-CAMLR-XXX, paragraphs 9.33 to 9.36) that consideration of future research in this area should also be informed by a larger analysis and review of available information indicative of current and historical factors affecting stock status.

4.8   The Working Group noted that the authors of WG-SAM-12/15 Rev. 1 had incorrectly applied the precautionary exploitation rate of 0.01 (corresponding to an assumption of a stock depleted to 30% B_0, from the formula of WG-FSA-10/42 Rev. 1) with reference to the estimated $B_{current}$ rather than B_0. A correct application of the formula would yield a higher precautionary catch level; this should be recalculated and evaluated by WG-FSA.

4.9   Comparative analyses of different Spanish and trotline fishing gear configurations described in WG-SAM-12/15 Rev. 1 (and also WG-SAM-12/16, below) indicate that the

modified trotline configurations adopted in 2012 resulted in a higher proportion of captured fish suitable for tagging without an apparent reduction in CPUE per km of line. The Working Group recommended that these analyses be submitted for consideration by WG-FSA.

4.10   The Working Group considered proposed modifications to the assignment of longline set locations, to allow the research vessel flexibility to adjust precise set locations by up to 5 n miles in response to weather and sea conditions. The Working Group noted that adhering to a fixed spatial grid vs. allowing limited flexibility in set locations has implications for CPUE comparisons in particular locations between years, but the effect on tag-returns at this scale is unknown. The Working Group recommended that the implications of spatial research designs be carefully considered with respect to the actual purpose of the research and the way in which research results will be analysed (i.e. using CPUE vs. tag-based indices of abundance).

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

4.11   The Working Group discussed WG-SAM-12/16, describing the results of research by Japan in 2012 in Divisions 58.4.4a and 58.4.4b, and also WG-SAM-12/17, describing a proposal to continue that research in 2013. The Working Group noted that in SSRU C additional tag-recaptures were obtained in 2012, potentially providing information sufficient to lead to an estimate of current stock status, but that in SSRU B observed levels of killer whale depredation may have compromised the success of research in this area.

4.12   The Working Group discussed the potential influence of killer whale depredation on abundance estimates from a tagging program. It noted that killer whale depredation at the haul may result in fewer tag recaptures, and would need to be taken into account when estimating total removals, but is not expected to bias tag-based abundance estimates. In contrast, if killer whales are present when tagged fish are released, this would be expected to bias tag-based abundance estimates. Noting that the *Shinsei Maru No. 3* utilised a holding tank to retain tagged fish until hauling was completed and killer whales were no longer visible in the area, the Working Group requested that additional information be provided on the distances moved by the vessel before releasing tagged fish. The Working Group also requested higher-resolution data on what proportion of the research hauls were attended by killer whales, killer whale abundance, and the proportion of the hauls with evidence of depredation observed on the line.

4.13   The Working Group welcomed reports that more than 1 000 photographs had been taken of killer whales in SSRU B during 2012 and that these were being analysed by French researchers to compare with photos of individual whales depredating lines elsewhere in the Indian Ocean sector. The Working Group encouraged researchers to continue this work and submit it for consideration by WG-FSA and WG-EMM.

4.14   The Working Group considered an option presented by Dr Taki to discontinue research fishing in SSRU B due to potential difficulties arising from killer whale depredation, and to instead continue research in SSRU C and initiate research in SSRU D where killer whales have not in the past been seen in high numbers. The Working Group requested that this proposed change should be considered by WG-FSA in light of the information requested in paragraph 4.12.

4.15   The Working Group suggested that the authors provide revised papers to WG-FSA, including additional information about what analyses are planned, and on what time frame, to lead to a stock assessment, noting that tag recaptures to date within SSRU C may be sufficient to inform a preliminary estimate of stock status. The Working Group also requested additional details regarding planned analyses of biological samples (e.g. otoliths and gonads) to inform estimation of biological parameters affecting stock productivity, noting the advice of SC-CAMLR-XXX, Annex 5, paragraphs 2.27 to 2.29.

Subarea 88.3

4.16   The Working Group considered WG-SAM-12/05, describing the results of two years of research fishing by Russia in Subarea 88.3, noting that there is no proposal to continue this research in 2012/13. The Working Group noted that there were no tag returns from this research, most likely due to low catches and inconsistent spatial overlap arising from difficult ice conditions, but that other biological and demographic information collected in the course of this research would contribute substantially to our knowledge of this poorly studied area. The Working Group thanked the authors of this paper for providing this report, and recommended that this paper be resubmitted to WG-FSA.

Subarea 88.2

4.17   The Working Group considered WG-SAM-12/08, describing the results of two years of research fishing by Russia in SSRU 882A, noting that there is no proposal to continue this research in 2012/13. The Working Group noted that there were no tag returns from this research, most likely due to low catches. The Working Group thanked the authors of this paper for providing a detailed and thorough report, and recommended that this paper be resubmitted to WG-FSA.

4.18   The Working Group noted that in WG-SAM-12/05 and 12/08, a much higher proportion of fish caught by the *Sparta* using trotlines were suitable for tagging, in comparison with fish caught using trotlines by the *Shinsei Maru No. 3* described in WG-SAM-12/15 Rev. 1 and 12/16. The authors of WG-SAM-12/08 noted that the trotline configuration used on board the *Sparta* has been described in the CCAMLR Gear Library (WG-FSA-06/05) but that, due to changing use of terminology, this configuration originally referred to as a 'deep-water Spanish longline' would now be more accurately classified as a type of trotline. The Working Group requested that Russian scientists provide an updated gear description paper for deposition in the CCAMLR Gear Library that clearly describes this particular trotline configuration (i.e. specifying bundle placement, bundle spacing, hook numbers per bundle, snood lengths etc.) to enable determination of the various factors affecting availability of fish suitable for tagging by different gear types.

Subarea 88.1

4.19   The Working Group considered WG-SAM-12/28 and 12/29, describing the results of the first year of a CCAMLR-sponsored survey to monitor the abundance of pre-recruit

Antarctic toothfish in the southern Ross Sea in 2012, and a proposal to continue the survey in 2013. The 2012 survey successfully demonstrated the feasibility of using a standardised longline survey to monitor trends in abundance of the target size range of Antarctic toothfish (<100 cm). The survey achieved a target CV of less than 10% for the main survey strata, and successfully defined depth ranges within which fish of the target size classes were concentrated, to better define target strata in subsequent years.

4.20   Dr Hanchet noted that the time series arising from this survey could be used to inform the existing stock assessment for the Ross Sea toothfish fishery, including providing an index of recruitment variability, indications of recruitment autocorrelation, and information on life-cycle movements, including to parameterise spatially explicit stock models.

4.21   The Working Group noted additional analyses comparing catch rates during the 2012 season with commercial catch rates recorded by the same vessel using the same fishing gear configuration in 1999 and 2001. Standardised CPUE analysis revealed no change in catch rates in this period, in contrast to reported declining catch rates by researchers in McMurdo Sound using handlines to capture Antarctic toothfish over the same period.

4.22   The Working Group supported the proposed design of the repeat survey in 2013, including the assignment of approximately 15 sets outside the core strata to explore, and potentially define, new strata in the Glomar–Challenger trough, which includes areas characterised by high catch rates of pre-recruit toothfish and which may constitute a biologically important migration corridor between pre-recruit settlement areas in the southern Ross Sea and adult feeding areas on the Ross Sea slope in SSRU K.

4.23   The Working Group recommended that the authors submit a revised proposal to WG-FSA, including additional analyses of the extent to which commercial fishing occurred inside the survey strata prior to the completion of the survey in 2012, and length-frequency distributions of fish caught by those vessels. The Working Group discussed the appropriateness of the term 'pre-recruits' to refer to the size range of fish captured to date by the survey noting that this size range overlaps with that of fish captured by the fishery. It was suggested that perhaps 'subadult' would be a more appropriate term.

METHODS FOR ASSESSING FINFISH STOCKS
IN ESTABLISHED FISHERIES

5.1   WG-SAM-12/18 presented a 'break and burn' method for ageing Antarctic toothfish otoliths collected by Russian vessels in the Ross Sea. The Working Group noted that a large number of otoliths (more than 6 000) were aged in the study and that the data has the potential to be included in a stock assessment model.

5.2   The Working Group recalled the discussion about ageing toothfish otoliths (SC-CAMLR-XXX, Annex 7, paragraphs 6.81 and 6.82) and the intention to set aside an afternoon during the next WG-FSA meeting to facilitate otolith reading work of *D. mawsoni*. The Working Group recommended that the focus of this meeting be on the ageing of both *Dissostichus* species, since the conclusions are expected to be applicable more widely across species. The Working Group encouraged all Members with an interest in ageing *Dissostichus*

to be involved in this meeting to facilitate otolith reading work, multiple readings of otoliths for estimating ageing error by individual readers, an otoliths exchange (prepared otoliths and images) and comparisons of different ageing techniques.

5.3 The Working Group welcomed the first comprehensive characterisation of the toothfish fishery in Subarea 48.6 that was presented in WG-SAM-12/33. This report summarised catch, effort, timing, depth, location, size structure and maturity of toothfish and by-catch from the fishery. The main topics discussed by the Working Group included the catch per unit of effort as abundance index and differences in fishing location between toothfish species and the associated by-catch. The Working Group noted that the analysis would benefit from a separate analysis of catch and effort information by gear type reflecting, for example, the shift from Spanish longline to trotline over time, and a standardisation of catch rate data.

5.4 The Working Group recommended that WG-SAM-12/18 and 12/33 be resubmitted to WG-FSA.

5.5 WG-SAM-12/20 presented a biomass estimation of *D. mawsoni* in Subarea 88.3 based on a spline approximation of catch-per-unit effort data and an assumed 3 n mile attraction distance. The Working Group noted that the estimation of biomass density extended spatially up to 150 n miles beyond the range of locations sampled, and recalled its concern that spatial predictions may be difficult if the fished areas are not well spread across the range of environmental variation in the multivariate space (SC-CAMLR-XXX, Annex 7, paragraphs 4.39 to 4.42). The Working Group considered that the analysis would benefit from a grid design to estimate fish density across the bathymetric range, although it recognised that fishing may be restricted in some locations due to heavy ice conditions.

5.6 The Working Group noted that the spline analysis presented in WG-SAM-12/20 was conducted with the program 'Chartmaster' which has not been considered previously by WG-SAM and recalled the advice of WG-FSA on evaluating new methods (SC-CAMLR-XXVI, Annex 5, paragraph 4.27) and 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. The Working Group recommended that the authors provide such an evaluation to future meetings of WG-SAM.

OTHER BUSINESS

Focus of future meetings

6.1 The Working Group noted the increased level of participation at its 2012 meeting, with a number of first-time participants and 33 papers submitted for consideration. This increased level of participation in the work of WG-SAM was encouraging, and had contributed to a very full agenda requiring a full five-day meeting.

6.2 The Working Group recognised that the evaluation of research plans in exploratory fisheries and research proposals in other data-poor areas that are designed to lead to an assessment would likely be standing agenda items at meetings for the next few years, while the continued use of focus topics would provide opportunities to address other priorities as determined by the Scientific Committee.

6.3   The Working Group requested that the Scientific Committee consider the following items as possible future focus topics:

- Improvement of research proposals – to review progress in developing research plans in exploratory fisheries and evaluate the application of recommendations and advice provided by working groups and the Scientific Committee.

- Multinational collaboration and research plans – to facilitate the development of collaborative research protocols in data-poor exploratory fisheries.

- Development of spatial population models – to develop spatially explicit modelling approaches, including in exploratory fisheries and krill fisheries.

Preview of the new CCAMLR website

6.4   The pre-release version of the new CCAMLR website was made available to participants for evaluation and feedback. The new website features:

- modern design with expandable menus, quick links and related pages
- fully indexed search engine consistent with access security rules
- comprehensive document archive
- delegated access control using individual email addresses
- online meeting registration
- internal framework and work flow for authoring, review and translation.

The Working Group looked forward to the launch and continued development of the new website.

ADVICE TO THE SCIENTIFIC COMMITTEE

7.1   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.

7.2   WG-SAM provided advice to the Scientific Committee and WG-FSA on the following items:

(i)   Review of the CCAMLR tagging protocol –

(a)   error trapping, sensitivity analyses and simulations (paragraphs 2.3 and 2.31)

(b)   tag-based abundance estimates (paragraph 2.7)

(c)   tagging information kit (paragraph 2.11)

(d)   training package (paragraphs 2.13 to 2.15)

(e)   experiments on the effect of handling and tagging on viability (paragraph 2.16)

(f)   minimising exposure of fish to full sunlight during tagging (paragraph 2.18)

(g)   tag-release programs in other regions (paragraphs 2.21 and 2.22).

(h)   removing the requirement to weigh fish during tagging (paragraph 2.26).

(ii)   Research plans for exploratory fisheries in Subareas 48.6 and 58.4 in 2012/13 –

(a)   maps of research haul deployments (paragraph 3.3)
(b)   data reporting requirements during research fishing (paragraph 3.6)
(c)   evaluation of revised and future research plans (paragraph 3.20)
(d)   correspondence group to facilitate coordination of research effort (paragraph 3.23).

(iii) Future meetings of WG-SAM –

(a)   focus topics (paragraph 6.3).

(iv)   Other advice –

(a)   ageing workshop at the 2012 meeting of WG-FSA (paragraph 5.2)
(b)   papers referred to WG-FSA for further consideration (paragraph 5.4)
(c)   evaluation of 'Chartmaster' (paragraph 5.6).

7.3   In addition, the Working Group provided specific advice to Members engaged in research fishing in closed areas and Subareas 88.1 and 88.2:

(i)   proposed research in Subarea 48.5 (paragraph 4.4)
(ii)   research in Division 58.4.3b (paragraphs 4.6 and 4.10)
(iii) research in Divisions 58.4.4a and 58.4.4b (paragraph 4.15)
(iv)   research in Subarea 88.1 (paragraph 4.23)
(v)   research in Subarea 88.2 (paragraph 4.18)
(vi)   research in Subarea 88.3 (paragraph 4.16).

ADOPTION OF THE REPORT AND CLOSE OF THE MEETING

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

8.2   In closing the meeting, Dr Hanchet thanked the participants for their contributions to the meeting and their work during the intersessional period, the rapporteurs for preparing the report, and the Secretariat for its support. Dr Hanchet also thanked the Centro Oceanográfico de Canarias for hosting the meeting, and Mr López Abellán and colleagues for their kind hospitality and assistance during the meeting.

8.3   The Working Group also thanked Dr R. Wiff (Chile) for his contribution to the meeting. Dr Wiff was the first recipient of a CCAMLR Scholarship, and his work on characterising the exploratory fishery in Subarea 48.6 (WG-SAM-12/23) was an important step towards developing assessments for exploratory fisheries in Subareas 48.6 and 58.4.

8.4   Dr Reid, on behalf of the Working Group, thanked Dr Hanchet for facilitating discussions in a convivial atmosphere which had resulted in a successful meeting.

REFERENCES

Agnew, D.J., J.M. Clark, P.A. McCarthy, M. Unwin, M. Ward, L. Jones, G. Breedt, S.D. Plessis, J.V. Heerdo and G. Moreno. 2006. A study of Patagonian toothfish (*Dissostichus eleginoides*) post-tagging survivorship in Subarea 48.3. *CCAMLR Science*, 13: 279–289.

Table 1: Schema for assessing the priority for addressing potential sources of bias in tag-recapture programs based on their likelihood of occurrence and impact on $\hat{N}$ derived from the Lincoln-Petersen equation.

Likelihood	Impact on $\hat{N}$	
	$\hat{N} > N$	$\hat{N} < N$
Low	Medium priority	Low priority
High	High priority	Medium priority

Table 2: Impact of processes that may occur during the initial capture, tagging and release of fish on a Lincoln-Petersen estimate (LPE) of abundance, assessment of the likelihood of a process occurring, the relative priority of remediating the issue (see Table 1), and a brief description of any existing mitigation or remediation in CCAMLR toothfish fisheries. N – the total population vulnerable to capture; $\hat{N}$ – the estimate of N using the LPE; M – the total number of tagged animals released that are available for recapture; $\hat{M}$ – the estimate of M used for an LPE.

Process	Impact on LPE parameters	Impact on $\hat{N}$	Likelihood	Priority	Mitigation	Remediation	Report text and recommendations
Transcription errors	$\hat{R} < R$	$\hat{N} > N$	Low	Medium	Data-checking/tag-matching methods at sea	Photo-matching recaptures	2.3(i, ii, iv), 2.10 to 2.14
Duplicate tag numbers released	$\hat{R} < R$	$\hat{N} > N$	Low	Medium	Use standard tags from a single source		
Selection of fish that are not representative of the catch	$\hat{M} > M$	$\hat{N} > N$	Low	Medium	Tag fish that are representative of the catch	Estimate area-/size-specific $\hat{M}$	2.3(iv), 2.10 to 2.14
Release rate of tagged fish higher in areas of low density relative to the overall population	$\hat{M} > M$	$\hat{N} > N$	High	High	Tag fish in proportion to the catch, spread tags across the experimental area	Use spatially explicit model	2.3(iii), 2.7(i)
Release rate of tagged fish higher in areas of high density relative to the overall population	$\hat{M} < M$	$\hat{N} < N$	High	Medium	Release fish at a constant proportion to the catch, spread tags across the experimental area	Use spatially explicit model	2.3(iii), 2.7(i)

Table 3: Impact of processes that may occur during the period a tagged fish is at liberty on a Lincoln-Petersen estimate (LPE) of abundance, assessment of the likelihood of a process occurring, the relative priority of remediating the issue (see Table 1), and a brief description of any existing mitigation or remediation in CCAMLR toothfish fisheries. N – the total population vulnerable to capture; $\hat{N}$ – the estimate of N using the LPE; M – the total number of tagged animals released that are available for recapture; R – the number of tagged fish recaptured; $\hat{M}$ and $\hat{R}$ – the estimate of M and R used for an LPE; PIT – passive integrated transponder.

Process	Impact on LPE parameters	Impact on $\hat{N}$	Likelihood	Priority	Mitigation	Remediation	Report text and recommendations
Tagged fish have a lower survivorship than the overall population due to release condition	$\hat{M} > M$	$\hat{N} > N$	High	High	Select fish suitable for tagging	Adjust $\hat{M}$ based on estimated post-capture mortality	2.3(iii), 2.10 to 2.14, 2.15 to 2.18
Fish are depredated post-release	$\hat{M} > M$	$\hat{N} > N$	High[a]	High[a]	Avoid areas with high depredation	Adjust $\hat{M}$ based on estimated depredation rate	2.6(ii), 2.15
Tag shedding	$\hat{M} > M$	$\hat{N} > N$	High[b]	High[b]	Double tagging, PIT tagging	Adjust $\hat{M}$ based on estimated tag-shedding rate	2.6(iii)
Tagged fish grow out of the size range selected by the fishery	$\hat{M} > M$	$\hat{N} > N$	Low	Medium		Estimate size-specific $\hat{M}$, include growth of tagged fish in model	
Tagged fish conduct large-scale movements out of the area of recapture effort	$\hat{M} > M$	$\hat{N} > N$	Low	Medium		Adjust $\hat{M}$ to account for movement out of the area of recapture effort, include fish movement in spatially explicit models	2.3(iii), 2.6(i)
Tagged fish do not have sufficient time to mix through the total population in the time between release and recapture	$\hat{R} > R$	$\hat{N} < N$	High	Medium	Spread tags across the experimental area	Adjust $\hat{R}$ to exclude recaptures with short times at liberty, include fish movement in spatially explicit models	2.3(iii), 2.6(i)

[a] Depredation of longline-caught fish has been reported in Subareas 48.3, 58.6 and 58.7 and Divisions 58.5.1 and 58.4.4.

[b] Some tag shedding is likely in all programs and may differ for larger fish where anchoring the standard size of CCAMLR tags between pterygiophores may be more difficult than for smaller fish, or where cacheloteras (used to minimise depredation) may cause tag shedding.

Table 4:   Impact of processes that may occur during recapture on a Lincoln-Petersen estimate (LPE) of abundance, including assessment of the likelihood of a process occurring, the relative priority of remediating the issue (see Table 1), and a brief description of any existing mitigation or remediation. N – the total population vulnerable to capture; $\hat{N}$ – the estimate of N using the LPE; M – the total number of tagged animals released that are available for recapture; R – the number of tagged fish recaptured; C – total number of fish caught and scanned for tags; $\hat{M}$, $\hat{R}$ and $\hat{C}$ – the estimate of M, R and C used for an LPE; PIT – passive integrated transponder.

Process	Impact on LPE parameters	Impact on $\hat{N}$	Likelihood	Priority	Mitigation	Remediation	Report text and recommendations
Not all tagged fish are detected	$\hat{R} < R$	$\hat{N} > N$	High	High	Make crew aware of need to check all fish, provide incentives to report tags, use automatic PIT tag detectors	Adjust $\hat{R}$ to account for undetected tags	2.10 to 2.14
Not all fish are scanned	$\hat{C} > C$	$\hat{N} > N$	High	High	Make crew aware of need to check all fish, use automatic PIT tag detectors	Adjust $\hat{C}$ to account for unscanned fish	2.10 to 2.14
Tagged fish are poorly selected by recapture effort	$\hat{R} < R$	$\hat{N} > N$	Low	Medium	Overlap recapture effort with areas where tagged animals have been released, use same gear for recaptures as for releases	Include estimates of area-/size-specific $\hat{R}$, growth and movement in models	2.3(iii), 2.6(i)

Table 5:   Recommended categories and criteria for assessing the suitability of toothfish prior to tagging. Supporting text and diagrams will be provided to assist in clarifying the specific criteria.

Assessment category	Suitable for tagging	Do not tag
Hook injuries	One or more in mouth area only*	Hook injury anywhere else in the body
Gills	Gills bright blood red	Gills pink or white
Bleeding	No visible bleeding from gill arches None or only minor bleeding from hook injury elsewhere (e.g. broken fin rays)	Any visible bleeding from gill arches, or excessive bleeding elsewhere
Trunk	No visible damage to the fish trunk that penetrates skin exposing flesh	Visible damage to fish trunk with open wounds
Skin	No visible damage penetrating skin, eye, body cavity. No visible inner organs	Visible damage penetrating skin, eye or body cavity, including by crustaceans (amphipods/lice)
Skin	No significant abrasion or recent scale loss that is equal to, or exceeding, the area equivalent to the fish tail	Abrasions or recent scale loss equal to, or exceeding, the area equivalent to the fish tail
Movement	Active movement (e.g. body flexing, fin waving, gill cover clamping)	No movement detected

*   Mouth area is defined as inside lips, jaw, or cheek, but not the back of the mouth.

Table 6:   Preliminary evaluation template for research plans in data-poor fisheries. Evaluation criteria are as agreed by the focus topic on data-poor fisheries as defined at WG-SAM-11 (SC-CAMLR-XXX, Annex 5, paragraph references are included in the criteria) and as set out in CM 24-01, Format 2.

CM 24-01, Format 2, Evaluation criteria	WG-SAM-12/___ Preliminary evaluation
1. Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	
2. Is there a detailed survey/data collection plan? (paragraph 2.25)	
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	
(ii) stock hypothesis/population structure	
(iii) biological parameters.	
4. Will the research achieve high performance with respect to tagging performance metrics? (paragraph 2.38)	
(i) tag overlap	
(ii) spatial overlap	
(iii) temporal overlap	
(iv) fish suitable for tagging	
(v) depredation.	
5. Is the initial design for a data-poor area complete? (paragraph 2.40)	
(i) appropriate spatially restricted area	
(ii) preliminary plausible estimate of B	
(iii) total catch and tag rates to achieve a target CV	
(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	
6. Is there a detailed description of proposed data analysis to achieve objectives of 1?	
7. Is there future planned research leading to an assessment along with a corresponding time frame?	

Table 7:	Preliminary evaluation of a research proposal. Evaluation criteria are as agreed by the focus topic on data-poor fisheries at WG-SAM-11 (paragraph references refer to corresponding paragraphs of SC-CAMLR-XXX, Annex 5). Where individual evaluation criteria are labelled 'N' the information is not provided in the research proposal; proponents are requested to provide it in their updated proposals to WG-FSA. Where criteria are labelled * information is provided but proponents are requested to provide more detailed descriptions or further information as described in the text.

CM 24-01, Format 2. Evaluation criteria	WG-SAM-12/04 and 12/11	WG-SAM-12/15	WG-SAM-12/16 and 12/17
1. Is there a detailed description of how the proposed research will meet its objectives, including annual research goals (where applicable)? (paragraph 2.25)	*	N	N
2. Is there a detailed survey/data collection plan? (paragraph 2.25)	Y	Y	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	Y	Y
(ii) stock hypothesis/population structure	N	N	N
(iii) biological parameters.	*	*	*
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	*
(iii) temporal overlap	Y	Y	Y
(iv) fish suitability for tagging	Y	Y	Y
(v) depredation.	Y (n/a)	Y (n/a)	*
5. Is the initial design for a data-poor area complete? (paragraph 2.40)			
(i) appropriate spatially restricted area	*	Y	Y
(ii) preliminary plausible estimate of B	(n/a)	Y	Y
(iii) total catch and tag rates to achieve a target CV	(n/a)	Y	Y
(iv) evaluate effects on stock, identify appropriate precautionary catch limits.	Y	Y	Y
6. Is there a detailed description of proposed data analysis to achieve objectives of 1?	*	N	N
7. Is there future planned research leading to an assessment along with a corresponding time frame?	*	N	N

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AGENDA

Working Group on Statistics, Assessments and Modelling
(Santa Cruz de Tenerife, Spain, 25 to 29 June 2012)

1.   Introduction

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

2.   Focus topic: review of the CCAMLR tagging program

      2.1   Design of program
      2.2   Implementation of program
      2.3   Analysis of results

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.   Methods for assessing finfish stocks in established fisheries, notably *Dissostichus* spp.

6.   Other business

7.   Advice to the Scientific Committee

      7.1   WG-FSA
      7.2   General

8.   Adoption of report and close of meeting.

LIST OF DOCUMENTS

Working Group on Statistics, Assessments and Modelling
(Santa Cruz de Tenerife, Spain, 25 to 29 June 2012)

WG-SAM-12/01	Draft Preliminary Agenda for the 2012 Meeting of the Working Group on Statistics, Assessments and Modelling (WG-SAM)
WG-SAM-12/02	List of participants
WG-SAM-12/03	List of documents
WG-SAM-12/04	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-SAM-12/05	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, I.I. Gordeev, E.F. Kulish (Russia)
WG-SAM-12/06	Deployment of research hauls in the exploratory fisheries for *Dissostichus* spp. in Subareas 48.6 and 58.4 in 2011/12 Secretariat
WG-SAM-12/07	Data requirements for research fishing Secretariat
WG-SAM-12/08	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)
WG-SAM-12/09	Research plan for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 in Subarea 48.6 and Divisions 58.4.1, 58.4.2 and 58.4.3a Submitted on behalf of Japan
WG-SAM-12/10 Rev. 1	Research plan for the exploratory longline fishery for *Dissostichus* spp. in 2012/13 in Division 58.4.1 Submitted on behalf of the Republic of Korea
WG-SAM-12/11	Notification for multi-year research in Subarea 48.5 Submitted on behalf of Russia

WG-SAM-12/12 Rev. 1   Research plan for the exploratory longline fishery for
Dissostichus spp. in 2012/13 in Subarea 48.6 and Divisions 58.4.2
and 58.4.3a
Submitted on behalf of South Africa

WG-SAM-12/13   Research plan for the exploratory longline fishery for
Dissostichus spp. in 2012/13 in Divisions 58.4.1 and 58.4.2
Submitted on behalf of Spain

WG-SAM-12/14   Research plan for the exploratory longline fishery for
Dissostichus spp. in 2012/13 in Division 58.4.3a
Submitted on behalf of France

WG-SAM-12/15 Rev. 1   Preliminary reports on abundance and biological information of
toothfish in Division 58.4.3b by *Shinsei Maru No. 3* in the
2011/12 and proposal of the consecutive survey in the 2012/13
K. Taki, T. Iwami, M. Kiyota and T. Ichii (Japan)

WG-SAM-12/16   Reports on abundance and biological information on toothfish in
Divisions 58.4.4a and 58.4.4b by *Shinsei Maru No. 3* in 2011/12
season
K. Taki, T. Iwami, M. Kiyota and T. Ichii (Japan)

WG-SAM-12/17   Research plan for toothfish in Divisions 58.4.4a and 58.4.4b by
Shinsei Maru No. 3 in 2012/13
Delegation of Japan

WG-SAM-12/18   Method of age determination for Antarctic toothfish (*Dissostichus
mawsoni*)
E.N. Kyznetsova, A.F. Petrov and V.A. Bizikov (Russia)
(*CCAMLR Science*, submitted)

WG-SAM-12/19   Movement of Patagonian toothfish (*Dissostichus eleginoides*) in
Subarea 48.3
T. Peatman, S.M. Martin, J. Pearce and R.E. Mitchell (United
Kingdom)

WG-SAM-12/20   Estimation of toothfish distribution and population size in
Subarea 88.3 by results of research longline fishing in 2011–2012
V.A. Tatarnikov, I.G. Istomin and V.V. Akishin (Russia)

WG-SAM-12/21   Finfish research proposals for Subarea 48.6 and Divisions 58.5.2;
58.4.3a by *Koryo Maru 11* for 2012/13
R. Ball (South Africa)

WG-SAM-12/22   CCAMLR tagging program: tag link status update
Secretariat

WG-SAM-12/23	Measures to avoid bias in abundance estimates of *Dissostichus* spp. based on tag-recapture data D.C. Welsford and P.E. Ziegler (Australia) (*CCAMLR Science*, submitted)
WG-SAM-12/24	Influence of tag numbers, size of tagged fish, duration of the tagging program, and auxiliary data on bias and precision of an integrated stock assessment P.E. Ziegler (Australia)
WG-SAM-12/25	Are tagging targets set in appropriate terms? R.W. Leslie and C. Heinecken (South Africa)
WG-SAM-12/26	Drawing on international experience to improve performance of CCAMLR tagging programs S. Parker and S. Mormede (New Zealand)
WG-SAM-12/27	Viability criteria for tagging toothfish S. Parker (New Zealand)
WG-SAM-12/28	Proposal to continue the time series of research surveys to monitor abundance of pre-recruit Antarctic toothfish in the southern Ross Sea in 2013 S.M. Hanchet, S. Mormede, S.J. Parker and A. Dunn (New Zealand)
WG-SAM-12/29	Results of a research survey to monitor abundance of pre-recruit Antarctic toothfish in the southern Ross Sea, February 2012 S.M. Hanchet, S. Mormede, A. Dunn (New Zealand) and H.-S. Jo (Republic of Korea)
WG-SAM-12/30	The development of spatially and temporally controlled measures of survival and tag-detection for the CCAMLR tagging program S. Mormede and A. Dunn (New Zealand)
WG-SAM-12/31	Recommendations for CCAMLR tagging procedures S. Parker, J. Fenaughty (New Zealand), E. Appleyard (Secretariat) and C. Heinecken (South Africa)
WG-SAM-12/32	Preliminary results from the Argentine tagging program for the Patagonian toothfish in the south-western Atlantic P.A. Martínez, J.A. Waessle and O.C. Wöhler (Argentina)
WG-SAM-12/33	A characterisation of the toothfish fishery in Subarea 48.6 from 2003/04 to 2011/12 R. Wiff (Chile), M. Belchier (United Kingdom) and J. Arata (Chile)